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Creative upcycling: reconnecting people, materials and place through making

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Abstract

Short 'product lives' and disposable packaging result in premature disposal of valuable resources. Industrialisation, mass production and global supply chains have resulted in a disconnect between people, places, materials and design. Upcycling is reuse of discarded materials which results in an increase in 'value'. We discuss the potential for creative upcycling to reconnect people with materials and establish cultures and communities of making. The reaction of the public to creative reuse is explored by creating a café structure made entirely from recycled materials, and this provides the starting point to consider the contexts in which upcycling occurs, the motivations for (and barriers to) reuse and upcycling, the potential benefits of upcycling in the context of affluent Western 'consumer' societies, and the scope for designers to imbue objects with the potential for creative reuse. We argue that designing to enable creative upcycling allows the future lives of objects to be contingent on context and culture, rather than being prescribed by the designer, with potential for widespread social, economic and environmental benefits.

Keywords: Upcycling, creative reuse, making, context, design, potential.

1 Introduction

1.1 Consumption

Current resource use is unsustainable and there are widespread concerns about the implications of continued economic growth and resource consumption (Meadows et al., 2005), including the scarcity of raw materials (Andreas R. Köhler et al., 2013) and energy, environmental degradation, and anthropogenic climate change (IPCC, 2014). Up until the nineteenth century *'everything one owned was cherished, taken care of, and used to the very limits of its utility'* (Fromm, 2013). In the decade following the Second World War mechanisation and automation of production, for the first time, enabled production of consumer goods from refrigerators to cars to exceed demand. At the same time, technological development had slowed and product reliability had increased, reducing the need for upgrade and replacement. The American economy relied on continually increasing production, exemplified by the Ford Motor Company, to provide the 'growth' that is fundamental to the functioning of modern capitalist economies. 'Marketing men' in sectors ranging from household goods to motorcars looked enviously at the clothing fashion industry with new styles driving purchasing long before products were worn out. The solution was 'planned obsolescence' in its many forms – functional, aesthetic and technological (Lilley et al., 2016; London, 1932; Packard, 1967).

Where previously products were designed to be serviced and maintained indefinitely, the concept of an (increasingly short) 'product lifetime' was created. The 'throw away' culture had arrived, and would expand to almost every type of product and spread around the globe for the subsequent half century (Cooper, 2005). Even the language of purchasing goods in the English language changed with the rise of the *consumer*. The word *'customer had always implied some degree of regular and continuing relationship to a supplier, whereas consumer indicates the more abstract figure in a more abstract market'* (Williams, 1985). In contrast, consumption is derived from the French *consommere* – to take up completely, devour, waste, spend (Williams, 1985), which seems apt for the take-make-waste economy. This model offers product owners no incentive to learn how products work, and discourages regular maintenance and mending (Graham and Thrift, 2007; Gregson et al., 2009; Salvia et al., 2015). In this way, the design and manufacture of products has introduced a generational shift in how people think about the products they buy and use. These cultural shifts have acted to increased resource use with negative environmental consequences. In this paper, we argue that one approach to changing these wasteful trends is for people to nurture new kinds of relationships with their possessions – creative, productive relationships.

1.2 Approaches to resource efficiency

Current approaches to increasing resource efficiency focus on recycling and a Circular Economy (Ellen MacArthur Foundation, 2013b; The Great Recovery, 2013a, b). This can be effective when materials are truly recycled, as opposed to down-cycled with a related loss in material quality, material purity and material value (Bjørn and Hauschild, 2012; McDonough and Braungart, 2002). The circular economy (Figure 1) strives for the decoupling of production from material inputs, but recycling consumes significant amounts of energy in transportation and processing, as does manufacturing using the recovered materials (Cooper, 1994; Ross and Evans, 2003): *'the delinking of effluence from affluence remains elusive'* (Cooper, 2005). Incremental gains in efficiency are insufficient to address global concerns related to economic growth, rapid urbanisation and climate

change. With continued economic growth anything short of absolute decoupling will be obliterated by exponential growth and rising population (Hobson, 2013; Meadows et al., 2005). One approach to minimise environmental impacts is to combine circular material flows with slower throughput, which extends and slows cycles of consumption (Botta, 2016) and has direct parallels with the *slow food* and *slow research* movements (Adams et al., 2014; Jones et al., 2003).

Figure 1. The Four Design Models, reproduced from (The Great Recovery, 2013b). To maintain economic growth these circular flows of materials must move ever faster, with associated negative environmental impacts due to transportation, processing and remanufacturing. By engaging citizens with reuse of materials, these cycles could be slowed and extended into the 'oval economy'.

Even if technical advances are sufficient to achieve the utopia of absolute decoupling (Costanza and Kubizewski, 2014), how does this continuing pursuit of Gross Domestic Product (GDP) affect the people engaging with the circular economy (Hobson, 2015)? Recent approaches to transitioning to a circular economy have primarily been 'top down', aiming to inform and influence designers, manufacturers and 'waste' (resource) management companies (Ellen MacArthur Foundation, 2015; The Great Recovery, 2013b). As ownership and disposal gives way to leasing, maintenance and remanufacturing, it is proposed that the role of the citizen changes from 'consumer' to 'user' (Macarthur, 2013). The citizen is further removed from the material world on which they rely, with once treasured possessions becoming depersonalised services with no scope for care, maintenance, graceful ageing or pride.

In this article, we argue that there is potential to contribute to resource efficiency whilst slowing material flows and engaging people with waste, materials and making, enabling communities to share resources and skills, and providing economic benefits to individuals and new, local enterprises.

1.3 Upcycling

The term *upcycling* originated in the 1990s and means '*reuse (discarded objects or material) in such a way as to create a product of higher quality or value than the original*' (Oxford English Dictionary, 2016; Wegener, 2016). Upcycling activities are influenced by the particular social, economic and

political context in which they take place. Two extremes are upcycling driven by necessity to meet basic human needs, for example using waste materials to construct shelters in informal settlements, and upcycling as an art or craft to make objects of beauty. Whilst the motivations of art and survival are distinct, this is not to suggest that reuse driven by necessity cannot be carried out with great skill and aesthetic quality. The economic, cultural and geographic context in which upcycling takes place influences the availability of raw materials, the end goal, and the creative influences and skills which shape the manipulation and re-purposing of the materials.

New products and packaging are precisely designed, engineered, manufactured and marketed; yet from the moment of purchase their monetary value drops. Virtually all products, from cars to mobile phones and clothing, are released at the point of purchase into a roller coaster value ride as tastes change and fashions are dropped or re-invented (Chapman, 2013). In this article, we focus on product packaging as an exemplar of material objects that, whilst carefully designed and manufactured, in affluent societies have very short life spans and little status as objects of value in themselves. Once packaging has been removed it has served its purpose and is discarded, even though it has not degraded and is still fully functional. Why are high quality materials discarded in this context, whilst simultaneously new products are purchased? Could these materials be upcycled into useful objects, tailored to the requirements of the individual?

In this article, we describe a public engagement research method that involved inviting people from a range of Newcastle-upon-Tyne communities, and academics from across Newcastle University, to discuss their relationships with packaging materials in a café built entirely from materials usually regarded as waste. In the process of trading coffee for conversation, the research team explored the cultural relationships people local to Newcastle have with these kinds of material objects. Unlike the usual focus on how best to separate and extract material resources from waste, this project focused on the socio-cultural-economic aspects of human-material object relationships and the power that inspiring, innovative design solutions have to prompt imaginative new solutions to reducing resource wastage. We focus on identifying the social, cultural, political and economic barriers that obstruct widespread upcycling in affluent societies, and the opportunities that are available if these barriers can be overcome.

2 Current upcycling practice

2.1 *Ad-hoc upcycling – unintended second lives*

Upcycling is not a new activity but has always been a part of human life. We could argue that when the first prehistoric people inhabited the earth, their crafting of tools from flints and bone or the fashioning of shelters from local vegetation was a kind of upcycling. In many parts of the world, millions of people with very limited resources practice the creative reuse of other peoples' waste as a means of survival to provide 'informal housing' (Das, 2012). People are dependent on the availability of natural and manufactured resources available to them in their local area. While some people may purchase resources, others may gather local supplies of stone, sand and wood or scavenge for manufactured items that are deemed by some to be worthless and so can be obtained without cost, however remain a resource (Tevera et al., 2004). In the favelas of Brazil for example, plastic water bottles and polythene are readily available and therefore the materials of choice to build structures. This can be contrasted with upcycling activities that take place in more affluent cultures and at a small 'craft' scale, for example making jewellery from circuit boards or other

discarded items (Figure 2). During World War II, upcycling activities were strongly encouraged by governments and supported a wider drive to optimise the use of limited resources (Witkowski, 2003). In particular, textile scarcity resulted in the innovative use of rationed cloth and worn-out clothing, eliminating waste and increasing its creative reuse. Despite the diverse motivations for the upcycling activities described above, they share a characteristic that we describe as ‘ad-hoc’ upcycling – the materials and objects that are being repurposed were not designed to be upcycled.

Figure 2. Informal housing created from available waste materials (left)[†], and jewellery crafted from waste circuit boards (right)[‡].

Clearly, the context of these upcycling activities and the motivations driving them are fundamentally different. We argue that promoting upcycling cultures requires a sound insight into the different sets of human motivations and values in play, in different temporal and geographical contexts. At one time, ideas for upcycling were shared in the press and by word of mouth, especially in times of war. Today websites such as www.co-product.org and www.ikeahackers.net provide a global inspiration, providing detailed instructions for household scale upcycling with scope for people to make beautiful, high value objects from waste. Despite the availability of these resources, and good availability of ‘domestic material resources’ (including both waste packaging and discarded household objects that are regularly discarded at ‘household waste recycling centres’), upcycling remains a niche activity (Sung, 2015) and greater adoption of upcycling will require a ‘*shift in cultural perceptions*’ (Richardson, 2011). Key questions we consider are: Why would affluent people create new objects from waste materials? What would motivate individuals to do this, and what are the potential benefits?

Upcycling projects often require specialist skills, equipment, tools, space and time (Coote et al., 2010) (e.g. salad spoons made from cut glass bottles, Figure 3). The Italian cardboard desk lamp solves many of these issues with use of easily available materials, a shared ‘open source’ design, and also provides scope for a small business to provide an upcycling service for those who feel that they lack the time, skill or inclination. The use of a pizza box to make a lamp introduces issues of cleanliness and hygiene, so called ‘contaminated interaction’ (Baxter et al., 2017), which can act as a barrier for upcycling many forms of waste, or limits the application of the upcycled objects.

[†] <http://www.npr.org/2011/05/17/136370629/southeast-asian-slums-network-for-housing-rights>

[‡] <https://www.treehugger.com/style/circuit-breaker-labs-recycled-circuit-board-jewelry.html>

Figure 3. Spoonboozer (left) – high quality salad spoons made from glass wine bottles require specialist tools (diamond circular saw, ceramic disc sander, sandblaster & lathe) and skills (www.co-oproduct.org/remake/details/30/273); Cardboard LED lamp made from a pizza box (www.fatello.com).

Larger objects such as furniture provide scope to create objects with high monetary value, with wood being relatively easy to work without specialist equipment. Two Ikea stools can be transformed into a balance bike or a sledge (Figure 4), creating objects which would cost substantially more to buy than the original stools.

Figure 4. Two wooden stools from Ikea transformed into a balance bike or sledge, enabled by 3D printing key components. All images reproduced from <http://www.designboom.com/design/ikea-frosta-stool-bicycle-hack/>.

The 'Ikea stools' (Figure 4) project highlights several barriers, and potential enabling strategies, to the widespread adoption of upcycling. As is common practice, the designs have been shared openly on the internet, making them accessible, but lacking any assurance that the resulting objects are safe or fit for purpose. To convert the stools into the bike requires some tools and expertise, but these are limited to cutting and drilling wood. If the stools had been *designed with the intention that they may be creatively upcycled*, a series of holes could have been pre-drilled to enable them to be recombined in different configurations. Some new components are required (orange parts in Figure 4) and these have been 3D printed. This technology is rapidly becoming more accessible to the public, and can help to democratise the manufacture of objects (Tanenbaum et al., 2013). Finally, how many people who want a bike or sledge have two spare stools that they no longer need? This highlights the importance of sharing or trading waste and resources within communities.

Lack of time is a clear barrier to carrying out creative activities in affluent 'cash rich, time poor' cultures. The multitude of benefits of shorter working weeks have long been proposed (Coote et al., 2010; Sanne, 2002), and this approach would fit well with an expanding upcycling culture. Creating objects with 'waste' would reduce expenditure, therefore fitting perfectly with working less but engaging more with community activities and developing and sharing practical skills.

At a larger scale, 'Earthships' (Figure 5) have been built by people seeking a low impact, environmentally sustainable way of living since the 1970s. These are earth sheltered, low energy, efficient buildings made by upcycling old tyres and bottles, but these techniques have not entered mainstream construction, most likely due to Western attitudes to waste and status. Fry and Willis note that the '*waste problem is one of thought and cultural categorisation rather than of materiality*' (Fry and Willis, 1996). These attitudes are complex, however, with the status of second hand goods changing in Western culture with the proliferation of 'car boot sales' (Gregson and Crewe, 1997) and the unprecedented success of *ebay*. Distinctions are subtle: reclaimed stone and timber can cost substantially more than newly cut materials, but use of materials such as tyres and bottles for construction has remained a niche activity. Natural materials, with their inherent variability, surface complexity, and resilience (Hoadley, 2000; Pye, 1968), avoid a clear distinction between 'shiny and new' and 'worn', and are perhaps better suited to long term reuse (Lilley et al., 2016), (Bridgens et al., 2015). In stark contrast, in our 'scratch-free world of slick polymers', (Chapman, 2013) any change to a man-made material surface, such as inevitable abrasion or scratching, is commonly interpreted as damage which can result in dissatisfaction and drive the cycle of premature replacement. The ability to create high quality objects that do not look 'home made' may reduce the potential stigma of making objects from 'waste', and with the increasing importance of the 'sharing economy' attitudes to owning second hand objects are likely to change (Baxter et al., 2016).

Within the construction industry, *Superuse Architecture* propose large scale upcycling solutions (Jongert et al., 2011; van Hinte et al., 2007) using local waste materials, with a focus on identification of waste resources using 'harvest maps' to allow integration of locally available waste into the design process. Another barrier to large scale upcycling is regulation, with current standards focused on conventional construction materials and techniques, making use of non-standard materials difficult.

Figure 5. 'Earthship' – off grid, low impact house made from waste, <http://qeprize.org/createthefuture/earthship-sweet-earthship/> (top left); Taiwan bottle building – modern office building clad with specially designed plastic bottles, <http://www.livbit.com/article/2010/04/19/worlds-largest-complete-functional-plastic-building-in-taiwan/> (bottom left); Heineken World Bottle – designed to interlock and be used as bricks, <http://inhabitat.com/heineken-wobo-the-brick-that-holds-beer/> (right).

2.2 Upcycling: designing for a second life

In contrast to the ad-hoc upcycling activities described above, there are limited examples of material objects that have been designed to fulfil the needs of a second life, a life that may have completely different functional requirements to that of its original use. This is the difference between the framing of upcycling as a post-production process and, as a design activity that happens upstream of manufacturing and production processes. Richardson (2011) highlights the central role that industrial design plays in promoting consumer culture. Richardson suggests that *design-for-reuse* should be considered as an integral part of both industrial design training and practice to allow an intelligent response to growing product waste concerns (Richardson, 2011).

The Heineken 'World Bottle' (Figure 5) was designed for reuse in construction and perhaps points the way towards future possibilities to 'design for upcycling', but the shape was deemed insufficiently ergonomic for marketing purposes. The 'plastic bottle building' in Taiwan (www.miniwiz.com) is a rare example that shows the potential for large scale, high quality construction using waste, but crucially this structure required reprocessing of the plastic bottles rather than direct reuse to allow them to interlock (Figure 5).

The Coca-Cola '2nd lives' project provided a wide range of replacement caps to enable plastic drinks bottles to be reused for a variety of purposes, with many of the second life objects having a higher monetary value than the original bottle of drink (Figure 6). Whilst this example provides scope for

multiple second lives, these second lives were prescribed by the designer rather than the users of the objects.

The Heineken World Bottle and Coca Cola 2nd lives projects both involve a prescribed interaction between a very limited set of objects. Greater potential for creative reuse could be achieved by enabling different objects and materials to be easily joined: *'Upcycling has the potential to transform the way we consider individual products, as assemblages of functional component modules with multiple life spans rather than complete stand-alone objects with singular finite lives'* (Richardson, 2011).

Figure 6. The Coca Cola '2nd lives' campaign enabled plastic bottles to be reused in multiple ways, but these second lives were prescribed by the designer with no scope for creativity, image: Coca-Cola.

3 The Upcycled Café: a study of attitudes to waste & upcycling

Why do people spend hard earned money purchasing products, whilst discarding high quality materials which could be reconfigured to provide the same function? As (Belk, 1988) suggests, *'we cannot hope to understand consumer behaviour without first gaining some understanding of the meanings that consumers attach to possessions.'* Our emphasis was not on tracking flows to make waste visible (see Boustani et al., 2011), but to understand why certain material objects appear to lose their value in certain contexts, but not in others. We also wanted to discover if it might be possible to motivate people to have new kinds of embodied engagements with waste, for as Chapman (2009) notes, *'the process of consumption is motivated by complex emotional drivers.'*

We argue that the power behind upcycling activities is centred on the cultural framings used by people as they engage with different material objects. The value models they employ dictate what they regard to be useful and worth keeping, and what is worthless and can be thrown away, a notion shared by Chapman (2009) who suggests that: *'The sustainability crisis is a behavioural issue, and not one simply of technology, production, and volume... sustainable design methodologies seldom engage with the meaning and place of products in our lives'*. However, this is not simply a matter of personal choice, for *'escalating environmental impacts are caused by production-consumption*

systems rather than the total sum of choices made by individuals, and these systems must be addressed if we are to achieve effective change' (Southerton and Welch, 2015).

The project team explored these issues through a small EPSRC funded research project that brought together diverse academic disciplines in a pilot project titled '*U-TEC, Upcycling To Engage Communities*'. Our thesis was that technical expertise alone, whilst essential, is unlikely to facilitate the required social and cultural shifts in how designers, engineers and manufacturers as well as individual consumers, engage with a material world, nor our reliance on damaging global material supply chains (e.g. Moran et al., 2015). What is required is a sea change in how people perceive and imagine the materials that make up their daily lives. We need to appreciate how individuals relate to manufactured goods and materials, what they value and what makes them decide an object has become worthless, and what will motivate them to invest time and effort in upcycling.

To stimulate discussion the research team decided to create a café made entirely from waste, where visitors could be offered a drink and while exposed to new kinds of material engagements, be invited to share their reflections of the space and the underpinning concept. This space was designed to challenge people's perceptions of objects they might usually have defined as waste. Architecture and Civil Engineering students were tasked with designing and building the café structure (see: <http://vimeo.com/64608690> and Figure 7). This was designed not only to be a café but most importantly as a space for research, and fully utilised materials usually discarded as waste, that included plastic drinks bottles, cardboard boxes, plastic bags, and heavy duty cardboard tubes. The project team decided to focus on packaging materials which have a very short functional lifespan and are regarded as having little, if any, intrinsic material value. In this sense, such packaging material becomes almost invisible as it is disposed of as soon as food is eaten or objects are unpacked, despite the fact that for low value purchases the packaging may represent a significant proportion of the cost and environmental impact of the purchase.

The Upcycled Café, or U-Café, was designed and built using an imaginative but ultimately ad-hoc approach. The café structure was built from cardboard (Figure 7), its strength characteristics derived from the design expertise of the civil engineering and architecture students. Because the material is freely available, the 'efficient' use of materials ceases to be a design constraint, and hence large quantities of weak materials can be used to create a sufficiently strong structure. Incorporation of folds and interlocking triangles allowed the stiffness of the cardboard to be increased significantly. The key challenge was developing sufficiently strong connections between elements.

The waste materials were collected locally from Newcastle University campus, resulting in minimal impacts from transportation. Materials were joined such that they could easily be disassembled for recycling at the end-of-life of the structure. In this way, it was assured that the Upcycled Café reduced environmental impacts compared to building the space from new materials, and did not increase long term environmental impacts.

Figure 7. U-Café – a space made from waste materials including cardboard walls, ceiling and furniture, with plastic bottles and crushed glass used for lighting.

The research team wanted to upend the taken-for-granted quality of packaging by using them to create a space that was both aesthetically pleasing and functional as a café. The café had to provide seating for ‘customers’, a space for ‘baristas’ to prepare coffee and tea, as well as a small performance area where music was upcycled from charity shop sourced records. The intention was to invite children from a local primary school to stage a short concert using instruments made entirely from packaging materials. Above all the café had to be a pleasing place to spend time and a space where people might be inspired by the novel and imaginative way in which packaging materials had been crafted to serve a different function and reveal a previously untapped quality of beauty. The hope was that the ‘barista’ aprons made from plastic bags and plastic drink bottle lampshades, might inspire customers to rethink their own waste streams, and recognise the potential value of engaging with material objects in a creatively new way.

While appearing to be a café, the structure’s prime function was to act as a research venue where ‘customers’ (research participants) could be interviewed by coffee serving ‘baristas’ (researchers). To encourage research participation, free coffee was offered to café customers in exchange for conversation. Information was collected in various ways, not only did ‘baristas’ take notes but ‘customers’ were also invited to complete a set of questions contained on a coffee cup’s detachable sleeve. ‘Customers’ were also invited to use off-cuts of card and post their anonymous comments in a post box near the exit door. Having reviewed ‘customer’ responses, it appeared that many were enthralled by the structure and how the cardboard furniture could support their weight by using monocoque design principles. In a similar way, the lampshades plastic bottle lampshades prompted a comment of, ‘*where can I buy one?*’ This was a true upcycling response, with the value of waste bottles of minimal monetary value, being transformed by creative engagement into a new kind of commodity. The café appeared to seize the imagination of a broad range of people, both those living in various Newcastle City communities and academics from across Newcastle University. The café also received attention from international media (<http://abcnews.go.com/WNN/video/cardboard->

[coffee-shop-built-by-newcastle-university-students-19013574](#)). Comments included, *'It's very exciting and increasingly important in a world that already is exhausting its physical resources'* (93). *'Yes! Exciting getting people to rethink waste... Great idea, I hadn't thought of up cycling in this way before'* (13), *'great ideas, all our cafes should be cardboard FAB!'*

'Customers' comments also identified key barriers to upcycling, including concerns about using other peoples' 'waste' as a construction material, as one participant commented, *'I'm not sure using waste to build houses in developing world is ethical.'* Another suggested that for upcycling activities to become mainstream would require *'negative views of 'waste' products to change.'*

While some research participants imaginatively discussed how to reuse packaging materials, others were less confident with their own practical design and building skills. Other doubts also surfaced, for while some were keen to be creative and re-engage with packaging materials, they also expressed the concern of having a lack of space to store material resources. *'Where do you store the 'stuff' before you use it?'* Hygiene was another issue, with one participant noting how *'some people may think that it is not clean enough.'* Time was another, *'How long did it take to fabricate?'* There were also concerns about whether packaging or other objects could be designed for multiple uses without excessive compromise like the *'risk of damaging efficiency, economy of primary function.'* One 'customer' explained that *'if resources are reused for something different, they really need to still be good for that second use'*. Others questioned the environmental cost and impact of upcycling activities, what was the *'cost of sourcing materials, cleaning containers... transport of materials and processing – even muscle power has a cost (food)!'*

A critical question of many U-Café 'customers', inspired from sitting on chairs made from cardboard and seeing lampshades made from old plastic drinks bottles was, how to achieve connectivity between a wide range of materials and objects? Participants identified both problems and solutions: *'Making polytunnels for gardens seems a good use of plastic bottles if an interface could be designed to join them'*. And whilst the challenge of convincing companies to get involved was often raised by participants, others thought it could be seen as marketing opportunity, *'You could imagine companies who would use packaging in stage 2 [the second life of the object] paying for original company to alter their packaging according to second use.'*

The next section explores an approach which aims to address the barriers to upcycling identified by the U-Café participants, whilst building on the opportunities and positive comments.

4 Designing for creative reuse

Industrialisation, mass production, global supply chains, and digital technology have resulted in a disconnect between materials, people and places. Before the industrial revolution, the appearance of man-made objects from household objects, furniture, farm machinery and buildings reflected locally available materials, shaped by local people, to meet individuals' and community's needs. Production and manufacturing was *'once visible in the built fabric of cities and towns'* (Carr and Gibson, 2015). These distinctive, individual objects, in particular buildings, are highly valued today (Pye, 1968), unlike the mass produced ubiquity of modern Western housing and consumer products. *'We would argue that rather than becoming increasingly marginalized and redundant, the ability to work with materials, and to make, repair or repurpose physical things, are vital skills, for a future where such resources become increasingly limited...'* (Carr and Gibson, 2015). We are defined by our possessions (Belk, 1988), *'Hollow hands clasp ludicrous possessions because they are links in the chain of life'* (Dichter, 1964). How powerful it would be if people were willing and able to manipulate

and create these possessions, rather than purchasing and rapidly disposing of mass produced, globally ubiquitous products. In the words of Donald Norman (2006): *'It is time to wipe words such as 'consumer,' 'customer,' and 'user' from our vocabulary. Time to speak of people.'*

Top-down approaches to resource efficiency do not recognise individuals and the changing engagements they have with the material world. Hobson (2015) asks *'what are the implications of a CE [Circular Economy] for quotidian spaces and practices, as the patterns and rhythms of everyday socio-materiality are potentially reconfigured?'* Resource efficiency should not be regarded as a top-down activity or purely the concern of policy makers and politicians. Engineers and designers are positioned on a threshold boundary, at the point where material objects come into contact with people and where people seek to appropriate [and change] material objects in ways to suit their needs. However, as products become more complex, miniaturised, made by robots, and made to be replaced after a short 'life' (Cooper, 2005), they become increasingly difficult to adapt, modify and repair (Wiens, 2015).

It is important to explicitly recognise that the packaging materials that were utilised for the U-Café had not been *designed* to be turned into a café, furniture or lighting. There was no design *intention* for reuse or upcycling. This meant that specialist knowledge, skills, equipment and considerable time were required to undertake the upcycling task. Participants' responses to U-Café revealed that many were inspired by the creative design and making on display, and many were positively encouraged to reframe how they engaged with packaging materials that were usually disposed of without a second thought. This raised the questions: How can designers introduce this ambiguous set of material values into the design and manufacture of objects in ways that makes future upcycling activities easier to undertake? How can objects be designed with the potential for creative reuse?

Current approaches to 'design for the circular economy' (The Great Recovery, 2013b) are based on design for disassembly, design for remanufacture and modular design within carefully designed flows of reuse, with the aim of retaining monetary value for the manufacturer and others in the supply chain. The challenge when designing for creative upcycling is to imbue an object with potential for imaginative reuse by individuals.

Our proposed solution is to design products and packaging to provide elegant connectivity across a wide range of materials, forms and scales. Rather than designing objects for single uses, of fixing utility to a particular form, the development of designs that provoke new opportunities and material collaborations could be considered. Designs that facilitate opportunities for individuals to use their imagination and creativity to find solutions that meet their own needs within their local environmental context. This potential for reuse would lie dormant during the objects 'first life', but would be revealed when need or desire arises to repurpose the object. A crucial dimension of upcycling centers on the imagination of individuals and how this motivates and inspires them to embrace the 'hidden' potential of objects. Applying this imaginative force can result in objects being altered and reshaped in ways that change their aesthetics, operation and functionality, and challenges the design briefs of designers, engineers and manufacturers. Crucially, it allows people to engage with and shape the material world around them. *'The having mode of existence is not established by an alive, productive process between subject [person] and object [possession]'* (Fromm, 2013). Upcycling has potential to change this to a productive, creative relationship, to Fromm's state of 'being' rather than 'having'.

The availability of waste products and packaging will vary in time and space; their availability is wholly dependent on the purchasing and disposal patterns of a local population. Likewise, the needs and desires of individuals when creating new objects will vary. From a Western perspective,

inconsistent availability of materials and uncertainty of the required outcome would be seen as a difficulty or failing in the proposed system. But can intermittent availability provide time dependent opportunities and drive creativity? In other cultures, such as the Japanese 'wabi-sabi' aesthetic which celebrates '*the beauty of things imperfect, impermanent, and incomplete*' (Koren, 2008), this inconsistent supply of materials would be seen as a source of inspiration and serendipity. This provides an opportunity to exploit the potential benefits of frugal innovation – innovative solutions arising from limited resources, with variability of resource flows driving creative solutions (Das, 2012) changing attitudes of designers and users from the constant availability of everything to using what is available at a particular time and place (Jongert et al., 2011). Use of locally and temporally available waste materials could result in distinctive objects defined by their geography, giving a renewed sense of place and identity, and a sense of pride and fulfilment for the people who make them (Nelson et al., 2007).

Within local communities, greater availability and variety of materials can be achieved by sharing resources. We envisage 'community resource hubs' replacing the town 'tip' or 'household waste recycling centre'. These could be modelled on the increasingly ubiquitous 'Fab Labs' (fabrication labs) and 'Makerspaces' (Moilanen, 2012; Smith et al., 2013). Within each community or district a facility could be provided where waste with the potential for reuse was collected and sorted, for others to use. These hubs could also provide tools and expertise to facilitate upcycling, and could be a place for people to meet and offer each other advice and ideas. Sharing materials, skills and ideas has scope to reunite communities, potentially bridging barriers such as age or race through shared interest (Albinsson and Perera, 2012; Belk, 2010; Nelson et al., 2007). If particular materials are required to fulfil a particular need, then recently developed 'harvest maps' for sourcing waste construction materials could be employed (Jongert et al., 2011; van Hinte et al., 2007).

Top-down circular economy approaches focus on benefits to big business (Ellen MacArthur Foundation, 2013a; Hobson, 2015). Upcycling has potential for new Small and Medium Enterprises and community enterprises to drive the transition from a small number of global businesses, towards a model of small scale, localised commerce with benefits for local people, the environment and economic resilience in times of global financial instability. As well as directly saving money by buying less 'stuff', upcycling provides opportunities for local entrepreneurs and a robust, local economy. Reduced 'consumption' raises concerns that upcycling damages businesses whose sales may fall. Whilst this is true for businesses unwilling to adapt to change, for responsive enterprises the emergence of upcycling would provide opportunities. Small scale local enterprises or community enterprises could form to provide upcycling services (collection and distribution of 'waste'/resources), provision of tools, space and training to facilitate upcycling, development of resources to share designs. For manufacturers and retailers, design for upcycling provides an opportunity for product differentiation and linked marketing of diverse products that have been designed to be creatively reused together.

Local reuse has clear environmental benefits compared to large scale circular material flows, as it potentially avoids impacts due to transportation and reprocessing, but it is critical that objects that are made by upcycling adhere to a set of principles to ensure that they do not result in short or long-term impacts that are greater than other reuse or recycling options:

1. Transport - use locally generated waste materials to minimise transportation.
2. Material selection – materials with high embodied energy and other negative impacts during extraction and refining and which can be recycled easily (as opposed to downcycled (Braungart et al., 2007)), should be recycled to minimise primary production. Examples

include aluminium and metals used in electronic circuit boards (UNEP, 2009). Simplified scoping Life Cycle Assessment tools are required to enable these decisions to be made.

3. Future lives – materials should not be combined in such a way that their future recycling or upcycling is compromised. For example, connections should be mechanical rather than bonded with adhesives,
4. Longevity is a key strategy to minimise the environmental impact of products (Cooper, 1994; Rogers et al., 2015; Van Nes and Cramer, 2006). Design for upcycling, with supporting information and resources, should enable high quality, well designed upcycled objects to be created that will last. Longevity may be further increased due to the personalised nature of the upcycled objects (Chapman, 2013; Mugge et al., 2009).

There is a tension between current efforts at resource efficiency, including ‘light-weighting’ of packaging and products (Helms and Lambrecht, 2006; Marsh and Bugusu, 2007) and development of materials which are designed to degrade (Albertsson and Hakkarainen, 2017; Lörcks, 1998), and design for upcycling. Light-weighting, or reduction of the amount of material required for a particular function, gives significant reductions in material use and transport emissions. Light-weighting makes creative use of waste more challenging; objects that are designed with only just sufficient strength for one particular function are unlikely to be able to be utilised for a wide range of other potential uses. Rather than suggesting that packaging and other objects should be over-designed in case they may be required for upcycling, we see this as a design challenge. If objects are designed for reuse, the way that multiple objects are combined, or the way that a single object is reused could result in a considerable increase in strength or stiffness, for example a thin, flat sheet of flexible plastic could be manufactured with fold lines that allow it to be easily folded into a concertina shape, increasing the bending stiffness of the sheet by several orders of magnitude. Materials which are designed to degrade, often through industrial composting processes, are well suited to short life-span products such as packaging. Design for degradation does not prohibit use of these materials for upcycling, but it is necessary for the person using the materials to understand the conditions which will trigger degradation (e.g. water, heat) and the timescales involved. This information would generally be useful to ensure that these materials are suitably disposed of.

5 Conclusions – towards widespread creative communities of upcycling?

Current approaches to ‘*design for the circular economy*’ (The Great Recovery, 2013b) are based on design for disassembly, design for remanufacture and modular design within carefully designed flows of reuse, with the aim of retaining monetary value for the manufacturer and others in the supply chain. This approach is firmly centred on large-scale, typically global, business models and is focused on finding top-down technocratic solutions. At the same time, there are a multitude of grass-roots movements and organisations which bring enthusiasts together to repair and make (Lang, 2013), but these efforts are frustrated by products increasingly being designed such that they are difficult to repair or modify (Wiens and Corcoran, 2013).

A UK organisation which aims to ‘*accelerate the move to a sustainable, resource efficient economy*’ (WRAP, www.wrap.org.uk) has updated its mission statement from the conventional 3Rs (reduce, reuse, recycle) to ‘*re-inventing how we design, produce and sell products, re-thinking how we use and consume products, and re-defining what is possible through reuse and recycling*’ (WRAP, 2015). A novel approach is offered here to ‘*re-define what is possible through reuse*’ by designing packaging and products with the potential for creative reuse. This would bridge the chasm between top-down circular economy approaches and the bottom-up ‘maker movement’, and provide opportunities for

small businesses to locally facilitate 'communities of upcycling'. It is understood that creating objects, ideally as part of a community of makers, increases wellbeing for a complex mix of reasons including pride in one's work and through a sense of community engagement and sharing (Bailey, 2013; Sennett, 2009), and this engagement with materials and making has scope to engender emotional attachment to the finished object, reducing the likelihood of premature disposal and replacement (Bramston and Maycroft, 2014).

Using a completely upcycled structure as a platform for engagement with hundreds of visitors across a wide socio-demographic range, the project team found great interest and enthusiasm for the concept of upcycling, and identified a number of barriers to widespread creative upcycling including availability of space, equipment, time, skills, materials and ideas. We propose that a combination of designing for creative reuse with provision of community 'resource hubs' could create 'geographies of making' (Carr and Gibson, 2015) which address many of these barriers and would reduce environmental impacts by slowing the circulation of materials and reducing the need for virgin materials, provide small-scale, local economic opportunities, and improve social cohesion and wellbeing for those involved.

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