Material Substitution

MATERIAL SWITCHING AND THE EFFECT ON RECYCLABILITY

Recyclability by Design Case Study

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RECOUP

About RECOUP

RECOUP is a charity and leading authority providing expertise and guidance across the plastics recycling value chain. Built on a network of valued members, collaboration is central to RECOUP's activities. The organisation is committed to securing sustainable, circular, and practical solutions for plastic resources both in the UK and worldwide.

The content and analysis contained in this document is based on the information received. While every effort has been made to ensure the accuracy of the contents, RECOUP cannot accept responsibility or liability for any errors or omissions. Opinions expressed and recommendations provided herein are offered for the purpose of guidance only and should not be considered legal advice.

RECOUP works to maximise plastic recycling through stimulating the development of sustainable plastics waste management, including the improvement of plastics collection and sorting activities across the UK, undertaking research and analysis to identify good practices and remove barriers to the adoption of efficient recycling systems.

Written by:

Kate Bedford

Packaging Project Manager

RECOUP

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The role of packaging

Packaging is defined as "all products made of any materials to be used for the containment, protection, handling, delivery and preservation of goods from the producer to the consumer."

Packaging must provide protection and reduce product wastage.

The main function of packaging is to:

- ✓ **Contain**
- ✓ **Protect**
- ✓ **Preserve**
- ✓ **Inform**
- ✓ **Identify**
- ✓ **Transport**

With sustainability high on most companies' agenda's due to media, consumer pressure and changing legislation, there is a requirement to be greener, use less materials, pack goods in packaging that can be fully recyclable but at the same time they must continue to perform the main function of any packaging, which is to protect the contents of the pack.

Life cycle assessment and carbon foot printing are widely used in analysing product impacts. Understanding how to improve the footprint of a company is vital in the challenge to manage unintended consequences of climate change but the temptation to reduce everything to one measure must be resisted. The most suitable package is the one that fulfils the requested function and minimises the total impact of the product over the full life cycle. Choosing the right combination is crucial.

When packaging is assessed in isolation rather than as part of the overall supply chain, it will miss these effects and fail to improve efficiency of all operations. This reduces sustainability and can have a negative impact on a business.

There is no such thing as environmentally friendly packaging, packaging should only be considered in synchrony with its contents and in many cases the product can be more environmentally damaging than the packaging.

An environmentally responsible pack is one that uses the least amount of materials, minimal energy consumption, and generates the least amount of waste.

Each part of the supply chain for food packaging will have its own objectives to meet and these can clash with environmental impacts,

for example:

- **Retailers - want attractive packaging that is easily displayed, increasing sales yet has minimal environmental impact.**
- **Consumers - want quality products, in easy-to-handle, easy to read packaging that is recyclable.**
- **Sorting facilities - want clean materials with guaranteed end markets.**

Not forgetting the start of the supply chain where material suppliers, manufacturers, distribution, and storage, all of who's objectives will be cost savings, less energy used, larger loads, and quicker process times.

"It is important to remember Packaging does not have a life of its own. Packaging only exists to ensure goods arrive at the point of use in appropriate condition. If there were no goods, there would be no need for packaging" Dick Searle, Packaging Federation

Packaging and packaging materials have seen huge developments in recent years, and these include the technology available to manufacture packaging.

Social and demographic changes have also affected the way packaging has changed. The demand for convenience and easy to read packaging has increased due to an ageing population and the popularity of premium products that requires premium packaging.

Recently there has been a change of focus with the increased costs of food resulting in shoppers cutting back on spending habits, consumers will not necessarily be seeking out sustainable, recyclable packaging but more the price tag! It is vital that packaging performs its functions and can be recovered at end of life with little intervention from the consumer to make this possible.

Consumers will continue to purchase what they are familiar with and is within their budget, changes in packaging materials needs careful consideration as this can impact sales, brand reputation, and end of life use.

This case study will highlight plastic packaging that has recently been moved to alternative materials with limited knowledge of the full environmental impacts and understanding of the recycling industry.
It will particularly look at how these changes can affect the environment, consumer behaviour and the recycling process.

Understanding the recycling chain

1. Disposal

2. Collection

3. Sorting

4. Reprocessing

5. Recycling

There are five stages of recycling and for packaging to be recycled and manufactured into something new it must pass these five stages

1. Providing the consumer with reliable and accurate instructions when it comes to deciding how and where to dispose of used plastics is vital. Consumers need to be able to make informed decisions, safe in the knowledge that they are responsibly disposing of items and what the end destination for each material is.
2. Consistent kerbside collections for recyclable materials are a crucial step in the plastics value chain. If recyclable materials are not collected and sorted, then regardless of the recyclability of an item the resource could be wasted.
3. Sorting of materials is now largely completed using NIR technology which detects materials via laser. Components such as sleeves and labels left on bottles or pots means that recyclable items such as PET can be mis-identified and possibly leave the recycle chain and end up destined for landfill or waste to energy.
4. Consistent sorting of plastics is a crucial step in achieving true circularity. Contaminants such as adhesives and inks can affect the quality of the recycled materials making them undesirable to reproducers.
5. As pressure builds on producers to increase recycled content in their products the need for clean plastics is becoming more important.
   Clear plastics are more desirable and have higher value to producers.

Paper vs Plastics

Paper as a material had declined in food packaging, traditionally paper could be found as bags for fruit and vegetables, some confectionary and dried foods. In recent times paper as food packaging has made a come-back and can be seen as a greener option to plastics, however when looking closely much of the paper-based packaging found on the shelves today, although can look and feel like paper on the outside will contain a plastic lamination on the inside. This is because on its own paper has poor barrier properties, it cannot protect from light and oxygen and would result in the contents having a much shorter shelf life than packaging that contains added plastic laminates.

Although the reported advantages of paper as packaging materials are suggested as being better for the environment, e.g., biodegradable and breaks down in the natural environment much quicker than other materials, easy to recycle and biobased, all of this is irrelevant if it encourages food waste and littering. Paper that is heavily contaminated with food or is wet cannot be recycled.

Paper substitutes may seem like the greener option for packaging, but careful consideration needs to be taken when making material swaps.

When Iceland wrapped bananas in paper bands instead of plastic bags, the fruit rotted more quickly or snapped off. When it packed bread in opaque paper bags, sales fell as shoppers balked at buying something they couldn't see. When they punched holes in paper bags filled with potatoes to make the contents more visible, the bags ripped.[1]

Figure 1: Lifecycle of bananas without packaging

[1] www.wsj.com 17th June 2022
https://metro.co.uk/2019/07/22/iceland-reintroducing-plastic-packaging-bananas-card-solution-failed-10436720/

Shampoo and conditioner in paper packaging

Garnier have produced shampoos and conditioners in paper packaging with a HDPE (High Density Polyethylene) flip closure. The packaging is marketed as being:

Figure 2: Paper packaged conditioner.

"Greener sciences and formulas"

"More eco-designed packaging"

"More renewable energies"

"75% less plastic with tube made of cardboard"

Figure 3: Paper packaged conditioner

The first thing that comes to mind is paper in a shower equals mush! So, what is the science behind it?

On inspection from the outside the packaging is multi-material, the HDPE closure cannot be separated from the main body

of the pack.

The inside of the packaging is laminated with a plastic. As paper has poor barrier qualities the plastic is required to protect the contents from light, heat, air, and oxygen but also protects during use to prevent the outer paper from becoming wet and soggy. The paper and laminated layers are held together with adhesives.

The messages on the back of this packaging to the consumer are misleading as it highlights how green and environmentally friendly the packaging is but there are no instructions for its disposal and the reason for this is because the packaging could not be recycled mechanically due to its multi composite materials and parts that cannot be removed.

So, in effect this becomes a single use item!! Like most bathroom products that lack on pack advice for after use, end up in the general waste bin.

The meat tray

In some cases, fresh meat trays have also had a material makeover. A fully recyclable clear PET (Polyethylene Terephthalate) tray has been replaced with a cardboard, plastic laminated tray. Rather than switching materials, this is adding materials.

A cardboard tray alone could not protect fresh meat, so to extend shelf-life, protect from oxygen and bacteria and keep the meat looking fresh on the shelf, plastic is required.

Figure 4: Original PET tray with sealing layer and top film, made with 95% recycled materials.

Figure 6: Cardboard laminated tray.

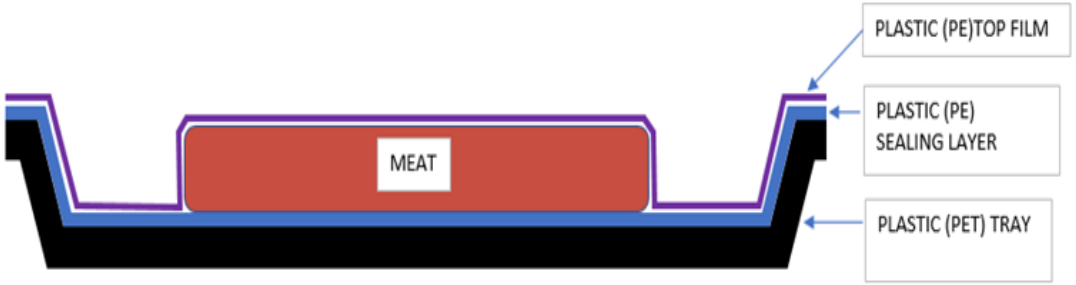

Figure 5: Original PET tray cross-sectional diagram.

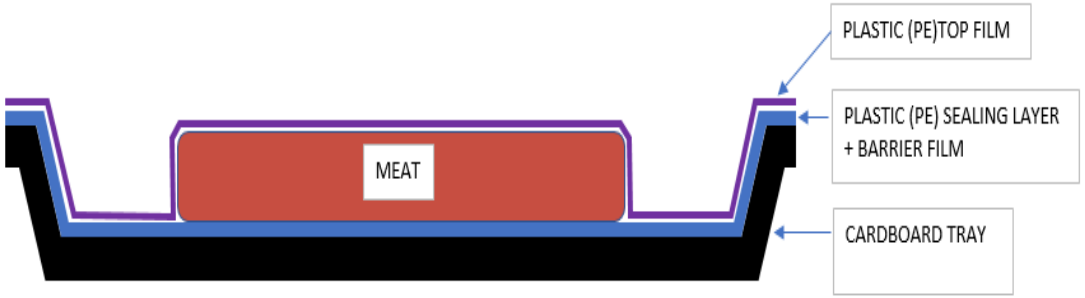

Figure 7: Cardboard laminated tray cross-sectional diagram.

The plastic tray is fully recyclable without any required consumer action; however, the cardboard tray is only recyclable if the consumer separates the plastic PE laminate from the cardboard base. On inspection and trial, the plastic laminate is very difficult to remove and separate from the cardboard tray, after food use this would be messy, wet, and especially difficult for the elderly. But it is also not obvious, when glancing at the black cardboard tray many users would not take note of the plastic laminate or that it is multi-material and needs separating and would most likely discard the packaging as it is after use.

Research and history have shown that consumers will, in most cases, not alter packaging after use to make it recyclable. If the consumer does not remove the plastic PE laminate, it cannot be recycled and may contaminate other material streams.

Glass into paper

There are many examples of material switches for packaging into paper and not just from plastic. Some beer and wines traditionally in glass have also transitioned into paper packaging. These moulded paper pulp bottled shaped containers are laminated with a plastic liner on the inside. This packaging will have a closure system made from other materials and some will contain an inner bag usually made from PE (Polyethylene) to contain the liquid and prevent the outer packaging from becoming soggy and unstable. These packaging formats are marketed to highlight the comparisons between glass as a primary material and their benefits to the environment but what is so often overlooked is the disposal and end of life options.

There are also claims about this packaging being bio-based which for some consumers would mean it breaking down in the natural environment, which is not the case as this is thermoformed paper which is a composite material of plastic laminates and barrier properties that would not break down naturally.

The CPI (Confederation of Paper Industries) recommend no more than 5% plastic on paper substrates.

Most paper mills would prefer not to receive plastic laminated board and designers should restrict plastic content to 5% of pack weight as a maximum, although the paper industry would prefer any more than 3% by weight.

The closures would need to be removed prior to disposure along with any plastic bags inside the bottles, this would need consumer action to make the packaging have any chance of being recovered for recycling. This can be confusing when for many the recycling message has always been tops on bottles or do not remove lids.

It is important that businesses research across the entire journey of the pack's life, these packaging formats would require feedback from the users before its launch. How is the packaging perceived by the consumer, what is their reaction to the image, the feel, the materials, how would they dispose of the packaging, do they think its fully recyclable as a whole and how do they feel about having to break down its components before disposal?

Often the impact of packaging production is the main focus when considering environmental factors, but this can result in unintended consequences when the packaging cannot be recovered for recycling.

In a Materials Recovery Facility, the material is sorted as 2D and 3D shapes at primary separation, this is usually automated, 2D items – anything flat, paper, card and newspapers are separated from 3D materials such as bottles, containers, and cans. Paper packaging even though bottle shaped will be crushed and compacted during collection, this results in plastics in the paper stream and likewise if a paper bottle is carried through as a 3D item it will reach the infra-red technology looking for plastics and be rejected.

Packaging should take into consideration recommendations from design guidance "Recyclability by Design "on how to maximise recyclability and end of life opportunities.


Figure 8: Examples of paper packaging that contain plastic inserts, plastic closures, and plastic pumps

The milk debate

The milk debate has historically always been about glass vs plastic in the UK. Traditionally milk was sold in returnable, refillable glass bottles delivered to the doorstep. However, lifestyles and consumer purchasing habits have changed and doorstep deliveries now account for only 3%[2]. Sales through retail outlets, at cost prices now dominate the market. This shift has allowed the use of lighter-weight plastic packaging, HDPE (High Density Polyethylene) because it does not have to be made strong enough to survive the pressures of a return/cleaning/refill system.

Figure 9: Traditional glass bottle.

The benefits of HDPE for bottles, in place of glass, are obvious, due to the lightweight nature of the HDPE and cutting the costs of transportation while retaining all the strength. In addition, the material is highly recyclable, because it can withstand the stresses involved in being collected, sorted, chopped up into flake and then recycled in large quantities.

The HDPE milk bottle that we are familiar with in supermarkets contains a small HDPE label that is easily removed and an HDPE screw cap. It is important to note that it is MONO MATERIAL!!

Figure 10: HDPE bottle.

Around 85%[3] of all the rHDPE milk bottles recycled goes back into dairy bottles (around 20K tonnes per annum). These milk bottles are targeted by sorting facilities, baled, and sent back to the re-processor to make new milk bottles.

More observant shoppers may have also noticed a subtle change in the colour of milk bottle tops over recent years.

The vivid green colour used for semi-skimmed milk bottle tops had become an issue for the reprocessing and recycling industry. The green pigment used affected the recyclability of the cap and the bottle.

But a subtle change to the colour has made a huge impact in the recycling stream.

The bottles are sorted, washed, and chopped to form HDPE flakes. These flakes are sorted by optical sensors to separate white from coloured.

[2] https://www.dairyuk.org/the-uk-dairy-industry/

[3] Biffa Polymers

However, as the flake passes through the reprocessing facility at high speed, even a small proportion of the green coloured flake can affect the quality, and therefore the value of the pellet produced by the re-processor.

So, since in the UK the majority of the milk we use is semi-skimmed, the result was green tinted HDPE pellets.

A project worked to persuade the supermarkets to improve the colour of the bottle tops, which would in turn help to improve the percentage of recycled material used in milk bottles.

There was a compromise reached, and the tops are now less intensely coloured. This slight change in colour, while retaining the colour code that distinguishes full fat from semi skimmed and skimmed, has allowed more HDPE milk bottles to be economically recycled.

Figure 11: Cartons in store at Morrisons.

However, at the time the supermarkets would not agree to white bottle tops but more recently one supermarket has taken this a step further. Waitrose has teamed up with Muller to trial clear tops on plastic milk bottles. The move will allow the lids to be completely recycled along with the bottles back into food grade pellets. This means the consumer will identify the milk type by the label colour rather than the colour of the cap.

But today the debate has widened with Supermarket chain Morrisons moving their milk out of HDPE bottles to Liquid fibreboard packaging.

Cartons which are used for milks, juices and soup are primarily made from paper, they will have a plastic laminated layer and/or aluminium. These three materials are layered together using heat and pressure to protect the contents from light, oxygen, air, and moisture. The aluminium layer being the thinnest does not come into contact with the contents and is there to protect against oxygen and light and maintain the flavour.

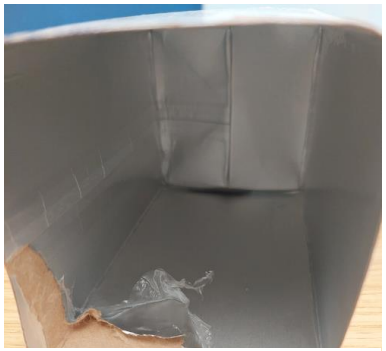

Figure 12: Inside of carton packaging.

In 2020, there were two common groups of cartons which have the following composition (by weight):

1) 75% Paper/Board, and 25% Plastic.

2) 75% Paper/Board, 21% Plastic and 4% Aluminium[4]

Liquid Fibreboard Packaging which contains a foil lining are often for long-life products such as UHT milk. This fraction usually accounts for around 4% of the packaging overall by weight. For the purposes of any analysis of a carton this is an important distinction, as the impact of the metal element of a carton has a significant impact on its overall environmental impact as a piece of packaging.

[4] Taken from a RECOUP independent report

Tetra packs and similar cartons are only collected by a small percentage of Local Authorities kerbside in the UK and is very often **not** a target material in sorting facilities. These would normally need to be picked manually from the sorting line.

Only one site is known to collect and have the technology to process Liquid Fibreboard Packaging on a targeted and significant scale and this is ACE UK, whose facility is based in Halifax, England, it should be noted that whilst the overall UK infrastructure capacity may be able to handle the amounts placed on the market each year, these sites do not necessarily run to full capacity. This may be due to several factors including quality and quantity of feedstock, or other commercial drivers and end markets.

Comparison Summary

The High-Density Polyethylene (HDPE) Milk Bottle

- Easily recognised by consumers as a recyclable bottle
- Collected by all 379 Local Authorities in the UK
- Efficiently sorted and detected in all UK MRF'S
- Has a proven and established closed loop process and end market

Liquid Fibre board packaging for milk

- Not easily identified by the consumer
- Not a target material for most MRF's
- Not collected kerbside by all Local Authorities
- Only one site in the UK with technology to handle liquid fibre board packaging

'YOU CANNOT PASS ON THE RESPONSIBILITY TO THE CONSUMER TO MAKE PACKAGING RECYCLABLE.'
STUART FOSTER - RECOUP

July 22 - World's First Tequila in Paperboard 'Bag-in-Bottle' Design

Based on Frugalpac's design, 77% less plastic, 94% recyclable paperboard outer - here is an example whereby packaging only has a chance of being recovered for recycling if the consumer follows the recommended steps below.

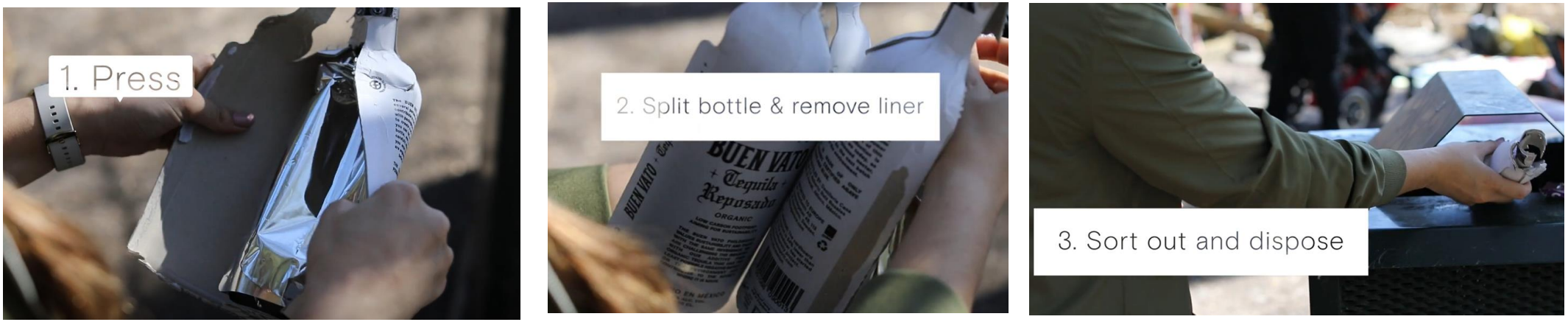

Figure 13: Tequila in a paper bottle

Recent material switches

Figure 14: PET tray with top film

Sainsburys have made a material switch for stir fry vegetables. Moving from a mono PET tray with a film top seal to flexible packaging.

The PET tray is collected kerbside by 87% of Local Authorities in the UK and has an established sorting and re-processing stream, flexible packaging is only collected by 13% of Local Authorities and does not have an established sorting and re-processing stream. The recycling instructions on the bag state “recycle with bags at large supermarkets.” A PET tray which can be used and recycled from home and re-processed has now become a bag that needs depositing at a collection point with currently no proven route for mechanical recycling.

Figure 15: Flexible packaging.

Figure 16: Card tray with film flow wrap

M&S have swapped a range of their tomatoes from a card tray with film flow wrap into luxury card packaging. This material swap can have an impact early in the supply chain. The original packaging containing the film flow wrap and card tray, would be much lighter to pack and transport than that of the heavier card box. It is cheaper to manufacture and uses less energy. This packaging can also be easily separated by the consumer allowing the materials to be separated into the correct streams. The card packaging is multi-material containing a plastic window which is not removeable making the recycling process more complex than it needs to be.

Figure 17: Card box with plastic window

Summary

There are many elements to consider when designing and re-designing packaging and above anything else its contents must be protected to withstand all the stages of the supply chain. All materials must be assessed in isolation and justification as to why material switching is necessary, there are areas where alternative materials are unrealistic, for practical, pricing and end of life reasons.

Packaging today contains many green claims, from “recycled content”, “bio-based”, “lower carbon footprint”, “made from sugar cane”, but does the consumer fully understand what these mean, as an industry we are aware of the UK plastic packaging tax and the 30% recycled content legislation but does the consumer and is it relevant to them to have this information on pack and will it make a difference over their decision to purchase? Very often the user is left to their own devices when trying to evaluate such claims which can result in incorrect disposal.

Packaging needs to be free from such claims which is relaying incorrect and irrelevant information, the messaging should be clear to enable the user to dispose of in the correct collection system. Packaging can have a positive impact on the environment by reducing food waste, using recyclable materials, and being recycled back into new packaging. Education and clear concise messaging on packaging is key to avoiding consumer confusion.

Although the manufacturing of packaging and its impact on the environment remains in the spotlight it is important to be realistic with new packaging designs to ensure the end life is not overlooked and that packaging can be handled avoiding obstacles to recovery, improving yields and producing less waste.

Following guidelines will help minimise the costs to companies in satisfying recycling obligations under European legislation and national agreements by maximising recycling efficiencies and minimising reprocessing costs. For existing plastic packaging, current portfolios should be reviewed against recycling guidelines, highlight where the design could be improved and then implement changes, as the opportunity arises.

RECycling of Used Plastics Limited (RECOUP)

1 Metro Centre, Welbeck Way, Woodston, Peterborough,
UK, PE2 7UH

Registered Charity No: 1072029 & Company Registration No: 02435729

t: +44 (0)1733 390021 e: enquiry@recoup.org

w: www.recoup.org