Object Lessons 3 :
Plastics

Social History
Curators Group

Object Lessons 3: Plastics

Contents

Page

1. How to use this box

The purpose of this box is to help you identify and care for plastics commonly found in social history collections. It is aimed at people with little or no prior knowledge of plastics and their properties, or as a refresher course for those who want to brush up their understanding of collections' identification and care. It is intended as a starting point for further exploration. By the end of this pack you should be able to make an 'educated guess' to identify the major historic plastics found in typical museum objects; for many plastics it is hard to improve beyond this without destructive analysis or expert assistance. The most important skill for a curator is to be able to distinguish the four 'problem plastics': those which are most likely to degrade and cause problems for other objects in your collection. The pack accordingly concentrates on these 'problem plastics'.

Once you have finished with these resources, there are many areas you could follow up with further study: for example, the technicalities of plastics manufacture; histories of production and use in your region, or around particular fields of design.

The box is designed for use as part of a programme of self-directed learning. You can use it on your own, or in a small study group. You might also wish to take it into a store, as a point of comparison with other objects whilst undertaking documentation work.

The box can also be used to support a one-day training seminar, facilitated by a conservator, curator or other plastics expert. For guidance on how to organise such a seminar, please turn to Appendix 6.

Getting started

You will need a clear, clean tabletop to lay the objects out on. The box contains 23 objects made of different plastics. Not all the plastics are represented, and some plastics are represented more than once. Some of the objects are inside cases which are made of a different type of plastic. A few objects are a mix of more than one plastic.

The resources may be read in any order, either with or without the objects. However, it is intended that the two are used together. Throughout the written resources are clues to help you confirm your identification of the objects, or to show you particular examples to look at.

First unpack the objects and the set of identification labels. Examining the objects closely, take a first guess at the identification of each object, by placing a label card in front of each. Some of the objects tell you what they are made of through their marks or trade names, so these should be easier to separate out. You may also find you know more than you think.

Once you have made a preliminary identification, you can either work through this folder sequentially, considering your choices as you go, or you can pick one particular plastic to study at a time. Chapters 4 to 14 deal with the plastics found in the box, as well as a few others which are classified as 'problem plastics', in need of particular attention from curators. Other plastics are covered in less detail in Appendix 2.

A note on the use of gloves: Ordinarily, nitrile gloves must always be worn when handling plastics. Cotton gloves are not recommended as they may leave specks of lint on plastics that have become tacky. However, SHCG is happy for the items in this box to be handled without gloves. You may prefer to wear gloves if you do not wish to get dirty. Please note also that some people can have allergic reactions to handling plastics, especially if they are actively degrading.

2. Plastics: The basics

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, i.e. substances made from things that have lived, including oil, cotton, sugar cane, coal, corn and many others. There are, however, exceptions such as silicon, which is derived from sand.

At the point of processing plastics consist of granules, pre-formed tablets, powders, syrups or pastes.

Plastics have been traditionally classified as:

- **Natural.** These are materials that can be moulded in their natural form. Examples are amber, gutta percha, horn, rubber, and tortoiseshell.
- **Semi-synthetic.** These are made of a natural material which has been chemically altered. Examples are casein, cellulosic plastics and rubber.
- **Synthetic.** These are entirely laboratory made from derivatives of oil, for example phenol formaldehyde, polymethyl methacrylate and the many poly-plastics.

Plastics are based on **polymers**. A polymer is essentially a very large molecule made up of many smaller units, or monomers, joined together. The chemical process of linking many **monomer** units together to create a polymer is known as polymerization. Polymerization can be visually demonstrated by hooking together hundreds of paper clips to form chains. Chains in different patterns make plastics with different properties.

2.1 Thermosets and Thermoplastics

Plastics are divided into two distinct groups:

- **Thermosets** are plastics which cannot be recycled. Once they have been heated and moulded into shape, they are set permanently. Thermosets found in this box include:
  - Melamine formaldehyde
  - Phenol formaldehyde
  - Urea formaldehyde

- **Thermoplastics** are plastics that can be re-melted after moulding again and again, and thus can be recycled by melting and reforming. Thermoplastics found in this box include:
    - Cellulose acetate
    - Polylactide
    - Polyethylene (polythene)
    - Polyvinyl chloride (PVC)

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, i.e. made up of two or more polymers, in order to increase the range of performance of the resulting material, e.g. Lycra.

For the categorisation of plastics not included in this box, see Appendix 2.

2.2 Additives in plastics

The performance, appearance and stability of a specific plastic can be greatly modified by a mix of additives in its recipe. They are used for a wide range of reasons including to:

- give additional strength or dimensional stability
- act as plasticisers or lubricants
- provide decoration or pigmentation
- improve chemical resistance
- act as fire-retardants
- protect against ultra-violet degradation
- act as a filler to reduce cost
- reduce weight
- provide barrier properties

Commonly found additives include:

- camphor and phthalates (as plasticisers)
- pigments
- cotton flock
- gas/air in foams (as expanders)
- glass and other fibres
- minerals such as mica, calcium carbonate, wollastonite, hydrotalcite, hydromagnesite, talc
- stabilisers
- wood flour

It would be impossible to process most polymers into useful objects without additives. Additives can be added in different quantities and can affect the 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.

2.3 Manufacturing processes

The principal manufacturing processes are: blow moulding, casting, compression moulding, extrusion, fabrication, foaming, injection moulding, rotational moulding and thermoforming of sheet. Currently far more plastic objects are made by injection moulding than by any other process (with the exception of plastic bags).

It is helpful to assess the quantities in which an object may have been made when considering manufacturing process. Some processes like casting can be used at home, involving a lower degree of investment and craft-based techniques. This is naturally not suitable for mass-produced goods. In contrast, injection moulding and blow moulding involve a high level of investment in tooling, and thus are only economically viable if a very high yield is required. For example, an injection moulding machine can convert plastic granules to a safety helmet in 40 seconds, producing 2,160 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.

As certain plastics are only used with certain processes, identifying the process can assist in the identification of the particular plastic. It is helpful to bear in mind when considering manufacturing processes that thermosetting plastics were not injection moulded before about 1960 and they cannot be thermoformed.

Below is a basic description of the main techniques. For more details, see the e-version of this manual produced by the Plastics SSN on www.collectionslink.org.uk.

2.3.1 Blow Moulding

Blow moulding can sometimes be identified by visible lines on an object where the moulds have joined. It was introduced in 1881 for use with cellulose nitrate, although is more commonly used for high density polyethylene (polythene) and polyethylene terephthalate. It is typically used for hollow articles which usually have an opening of a smaller diameter than the body (e.g. bottles and containers).

Blow moulding is so-called as the process blows hot air into a pre-formed tube (or parison) of semi-molten plastic. As a result, this 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. Textures can be formed on the mould walls.

2.3.2 Casting

Casting is essentially a craft process, where plastic in liquid form is poured into an open mould (itself often moulded from plastic). Open casting allows the finished result to be manipulated throughout the curing process. It is used for pre-formed shapes, such as sheets, rods and tubes, as well as jewellery, radio housings, designer furniture and paperweights. It most commonly uses phenol formaldehyde as a liquid resin, polymethyl methacrylate or polyurethane.

2.3.3 Compression Moulding

Compression moulding is a relatively slow and labour intensive process, which subjects powdered resin in a two-part mould to heat and pressure. It may leave marks or fine lines on complicated mouldings, although mould lines are normally polished off by hand. It was used for radio and telephone housings, plugs and sockets, tableware, ashtrays, bowls and boxes, normally using thermoset plastics such as phenol and melamine formaldehyde.

2.3.4 Extrusion

Extrusion is used for anything with a constant cross-section: all synthetic fibres, as well as items such as tubing, piping, cable sheathing, sheets and films. It was first experimented with in the 1840s, but not in wide use until the late 1930s. The process works much like a mincing machine, pushing plastic pellets through a heated cylinder with a turning screw. The melted plastic is forced out of a die at the end creating continuous lengths of shapes with the desired profile. It can be used on any plastic, but particularly high density polyethylene (polythene), polystyrene and polyvinyl chloride.

2.3.5 Foaming

Foaming releases air or gas into the plastic by various processes to fill it with bubbles. It will then be shaped in a two part metal mould. Foaming is used for packaging, sponges, steering wheels, vending cups, insulation and foam furniture. It can use most plastics, but typically is used for polystyrene, polyurethane and polyvinyl chloride.

2.3.6 Injection moulding

This is the most common of the manufacturing processes used on thermoplastics, and also the one which is most distinctive to identify. It is similar to extrusion, except that the plastic is injected into a metal mould often with branches connecting to additional moulds. The plastic enters the mould through what is known as a gate. This leaves a sprue of plastic which is broken off, but may leave a slightly rough, often circular area. The sprue mark is one way of identifying injection moulding, but such marks can be hard to detect and they may not be where you might expect to find them, for example centrally placed on the base.

Injection moulding can also leave smooth circular marks, where ejector pins have been used to help release the warm moulding from the mould.

Injection moulding was first used successfully with cellulose acetate in the 1930s, but became widely used for thermoplastics from 1946. Since 1960 it has also been used for processing some thermosets. It is a precision technique capable of complicated shapes: e.g. Airfix kits, Lego, plastic cutlery, machine housings, and many cheap products produced in very large quantities.

2.3.7 Rotational moulding

Rotational moulding was introduced in the 1940s. As the name suggests, it rotates plastics in pellet or liquid form in a mould at a low speed within an oven. The plastic covers and adheres to the inner surface of the mould, which continues to rotate during cooling. It is only used for products with uniform wall thickness, and where the inner surface of the product can be of an inferior quality to the exterior: e.g. storage tanks, traffic cones and bollards. It most commonly uses low or medium density polythene; polypropylene can be used if the end product needs to withstand high temperatures. Polyamides may also be used, but rarely because they are expensive.

2.3.8 Thermoforming

Thermoforming was introduced in 1890 for use with cellulose nitrate. It is used for most sheet thermoplastic materials, typically for low quantities or even one-offs. It uses pre-formed 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. The process can be mechanised to speed it up. It is used for shallow forms such as baths and boat hulls, bowls and margarine containers.

3. Identifying plastics: easy places to start

Plastics are not the simplest of materials to identify: there are some items in the box which even experienced experts aren't 100% sure about! However, there will always be something you can glean from the object to help you decide what it is made of. A good sense of design history and knowledge of the key developments in plastics and production processes will go a long way in helping you to make a 'best guess'. You can also consider its colour, what it looks and feels like, its smell, and any signs of deterioration.

3.1 When was it made?

If you have an idea when the object was made, use the information under the relevant date span to narrow down the probabilities. Bear in mind though that what you are getting are probabilities not possibilities. Many plastics have had long periods of gestation and, as more and more plastics are invented, some become outmoded but nonetheless stay in production. Although some materials are used most often with a particular manufacturing process, they may also be used from time to time with another. If you have a hunch that an object is made of a particular material outside the dates given or manufactured in a different process go to the material or process in the main chapters and in the Appendix 2 A-Z to check out what is possible in greater detail. Check Appendix 1, the plastics timeline, as well, especially for iconic design objects.

Year	Materials	Manufacturing processes
1840 -1880	Bois Durci Gutta Percha Hard rubber Shellac	Compression moulding Compression moulding, extrusion Compression moulding Compression moulding
1880 -1915	Cellulose nitrate Shellac	Blow moulding, fabrication, thermoforming Compression moulding
1915 -1925	Casein formaldehyde Cellulose nitrate Phenol formaldehyde Phenolic resin Shellac	Fabrication, thermoforming Blow moulding, fabrication, thermoforming Compression moulding Casting Compression moulding
1925 -1940	Cellulose acetate Cellulose nitrate Phenol formaldehyde Phenolic resin Urea formaldehyde Shellac	Compression moulding, injection moulding Blow moulding, fabrication, thermoforming Compression moulding Casting Compression moulding Compression moulding
1940 -1950	Phenol formaldehyde Polyamides Polymethyl methacrylate	Compression moulding Casting, extrusion, injection moulding Casting, extrusion, fabrication, thermoforming

Year	Materials	Manufacturing processes
1950 -1965	Melamine formaldehyde	Compression moulding
	Phenol formaldehyde	Compression moulding
	Polyamides	Casting, extrusion, injection moulding
	Polyethylene (polythene)	Extrusion, blow moulding, rotational moulding
	Polymethyl methacrylate	Casting, extrusion, fabrication, thermoforming
	Polystyrene	Extrusion, foaming, injection moulding
	Polyurethane	Blow moulding, extrusion, injection moulding, foaming
	Polyvinyl chloride	Blow moulding, extrusion, injection moulding, foaming, rotational moulding
	Silicones	Injection moulding
1965 onwards	Acrylonitrile butadiene styrene	Injection moulding
	Polyamides	Casting, extrusion, injection moulding
	Polycarbonate	Blow and injection moulding, extrusion, foaming
	Polyethylene (polythene)	Rotational moulding
	Polypropylene	Injection and blow moulding
	Polyethylene terephthalate	Blow and injection moulding
	Polymethyl methacrylate	Casting, extrusion, fabrication, thermoforming
	Polystyrene	Extrusion, foaming, injection moulding
	Polyurethane	Blow moulding, extrusion, injection moulding, foaming
	Polyvinyl chloride	Blow moulding, extrusion, injection moulding, foaming, rotational moulding
	Silicones	Injection moulding

3.2 What does it look like?

Transparent

Relatively few plastics are transparent like glass. All transparent plastics can be made translucent or opaque by the addition of pigments or fillers. Some plastics are only transparent in sheet form. If it is moulded and transparent it is probably made of one of the following:

- Phenol formaldehyde as liquid resin not with filler
- Polycarbonate
- Polylactide
- Polyethylene terephthalate
- Polymethyl methacrylate
- Polyurethane

The following plastics can also be clear in sheet form but are translucent or opaque when moulded:

- Cellulose acetate
- PVC
- Polypropelene

Translucent

It can be any of the above and also:

- Polyethylene (polythene)
- Silicones

Pale or bright coloured
If so it cannot be made of one of the following as they only come in dark colours. However other plastics that can be light or bright in colour also come in dark colours.

- Bois Durci
- Gutta percha
- Vulanised rubber
- Horn
- Phenol formaldehyde as a liquid resin, not with filler
- Shellac

Amber, ivory or tortoiseshell or pearlised
If it imitates one of these it is likely to be made of one of the following:

- Casein formaldehyde
- Cellulose acetate
- Cellulose nitrate
- Phenol formaldehyde as a liquid resin, not with filler

Shiny
If it has a hard glossy surface it is likely to be one of the following:

- Acrylonitrile butadiene styrene (ABS)
- Casein formaldehyde
- Melamine formaldehyde
- Phenol formaldehyde
- Polycarbonate
- Polymethyl methacrylate (acrylic)
- Polystyrene

3.3 What does it feel like?

Soft
Some plastics have such a soft surface that they can be indented with a finger nail. If the object feels as if that is likely it is probably made from one of the following:

- Polyethylene (polythene)
- Polyurethane
- Polyvinyl chloride (when in flexible form)
- Silicones

Flexible or rigid?
Many plastics can be rigid or flexible. However a few are always rigid. These are:

- Acrylonitrile butadiene styrene (ABS)
- Bois Durci
- Gutta percha
- Phenol formaldehyde
- Vulcanite

Sticky
Stickiness is a sign of degradation. The following can go sticky:
- Cellulose acetate
- Cellulose nitrate
- Polyvinyl chloride
- Polyurethane foam

3.4 Does it smell?

- **Carbolic acid:** → phenol formaldehyde
- **Formaldehyde:** → casein formaldehyde
- **Milky, if rubbed:** → casein formaldehyde
- **Mothballs (camphor):** → cellulose nitrate
- **Plasticky (new car smell):** → polyvinyl chloride
- **Sweet:** → polyvinyl chloride but only when degrading
- **Sulphurous:** → hard rubber
- **Vinegar:** → cellulose acetate
- **Vomit /rancid butter:** → cellulose butyrate, cellulose acetate
- **Waxy:** → butyrate
- **Milky, if rubbed:** → polyethylene (polythene)

3.5 What signs of deterioration can you see or feel?

The following signs of deterioration are associated with the materials listed:

Bloom
This takes the form of a white powder that can be wiped off or a pale mistiness:
- Cellulose acetate
- Cellulose nitrate
- Polyvinyl chloride

Cracks and splits
- Casein formaldehyde
- Cellulose nitrate
- Phenolic formaldehyde
- Polycarbonate

- Polystyrene
- Polyvinyl chloride
- Shellac
- Urea formaldehyde

Crazing
- Casein formaldehyde (surface crazing)
- Cellulose nitrate (internal crazing)
- Gutta percha (network of small cracks on surface)
- Polymethyl methacrylate
- Polystyrene
- Urea formaldehyde (an orange peel effect)

Crumbling
- Gutta Percha
- Polyurethane foam

Fading and discolouration
Pigments can fade independently, leading to complete changes of colour.

- Phenol formaldehyde fades and also dulls
- Polyamide has a tendency to yellow
- Polymethyl methacrylate sometimes discolours in light
- Polyvinyl chloride yellows and goes brown
- Polyurethane yellows
- Urea formaldehyde fades and also dulls
- Vulcanite often has yellowish brown tinge

Physical distortion or warping
- Cellulose acetate
- Polyvinyl chloride

3.6 Symbols or marks

The following symbols identify the plastic of which the object is made:

A small bird's wing indicates the object is made of Bois Durci.

An infinity sign is the Bakelite logo and thus frequently indicates the material phenol formaldehyde. However, the company made many other plastic materials. The sign only appears on Bakelite promotional mouldings. Bakelite did not make mouldings for the general market.

Recycling triangles were introduced in 1988 so any object with these on must date from that year or later. The triangles typically include the acronym of the plastic underneath, to identify what the item is made of:

1 PETE

Polyethylene terephthalate
Fizzy drink bottles and oven-ready meal trays.

2 HDPE

High-density polyethylene
Squeezy bottles e.g. washing-up liquid.

3 V

Polyvinyl chloride
Food trays, cling film, bottles for squash, mineral water and shampoo.

4 LDPE

Low density polyethylene
Carrier bags and bin liners.

5 PP

Polypropylene
Margarine tubs, microwaveable meal trays.

6 PS

Polystyrene
Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.

7 OTHER

Any other plastics that do not fall into any of the above categories.

Clue: Find the Benecol bottle in the box. On its base is an example of the recycling triangle with PE written underneath. This indicates it is made of polyethylene (polythene).

Faint **parallel lines** are indicative of cellulose nitrate sheet cut from a block. But they are not to be confused with extrusion marks parallel to the long axis of the object.

Trade names will sometimes be found on mouldings. They are associated with the materials indicated:

- **Bandalasta** Thiourea-urea formaldehyde
- **Beetleware** Urea formaldehyde
- **Carvacraft** Phenol formaldehyde
- **Gaydon** Melamine formaldehyde
- **Linga Longa** Urea formaldehyde
- **Melaware** Melamine formaldehyde
- **Melmex** Melamine formaldehyde
- **Xylonite** Cellulose nitrate

A Bandalasta Ware bowl, c.1926, clearly showing the trade mark.
© Science Museum

Clue:

Look at the base of the salt and pepper pots for an example of the Beetleware trade mark.

4. Casein formaldehyde

Please note: there are no objects made of casein formaldehyde in this box.

Casein is a protein found in milk, which reacts with formaldehyde to form a hard plastic. It is a thermoset, although it can also be thermoplastic to a certain extent. It was patented in 1899 as Galalith in Germany, but was manufactured in Britain under the trade name of Erinoid from 1914. It has been little used since the 1980s, although is still found in buttons.

Appearance and properties:
Casein formaldehyde is considered to be one of the early plastics with a high aesthetic appeal. It is highly decorative, coming in any colour, including mottles, pearls and special effects. It is usually opaque, but can have some translucency when imitating tortoiseshell, horn or other decorative effects. It is hard and firm, but can flex.

Casein formaldehyde can accept surface dyeing with acid dyes. It also polishes to a brilliant lustre. Occasionally it can smell of the formaldehyde used in its production.

Manufacturing process:
Casein formaldehyde is usually machined to the required shape from a sheet, rod or block, although it can also be extruded. Textures are achieved by laminating sheet on sheet. It is a medium-cost plastic.

Typical uses:

- buttons
- knitting needles
- fountain pens
- jewellery
- dressing table sets
- manicure sets
- inlay in furniture

Trade names:

- Lactoid
- Erinoid
- Galalith

Casein formaldehyde door handles, made at the Erinoid factory at Lightpill Mills, in Stroud. © Science Museum

Conservation issues:
Casein plastics are plasticised with water, and so will absorb and release moisture, causing it to expand or contract. If not kept in the right environmental conditions casein formaldehyde will thus degrade to form surface crazes and cracks, although it is unlikely to disintegrate completely.

5. Cellulose acetate

Cellulose acetate is thermoplastic. It was invented in 1894, but only developed for commercial use from 1918 (although used to form cellophane from 1908). It didn't become truly common until the late 1920s.

Use of cellulose acetate fell off in the 1970s, but interest in it is now reviving, as it is made from a renewable resource (wood-based cellulose).

Cellulose acetate was also modified in 1892 to make a form of artificial silk, called **viscose**. By 1904 this was known as **rayon.**

Appearance and properties:
Cellulose acetate can come in any colour, from transparent to opaque. It is usually plain, but occasionally marbled. It was often used to imitate tortoiseshell. It will accept surface colouring. It is strong, but slightly soft, and may be flexible in thin sections. It feels hard, and may smell of vinegar if degrading.

Manufacturing process:
Cellulose acetate is a medium-cost plastic to make. Early examples will be compression moulded. From c.1928 it was injection moulded.

Typical uses:

- as liquid to stiffen and waterproof fabric wings and fuselage of early aircraft
- fancy goods e.g. by Lalique
- sculpture e.g. by Naum Gabo
- hair brush handles, especially Addis Ltd
- supports for archival material from 1940s
- negatives and film
- spectacle frames
- typewriter keys
- toys

**A buckle made of cellulose acetate with chrome plated metal fastener, c.1940
© Science Museum**

Clue: There are four items containing cellulose acetate in the box. Two are on the list of common uses, and one is the base of an object made principally of another plastic. The fourth shows CA with a marble effect, and has sprue marks from the injection moulding on the base.

Trade names:

- Celanese
- Estron
- Plastacele
- Bexoid
- Tenite
- Clarifoil

Conservation issues:
Cellulose acetate is one of the 'problem plastics'. Moisture in the environment causes the loss of acetate groups and the subsequent production of acetic acid, which can be visible as small droplets on the surface of the object. The presence of acetic acid accelerates the process of deterioration. As this happens a smell of vinegar is given off. Plasticisers can also migrate to the surface leaving a white powdery deposit and resulting in shrinkage which itself often causes distortion and further stress. As degradation proceeds, crazing and cracking may occur. The acetic acid fumes from deterioration will also corrode metals.

Cellulose acetate should therefore ideally be stored at a **very low temperature** and humidity: ideally 2-5° C and 20 to 30 % RH. It should be **isolated** from metals and other materials if possible, and left **unwrapped**. Use PH indicator strips to monitor for the presence of acid. Air filtration or vapour scavengers can also be used to remove polluting vapours.

6. Cellulose nitrate

Please note: there are no objects made of cellulose nitrate in this box.

Cellulose nitrate is thermoplastic. It is the first common domestic plastic which was initially displayed at the 1862 International Exhibition in London under the name Parkesine, after its inventor Alexander Parkes. **Parkesine** was not commercially successful, but later developments by the Hyatt brothers using the trade name **Celluloid** were. In 1884 it was used to create an artificial fibre like silk called Chardonnet silk. In 1888 the first commercially successful celluloid photographic film was introduced by George Eastman Kodak.

By the 1940s cellulose nitrate had almost entirely fallen out of use, as it is highly flammable. However, it is still used today to make ping pong balls.

Appearance and properties:
Cellulose nitrate can come in any colour, including mottled and pearlised effects. It was often used to create imitation tortoiseshell and ivory. It feels hard, but comes in a wide range of rigidities. It can be transparent or opaque.

Ways of identifying cellulose nitrate include its smell. It smells of camphor (which was used as a plasticiser) – you are most likely to experience this with cellulose nitrate containers with lids. Occasionally, you can also see blade marks on the plastic, created during the manufacturing process.

Manufacturing process:
Cellulose nitrate is a medium-cost plastic. It can be blow moulded. It was also made into blocks that were sliced into thin sheets for fabrication; this method can result in visible blade marks on the surface of the plastic. Thin sheets were also thermoformed.

Typical uses:

- collars and cuffs
- dressing table sets and combs
- billiard and ping pong balls
- knife handles
- jewellery and costume accessories
- imitation jet mourning accessories
- spectacles
- toys
- false teeth
- sculpture e.g. by Naum Gabo
- in mortars
- as a support for film and still photography and from 1940s archival material

Trade names:

- Parkesine 1862 – 68
- Xylonite (UK)
- Celluloid (USA) from 1870s

An advert for Celluloid collars and cuffs from 1895.
© Steve Akhurst, Plastics Historical Society

An imitation ivory hair comb made of ivoride and xylonite (celluloid nitrate), c.1862 © Science Museum

Conservation issues:
Cellulose nitrate is a ‘problem plastic’. Light and moisture cause the loss of nitrate from the polymer, which is released as nitrogen oxides. Water and oxygen then turn this into acids which accelerate the process of deterioration further, making the object brittle and prone to internal cuboid crazing and cracking. An acidic wet bloom (sticky droplets on the surface of the object) will form, and ultimately the plastic will entirely collapse. The emanations from deterioration also corrode metals.

This celluloid nitrate buckle shows interior crazing. The metal has also deteriorated badly from contact with acid emanations. © Cordelia Rogerson, British Library

Cellulose nitrate should therefore ideally be stored at a **very low temperature** and humidity: ideally 2- 5° C and 20 to 30 % RH. It should be **isolated** from metals and other materials if possible, and left **unwrapped** in a well ventilated room. Use indicator strips to monitor for the presence of acid. Air filtration or vapour scavengers can also be used to remove polluting vapours.

7. Melamine formaldehyde

Melamine formaldehyde is a thermoset. It was developed commercially after World War II, with its heyday being in the late 1950s and early 1960s. It is still in use today, particularly for picnic ware and ashtrays.

Appearance and properties:
Melamine formaldehyde is always opaque and rigid, with a hard feel. It can come in any colour, but is often two-toned. It can be porcelain-like, and is capable of a high gloss appearance. It has no smell.

Clue: There is only one object which contains some melamine formaldehyde in the box. It has the characteristic high gloss appearance.

Manufacturing process:
Melamine formaldehyde is a low-cost plastic, made by compression moulding.

Typical uses:
- colourful table and picnic ware
- ashtrays
- a component of Formica™

Trade names:
- Argosy
- Gaydon
- Melaware
- Melmex

Conservation issues:
Melamine formaldehyde is relatively stable, but it will scratch and stain.

Above
An advert from 'Woman and Home' in 1959 showing the 'modern' place setting using melamine formaldehyde tableware.
Left:
'Melaware' tableware © Steve Akhurst, Plastics Historical Society

8. Phenol formaldehyde

Phenol formaldehyde was the first synthetic (i.e. entirely laboratory made) plastic. It was developed by Leo Baekeland, a Belgian chemist who emigrated to the USA. He coined the name Bakelite, by which phenol formaldehyde is most popularly known. It is a thermoset.

There are two forms of phenol formaldehyde, both of which are commonly referred to as Bakelite. The first to be developed in 1907 was a powder containing wood flour as a filling agent. The wood flour improved the mouldability of the plastic. Other materials may also be incorporated as a filler. It was not widely used until after 1915, and can still be found today in saucepan handles and electrical moulds.

The second form of phenol formaldehyde is a liquid resin, which is often called cast phenolic. It was developed in 1927. Cast phenolic was frequently formed into long rods which were then cut and polished (e.g. for napkin rings or toast racks). It was not used much after the 1960s.

Appearance and properties:
Phenol formaldehyde made with a filler will always be opaque and usually dark in colour: black, shades of green, red and brown, often mottled, and sometimes in wood effects. As a liquid resin it can come in any colour, most frequently amber and green, and most rarely blue. It is occasionally transparent, but more normally translucent or marbled, and sometimes opaque. Both forms are always hard and rigid.

It has good electrical and heat resistance (and hence is often found as a casing for electrical items). It can smell of carbolic acid.

Clue: There are five items made mainly of phenol formaldehyde in the box, showing the full range of opaque colours from classic Bakelite brown, to maroon, to mottled red and mottled green.

Manufacturing process:
Phenol formaldehyde made with a filler is manufactured by compression moulding. The liquid resin is cast, often as a rod or tube, which may be cut or carved. It is a medium-cost plastic.

Typical uses with filler:

- radio, clock and hair dryer casings
- ash trays
- boxes
- electrical fittings
- car components
- aircraft and military components
- cooker knobs
- kettle handles

Typical uses as liquid resin:

- napkin rings and bangles
- desk accessories
- wireless cabinets, especially American
- jewellery
- laminate surfacing, e.g. Formica™

Trade names with filler:

- Bakelite
- Mouldrite
- Nestorite
- Roanoid

Trade names as liquid resin:

- Bakelite
- Catalin
- Carvacraft

This 1940s ashtray is made of both phenol formaldehyde (Bakelite – the brown base) and urea formaldehyde (the ivory 'Michelin' man). Both plastics are heat resistant, and hence suitable for cigarette ash.
© Science Museum

Conservation issues:
Phenol formaldehyde made with filler is relatively stable, but its colours will darken with exposure to light (typically, green will turn to brown). It also goes dull.

Cast phenolic is also relatively stable. It will become brittle and discolour as it degrades.

9. Polyethylene (PE)

Polyethylene is more commonly known by one of its trade names, **polythene.** It is a thermoplastic, which was discovered as the result of a laboratory accident at ICI's Cheshire research laboratory in 1933. Polythene is categorised as being either of low density (LDPE) or high density (HDPE). Low density polythene was developed first, initially for military purposes: it played a crucial role in the insulation of British radar cables during World War II. It was released for more commercial uses from the mid-1940s. It is currently the plastic with the highest volume of use, being used for all sorts of packaging (most classically **Tupperware**), including the ubiquitous plastic bag.

High density PE has been manufactured since 1953. The acronyms LDPE and HDPE will often be found underneath the recycling triangle symbol on many modern products.

Appearance and properties:
PE can come in any colour. It is naturally translucent, but can be opaque. It is semi-rigid to flexible, depending on its density (HDPE will be more rigid). It can smell of wax, and will scratch with a fingernail.

Manufacturing process:
Polythene can be made by blow moulding, extrusion, injection moulding and rotational moulding. It is a very low-cost plastic.

Sqezy was the first detergent to use polythene for its packaging in 1951. It was made in PE by Cascelloid for Domestos Ltd.
© Science Museum

Typical uses with filler:

- kitchenware and domestic wares e.g. bowls
- first squeezable bottles e.g. for washing up liquid
- airtight food containers e.g. Tupperware
- road cones
- 'poppit' beads and toys
- packaging film, e.g. carrier bags, cling film (LDPE)
- cereal box liners (HDPE)

Clue: There are four objects containing PE in the box. They are all semi-rigid plastics. One is a modern item, and has the recycling triangle identifying it as PE on the base. Two of the others have yellowed, showing signs of light damage. The fourth is a classic use of polythene, showing it in its translucent form.

Trade names:

- Polythene
- Alkathene
- Tyvek

Conservation issues:
Over time, polythene will yellow, stiffen, and ultimately become embrittled, especially if stored in poor conditions.

A talcum-powder bottle made of blow moulded polythene, 1950.
© Science Museum

10. Polylactide (PLA)

PLA is one of the new generation of plastics made from renewable resources. It has been developed since 2000 and is derived from corn starch.

Clue: There is one object in the box which has PLA in it: it prominently advertises itself as being compostable. It is therefore perceived to be an 'eco-friendly' plastic, although this is hotly debated on the internet and in some press reports.

Appearance and properties:
PLA can come in any colour, and ranges from transparent to opaque. It can be rigid or flexible, and the feel of it also varies. It has no smell.

Manufacturing process:
PLA can be made using any of the manufacturing processes. It is a medium-cost plastic.

Typical uses:

- disposable plates and cutlery
- trays in confectionary industry
- compostable packaging
- suitable for anything from toys to car parts

Trade names:

- NatureWorks
- Plantic
- Mater-bi (largely PLA, with also vegetable oil components and a small amount of petroleum based material)

Conservation issues:
As PLA is intended to biodegrade in composting conditions, it should be kept cool and dry.

11. Polymethyl methacrylate (PMMA)

PMMA is more often called **acrylic**. It is thermoplastic. It was developed in 1932, used initially in the canopies of Spitfire fighter planes. It was in commercial use from 1934, including the first plastic contact lenses from 1938. It was most fashionable in the 1960s, but will be most familiar to curators in the form of Perspex object mounts.

Appearance and properties:
Acrylic can come in any colour. It can be transparent to opaque, and has better optical properties than glass. It is rigid and feels hard. It can take a high gloss, and will make a dull sound when struck.

Clue: There is one item with acrylic parts to it in the box. It shows the high gloss of acrylic, and also how it can be used to create a pearlised effect.

Manufacturing process:
PMMA is a medium-cost plastic. It was initially thermoformed from cast sheet and then fabricated. Today it can also be manufactured by casting, extrusion or injection moulding.

Typical uses:

- aircraft glazing
- containers fabricated from sheet (e.g. handbags)
- blocks with embedded objects (e.g. jewellery, paper weights)
- display stands and mounts
- artists' paints

Trade names:

- Oroglas
- Perspex
- Plexiglass
- Lucite
- Corian

Dentures made of acrylic, 1955-1965.
© Science Museum

Conservation issues:
PMMA is relatively stable, but susceptible to physical damage, especially scratching. Pressure or stress may result in crazing.

12. Polyurethane (PU)

Please note: there are no objects made of PU in this box.

Polyurethane was developed from 1937. It is still in widespread use today. It is thermoplastic as a fibre or surface coasting, but thermoset in foam form. As a copolymer with polythene glycol it is generically known as Spandex or Elastane.

Appearance and properties:
Polyurethane can come in any colour, from transparent to opaque. It has no defining features, being odourless, both flexible and rigid, and with a variety of feels to it. Its surface can scratch with a fingernail.

Manufacturing processes:
All the processes can be used to manufacture PU. It is a medium-cost plastic.

Typical uses:

- furniture
- paint
- shoe soles
- synthetic leather-like fabrics
- bicycle seats
- as a foam: seating, large mouldings

Trade names:

- Lycra

Conservation issues:
Polyurethane foam is a 'problem plastic'. Oxidisation causes discolouration and loss of strength. The result can be catastrophic loss of structure leading to crumbling and ultimately total collapse. Ideally, therefore, it should be stored in an oxygen-free environment, using products such as **oxygen** scavengers. It should be kept at a temperature of **20° C**, and at a RH at the **low end of 20 – 30%.**

As polyurethane can crumble, it is useful if it is stored with future display requirements in mind, to minimise handling when it does go on display.

The sole of this late 1970s Clarks' Polyveldt shoe is made of a polyester-based polyurethane, which has deteriorated probably because of storage conditions. © National Museum of Wales

13. Polyvinyl chloride (PVC)

PVC is a thermoplastic. It was known from 1870, but suitable plasticisers were not discovered until 1933. It has been in wide use from the 1940s and continues to be used today.

Appearance and properties:
PVC can be any colour, from transparent to opaque. It is basically rigid, but is made soft with the use of plasticizers. It has no smell, but it can feel sticky as it degrades.

Manufacturing process:
PVC can be made by any of the thermoplastic processes. It is a low-cost plastic.

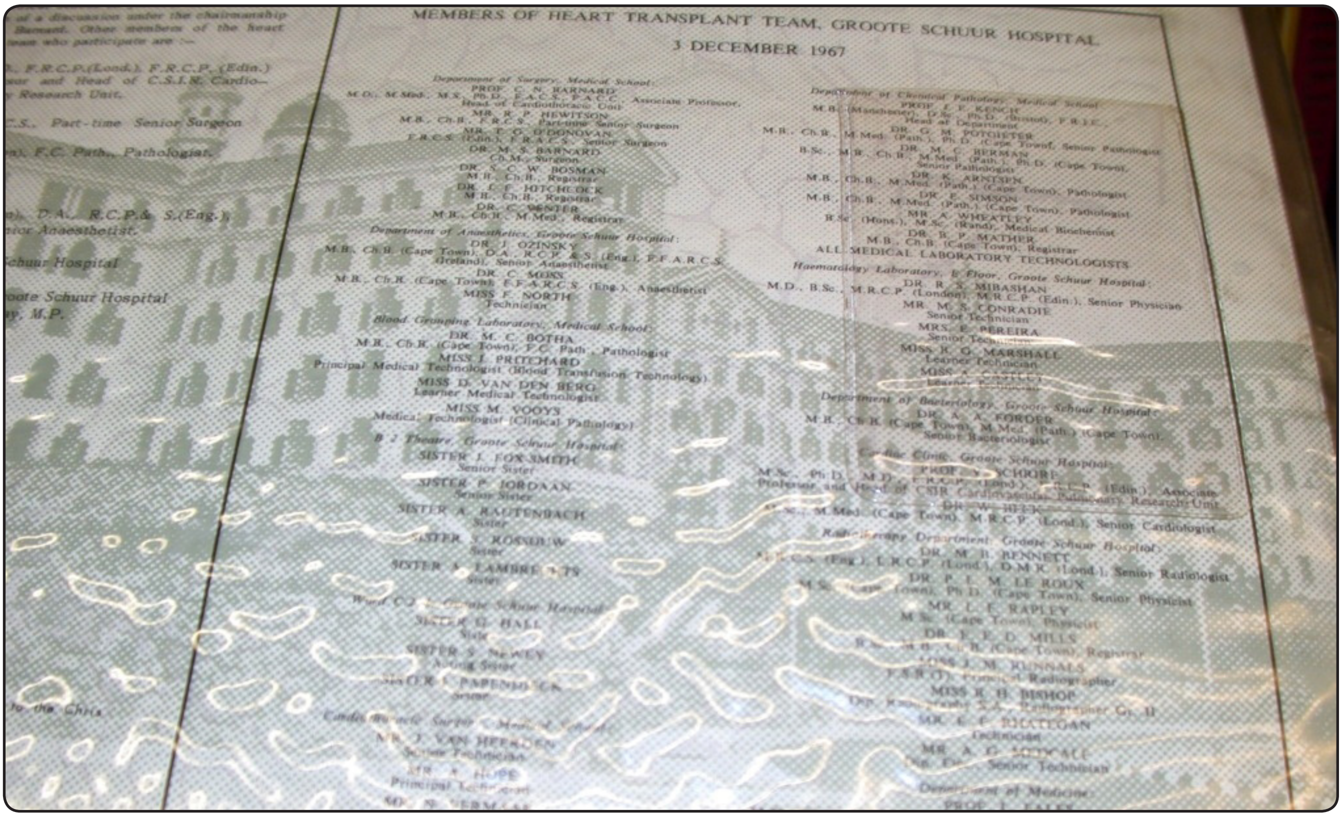
Typical uses:

- as copolymer: LP gramophone records (from 1952)
- in unplasticised form: guttering, window frames, flooring
- cables e.g. computers and other electrical items
- flexible toys and dolls e.g. Barbie
- shiny leather-like fabric
- fashion belts
- inflatable furniture
- credit cards
- blood bags
- flooring

Classic rubber ducks for baths are made out of toughened PVC, using a blow moulding process. © Science Museum

Clue: There is one item made of PVC in the box, which handily has 'PVC' written on it! It shows PVC in its transparent, semi-rigid form. A second object may possibly be PVC, although it is hard to be 100% certain…

Conservation issues:
PVC is another 'problem plastic'. It needs careful handling, as in flexible form it will easily scratch, or indent with a fingernail. Light causes yellowing and darkening and can lead to it giving off hydrochloric acid. Oxygen is also harmful. Plasticisers have a tendency to migrate to the surface causing bloom and tackiness or stickiness which attracts dirt. The weeping is accompanied by a sweet smell. The loss of plasticiser ultimately causes the plastic to shrink and warp and also to become more rigid or embrittled.



The PVC sleeve of this document has shrunk and 'cockled'.

PVC should ideally be stored at a **very low temperature** and humidity: ideally 5° C and 20 to 30 % RH. Ideally, it should be stored in an **oxygen-free environment**, by using products such as oxygen scavengers. It should be kept away from absorbent materials, and left **unwrapped**. To prevent the loss of plasticiser, enclose in a non-absorbent material such as glass or polyester bags. As an indemnity against possible embrittlement, store also with future display requirements in mind.

14. Urea formaldehyde

Urea formaldehyde is a thermoset. Patents were taken out on it in 1915, but it only became practical for commercial use as thiourea-urea formaldehyde in 1925. In 1929 it was improved to urea formaldehyde. By the 1950s its role had been taken by other plastics, so it is most likely to be found in items dating from the 1930s and 1940s.

Appearance and properties:
Urea formaldehyde is naturally white, but it can be found in any slightly muted or pastel colour. It was also made with speckled or marbled effects. It is never transparent, but can be translucent or opaque, without a high gloss. It is rigid, brittle, and feels hard. It usually has no smell, but occasionally can give off a faint smell of urine.

Manufacturing process:
Urea formaldehyde is only made by compression moulding. It is a medium-cost plastic.

Clue: There are seven items made mainly of urea formaldehyde in the box. One of them is a typical UF cream colour. Two of them (a pair) are marked 'Beetleware', and a third item looks very similar, but lacks the trade marking. A fourth item is also almost identical in colour. Two of the speckled multicoloured items are probably UF, although the colours are very dark for it.

Typical uses:

- domestic wares
- picnic sets
- jewellery
- electric fittings and casings

Trade names:

- Beetle
- Beatl
- Bandalasta
- LingaLonga
- Plaskon
- Scarab

A 1950s thermos flask made of grey and maroon urea formaldehyde, and lined with glass. © Science Museum

Conservation issues:
Urea formaldehyde is reasonably stable. It is badly affected by hot water. If it degrades, it will dull, discolour and crack, and can acquire an orange peel effect on the surface.

15. Environmental requirements

Plastics differ from each other in their care needs. The exact recipe of each plastic, including its range of additives, influences how it will age. Even the pigment used to colour an otherwise identical object can cause objects to age differently. That said, most plastics are relatively stable if looked after appropriately. Degradation when it does occur is irreversible. Environmental conditions impact dramatically on the life-expectancy of plastic objects and are therefore vital for slowing down or preventing degradation.

Plastics should be kept in a dark, cool, dry room. Whether in store or on display the **temperature** for the majority of plastics should be restricted to **20° C** and **30 to 50% RH**, with no more than ±5%RH change in any 24 hour period. Sharp fluctuations of heat and RH are especially damaging.

Light can also cause irreversible damage. Recommended good practice varies from a maximum of **50** to **150 lux.** Windows should be covered with UV filters. However even UV-filtered light is bad for plastics so when stored plastics must be kept in the dark and when on display light should be limited. Plastic objects should not be on permanent display. The damage is cumulative and dependent on the overall amount of light - whether a short blast of very bright light or a very low light for a long time. It is for each curator/conservator to decide what is appropriate for any particular object at any particular time.

Problem plastics
Four plastics are especially problematic and require particular attention. These are **cellulose acetate, cellulose nitrate, polyvinyl chloride** and **polyurethane.** Objects made of these materials should be identified, separated out from the collection and managed separately, according to their special needs. For their particular environmental requirements, see the chapters on each individual plastic.

Degradation
The onset of degradation is unpredictable and rapid. It can manifest itself in an advanced state apparently almost overnight. It is irreversible and in most cases, once started, unstoppable. The best that can be achieved is to slow down the process by storing in the appropriate environmental conditions.

Degradation products from objects (e.g. acidic vapours) can contaminate other objects in the vicinity. Collections should be checked regularly, ideally at least once a year, and any object showing signs of degradation should be separated from the rest of the collection.

Causes and effects of degradation:

- excessive humidity can lead to chemical breakdown of certain plastics.
- fluctuating temperature and humidity, leading to shrinkage and expansion which in turn result in crazing and cracks.

- migration and loss of plasticizers, leading to surface bloom and /or surface tackiness and then to loss of flexibility and embrittlement.
- pollutants and exhaustion of stablisers leading to chemical break down of the material's structure and, ultimately, collapse.
- light, leading to darkening, loss of flexibility and embrittlement of the plastic and fading of pigments.
- bad handling, leading to chips, cracks and breaks.

Early signs of degradation can include:

- bloom, a white powder of the surface.
- corrosion of metal parts or surrounding objects.
- crazing and cracking.
- discoloured or even shredded packaging materials.
- distortion of the shape of the object.
- smells: mothballs (camphor), sweetness, vinegar, vomit, rancid butter.
- surface stickiness.
- haze - a wet acidic deposit on the surface.

The polyurethane sole of this shoe shows cracking caused by hydrolysis – a process of deterioration which can occur in a warm, moist environment. © National Museum of Wales

Numbering
Neither barrier coatings as often applied to objects nor adhesive tapes are appropriate for plastics as they may react adversely with the surface. Rubber bands should also be avoided. The options are:

- labels tied on with cotton tape
  or
- writing directly on the plastic surface with a soft pencil, ideally inside the object.

16. Storage and display materials

Objects should be stored and displayed in and on inert materials, in such a way as to minimise handling.

Ideally each type of plastic should be stored separately. Objects should never touch each other and air should be able to flow freely around them. The space should be dust free, but it must not be airtight.

Try to store objects supported as you would wish them to be on display (for example, unfolded or opened out). Should degradation take place this will enable them to be displayed without leading to further degradation as they are handled. This is especially important for objects made of polyvinyl chloride and polyurethane foam.

Display cases and shelving

Display cases and shelving should be made of inert materials like powder coated metal, galvanised and stainless steel, glass or acrylic sheet. External air ingress should be minimised to improve the stability of the relative humidity inside the case. However, if a display case or storage unit is well sealed, activated charcoal cloth should be used to absorb any acid vapours the plastic may give off, so slowing the rate of deterioration.

Avoid especially materials that could off-gas organic vapours, such as painted materials, wood and MDF. If wood panel products are used they must be totally sealed using an aluminium barrier foil. Plinths should be left for at least 72 hours for paint to dry completely before covering. Plasticisers are drawn out by contact with absorbent materials so they too should be avoided.

Acrylic (polymethyl methacrylate) is an acceptable material to use for display stands.

Packaging

Do not store plastics in plastic bags, sealed boxes or other wrapping which restricts ventilation. Do not allow any objects to touch each other.

Trays made of polypropylene are appropriate for holding objects in storage.

Acid free paper is not always suitable for wrapping, and should not be used for plasticised items, as the paper may stick to them.

If an object is sticky, or tacky, it can be placed on silicon release paper. Objects that have the potential to off-gas acidic fumes (e.g. cellulose acetate and cellulose nitrate) can also be wrapped in charcoal cloth.

Plastazote, a form of polyethylene (polythene) foam, can be used for securing objects within storage spaces.

- Melinex, a form of polyethylene terephthalate, can be laid over degraded objects to protect them from dust and to put between them to discourage cross contamination. Melinex is also useful as a buffer to sit objects on, on painted surfaces.

- Polyester wadding is useful for providing padding, for example on hangers for costumes.

- Large objects in store can be loosely covered using Tyvek sheeting to minimise dust and exposure to light, and help buffer humidity fluctuations.

Monitoring and maintaining the environment:
In order to detect acidic vapours as an early sign of degradation, it is useful to place indicator strips alongside plastic objects. These come in strip form, or as a chemical-impregnated string which will change colour in the presence of acidic gasses.

Products that help you maintain a good environment are:

- Ageless oxygen scavengers for an oxygen free environment. This is suitable for preventing the crumbling of polyurethane foams.

- Silica gel, as a buffering agent moderating the effects of change in relative humidity.

- Scavengers such as charcoal cloth and molecular sieves to remove polluting vapours and oxygen.

17. Cleaning plastics

Cleaning tends to cause both chemical and mechanical damage so keep a balance between the risk of damage and your wish for the object to look pristine. Always consult a conservator beforehand, and make sure any cleaning done is fully documented and photographed.

Often, all that is required is a light dust using a soft brush and a museum vacuum.

If cleaning must be undertaken, use cotton swabs with deionised water. If more in depth cleaning is essential, a lint-free microfibre cloth dampened with deionised water can be used but the dampness should be kept to a minimum. The object must be completely dried after treatment. Water is especially bad for casein formaldehyde, cellulose acetate and cellulose nitrate. **Never** immerse a plastic object in water. Do not use solvents: severe damage that could ensue may not show immediately.

Appendix 1
Plastics timeline

1712	John O'Brisset moulds snuff boxes from horn.
1823	Macintosh uses rubber gum to waterproof cotton and the 'mac' is born.
1839	First deliberate chemical modification of a natural polymer produces **vulcanised rubber** (see vulcanite).
1851	**Gutta percha** used to insulate submarine telegraph cables between England and France.
1854	**Shellac** mixed with wood flour patented in USA as moulding material for making 'union cases', protective frames for daguerreotypes and ambrotypes, early forms of photographs on glass.
1855	Soccer ball with vulcanised rubber panels, glued at the seams, designed and produced by Charles Goodyear.
1861-87	Queen Victoria's mourning for the Prince Consort fuels the production of imitation jet mourning jewellery in such materials as **cellulose nitrate,** hard rubber and horn.
1862	A range of toiletry and household objects, some imitating the appearance of tortoiseshell and ivory, made of an early form of cellulose nitrate, is displayed at the International Exhibition in London. The material was called Parkesine after its inventor Alexander Parkes. Ultimately **Parkesine** fails as a commercial venture.
1870	In USA Hyatt brothers in search of substitute material for ivory billiard balls turn cellulose nitrate into a commercially viable material. Dental palates are one of their good sellers. They register the name **Celluloid** for their material in 1873.
1884	Cellulose nitrate modified to make artificial silk, called **Chardonnet silk.**
1889	Dunlop Rubber Company founded and motor industry revolutionised.
1888	First commercially successful celluloid (cellulose nitrate) photographic film introduced by George Eastman Kodak.
1890	**Thermoforming** introduced and used to make babies' rattles from cellulose nitrate.
1892	Cellulose acetate modified to make a form of artificial silk, called viscose. By 1904 this was known as **rayon.**

1898 Beginning of mass-production of 78 rpm gramophone records from shellac, for which it remains the most common material until the 1940s.

1899 **Casein formaldehyde** patented as Galalith in Germany.

1905 Laminated safety glass, first with gelatine but then with cellulose nitrate inter-layer introduced.

1907 First synthetic (lab made) plastic, **phenol formaldehyde,** better known as **Bakelite,** introduced. Later known as 'the material of a 1000 uses'.

1910 **Viscose** stockings begin to be manufactured.

1913 **Formica** invented.

1915 Queen Mary orders **casein** jewellery at the British Industries Fair.

1916 Rolls Royce boasts about use of phenol formaldehyde in its car interiors.

1920 Hermann Staudinger publishes his realisation that plastics are made up of polymers. Only in 1953 was the value of his work properly recognised when he was awarded the Nobel Prize for Chemistry.

1926 Harrods, the London store, mounts a display of Beetle products, made from a form of thiourea-urea formaldehyde. It is a huge success.

National Grid for electricity is established, fuelling the desire for consumer goods that plug in and switch on, often with plastic housings.

1929 Bakelite Ltd receives its largest ever order of phenol formaldehyde for the manufacture of the casing of the Siemens Neophone Number 162 telephone.

1930 Scotch Tape, the first transparent (see cellulose acetate) sticky tape, invented.

1933 The British Plastics Federation, the oldest national organisation in the world with plastics in its name, set up.

1935 Couturier, Elsa Schiaparelli, begins to use zips made of **cellulose nitrate** and **cellulose acetate** in her garments.

1936 Acrylic (**polymethyl methacrylate**) canopies used in Spitfire fighter planes. From 1940 it becomes the most widely used material for aircraft glazing.

1938	First toothbrush with plastic tufts manufactured. The tufts were made of nylon (**polyamide**).
	Introduction of plastic contact lenses. The lenses were made of acrylic (polymethyl methacrylate).
1939	First **polythene** factory opens in Britain. Polythene plays a crucial role in the insulation of British radar cables during World War II. Entire production for military use.
	Plastic Man, a fictional comic-book hero, first appears.
1945	End of the war releases a range of plastics developed to support the war effort on the commercial market looking for uses.
1947	First **acrylic paint** (polymethyl methacrylate dissolved in turpentine) becomes available. Appreciated by artists such as Roy Lichenstein for its intensity and rapid drying properties.
	Tupperware, with flexible seals made possible by the invention of polythene, patented in the USA.
1948	Introduction of long playing vinyl copolymer gramophone records
1949	Charles and Ray Eames glass reinforced plastic shell chair showed that plastic could be more than a furniture covering or veneering material.
	First Airfix self-assembly model produced. It was made of **polystyrene.**
	Kartell, the Italian firm associated with plastic objects of desire for the home, founded.
1950	Silly Putty, made from **silicon,** launched at the New York Toy Fair.
Early 1950s	The ubiquitous **polythene bag** makes its first appearance.
1951	First **polythene bottle** made by Sqezy.
1953	Commercialisation of polyester fibre introduces the concept of ‘wash and wear’ for fabrics.
	Chevrolet Corvette, the first mass-produced car with a glass reinforced plastic chassis, begins manufacture.
1954	Synthesis of polypropylene.
1956	Reliant Regal 111, first commercially successful all glass reinforced

plastic bodied car, goes on sale.
Eero Saarinen's Tulip chair, the seat consisting of a glass reinforced plastic moulded shell, launched.

1957 Invention of **polyacetal,** the first 'engineering' plastic.

The Monsanto Company's House of the Future with 100% plastic structural parts built at the entrance to Disneyland's Tomorrowland.

Polyvinyl chloride road cones used in the construction of the M1 motorway.

1958 Invention of the silicon chip.

American Express launches first plastic credit card in US.

Lego decides to concentrate exclusively on plastic toys and patents its stud-and-block coupling system. Originally made of cellulose acetate, it has been made of ABS (**acrylonitrile-butadiene-styrene**) since 1963.

1959 Birth of the Barbie doll, made mainly of PVC (**polyvinyl chloride**) and the **Lycra** (copolymer of polyurethane) bra.

Early 1960s **Acrylic paint** (polymethyl methacrylate diluted with water) comes on market and is soon widely used by artists such as Warhol, Rauschenberg and Hockney.

1962 Silicon gel breast implants pioneered successfully.

1963 Mary Quant launches her 'Wet Collection" made of **plasticised PVC** (polyvinyl chloride). It had taken two years to work out how to bond the seams successfully.

Robin Day polypropylene one-piece injection moulded chair shell begins manufacture.

1965 Twiggy models John Bates's plasticised PVC (polyvinyl chloride) dress.

1967 Inflatable PVC (polyvinyl chloride) 'Blow' chair designed by DePas, D'Urbino, Lomazzi and Scolari for Zanotta SpA, launched.

1969 Neil Armstrong plants a **nylon** (polyamide) flag on the moon.

1969 Beatles' song 'Polythene Pam', the kind of a girl that makes the News of the World released on Abbey Road album.

1970 Verner Panton's cantilevered stackable chair, the first whole chair to be made out of a single piece of injection-moulded plastic becomes a reality. He had been working on the design since 1960. The first pilot production models were made of glass-reinforced polyester resin in 1967. It has since been made of polyester integral foam, polyurethane, **styrene acrylonitrile** (SAN) and polypropylene.

1976 Plastic, in its great variety of types, said to be the material with the most uses in the world.

Concorde with its nose cone of purpose-made plastic goes into service.

1977 PET (**Polyethylene terephthalate**) drinks bottle introduced.

1978 PolyStyrene, lead singer of the Punk band X-Ray Spex, bursts on the scene with ‘the day the world turned day glow’.

1980 During this decade ICI and Bayer launch **PEEK, PES** and **PPS** as the new engineering thermoplastics. Costs are enormous but specialist applications make a lasting market even after ICI retreats from the plastics market.

1982 First artificial heart made mainly of polyurethane implanted in a human.

1983 The slim Swatch watch launched, its case of ABS (**acrylonitrile butadiene styrene**) and strap of PVC (polyvinyl chloride).

Authentics Ltd., British firm renowned for its sharp, modern designs in various plastics for domestic use, founded.

1988 Triangular recycling symbols identifying different types of plastics introduced.

1990 First **biodegradable plastics** launched by ICI

1993 Alessi designs its first all plastic product: the Gino Zucchino sugar pourer designed by Guido Venturini.

1994 Smart car with lightweight flexible integrally coloured polycarbonate panels introduced.

1998 Amorphous free standing Zanussi Oz fridge, with insulation and outer-skins made in one process from polyurethane foam, launched.

2000 Issues relating to sustainability and the creation of plastics from renewable sources start gathering momentum.

2005 Nasa explores the advantages of a polythene-based material, **RXF1,** for the space-ship that will send man to Mars.

Appendix 2
A-Z of trade names and plastics not included in the box

The plastics featured here are those commonly found in museum collections. The aim of the information is to help you identify the material of which an object is made. Most plastic materials have been produced in a large number of formulations to suit particular applications and manufacturing processes. They may be what is called a copolymer, that is made up of two or more polymers, in order to increase the range of the plastic's performance. The complexity of the subject is only hinted at here.

For further information on plastics marked in purple, see the main body of the resource pack.

The manufacturing processes listed are those most commonly used with the particular material. However, it is possible to find the material manufactured by other processes.

Many plastics have long gestation periods and were 'invented' at slightly different times in different countries. Dates should therefore be taken as indicative rather than absolute.

Acrylic see polymethyl methacrylate

Acrylonitrile butadiene styrene (ABS)

Group:	thermoplastic
Developed:	from 1948
Trade names:	Cycolac
Manufacturing:	injection moulding; extrusion (sheet); thermoforming
Cost:	low
Colour:	any
Transparency:	almost always opaque
Rigidity:	rigid
Feel:	hard
Smell:	none
Other:	glossy
Typical uses:	domestic appliance and computer housings; Lego
Degradation:	relatively stable but has tendency to yellow

Metropolitan police helmet, c.1980, made of ABS
© Science Museum

Alkathene™	see polyethylene
Alketh™	see polyethylene
Argosy™	see melamine formaldehyde
Bakelite™	see phenol formaldehyde
Bandalasta™	see thiourea-urea formaldehyde
Beatl™	see urea formaldehyde
Beetle™	see urea formaldehyde
Bexoid™	see cellulose acetate

Bois durci

Blood albumen and powdered wood

Group:	thermoset
Developed:	patented in Paris 1855, exhibited 1862 and 1867 International Exhibitions, London; commercial production ceased in 1875
Manufacturing	compression moulding
Cost:	high
Colour:	black and dark brown, but sometimes has a lacquered finish
Transparency:	always opaque
Rigidity:	always rigid
Feel:	hard
Smell:	none
Other:	can sometimes be identified by the moulding of a small bird's wing or by the name 'Bois Durci'
Typical uses:	desk accessories; plaques with reliefs of notable people or mythological scenes
Degradation:	relatively stable

Commemorative plaque of Shakespeare made of Bois Durci, c.1860. © Science Museum

Cast phenolic	see phenol formaldehyde
Celanese™	see cellulose acetate
Cellophane™	see cellulose acetate
Celluloid™	see cellulose nitrate
Chardonet silk	see cellulose nitrate
Clarifoil™	see cellulose acetate
Corian™	see polymethyl methacrylate
Crimplene™	see polyester
Cycolac™	see acrylonitrile butadiene styrene
Delrin™	see polyacetal
Diatite™	see shellac
Erinoid™	see casein formaldehyde
Ebonite	see hard rubber
Estron™	see cellulose acetate
Fibreglas™	see glass-reinforced plastic
Florence compound	see shellac
Formica™	see phenol formaldehyde resin and melamine formaldehyde
Galalith™	see casein formaldehyde
Gaydon™	see melamine formaldehyde

Glass reinforced plastic (GRP)
A composite material made of glass fibres and plastic, usually polyester.

Group:	thermoset
Developed:	during World War 2; first used in civilian life in 1950s
Trade names:	Fibreglas
Manufacturing:	compression moulding or fabrication: hand-laying in an open mould
Cost:	low
Colour:	any
Transparency:	translucent to opaque

Rigidity:	rigid
Feel:	hard
Smell:	none
Typical uses:	very large containers, boat hulls, car panels, sculptures e.g. by Claus Oldenburg and Philip King
Degradation:	relatively stable

Gutta percha

A hard substance exuded from tropical trees that softens in hot water.

Group:	thermoplastic
Developed:	introduced from Far East in1843; wide range of products shown at 1851 Great Exhibition, London; use falls off in 1930s
Production:	compression moulding; extrusion
Cost:	low
Colour:	dark, but sometimes painted
Transparency:	always opaque
Rigidity:	normally rigid
Feel:	old material is hard; modern gutta percha is often softer; dry-ish
Smell:	none
Other:	can look woody
Typical uses:	golf balls; dentistry; insulation for submarine telephone cables; household uses similar to those of tin; fancy mouldings
Degradation:	oxidises and embrittles, as a result mouldings are now scarce

Gutta percha golf balls from the early 20th century.
© Science Museum

Hard rubber — see vulcanite

Horn

Group:	thermoplastic
Developed:	moulding technology from early 17th century
Manufacturing:	compression moulding; thermoforming
Cost:	medium
Colour:	natural **horn** colour, typically dyed black; also imitations of tortoiseshell
Transparency:	translucent or opaque
Rigidity:	rigid but when thin flexes

Feel:	sometimes textured
Smell:	none
Other:	fibrous texture sometimes visible
Typical uses:	drinking vessels; buttons; combs; imitation jet jewellery; snuff boxes; cutlery handles; small translucent panels used e.g. in windows and lanterns
Degradation:	stress cracks; some distortion and shrinkage but otherwise stable

Ivoride™	see cellulose nitrate
Kematal™	see polyacetal
Lacqrene™	see polystyrene
Lactoid™	see casein formaldehyde
LingaLonga™	see urea formaldehyde
Lucite™	see polymethyl methacrylate
Lycra™	see polyurethane
Makrolon™	see polycarbonate
Melaware™	see melamine formaldehyde
Melmex™	see melamine formaldehyde
Mouldrite™	see phenol formaldehyde
NatureWorks™	see polylactide
Nestorite™	see phenol formaldehyde
Nylon	see polyamide
Oroglas™	see polymethyl methacrylate
Parkesine™	see cellulose nitrate
Peck™	see shellac
Perspex™	see polymethyl methacrylate
Plantic™	see polylactide
Plaskon™	see urea formaldehyde
Plastacele™	see cellulose acetate
Plexiglass™	see polymethyl methacrylate

Polyacetal

Also referred to as polyoxymethylene (POM) and polyformaldehyde

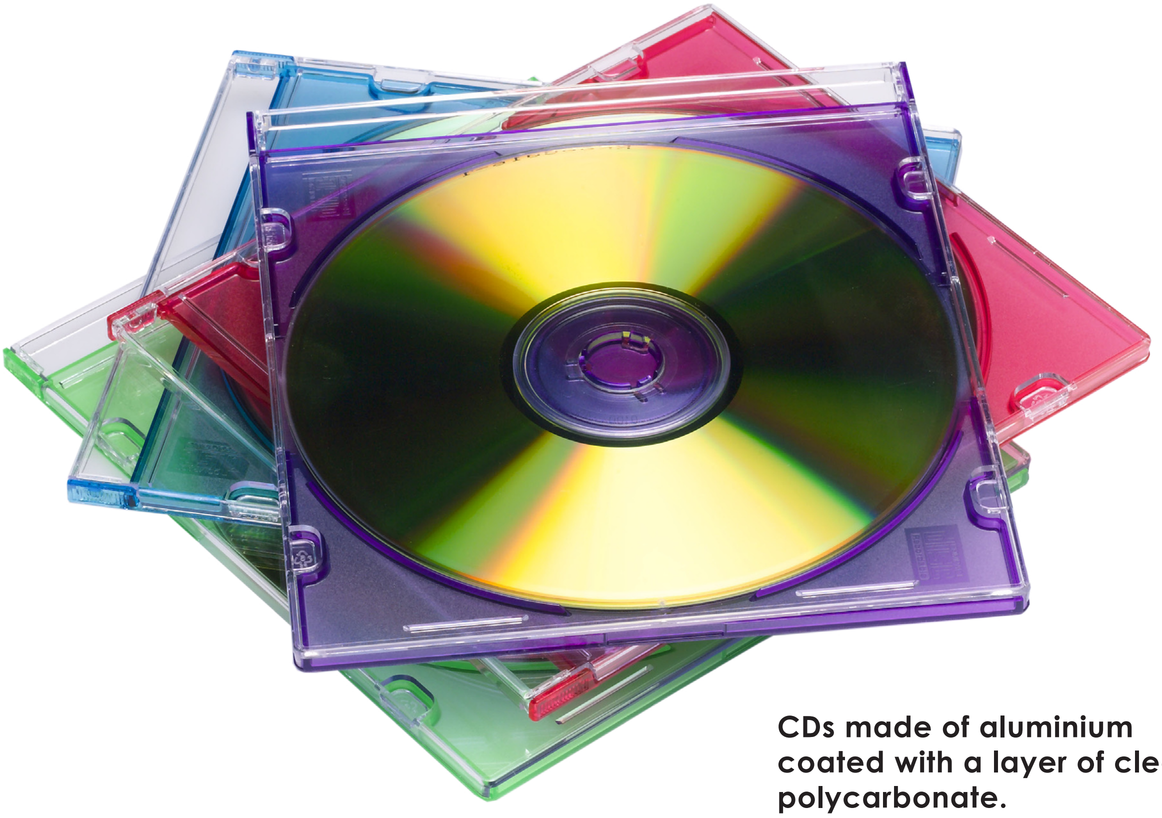
Group:	thermoplastic
Developed:	1957
Trade names:	Delrin; Kematal
Manufacturing:	extrusion; injection moulding
Cost:	medium
Colour:	naturally white, but any
Transparent:	translucent to opaque
Rigidity:	always rigid
Feel:	hard
Smell:	none
Other:	strong; recognised as the first 'engineering' plastic
Typical uses:	gear wheels and mechanisms; disposable lighters; bathroom taps; plectra and guitar picks
Degradation:	stable

Polyamide (PA)

Group:	thermoplastic
Developed:	1933; nylon trade name given in 1938
Trade names:	Nylon
Manufacturing:	extrusion; injection moulding
Cost:	medium
Colour:	all
Transparency:	transparent to opaque
Rigidity:	rigid to flexible depending on type
Feel:	varies; can be waxy
Smell:	none
Typical uses:	toothbrush tufts, combs, kitchen utensils, zips, Velcro; as textile fibres: carpets stockings, tents; glass-reinforced moulding compounds
Degradation:	discolouration, especially yellowing

Polycarbonate (PC)

Group:	thermoplastic
Developed:	from 1958
Trade names:	Makrolon
Manufacturing:	blow moulding; extrusion; injection moulding
Cost:	medium
Colour:	injection moulding
Transparency:	transparent to opaque
Rigidity:	rigid
Feel:	hard
Smell:	none
Other:	can be outstandingly strong
Typical uses:	safety and space helmets; compact discs and DVDs; as copolymer as mobile phone housings; car components; large bottles; glass substitute
Degradation:	stable but can crack



CDs made of aluminium coated with a layer of clear polycarbonate.
© Science Museum

Polyester
A category of polymer often used to describe its fibre form; a huge family of 'plastics'. See also polyethylene terephthalate

Group:	thermoplastic
Developed:	1941
Trade names:	Crimplene, Dacron, Terylene
Manufacturing:	as a fibre: extrusion
Cost:	low
Colour:	any
Transparency:	transparent to opaque
Rigidity:	flexible
Feel:	varies
Smell:	none
Other:	resilient, quick-drying, flammable
Typical uses:	clothing and upholstery; also from 1955 in sheet form as support for archival material
Degradation:	relatively stable

Polyethylene terephthalate (PET)
A polyester

Group:	thermoplastic
Developed:	1941 announced as a commercial polymer; widely used in blow moulded form from1980s
Trade names:	related film Melinex and Mylar

Manufacturing:	especially blow moulding; injection moulding
Cost:	medium
Colour:	any
Transparency:	transparent to opaque
Rigidity:	rigid
Feel:	varies
Smell:	none
Other:	strong
Typical uses:	carbonated drinks bottles; video and audio tape
Degradation:	relatively stable

Polyformaldehyde see polyacetal

Polyoxymethylene see polyacetal

Polypropylene (PP)

Group:	thermoplastic
Developed:	from 1956; increase in use from 1976 when initial patents ran out; became fashionable in translucent sheet form in 1990s; now one of the most used plastics
Trade names:	Propathene
Manufacturing:	blow moulding; extrusion (as a fibre); injection moulding;
Cost:	low
Colour:	any
Transparency:	translucent, but can have clarifying agents added making it trans parent; also comes as clear film (modern cellophane)
Rigidity	fairly rigid but flexible
Feel:	varies
Smell:	none
Other:	can be moulded to create an integral hinge; can achieve reasonably glossy surface scratches with fingernail
Typical uses:	chair shells and garden furniture; luggage; car bumper; petrol cans; food wrappings; microwaveable meal trays; margarine tubs; netting; household goods; carpets; packaging; rope
Degradation:	relatively stable

A Russell Hobbs kettle from 1996, made of polypropylene, which is tough and heat resistant. © Science Museum

Polystyrene (PS)

Group:	thermoplastic
Developed:	became a usable material in 1930s but not used commercially until after World War II
Trade names:	Lacqrene; Polystyrol; Styron
Manufacturing:	usually injection moulding; also extrusion; fabrication: especially cutting and sticking; foaming; thermoforming
Cost:	very low
Colour:	any, including streak and pearlised effects
Transparency:	transparent to opaque
Smell:	none
Rigidity:	always rigid
Feel:	hard, except when foamed
Other:	can be brittle but can be toughened, e.g. high impact polystyrene (HIPS); metallic ring when tapped; good for bonding
Typical uses:	disposable pens and razors; cutlery and vending cups; CD cases; yogurt pots; model kits; insulation and packaging food trays, hamburger and egg boxes, electronic equipment, when foamed
Degradation:	crazing and discolours

Polystyrol	see polystyrene
Propathene™	see polypropylene
Rayon	see cellulose acetate
Roanoid™	see phenol formaldehyde
Rubber	see vulcanite
Scarab™	see urea formaldehyde

Shellac

An excretion of tropical beetle mixed with fillers such as cotton flock, powdered slate, wood flour.

Group:	thermoplastic or set depending on heat used in manufacture Developed: known for thousand of years; used to make products from 1860s to 1940s
Trade names:	Diatite; Florence compound; Peck
Manufacturing:	compression moulding
Cost:	medium
Colour:	dark brown, black and occasionally paler dull shades
Transparency:	always opaque
Rigidity:	rigid
Feel:	hard
Smell:	sealing wax
Other:	brittle; capable of reproducing very fine detail
Typical uses:	cases for daguerreotypes and ambrotypes (early forms of photographs on glass); dressing table sets; 78 rpm records until 1948; as stiffening for bowler and riding hats; also used as lacquer
Degradation:	relatively stable

An octagonal Union case made of shellac, containing an ambrotype photograph, 1851.
© Science Museum

Silastic™	see silicon

Silicon

Derived from sand

Group:	usually thermosets
Developed:	discovered in 1934; used commercially from 1942
Trade names:	Silastic
Manufacturing:	injection moulding
Cost:	high
Colour:	any
Transparency:	translucent to opaque
Rigidity:	flexible
Feel:	soft and bouncy
Smell:	none
Other:	water-repellent; can be subjected to high heat without damage; bouncy; feels sensuous; softer than fingernail
Typical uses:	baking and ice trays; oven gloves; breast implants; baby teats; silly putty; micro-chips
Degradation:	relatively stable

Spandex™	see polyurethane
Styron™	see polystyrene
Tenite™	see cellulose acetate
Terylene™	see polyester
Tyvek™	see polyethelene

Vulcanite

Also known as ebonite and in USA as hard rubber. It is made from chemically altered natural rubber. The process involves heat and sulphur.

Group:	thermoset
Developed:	reaction when heated with a large percentage of sulphur to make it rigid discovered in 1839; still in use in 1930s
Manufacturing:	compression moulding; fabrication; turning
Cost:	medium
Colour:	typically black (fades to brown) but can also be red
Transparency:	always opaque
Rigidity:	rigid
Feel:	hard
Smell:	sulphurous rubbery
Typical uses:	match boxes; combs; fountain pens; imitation jet jewellery; denture palates (with pigmentation to resemble gums); pipe stems
Degradation:	often faded to a greyish greenish brown shade

Vesta matchbox, 1897, made of ebonite (or vulcanite). © Science Museum

Viscose — see cellulose nitrate

Xylonite™ — see cellulose nitrate

Appendix 3
Sources of further information and support

Australian Network for Information on Cellulose Acetate (ANICA)
www.nla.gov.au/anica
This network has formulated a national strategy on dealing with cellulose acetate collections, which could be applied to plastics more generally.

American Plastics Council
www.plasticsresource.com
The website includes a succinct history of particular plastics up to 1950.

British Plastics Federation
www.bpf.co.uk
The website of the leading trade association of the UK's plastic industry, especially good on materials and their histories and capabilities.

Canadian Conservation Institute
www.cci-icc.ge.ca
Includes technical bulletins that include care of plastic and rubber.

Collections Link
www.collectionslink.org.uk
Contains further guidance on Subject Specialist Networks as well as links to ICON factsheets.

Conservation by Design
www.conservation-by-design.co.uk
One of the specialist suppliers of conservation products, with good information on and products relating to absorbents and buffers.

Conservation Register
http://www.conservationregister.com
A site run by ICON to help you find specialist conservators in your area. The site also includes a succinct account of plastic conservation issues in the 'care of' section.

German Plastics Museum
http://www.deutsches-kunststoff-museum.de
A website which is a little hard to navigate but worth the effort for researching objects. Objects are grouped by materials and themes with good images and texts.

Italian Museum of Plastics
http://museo.cannon.com/museonew/UKmuseo/default.htm
Founded in 1985. The website presents 2,500 well-catalogued objects informatively through a range of themes.

Modern Materials in Collections: Scotland network
http://mmics.wordpress.com/
A Scottish network of curators and conservators which runs occasional conferences and events, covering both objects and contemporary art.

National Plastics Center & Museum, Massachusetts
www.plasticsmuseum.org
The museum is in the process of developing an on-line collections database: excellent so far as it goes but currently limited, plus a useful timeline.

Plastics Historical Society (PHS)
www.plastiquarian.com
The PHS publishes regular newsletters and a journal, as well as running events. It holds a library of specialist publications in the Institute of Materials, Minerals and Mining in London. The website includes a virtual museum. The website is especially good on the history and uses of plastics and their inventors/ manufacturers (up to 1965). It also includes a useful index of trade names/ materials/ manufacturers.

Plastics Subject Specialist Network
www.plasticsnetwork.org
A site created by the Bakelite Museum, Design Museum Collection (now the Museum of Design in Plastics), National Plastics Museum, and Plastics Historical Society in partnership. Includes the complete catalogue of the Museum of Design in Plastics and interesting case studies on a range of design related themes.

Appendix 4: Further reading

Included in this box:

Early plastics
Susan Mossman (ed.), Leicester University Press, 1997
Very readable and full of useful historical information. Large section devoted to a catalogue of the Science Museum plastics collection.

Conservation of plastics, materials science degradation and preservation
Yvonne Shashoua, Elsevier, 2007
Source for all that is required to keep plastic objects in prime condition and includes a history of plastics. Excellent for curators as well as conservators.

Plastics Collecting and Conserving
Anita Quye & Colin Williamson (eds.), NMS Publishing Limited, Edinburgh,1999.
Encompasses its subject comprehensively but succinctly with contributions from the key figures working in the field in the UK.

Other publications:

Classic plastics from Bakelite to high-tech
Sylvia Katz, Thames & Hudson, 1984
Authoritative history with good pictures of products made of plastic. Conservation advice aimed at private collectors rather than museums.

Early plastics
Sylvia Katz, Shire album 168, 1986
32 pages of essential information. Images black and white but nonetheless helpful. Care and repair section more suitable for private collectors than a museum.

Fantastic plastic, the kitsch collector's guide
Pete Ward, Quintet Publishing, 1997
Good for images of, in its own words, the 'wacky, crazy, eccentric, gaudy, tasteless' from the 1950s onwards.

The First Century of Plastics
M Kaufman, The Plastics Institute,1963
Comprehensive coverage of the history of early synthetic and semi-synthetic plastics, particularly Parkesine and Xylonite. One of the most authoritative books on the subject.

Material characterization test for objects of art & archaeology
N. Odegaard, S.Carroll, and W.S.Zimmt, Archetype Publications, 2000
Places plastics in the context of other materials. Provides detailed information on tests available. Perhaps for the more scientifically inclined.

Plastics
E G Couzens & V E Yarlsey, Pelican, 1941; updated edition 1968
Clear and concise on plastics and their use to date but of special interest as a pioneering attempt to bring a little known subject to a wider public.

The Plastics age, from Bakelite to beanbags and beyond
Penny Sparke (ed.), The Overlook Press, 1993
First published as the book of an exhibition held at the V&A in 1990 but hard to find in that version. Includes key texts by a wide range of thinkers and plastics experts mapping the intellectual territory.

Plastics Applied
V E Yarsley (ed.), National Trade Press, 1945
A comprehensive survey of the British plastics industry in 1945. Separate sections on plastics in domestic appliances, electric lighting, medicine and surgery etc.

Plastics: design and materials
Sylvia Katz, Studio Vista, 1978
Fulfils its title brilliantly bringing out the impact of the capabilities of different plastics on the evolution of form in design. A must for any museum with a design remit whether concerned with plastics or other materials.

Plastics and industrial design
John Gloag, George Allen Unwin, 1945
Historically interesting, giving an insight into the 'state of plastics' at the beginning of the post-war period. Gloag sets out some ground rules for the newly emerging role of industrial designer. Includes useful section on plastics, their properties and uses, and on manufacturing processes by Grace Lovat Faser.

Plastic: the making of a synthetic century
Stephen Fenichell, Harper Collins, 1996
Irreverent look at the social and economic revolutions brought about by plastic and how it has moulded and been moulded by scientists, artists, politicians and shoppers.

Plastics Materials
J A Brydson, Butterworths, 1989
Over 800 pages of plastics. Perhaps a little technical for the layman in places but still an essential reference book.

Simple methods for the identification of plastics
Dietrich Braun, Carl Hanser Verlag, 1982
Just what it says it is and includes a plastics identification table.

100 designs / 100 years, innovative designs of the 20th century
Mel Byars, RotoVision SA, 1999
Not a history of plastics but half the designs happen to be made of plastics or have plastic components.

1950s Plastics Design
Holly Wahlberg, Schiffer Publishing, 1999
Good for images of plastics in context but limited to plastics in the USA.

The World of Plastics
British Plastics Federation, 1962
96 pages on raw materials to plastic products and their impact on the environment, presented as a primer. Excellent introduction to the facts and issues.

If you have found other books, journals, websites or other resources that you would recommend for the study of plastics, please add them to FirstBASE, SHCG's online database of reference materials. See www.shcg.org.uk/firstbase

Appendix 5: Selected museums to visit

All social history museums will have plastics in their collections to some degree. The following have specialist collections or particular expertise in the field:

- Bakelite Museum, Williton, Somerset
  The largest collection of Bakelite on display in the UK.

- Design Museum, London
  High-end design collection, including many plastic design 'classics'.

- Museum of Brands, Packaging and Advertising, London
  Extensive collections of packaging and popular culture items such as toys and games.

- Museum of Childhood, London
  Extensive plastics in collections of toys, dolls and games.

- Museum of Design in Plastics, Bournemouth
  Located in the library of the Arts Institute at Bournemouth, MODIP offers a study collection of some 8,000 items of mass-produced design and popular culture.

- The Museum in the Park, Stroud
  Collection of items related to the Erinoid factory at Lightpill (making casein products).

- Science Museum, London
  Displays currently include Plasticity – 100 years of making plastics (until January 2009), and The Challenge of Materials gallery. Collections include some plastics manufacturing machinery.

- V&A, London
  High-end design, including plastic jewellery, and innovative uses of plastics in fashion textiles.

- Wakefield Museum, Wakefield
  Around 2,000 items from 19th century onwards, which have been surveyed and re-packed with HLF funding.

Appendix 6
Using the box for a one-day seminar

The contents of the box and the resources can be used as the basis of a wider one-day event, if you would like to deliver training to more curators in your region, or, for example, as a programme of basic collections care for volunteers and other non-curatorial staff.

The SHCG Seminars Organiser can offer advice on how to run a one-day event, and may be able to suggest contacts in your area for delivery. Below is a brief step-by-step guide of things you will need to consider. From experience, we recommend that one-day events accommodate no more than 25 people.

Content and delivery of the event:

- Consider who will deliver the day. Do you have conservation staff who would be willing to lead it? Or is there a local expert who could be bought in for a day?
- Consider whether you could add to the sample programme: are there any interesting and relevant conservation case studies or plastics collections in your region? Is there an aspect of a local industry or design history that you might wish to cover in more detail?
- Once you have identified who will deliver the day, fix a date according to their availability.
- A typical timetable might be:

10.00 Arrival and tea/coffee
10.15 Talk: the features and properties of plastics
11.00 Break
11.15 Handling session: identifying items from the box
12.00 Lunch
1.00 Talk: Collections management and cleaning
2.00 Handling/ viewing session: additional items from your collections/ the local social history of plastics/ particular industries
2.45 Break
3.00 Opportunity for delegates to bring own objects and discussion
3.50 Summary
4.00 Close

- Make sure that the speakers are briefed in advance on the content that you require and that they provide a handout or notes for delegates to take away.

Organisation before the event:

- Source and book a suitable size room. This will need sufficient chairs in lecture format, and space for up to four trestle tables for objects with room between them for people to gather around in small groups. You may also need to provide a data projector, screen and laptop depending on the speaker's requirements. A second space, or a clearly sectioned-off part of the room, will be needed if you intend to offer refreshments and lunch, to keep food and drink away from the objects.
- Consider accessibility issues before booking the room: will all delegates be able to use it, and get to an accessible toilet if needed?
- Cost the event. Consider the following possible expenses:
  - Room hire
  - AV equipment hire
  - Speaker's travel and lunch expenses (remember to ask them to provide a receipt). SHCG does not normally pay fees to speakers as this can make events too expensive for small museums to attend. However, a freelance expert may require some recompense for their time.
  - Refreshments and lunch for delegates. You can ask delegates to bring their own lunch if you are unable to provide this, but a tea or coffee and water is normally needed at some point!
- When you have assessed your expenses, you may have to consider charging a nominal fee for your event. Divide the total cost by the anticipated number of participants for a rough calculation of a break-even charge.

Promotion of the event:

- If you would like to promote your event to a wider audience, advertise on the SHCG website and email list. Your regional MLA may also have a news alert service.
- A sample booking form has been provided for you distribute prior to your event with any advertising. An editable version is available on the CD in this pack, for you to adapt to suit your needs. Remember to ask delegates in advance if they have any particular access requirements. Be prepared for requests for information in alternative formats.
- Once people have booked, you will need to provide them with a programme for the day and directions to your venue.

Organisation on the day:

- Provide a participant sign-in sheet and name badges.
- Provide a delegate pack, containing the programme for the day, any handouts, and evaluation sheets (download from the CD in this folder).
- You will need to nominate a person to act as convenor on the day. Their role will be:
  - To welcome and register delegates.
  - To inform delegates of housekeeping/health and safety issues of the venue.
  - To introduce the speakers and sessions.
  - To facilitate discussion sessions.
  - To collect evaluation forms at the end of the day.

Appendix 7
Sample booking form

The CD in this pack contains a version of this booking form in a word format, for you to edit to meet your needs.

Object Lessons 3:
An Introduction to Plastics

MLA MUSEUMS LIBRARIES ARCHIVES

Social History Curators Group SHG

This seminar will provide a hands-on introduction to the care and identification of plastics. Drawing on handling resources provided by the Social History Curators Group and the Plastics Subject Specialist Network, it will provide delegates with a basic understanding of how to identify and care for many of the types of plastic most commonly found in social history collections.

Venue: *(insert host venue here)*

Date: *(insert date of seminar here)*

Time: *(insert times of seminar here)*

Cost (including lunch): £*(insert cost)* SHCG Members £*(insert cost)* Non-members

LIMITED PLACES – BOOK NOW! We expect this seminar to sell out quickly.

Booking Form – Object Lessons 3: Plastics

Name: ______________________________

Workplace: ______________________________

Address: ______________________________

Postcode: ______________ Tel: ______________________________

Email: ______________________________

Are you a member of SHCG? Individual ☐ Institutional ☐ No ☐

Special dietary requirements:

____

If you have any access requirements, please give details on the reverse of this form or contact *(insert name and details of organiser here)*

I enclose a cheque for £________ made payable to *(insert account name here)*

Or Please invoice ☐ Purchase order no ___________

Please return the completed form and payment by *(insert booking deadline here)* to: *(insert name, address, and telephone number of seminar organiser here)*

Appendix 8: Evaluation form

Once you have finished using the loans box, it would greatly help SHCG if you could complete this evaluation form. Your comments will be used to help us plan future learning resources. You can photocopy this form, or print a copy off from the CD in this pack.

Object Lessons 3: Plastics

Evaluation Form

1. Please rate the following statements:

	Strongly Agree	Agree	Neither Agree / Disagree	Disagree	Strongly Disagree
I have a better understanding of the properties of plastics.					
I have increased my understanding of the common uses of different plastics in social history collections.					
I have increased my understanding of the care and storage of plastics collections.					
I have found new sources of information and support which might help me in the future.					
I have increased my knowledge of how to identify plastics.					
I feel I will be able to document plastics collections more accurately.					
Using these resources has increased my confidence about working with plastics collections.					
I found the resources inspiring.					
I will use the information I have learned in the workplace.					
I feel more able to interpret plastics collections in exhibitions and displays.					
I would like to get more involved in SSNs or other specialist groups interested in plastics.					

2. What was the most valuable part of the Object Lessons Resources?

3. How could we have improved these resources?

4. How did you use the resources?

Self-directed learning………………….. ☐ Group seminar…………… ☐

Other (Please specify) ….. ☐ ……………………………………………….

5. How long did you borrow the resources for?

6. What themes would you like us to consider for future handling resources?

7. Are you a member of SHCG?

Yes………………………… ☐ No………………………….. ☐

8. Any other comments or suggestions:

We would be grateful if you could take the time to complete this form. Please post your completed form to Zelda Baveystock, National Museums Liverpool, William Brown Street, Liverpool L3 8EN

Acknowledgements

This pack was written by Susan Lambert, Museum of Design in Plastics at the Arts Institute at Bournemouth, and edited by Zelda Baveystock for SHCG. Its structure and content has been discussed in an ongoing process with all those involved in the Plastics Subject Specialist Network, through a series of seminars and events. The content has been reviewed by 6 specialist reviewers with complementary knowledge in the field of plastics. Any errors that remain are, however, entirely the fault of Susan Lambert and Zelda Baveystock. If you find errors please send them to modip@aib.ac.uk and they will be corrected in the on-line version of the pack. Susan is most grateful to everyone involved for the generosity with which they have given of their expertise, ideas, and time, and for the marvellous support she has received throughout.

SHCG would like to thank also: Chris Liauw and Beamish North of England Open Air Museum for the generous donation of objects; Allison Roohi and Robyn Hughes at Northumbria University for packing the box.

Designed by Richard Chippington, Oojah Design.

Images supplied by: Science Museum, Cordelia Rogerson, Steve Akhurst, Wakefield Museum and National Museum of Wales.

For further information on SHCG and its activities, see
www.shcg.org.uk

Social History Curators Group SHG

MLA MUSEUMS LIBRARIES ARCHIVES COUNCIL

RENAISSANCE NORTH EAST