Packaging Design Principles

Small changes for a big impact

RECOUP

Leading a more circular plastics value chain

RECOUP is the UK's leading independent authority and trusted voice on plastics resource efficiency and recycling. As a registered charity, our work is supported by members who share our commitments including a more sustainable use of plastics, increased plastics recycling, improved environmental performance and meeting legislative requirements. We achieve these by leading, advising, challenging, educating, and connecting the whole value chain to keep plastics in a circular system that protects the environment, underpinned by evidence and knowledge.

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Researched and written by:

RECOUP Packaging & Recycling Team

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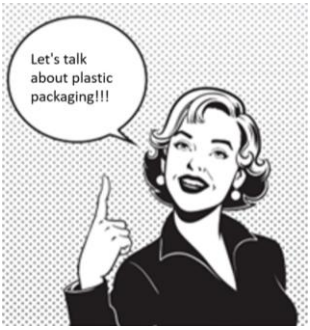
Plastic packaging



Plastic packaging comes in many forms, and we come across it in all aspects of daily life, but do we ever look at plastic milk bottles and wonder why they are the same colour or why are plastic ketchup bottles upside down? There are reasons why packaging is designed and manufactured in certain ways, and this is because packaging has a function, and needs to meet the requirements of the contents.

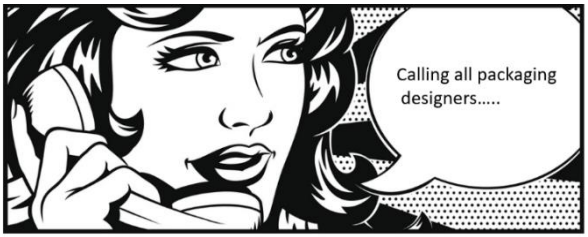
Plastics are a complex subject and there are many aspects to consider from the science and how polymers are formed. This includes sourcing the right materials and how they can be manufactured, adhering to current and new legislation relating to plastic packaging and finally ensuring the packaging, once disposed of, is captured correctly for further processing.

In recent years consumers will have seen many changes to the packaging in their weekly shop. This could be laundry products moved to flexible pouches, beverages from plastic to paper bottles, and fresh meat from plastic trays to plastic film, to name a few. Media pressure

and changing legislation has prompted packaging producers and brands to reduce plastic packaging and move to alternatives which are not always more sustainable and can come with environmental claims that are misleading for the consumer.

Packaging needs to be designed in a way whereby it can transport, protect, and preserve the product, but also be captured for recycling and processing and in some cases, this is not always possible.

Packaging design



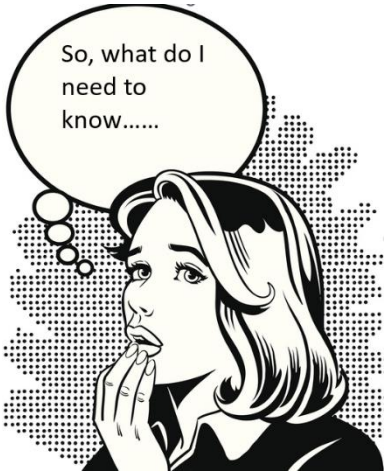
Packaging should be designed to satisfy technical, consumer and customer needs in a way that minimises environmental impact. This means that packaging should be designed to use the minimum number of resources but have the maximum scope for recovery to be recycled.

Design guidelines for plastic packaging are available to assist designers when making material choices for packaging. These guidelines prompt the user to pick materials and additional components that are compatible with mechanical recycling infrastructure.

These guidelines are produced to provide designers with a better understanding of the environmental impacts of their designs and promote best practice. They include polymer tables for rigid plastics along with film and flexible material tables.

There are a number of different versions that have been developed with experts from the industry. RECOUP's guidelines are regularly updated to reflect current practice, with input from an industry led technical steering committee.

Materials and increasing the ability to recycle packaging.



- ✓ PET & PP and PE are widely collected for recycling in the UK.
- ✓ Any other material may only be recycled in closed loop systems.
- ✓ Components of different materials need to separate in the float/sink process. The density of an object will determine if it floats or sinks, if an object is denser than the liquid it will sink and if less dense it will float. This is how different polymers are separated during the recycling process. PET has a density higher than water and therefore will sink while PE and PP has a density of under 1.0g/cm and will float.

Plastic packaging needs to be strong and resilient, able to withstand heat, cold, sunlight, handling and remain safe in all conditions.
In an ideal world all packaging would be fully recyclable and be:

- ✓ Mono material, made from one of PP, PE, or PET
- ✓ Contain no additives or colours.
- ✓ No sleeves or labels
- ✓ Be larger than 50mm in diameter.
- ✓ Contain no hazardous substances.

These criteria are not ideal as in the real-world packaging needs to contain information that includes branding, marketing, and mandatory information such as ingredients, nutritional information and best before dates. The packaging also needs to protect and preserve the contents and will contain additives and barriers to enhance flavour and prolong shelf life.

Additives and barriers

If packaging was made from just the polymers alone, they would not be able to carry out their role as packaging and protect the contents. The polymers are adapted during manufacturing with additives and other barrier properties to enable the packaging to be fit for purpose. Nearly every plastic is prone to degradation when exposed to UV light, from sunlight or fluorescent lighting. Without additives plastics can become brittle or lose colour and strength. These chemicals cannot be seen and do not affect the overall desired look of the packaging, but they do play a significant role in the life of the pack from it being filled to it being kept in the cupboard at home.

Additives in packaging include heat stabilisers, antioxidants, and UV stabilisers. They are added during the conversion and heat process of manufacturing or prepared as part of a masterbatch. Masterbatches are used in the process of packaging by way of incorporating colour or additives to polymers. It is usually in the form of small pellets.

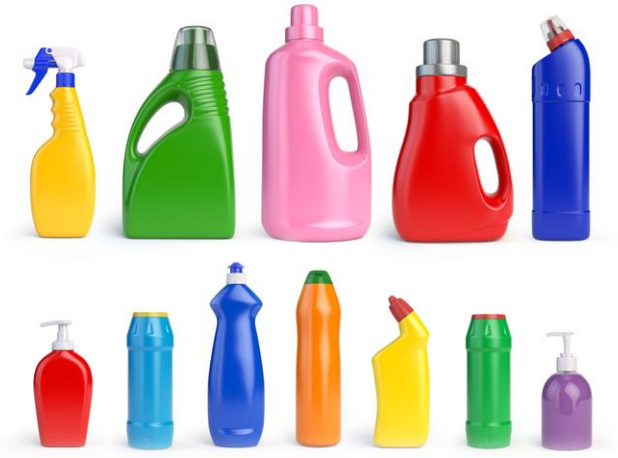
Although, on their own, most thermoplastics generally have good barrier properties, they cannot protect all areas especially when it comes to food packaging. For example, PP can provide an excellent moisture barrier but lacks an oxygen barrier and therefore additives are often required. Ethylene Vinyl Alcohol (EVOH) is a barrier that provides protection against oxygen and bacteria and is often used in

meat packaging. This and other barriers prolong shelf life and enhance flavour.

It is important when using additives in packaging to consider the following:

- ✓ It does not alter the density of the material.
- ✓ Use additives that have a lasting effect – i.e., foaming agents.
- ✓ Fillers should only be used in small amounts.

Coloured packaging



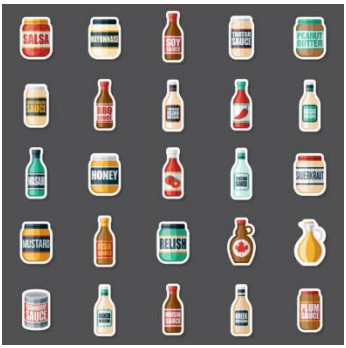
Colour is an additive that is added to plastic packaging and is also used for decoration on labelling. Small, coloured masterbatch pellets are added during the heat process. The carrier material (the material that

carriers the colour and additives) must be compatible with the main plastic in which it will be blended with during moulding.

Clear and natural materials are most valuable and have the most end uses. Coloured polyolefin (PO) packaging, PE, and PP is widely used and does have end markets. Coloured PET currently has limited markets for recycling.

It is important not to use a masterbatch that contains carbon black. This can often be found in dark colours and prevents packaging from being correctly identified and sorted for recycling.

Labels and decoration



Labels play a key role in the packaging of consumer goods. Everything we purchase from food, to clothing, DIY and home goods are all labelled. We use labels to identify our favourite products and brands and in turn brands use labels as a marketing tool to increase sales and brand loyalty. A high-quality label can be the difference between

getting the sale or not. It is also the first point of communication after the sale, helping consumers to use the contents correctly.

However, product labelling is not just about branding and product promotion, there is far more vital information that consumers take note of when they make purchases.

All prepacked food requires a food label that displays certain mandatory information. All food is subject to general food labelling requirements and any labelling provided must be accurate and not misleading.

That is a lot of information to fit onto a small surface and all of which can help to reduce food waste and encourage recycling.

Another requirement for labelling on packaging is to communicate disposal details for the consumer once they have used the contents and the packaging is empty.

Taking all the above into consideration there are still requirements for labelling and decoration that have to be met to ensure the pack remains recyclable:

- ✓ The label must not prevent the main material of the pack from being identified during sorting.
- ✓ The label or sleeve should be easily removed in the washing process during recycling.
- ✓ Materials used for labelling and decoration should be compatible with recycling.

- ✓ Inks should be EuPIA European Printing Ink Association approved and adhesive on labels should be water soluble and comply with guidelines. FEICA is the Association of the European Adhesive & Sealant Industry.

For recyclability and to ensure maximum recovery of packaging it is recommended that sleeves and labels should cover no more that 60% of the surface area of the packaging. More detail can be found in the RECOUP design tables. https://www.recoup.org/wp-content/uploads/2023/09/rbd-2022-1687261042.pdf

Know your symbols

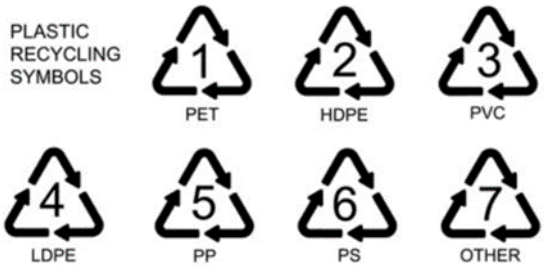
There are various symbols on packaging which all have different meanings. Not all of them refer to the disposal of the packaging which can often be misleading. A recent study from Sheffield University highlighted that on average a consumer spends 10 seconds reading a label on packaging which means clear, concise instructions are key to assisting recyclability.

On Pack Recycling Label (OPRL) does this by using clear, direct messages on packaging helping to advise the user on how to place the packaging in the correct bin.

Not all logos and symbols on packaging are clear …….

Resin Identification

It is normal to see the resin identification code on the base of packaging. These identify the type of plastic used to make it and were developed to ensure consistency in plastic manufacturing. There is no mandatory requirement to display these codes on packaging and they should not be used alone to determine recyclability of packaging.



The Mobius Loop

This symbol is recognised internationally on packaging and indicates that the packaging can be recycled. Although, it does not have any

official usage and does not demonstrate the material types or any recycled content within the pack.

The Green Dot

This symbol can often be mistaken for suggesting that an item of packaging is recyclable. Instead, the Green Dot indicates that the manufacturer has made a financial contribution towards recovery and recycling of the packaging.

Compostable Logo

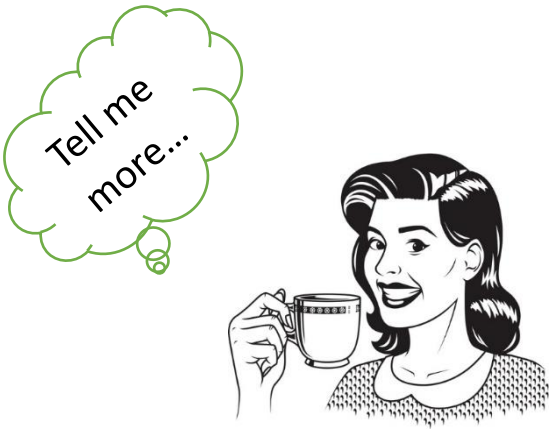
This logo indicates that the item of packaging is certified to be industrially composted according to European standards. Compostable packaging should never be placed in with kerbside recycling, it must be processed in the correct industrial composting facilities where it can break down. The logo below represents composting in the correct conditions.

Designs to be avoided

These are some of the materials and combinations that can impact plastics recycling as reported by waste management companies.

- ✓ Aluminium and metal closures on plastic bottles.
- ✓ Black plastic.
- ✓ Coloured, opaque PET bottles.
- ✓ Compostable, bio-degradable, and oxo-degradable plastics.
- ✓ Sleeves with more than 60% coverage of the packaging.
- ✓ Multi-layer laminates and PE sealing layers.
- ✓ Non-removable film lids.
- ✓ PVC sleeves and components.
- ✓ Silicone values used in PET bottles.

Material Sorting



Packaging that is collected kerbside is targeted at the primary packaging polymers, these being PET, PP and PE. These polymers can be mechanically recycled and can have a selection of viable end markets. Packaging, when disposed of, needs to be clean, dry, and loose to allow for efficient handling during the sorting stage.

Materials Recovery Facility (MRF)

The MRF plays a key role managing the waste stream, as it separates and prepares recyclable materials into single streams that can be sold on for further processing to be recycled.

The materials include:

- ✓ Plastic.
- ✓ Paper.

- ✓ Cardboard.
- ✓ Glass.
- ✓ Metals and aluminium.

The technology within a MRF is designed to separate materials based on a variety of characteristics:

- ✓ Size.
- ✓ Shape.
- ✓ Weight.

The system is designed to sort the materials by shape, both two-dimensional from three-dimensional. Two-dimensional can be paper and cardboard, three-dimensional can be bottles, cans, pots, and tubs.

There are three main phases in the MRF sorting process:

- ✓ Receiving materials.
- ✓ Sorting materials into their individual streams.
- ✓ Baling, storing, and shipping sorted materials.

The quality of the input material that goes into the MRF has an impact on the outputs. Poor quality materials and high levels of contamination lead to rejects and lower quality outputs.

Common contaminates include wet paper and cardboard, food residue, and unemptied bottles. Other non-target materials such as PVC and polystyrene (PS) is also rejected. Packaging that contains mixed materials and some sleeves and labels can also be rejected at this stage due to being unrecognisable as a target material.

Packaging design can have an impact on how material can be managed in a MRF and can dictate which stream materials end up in. Mis-sorting

of material can occur due to packaging that contains mixed materials that are difficult to separate, full sleeves and labels, dark colours and metallic inks that can hinder detection. These can result in material losses.

Plastic is sorted by near infra-red optical scanning (NIR) which can identify plastic from other materials. Once the infra-red optical eye recognises the plastic type an air jet separates the plastic ejecting into a plastics stream.

The MRF will sort the primary polymers from other materials. This is usually clear PET, PP, and HDPE. In some cases, a MRF will sort clear PET and all other mixed plastics on one line. Further sorting of the mixed plastic bales can take place at a Plastics Recovery Facility (PRF).

Further reading and research

Packaging buyers, technologists and specifers can download a copy of the RECOUP guidelines here: https://www.recoup.org/wp-content/uploads/2023/09/rbd-2022-1687261042.pdf

Each year RECOUP produces a set of case studies and fact sheets inspired by packaging trends and developments. The result is a growing library of insights and ideas to help inspire designers, manufacturers, and brands to refine their efforts to make recyclability easier and more accessible. They can be accessed using the link:

https://www.recoup.org/our-work/packaging-recyclability-and-design/

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