Report 01: June 2013

Investigating the role of design in the circular economy

THE GREAT RECOVERY
REDESIGNING THE FUTURE

RSA
Action and Research Centre

Contents

Businesses who want to be profitable, innovative and progressive will look to reduce the volumes of waste they produce, will think about the way their products are made and distributed, and what happens to them when they reach their end of life.

Government Review of Waste Policy in England 2011, Defra

Executive Summary

> The Great Recovery project, launched in September 2012 by the Action and Research Centre at the RSA, aims to build a cross disciplinary design community that is equipped to support the development of an economy based on resource-efficient principles.

> Waste & Resources Action Programme (WRAP) estimates that around 540m tonnes of products and materials enter the UK economy each year but only 117m tonnes of this gets recycled. Redesigning our manufacturing processes around circular economy principles will increase reuse and recycling, create new business opportunities, address material security issues and contribute to sustainable economic growth.

> We have created a network of professionals involved in all parts of the lifecycle of products in our economy, and engaged them in rethinking the design of these products from a circular perspective.

> The Great Recovery has run a programme of workshops, networking and brokering events, presentations, debates and round tables. These have helped build understanding around the principles of closed loop design and the barriers to achieving full circularity.

> These events have supported Technology Strategy Board's (TSB) 'New Designs for a Circular Economy' competition that has invested £1.25m to 35 cross-disciplinary teams to carry out feasibility studies across a wide range of products and processes.

> We have developed an online resource that focuses on design for a circular economy. This includes a growing database of reports, images and information, articles, blogs, Twitter feeds and a dedicated YouTube channel which hosts films of the workshops.

Through the circular network, workshops and teardown observations, we have gained a better understanding of what action and research is required to transform the way society manages resources. We have made a series of key recommendations based on the findings of the first phase of The Great Recovery programme.

Key recommendations:	Actions:
1. Skilling up the design industry	
Prepare future generations of designers. Embed circularity in the design education system. Sustainable design must not continue to be left behind or added as a last minute thought. Make sustainability a matriculation criterion in every design and engineering degree. Encourage multi-disciplinary learning based on an understanding of the lifecycle of the products and services that we create.	Develop further and higher education modules to integrate design for circular economy and systems thinking into a wide range of design curricula. Develop an education programme that encourages cross-curricular learning, connecting designers with engineers, material scientists, anthropologists, marketeers and business students.
2. New Business approaches	
Redesigning the brief. Businesses must begin to develop design briefs around new business models that take account of provenance, longevity, impact and end-of-life. They must consider a circular approach.	Help businesses to develop briefs that incorporate resource efficiency and closed loop principles. Support the commissioning of effective design that incorporates circular economy principles. Broker new dialogues between the designers, suppliers and the waste industries to instigate new collaborations for innovation around end-of-life, with an initial focus on packaging.
3. Networks: connecting and collaborating	
Create access to new spaces that allow collaborative R&D for businesses and their supply chains to test, trial and design around circular principles and the four design models; design for longevity, design for leasing/service, design for re-use in manufacture, design for material recovery.	Create a physical space where industry stakeholders can come together to test product, systems and service design, supported by a network of expert consultants. Develop design standards and tools to support closed loop design and continue to build the online library of open source information about closed loop design and the circular economy.
4. Pushing the policy	
Multi-layered packaging which prevents or increases the complexity and cost of recycling should be designed out. At the same time, investment in innovation into fully recoverable mono-material packaging should be supported to increase greater resource recovery.	Open up dialogue with government around new legislation to encourage packaging design for full recoverability. Encourage companies to provide full operating and repair manuals for all electronic products. Enable discussions with the *Circular Network* and government which investigate the legislative barriers involved in moving to a circular economy.

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Introduction to The Great Recovery

What is The Great Recovery?

Design will play a key role in the transition to a circular economy. We need to educate and inspire the design industry to take up this challenge.

Sophie Thomas
Project Director, The Great Recovery

The Great Recovery is a two year project run by the Action and Research Centre at the RSA and supported by the Technology Strategy Board.

Its aim is to build a cross disciplinary design community to drive forward a new resource efficient economy. It will do this by: raising the awareness of issues around increased resource scarcity, building up understanding in the principles of closed loop design, and fostering ideas and exploring new opportunities through collaborative partnerships in the wider supply chain network.

Since its launch in September 2012 The Great Recovery project has delivered a programme of hands on workshops, brokering events and presentations, debates and round table discussions. These have supported the competition 'New designs for a circular economy', led by the Technology Strategy Board. Their initial investment of £1.25m looked into new design and business collaborations which re-think products, components and systems that 'close the loop'.

This report reviews the first six months of the programme and makes a number of observations and proposes recommendations.

The Investor

John Whittall, TSB Lead Technologist, Resource Efficiency.

The TSB have understood for sometime the importance of design, but for me the key moment came about two years ago when I saw Sophie Thomas give an inspirational talk on how very often we design products with scant regard for what happens when we no longer want them.

She used lots of dramatic images on the consequences of such short-term thinking – piles of plastic waste accumulating on beaches after being concentrated by ocean currents, the persistence of everyday items in the environment long after we have finished with them – and the key message was that waste is design gone wrong.

For TSB it's all about generating long-term wealth for the UK. Yes, these issues are seen by many as environmental or societal problems, but we believe the way to address them at scale is to bring businesses to the table, articulate the opportunity and give them the tools and connections they need to make change happen.

The UK is well placed with many good eco-design practitioners, but at present it seems to be a niche activity. If we could mobilise the broader design community so that eco-design principles become embedded into good design practices that would be a real win. We have a world-class design sector in the UK and working with the RSA is a great way to reach out to this community.

The 'Government Review of Waste Policy in England, 2011' deemed the current levels of virgin raw-material usage in the UK manufacturing industry to be unsustainable.[1] Like many developed countries, the UK economy is highly dependent on several finite materials, and resource security is a growing concern. Nearly a third of profit warnings issued by FTSE 350 companies in 2011 were attributed to rising resource prices.[2]

Waste & Resources Action Programme (WRAP) estimates that around 540m tonnes of products and materials enter the UK economy each year but only 117m tonnes of this gets recycled. While there have been significant improvements in the UK's recycling rates in the past decade, we are still losing valuable streams of resource into landfill.[3]

The economic vulnerability of this situation indicates that current linear manufacturing models of 'take-make-dispose' (defined as taking raw material out of the ground, making products for consumption and disposing of these after use in a way that loses the resource) are not sustainable and a more circular system could bring stability and further economic opportunity. This model keeps valuable materials in the system by designing products that can adapt and are built to last. This may seem like a big challenge for business but could represent huge opportunities. In WRAP's 'Vision for the UK circular economy in 2020' it estimates that UK business could benefit by up to £23bn a year through such efficiencies in resource use.[4]

While our current crisis in resource management develops, society at large seems to have very little knowledge of, or interest in, what goes into making products that people consume daily. This 'ecological rucksack' of materials used to make a product can often be staggering. Innocuous objects such as plastic toothbrushes are heavier than expected, with more than 1.5kg of raw material used in production. Even a simple A4 piece of white paper can require 10 litres of water to produce.[5]

Generally, in manufacturing, 90 percent of the raw materials which go into making durable products become waste even before the product leaves the factory, and approximately 80 percent of what is made gets thrown away within the first 6 months of life.[6]

Take the mobile phone as another example. In 2011, the UK had over 80m mobile phone subscriptions, with 1,000 mobile phone replacements sold every hour. At

The Service Designer

James Rock
Managing Director, Design Thinkers.

When I started my career, the UK was a manufacturing economy. Now the UK doesn't manufacture so many products and we're essentially a service economy. Service design is really in its infancy. Many design schools still aren't teaching service design and most service designers are only in their twenties.

After World War II, America had excess manufacturing capacity and it had to develop a market for that manufacturing capacity. That's how marketing began, that's how graphic design began, that's how commercial TV began, because it was all about promoting the capacity of manufacturers to deliver products. From that we ended up with our consumer society.

China have been soaking up our manufacturing requirements with their low cost manufacturing capacity. They have a growing middle class and are now developing their own markets. In the UK, Europe and North America we have a situation where 78 percent of our economy measured by GDP is in services and 91 percent of employment is in services. It's therefore not surprising that we're using new service design tools to bring innovation.

the same time, an estimated 80m mobile phones that still worked but were not in use were retained in UK households, lost or forgotten in drawers and cupboards.[7]

While figures build an astonishing picture of consumption, there are even more extraordinary calculations to make when looking at what goes into making these popular devices. Every mobile phone is made from approximately 40 different elements, including copper in the wiring, indium in the touchscreen and gold in the circuit boards. It is estimated there is five times more gold in a tonne of electronic waste than there is in a tonne of mined ore from a gold mine.[8] As the price of metals and minerals rises, it makes increasing financial sense to recover these elements.

Between now and 2020, WRAP estimates that electronic waste in the UK will total more than 12m tonnes. Within this waste stream there will be numerous precious raw materials, which at the time of writing, have a total estimated market value of £7bn.[9] Of the 30 percent of e-waste that actually makes it to a recovery facility, most is crushed, sorted and exported, not just to countries that have established recovery industries but also to those that have more informal ones.

Revolutionary technologies such as smart phones are undoubtedly great assets in our daily lives and yet the shadow these devices leave behind tell stories of war and conflict, resource depletion and scarcity, environmental damage, water and energy use. It is the kind of complexity those working towards a circular economy will regularly face. The crux of the argument is the need for a manufacturing industry that is fit for purpose and a design industry that prioritises resource as value. It is unacceptable in the 21st century that the industrial world is operating through an ad-hoc system based on old and merged industrial revolution models.

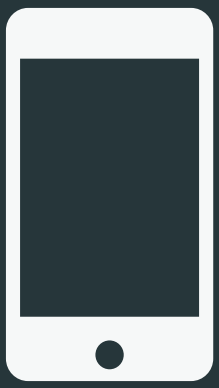
The acceleration of consumer culture, particularly over the last 60 years, and even more dramatically in the last 20 years thanks to technological change, has resulted not in systemic thinking but in constant adaptations and add-ons to existing systems which, like a building covered in dodgy builder's extensions, has become almost unrecognisable as a result. The original architect of a system cannot be identified due to constant re-iteration over time.

Industrialists may think they are working with the most up to date technology and fully optimised systems, and by some definitions they are. However, if the layers are peeled back they reveal real horrors: hazardous factories in developing countries producing our cheap clothes; mines that contaminate land while fuelling conflict; and unstable systems built on slave labour, accidental deaths. These now antiquated foundations do not work for the triple bottom line of people, planet and profit.

The business opportunity of moving to a more circular system has now been well proven. The Ellen MacArthur Foundation/McKinsey report 'Towards

Mobile Phone Composition

Materials Research Institute
Sheffield Hallam University



Mostly contained in...

- *Circuit Boards*
- *Case*
- *Wires*
- *Screen*
- *Chips*
- *Batteries*

F	Na	Mg	Si	P	S	Cl	K	Ca	Sc
Fluorine	Sodium	Magnesium	Silicon	Phosphorus	Sulfur	Chlorine	Potassium	Calcium	Scandium
0.040	2.75	0.934	23.96	0.688	0.499	0.166	0.978	10.94	0.0032

Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga
Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc	Gallium
1.96	0.0046	0.059	0.0483	1.52	0.110	3.10	25.69	0.145	0.156

Ge	As	Se	Br	Rb	Sr	Y	Zr	Pd	Ag
Germanium	Arsenic	Selenium	Bromine	Rubidium	Strontium	Yttrium	Zirconium	Palladium	Silver
0.0075	0.185	0.0007	11.22	0.0080	0.123	0.026	0.142	0.068	0.687

In	Sn	Sb	I	Ba	Nd	Gd	Er	Tm	Hf
Indium	Tin	Antimony	Iodine	Barium	Neodymium	Gadolinium	Erbium	Thulium	Hafnium
0.033	5.06	0.060	0.414	4.98	1.25	0.052	0.0512	0.0110	0.004

W	Ir	Au	Ti	Pb	Bi	Am
Tungsten	Iridium	Gold	Thallium	Lead	Bismuth	Americium
0.642	0.036	0.484	0.0028	0.789	0.023	0.0033

Mass %

a Circular Economy' made the case that the EU manufacturing sector could realise resource savings worth up to $630bn a year if they made the transition, stimulating economic activity in the areas of product development, remanufacturing and refurbishment.[10]

The Great Recovery has set out on a journey to investigate the role of design in this new resource efficient economy. With an ambitious tagline: 'Redesigning the Future', the project aims to highlight the pivotal role of the designer in shifting systemic behaviours. Many government and NGO reports around resource scarcity cited design as the solution, the key in fact, in moving towards a circular, more self-reliant system. Pockets of designers have heard this but the reach has not been widespread. According to research done by the Design Council, approximately 80 percent of a product's environmental impact is 'locked in' at the concept design stage,[11] making a clear case for the major part that design needs to play, not just at the product efficiency level but at a system level and the very core of business re-structure. And as such, the first phase of The Great Recovery places emphasis on proper engagement with the design community and linking it to the supply and recovery network.

During the first phase of the project, a series of demonstration workshops were run, bringing sectors together to look at the common problems. Many of the events were hosted at material recovery centres, where attendees explored how 'problem products' could be better designed. The workshop started where problems currently end up, either thrown away or recovered to the best of our physical and technological abilities.

An online resource has been established with an extensive archive of reports and resources around the subject of the circular economy. All the workshops and events were filmed and have been watched by over 11,000 people on our dedicated YouTube channel. Guest articles, blogs and visual references have made The Great Recovery website a destination for those that are interested in circular design.

Greater collaboration throughout the supply chain will ensure that all views and concerns from different sectors can be recognised, and solutions can be developed.

Laura Wilton
Policy Connect

The Material Expert

Rob Ireson
Innovation Team Leader at Glass Technology Services.

The key thing was the chance to think about the full lifecycle of things, the different processes that are out there and the amount of dead materials that sit in people's drawers. It's also been a good opportunity to network.

One of the things we've realised in our company is that we have good links with the manufacturing sector and we're linked with the British Glass Trade Association. We've got good links with the retail people and people like the brewers and the distillers. But, we don't have particularly good links with people who actually design products. I've realised today that we actually need to develop those links with the designers who might use glass in their products to see if we can support them or inspire them.

The Maker/Fixer

Kyle Weins
Founder, iFixit and Dozuki.

We live in an age where information is at our fingertips – 24 hours a day, 7 days a week. Want to learn how to build a deck, make a robot, or program a computer? You can find that information for free on the web. Unfortunately, the flow of information stops when it comes to fixing what you own. Under the cloak of copyright, manufacturers have been able to keep critical service information and repair documentation under lock-and-key.

Keeping repair manuals off the internet shortens the life of a product. It ensures that most consumers won't be able to fix what they own. Instead, consumers are forced to send broken devices back to high-priced, manufacturer-authorised service centres. Repair costs can be exorbitant – especially for complex electronics, like cell phones. It's often easier and cheaper to just buy a new one. The old stuff gets thrown away.

Service and repair information needs to be free. The world desperately needs to know how to fix these products. Electronics repair is critically needed to solve the e-waste crisis; it helps bridge the digital divide by keeping secondhand electronics and developing countries' markets alive; and it accounts for hundreds of thousands of jobs in the United States alone.

Throughout the programme, feedback from participants was collected to help understand the problems and identify opportunities and challenges. This information is now being used to develop new work streams, test tools and new design systems, and build industrial-education programmes.

Future phases will take the lessons learnt to businesses, the government, education and, ultimately, consumers. This will ensure that everyone who has a role or an influence in the lifecycle of a product understands how they can play their part in redesigning the future.

How do we keep the value of all these high-risk materials and the benefits they will have, both economically and in terms of remanufacturing jobs created and export potential associated with those industries within the UK economy?

Andrew Raingold
The Aldersgate Group

Mapping the making of a laptop – Mark Shayler

It is possible to map the complexity of supply chains through the movement of just one laptop's component – the valuable mineral ore called COLTAN (columbite tantalum). When refined, COLTAN gives us metallic tantalum, a heat-resistant powder that can hold a high electrical charge. This is used to make tantalum capacitors, which are used in most electronic products on the planet.

One of the sources for this mineral is the Democratic Republic of the Congo (DRC).[12] Somewhere between 14 and 64 percent of the world's COLTAN comes from the DRC.[13] Its neighbours sell COLTAN even though the mineral doesn't naturally occur there, and as markets are unregulated, it is impossible to accurately measure the quantities of COLTAN coming out of the DRC.

The COLTAN goes on a convoluted journey before ending up inside a laptop. From DRC it is sent to Japan to be processed, then on to Taiwan to be manufactured into capacitors. These are then shipped to China where they are assembled onto circuit boards with other components from around the world.

An amazing variety of elements are needed – other rare earth metals, flame-retardants, Teflon, copper, tin, gold, copper, acetone, nickel, platinum, chromium, to name just a few. Tracking where these come from is nearly impossible, the majority come from Africa, South America, Russia, and Australia.

The manufacture and processing of electronics also uses a significant amount of water and energy.[14] The packaging materials that are wrapped around all the sub-assemblies and products can't be forgotten either. Finally when the laptop is fully assembled and packaged it will be shipped or flown to its final destination and delivered to our homes.

The Design Student

Chloe Tuck
Industrial Design Student, Loughborough University.

I've always been interested in sustainability. I think design is crucial in its implementation. And it all starts with design. What you decide at the beginning determines a product's end. We have learned if you change something at the design stage it'll cost you 10p in a pound, but if you change something at the manufacturing phase it will cost hundreds of pounds. It shows how a tiny change at the beginning can impact so much at the end.

For example, we learned at Closed Loop if you cover the whole milk bottle label in glue rather than just one strip it causes problems in the whole recycling process. It's tiny things like that, that have such a big impact. A lot of it seems like common sense. Sustainability is a really crucial part of design now, rather than just an after thought. It's something that needs to be fully considered at the very beginning.

There isn't as much closed loop thinking in design education as there should be. In the first year we did some projects similar to this where we stripped down an electric shaver and had a look at the components. But it's not as ingrained in the course as it should be. In the second year you aren't exposed to any kind of sustainable legislation unless you choose that option module. You aren't going to be that informed about unless you take a particular interest in it. I think all designers should take an interest in it because it's so crucial to what we're doing.

2

Teardown, Build Up – The Workshop Process

Community and Network

Designers are excellent problem solvers, but we're giving them the wrong problems to solve.

Mark Shayler
Ticketyboo

In the first phase of the project we have focused on building connections within the design and manufacturing community through a programme of events around the country. This process began with the mapping of different groups involved in the creation and use of a designed product or service; we call this the Circular Network.

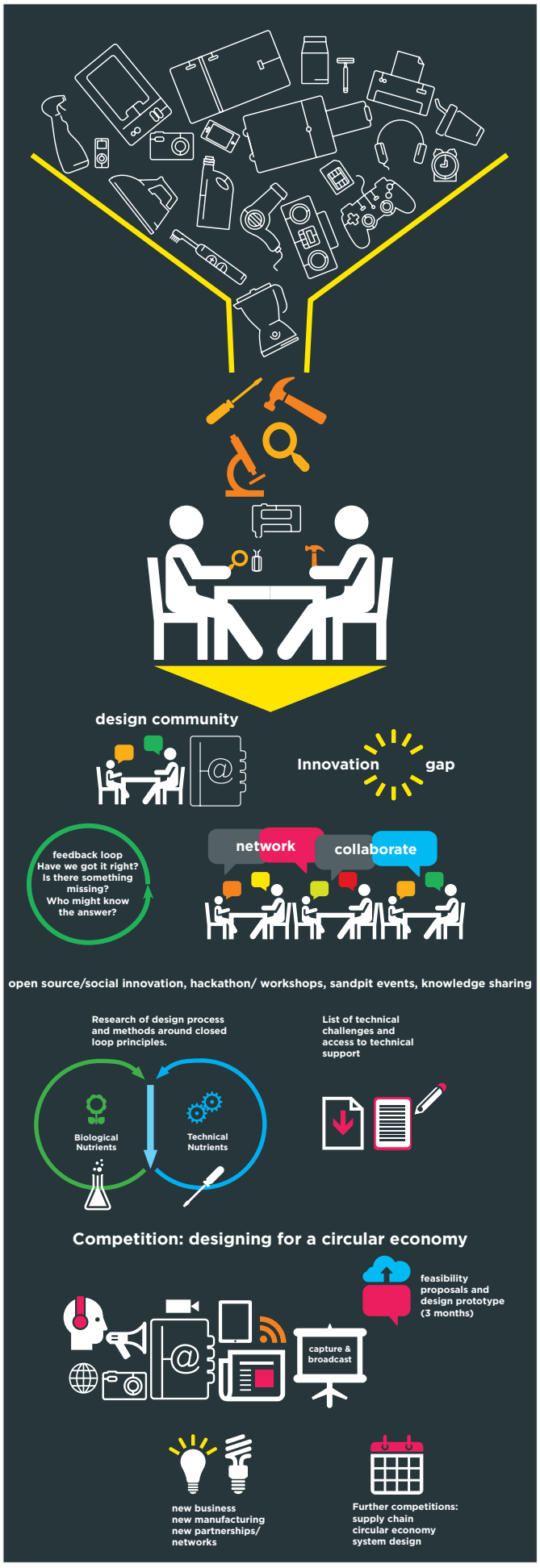
Addressing the UK design industry
Reaching our target audience as a whole is a challenge given the breadth of design disciplines and the lack of a single representative body, the different types of business practice (including those that might not recognise themselves as designers), and the programme's desire to target experienced design practitioners, as well as design students.

Our aim was to reach a mix of the design disciplines: from architecture to interiors, products to furniture, ceramics to textiles, graphics to digital, manufacturing to design engineers, systems to services, and many variations in between. Out of these groups we were particularly interested in attracting the large number of in-house industrial designers often described as the 'powerhouse' of the UK design industry. It was also important that we connected with those designers who did not consider sustainability to be part of their creative process.

We collaborated with a number of existing networks in the different design disciplines including the awards body D&AD, Royal College of Art alumni, RSA Student Design Awards past winners, Royal Designers for Industry, RSA Fellows and the design press to promote our activities.

The project launched in September 2012 with a networking event, competition launch and an exhibition stand at 100 percent Design, the UK's biggest design trade show at the London Design Festival. Working with curator Daniel Charny and our long-standing partners Bright Sparks, Islington Council's social enterprise repair and reuse shop, we re-created an electrical repair workshop in the heart of the trade show. The Bright Sparks team were on-hand fixing and advising for the duration of the event. Many people brought their broken kettles, hair dryers and toasters to see if they were fixable. Concurrently we curated a day of speakers on the public open day on the subject of the circular economy.

We had over 2,000 conversations with many people stopping to digest all the information on our exhibits. Most were keen to talk to us about the project's aims and where they fitted into our Circular Network diagram, which was on display. This early engagement also highlighted a particular problem around the writing of the design brief and the subsequent inability of designers to have the power to challenge it. It therefore became a priority to invite those who write design briefs to our events.



We have run seven public workshops, four organisation workshops, two networking evenings and four brokering events across the UK, attended in total by over 500 people.

Our website has a mailing list with 3,610 subscribers and we have 1,300 followers on Twitter. Our YouTube channel hosts the 18 films we have so far produced which have been watched 11,000 times. Our blogs and articles have been read by more than 9,000 people around the globe.

Over the first phase of the programme The Great Recovery has met and mapped out key stakeholders in the Circular Network. Here are just some of the people we talked to from the network:

The Brand/ Company

Matthew Polaine, BT's Senior Researcher on The Circular Economy.

We've realised (at BT) that our supply chains are key. They are key because when something's being manufactured at the front end of the supply chain, we need to tell them that it needs to be manufactured in a way that could help throughout its life cycle. If they have no vested interest in doing this, where's the incentive? We created the Better Future Supplier Forum, a campaign that BT uses to push the principles of circular economy into supply chains.

Where there could be a big advantage is economic clout. With a large manufacturer in the Far East, BT might represent two percent of their business. If within the UK we've joined forces with four or five other companies that are purchasing similar components from that company and we represent 20 percent of their business, then suddenly we have much more leverage in getting them to see our way of thinking. That's quite a good opportunity, but we're not at that level yet. There are still a lot of other things to be covered before we can get to that level of collaboration.

> Restart Project
> iFixit
> Fixperts
> Royal Designers for Industry
> Ticketyboo
> Useful Simple Projects
> Seymour Powell
> Thomas.Matthews
> Expedition Engineering
> ARUP
> Agency of Design
> Autodesk
> V&A
> Science Museum
> Design Museum
> Design Council
> 100% Design
> EcoDesign Centre, Wales
> MAKLAB

> London College of Communication, University of the Arts, London
> Royal College of Art
> UCL
> The University of Warwick
> Kingston University
> The University of Nottingham
> University of Bradford
> TU Delft
> Sheffield Hallam University
> Nottingham Trent University
> University of Cambridge
> Opening Minds Academies

> Technology Strategy Board
> PWC

> LCRN
> Lewisham Council
> Camden Council
> BSI
> BIS
> Defra
> WRAP
> Houses of Parliament
> Policy Connect
> European Government
> Science and Innovation Office Benelux
> UK Science and Innovation Network
> Resource Efficiency SIG
> British Embassy, Berlin
> EPOW
> Green Alliance
> Institute for Sustainability
> Ellen MacArthur Foundation
> BioRegional
> NNFCC
> Aldersgate Group
> Circular Economy Task Force
> The Resource Revolution
> Forum for the Future
> Friends of the Earth
> Gaia Foundation
> Tipping Point
> The Guardian
> Design Week
> Creative Review
> Computer Arts
> MADE magazine
> EDIE

> 2Degrees
> LAWR
> AJ sustainability

> SWEEEP Kuusakoski
> S2S
> Closed Loop
> WEEE Ireland
> NIPAK ltd
> LMB Textiles
> British Metals Recycling Association
> LCRN
> The Salvation Army
> ESA
> Veolia
> Van Gansewinkel
> Viridor
> Biffa
> Cat ReMan
> Bright Sparks
> Recycling Lives
> CIWM
> Ecolateral
> NISP
> Zero Waste Scotland

> What's in My Stuff
> Institute of Making
> Institute of Materials
> Ferroday
> NPL
> BRE
> Royal Society of Chemistry
> Granta

> Desso
> Cisco
> Interface

> Kimberly Clark - Europe
> Axion Polymers
> Saint Gobain
> Dupont
> EEF
> The Packaging Society
> Plastics Europe UK
> BASF
> Asda
> M&S
> Lego
> Google
> Philips
> P&G

> BT
> O2
> Fairphone
> Kyocera
> Unilever
> Samsung
> B&Q
> Asda
> Sainsbury's
> Travis Perkins

> McCann Erikson
> UCL Anthropology
> Which?
> Collaborative Lab

Workshops

Every time you get pulled back to the reality of things, and get your hands dirty, there's always a benefit. It brings you back down to earth to actually solve things at the coal face, rather than floating away in the clouds thinking 'wouldn't this be great'.

Sam Lanyon
Designer/engineer, Concept Shed

The programme for the workshops began in October and was phased to support the TSB competition 'New Designs for a Circular Economy'. In total, there were seven public workshops held around England, four dedicated workshops for organisations and a series of networking and brokering events, round table discussions and public debates at the RSA.

Our ambition was to get many different people representing all groups of the Circular Network together to observe, debate, tear apart, re-build and co-create a wide variety of products. Setting this multidisciplinary group the task of getting their hands dirty was the launch pad for exploring what it would take to develop a circular economy.

The workshops were spread out geographically around the country, to attract as broad a range of participants as possible. Each one was situated in an industrial facility that dealt with a specific type of material recovery or process. This located the workshop programme within the context of material resources and provided a visceral experience for participants. Seeing first hand the complexities and risks of not only sourcing, but also recovering materials, opened people's eyes to the challenges laid out in the introduction to this report.

In all the workshops the average mix of participants was 55 percent design to 45 percent 'other' from the Circular Network.

Disassembling a power drill

It's three o'clock in the afternoon in a fluorescent-lit room on a grey industrial estate in deepest Kent. The space is vibrating with the noise of destruction as 30 people intently hammer away at various gadgets trying to break them apart. This industrious mayhem is what is known as a teardown session. Expletives can be heard echoing around the room as the workshop attendees try, and try again, to crack into electronic appliances to retrieve the valuable materials trapped inside.

Amongst the melee, Royal Designers for Industry (RDIs) Terence Woodgate and Kenneth Grange are hunched over what remains of a power drill. Neatly laid out beside them are all the cogs, springs and other components they have successfully reclaimed from the tool so far. However, the motor of the power drill is proving impenetrable and it's driving them nuts. Terence is jamming a screwdriver vigorously into the object, trying to prise open the motor housing while Kenneth looks on with words of encouragement.

The setting of this Great Recovery scene is the recycling facility SWEEEP Kuusakoski (Specialist Waste Electrical and Electronic Equipment Processor) in Sittingbourne, Kent. This plant reprocesses 1,400 tonnes of electrical waste every month. A lot of it is broken down by massive industrial rock crushers once used in the Irish mining industry. The effort and frustration felt by Woodgate and Grange in trying to disassemble a power drill by hand is noticeable by comparison.

Workshop locations

Geevor Tin Mine, Cornwall
The participants ranged from practicing designers in service, product and engineering as well as HE design tutors and students. Following a tour around the now closed tin mine the group heard from The Great Recovery workshop facilitator, Mark Shayler on the element journey taken by the ingredients of a laptop, focusing on Tin and Indium, two elements that the mine would have produced. The group were then given electrical appliances including a washing machine, flat screen monitor, mobile phones and digital cameras. Tasks were set to rate these objects on ease of disassembly, value of components after disassembly, and rarity of materials. Discussions then focused on how we could completely redesign these products under a number of criteria, including design for longevity, design for remanufacture, design for disassembly and design for leasing. This process was mirrored in all the subsequent workshops.

Closed Loop, Dagenham
This event followed a very similar format to the Geevor event with a tour of the HDPE and PET recycling plant. The tour gave a glimpse into the innovative world of plastic recycling, including both the successes and problems that arise when returning packaging back to food grade. The group took apart multi-material packaging and products and discussed the challenges of redesigning for material recovery.

SWEEEP Kuusakoski, Kent
This workshop focused on e-waste disassembly and included a demonstration of SWEEEP's new furnace in action splitting the lead and glass from CRT television screens. The group took apart a number of electrical appliances including electric toothbrushes, radios, toasters, coffee machines and laptops.

S2S, Rotherham
This workshop was hosted by S2S, who work in recovery and recycling of electronics, including WEEE services through to decommissioning of IT equipment, refurbishment, re-sale, end of life recycling and secure data destruction. The tour demonstrated manual disassembly of electronics for re-use and refurbishment of electronics for re-sale. The group explored design for re-use in manufacturing and service design opportunities.

Cat Reman, Shrewsbury
A large group went out to Caterpillar's re-manufacturing plant, Cat Reman. Here the group investigated designing for disassembly and re-manufacture. The tour saw the manual process of taking apart and reconstructing engines, and discussed the business models and services needed around re-manufacture. The group disassembled engine parts and Cat Reman's electrical components and compared those designed for disassembly to others that were not.

LMB textiles, Stratford
The host for this workshop was the family run business LMB textiles who recycle clothes from across the South East, sending most of them to Africa and Eastern Europe, where there is a huge market for second hand western clothing. The group learned about successful sorting processes, design issues around the consideration of re-sale and challenges around collection and quality control. Clothes and textile items were taken from the sorting bins and dismantled by the group.

MERI, Sheffield Hallam University
The Materials and Engineering Research Institute in Sheffield Hallam hosted a day where attendees worked with the laboratory staff and their hi-tech equipment to look further into the material composition of products at a microscopic level. Participants did a teardown on a number of electrical items, particularly mobile phones that were analysed for their element ingredients. The group discussed challenges around re-sale versus material recovery in the electrical appliances sector.

Association workshops
A number of workshop were run for heads of sustainability, marketing and product development for manufacturing companies and corporate brands. Participants were asked to bring one of their own products for disassembly. They were asked to compare products that had been designed to be taken apart and those that hadn't. There were discussions on different business models for circularity and the barriers that hinder progress in closed loop design.

In some of the large Japanese electronics factories a new designer will cut their teeth spending the first months on a disassembly floor where products are taken apart for recycling. Here they understand what components go where, what job they do and what the value is of each part. They also see where opportunities lie for improvement and efficiency.

Sophie Thomas
Co-director of Design, RSA

The workshop day

The workshops were designed to re-connect participants with raw materials. The day started with a tour of the industrial facility to learn about what it did and how it operates. Each of the sites chosen allowed the groups to connect with different challenges around resource resilience and circularity.

The groups then embarked on teardown and design-up sessions. Attendees were asked to guess the ingredients list in the products in front of them. Generally they could name around half. Most would write down plastic (carbon, oxygen, nitrogen and maybe chlorine) but not the antimony in the drinks bottle or fleece, (used in the manufacture of the PET), or the bromine in the polybrominated biphenyls that is added as a flame retardant to electrical casings made from ABS plastic. They were given a set of cards to help the process, each card representing an element from the periodic table and with additional information on supply risk.

Participants then went through the process of deconstructing an object (also known as 'teardown') in order to understand how it has been put together and how it can be improved. This is a well-established design tool. Many designers talk about their misspent youth tearing apart anything they could lay their hands on, with nostalgia and joy. It engages the practical maker/creative part of the brain and even the most cynical consultants and heads of finance attending the workshops had glints in their eyes when handed a pair of safety specs and a hammer.

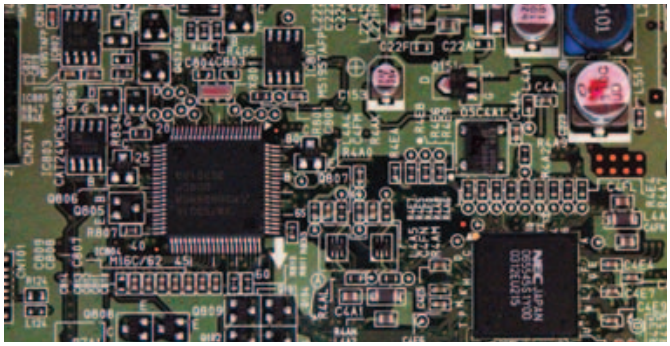
There were generally two types of routes to disassembly taken by participants at the teardown sessions. Some would take time to consider the object and attempt to take it apart screw by screw so that maybe re-assembly or even recovery of components could be achieved. Others immediately tore into the products, generally ending up with a pile of smashed up pieces. Both these routes of teardown had been witnessed on the tours and crudely represent the way industry recovers resource. The former was seen at S2S where they disassemble by hand and recover value in components for re-sale and the latter 'crush' process was seen at SWEEEP Kuusakoski where volume is the driver.

The experience of sitting in a materials recovery facility with a spudger and hammer in one's hands and a chunk of broken electronic waste on the table, that a moment ago was part of an enormous pile outside, is a very creative proposition for exploration. This is the premise on which The Great Recovery workshops were built. The workshops created a space for new perspectives and 'What if?' moments. Those that came to the workshops walked away from this process with a new sense of reality that came to be known as the three steps of 'Fear, Farce and Challenge'.

> The Fear is a reaction many of the designers have expressed when they are asked to look at the product they spent months designing, launched to much fanfare a year ago that now sits in the mountain of rubbish in front of them at the recovery centre.

> The Farce is the growing realisation that in order to make these devices, enormous amounts of raw material have to be sourced, numerous production processes are engaged around the world, and the products are transported from continent to continent incurring many ship and air miles.

> The Challenge is then to re-think the design of products from first principles. Pull an item off the waste mountain and take it apart. Understand what is in the product, where the materials come from and what job they are doing.



Is material recovery modern day mining?

At the SWEEEP Kuusakoski workshop in Kent, the workshop attendees begin to see how a facility like this, with its impressive 97 percent recovery rate of materials, is in fact a kind of modern day mine. It is an industrial site that extracts raw materials from waste. Some of the materials they end up with can be made into new materials.

The glass from old television screens melted down by SWEEEP Kuusakoski's specially designed CRT (cathode ray tube) furnace, is one great example (pictured above). The furnace is the currently the only one in the world and it can extract lead from up to 10 tonnes of funnel glass per day, that's the glass from approximately 60 tonnes of televisions.

This is one seriously profitable piece of kit. Apparently 1kg of lead can be extracted from each screen and, with its increasing value, the London Metal Exchange currently values lead at about £1,300 a tonne. At some point, when there are no CRT screens left to recycle, this specialist technology will become defunct. But, with approximately 1.9bn still in use globally, there is a guaranteed waste and revenue stream for several years to come.

The by-product of this extraction process is a grey glass that still has traces of lead (less than 1 percent). A design solution has yet to be found for it and SWEEEP Kuusakoski have so far developed an alternative to garden stones aptly named 'FAT' (short for Formerly A Television). But the results are somewhat lacklustre. This is a good example of the need for networked co-creation. If SWEEEP Kuusakoski brought good designers and craftsmen on board, they could see real value-added potential in their grey glass and designers would understand more about newly recovered materials they could specify in their work.

Observations from the workshops

'No-one has designed this system'
The result of doing a practical exercise like a teardown allows people to see things in a different way. Some things suddenly become ridiculous: A disposable electrical toothbrush becomes an electrical appliance with a four-month life designed with multi-moulded unrecyclable plastic, a long life battery and almost as many elements as a mobile phone. And some things become expensive: All LCD flat screen TVs have thin CLF light tubes with mercury vapour inside, which must be taken out by hand before they can be put through the crusher. Some models have over 250 screws requiring 15 different screwdrivers before you can extract anything. Every time a TV like this comes into a recovery facility the disassembler has to slow down to consider what tools they may need, reducing efficiency.

'Policy has a key role to play in design'
The workshops have been an excellent opportunity to start connecting designers and manufacturers. However, as the Circular Network shows, there are other key players who have a role in creating the circular economy. In the teardown workshop at SWEEEP Kuusakoski, as the destruction continued, Andrew Raingold, the director of the policy think tank The Aldersgate Group explained why it is important to have policy makers involved in The Great Recovery.

"The policy world is such a driver, in terms of the value certain metals have, in terms of recycling, and in terms of redesign. It provides the framework for plants like SWEEEP Kuusakoski, that have been driven by the WEEE directive." So why did Andrew come to this Great Recovery workshop? "I am interested in how we accelerate the transition to the circular economy. How do we keep the value of all these high-risk metals in the UK economy and the benefits that will have in terms of jobs and export potential."

'I didn't know so many were involved'
As well as building an informed and networked UK design community to drive forward the circular economy The Great Recovery sees need for the opening of industry supply chains in order to enable collaborative design learning. The way to start redesigning for better results in a resource scarce future is by re-examining the current system from the inside out. This involves getting to know what happens all along the supply chain. In the design and manufacturing world there are many segregated roles that are surprisingly not properly networked together. The client who sets the brief, the designer who selects the materials and creates the aesthetics, the policy makers that dictate the value of the materials, and the manufacturers who make designs a reality. Now, more recently, added to this line up is the end of life materials recovery role taken up by new entrepreneurial facilities like the ones that hosted the workshops.

'End of life is never in the brief'
Designers have a tendency to focus their effort on the manifestations of their creativity, which in the majority of cases is a physical product. But imagine if the brief was expanded out to become about the entire life cycle of materials which form the product for a brief moment, but are then designed to be taken back to their separate material streams. This kind of shift in emphasis would move the attention away from aesthetics and towards maximising the energy embedded in production, making sure that full material recovery was a certainty.

'This is designed for effective manufacturing, not effective recovery'
Designing with consideration to material flow would make co-moulded products, like the humble non-electric toothbrush, mentioned earlier for its 1.5kg ecological rucksack, first in line for a redesign. These types of products have manufacturing processes that mould two or more plastics together in one manufacturing step. This is very efficient and economical for the making but renders recovery of materials pretty much impossible.

These kinds of products make interesting design case studies and often came up in the workshops. They are designed to be cheap, disposable objects for specific tasks, in this case - plaque removal. Their design innovation lies in the ergonomic handle and, in the case of the toothbrush, in new manufacturing processes that can co-mould several plastics in one action: machine-constructed and impossible to separate. Like with a lot of these small inconsequential objects that clutter our lives the impact only rears its ugly head when you add up the mass: the USA sends approximately 25,000 tonnes of toothbrushes to landfill every year.

The toothbrush is a case in point where the raw materials are relatively cheap as long as the cost of the those materials (oil) stays low. Other products highlight the absurdity where a high quality specification meets limited life span. 'All-in-one' computers with their incredibly high-spec components are now pretty much impossible to repair or upgrade with a fused glass front panel onto an LCD screen. When the online repair site, iFixit took apart the new iMac they not only had to use a heat gun to remove the adhesive, but also guitar picks to pry the fused glass and LCD screen apart – a process only the strong hearted and confident consumer would consider undertaking. They gave the new model a measly 3 out of 10 on their Repairability Score scale demonstrating that the trade-off for this new elegant design is that it has effectively been designed for limited-use life.[15]

'I was surprised what was in it'
This ingredients list hidden within our products is another part of the problem – if you don't know what is in there how can you design a system to get it back out? It brings up a number of issues. Firstly, how far into the ingredients list should designers know and go? Design methods like Cradle-to-Cradle require extensive understanding of what is in products. Designers generally don't have this level of understanding and need to befriend chemists to get this deep. Secondly, these elements are often used in such tiny amounts that it is almost impossible and economically unviable to consider recovery unless these objects are brought together to create the volume. It is easy to dismiss the microscopic amounts of neodymium used in the tiny vibrating motor of a disposable electric toothbrush but worth considering when you add up the large percentage of small electronic appliances like the toothbrush or glowing party balloons lit by LEDs or a children's toy in a Happy Meal that disperse these vital elements across the waste landscape. This scrutiny of material make-up also helps the understanding of any potential toxicity and contamination that could occur in the later stages of material recovery.

'I've never talked to a waste manager before'
A networked supply and recovery chain is the key to enabling circularity. The Great Recovery's work has shown the importance of the design element being part of this discussion. Through the initial programme of workshops, events, networking and debates new connections were already developing across disciplines and across networks. This opportunity generated conversations between people who would never normally have interacted with each other in their usual job roles and fuelled new ideas and problem solving.

One of the most effective impacts was the immersive nature of the workshops. The participants swapped their studios and offices for rooms that overlooked enormous waste mountains deep inside packaging recycling plants, textile sorting centres and electronic waste recovery facilities. These places were physical demonstrations of the potential value in resource and the current best, but far from complete, practice of recovery.

The UK leads the world in many design and manufacturing skills. However, the threat of that knowledge being lost is all too real, because industry is failing to skill up future leaders as the experts move towards retirement. In the textile industry, for example, it is considered that in only five short years a whole generation of craftspeople and technicians will retire, taking vast amounts of knowledge with them that have not been passed down, the consequence of a declining manufacturing industry.[16]

'We weren't taught this at college'
The Great Recovery sparked many discussions around the role of higher education and continued professional practice (CPD) in design. While creative subjects such as art and design are currently being threatened by reforms in the school curriculum,[17] the UK's creative design degrees are still considered among the best in the world. Design colleges across the UK attract students from around the globe to study in their cutting-edge programmes. Yet the question of designing for resource efficiency has for years been regarded as an add-on, rather than set as the foundation of design education.

We are slowly seeing changes and more integration. Certain universities have sustainable design electives running inside their course programmes, or have parallel sustainable design degrees alongside the 'regular' courses. What is needed is a greater amount of cross-fertilisation between different disciplines. Just as the network of closed loop manufacturers, businesses, designers and material experts join up around the movement towards circularity, this model should be mirrored in education with cross-curricula collaboration and a more focused approach to system and service design, moving away from the product focus and closer to bigger systemic change.

'There are so many challenges, where do you start?'
The workshops were designed to allow people to find their own ways to deconstruct barriers. Whether that was by breaking apart a mobile phone with their bare hands or taking the time to understand the challenges faced by the workshop participant and member of the network sitting next to them.

The teardown's atmosphere of creative destruction was not only an educational experience for people, but also an emotional one. They found it both frustrating and satisfying. People liked using their hands and having to do something physical. It made a welcome change from their usual desk jobs. Conversation was aided by the physical interaction and by the end of the day, in the concluding session, people felt more comfortable sharing their opinions with each other due to this novel shared experience.

A final observation from the workshops is that everything is connected, from the way we design the packaging and market our consumer goods to how we deal with and recover the waste materials coming out of households and industry. The workshops clearly illustrated how easy it is to build in negative environmental impact at the design concept stage by designing in isolation. Working through the challenges with the right network around you avoids these pitfalls and creates great opportunity.

It has been a joy to meet with designers from all sorts of backgrounds and realise the appetite they have for understanding the journey materials take through product lifecycles.

Dr. Michael Pitts
TSB Lead Specialist, Sustainability

The Brand/Company

**Neil Harris,
Green Technology and
Innovation Manager at Cisco.**

One of the things that really struck me about The Great Recovery workshop, as somebody doing what I'm doing, and maybe for others as well, is that you don't touch stuff anymore. We're all on our laptops or all in meetings. It's very rare that we get an opportunity to get hands-on and tactile with things. It's a good reminder of the complexity in electronics, in all types of different electronics; consumer, business and computing.

I've really enjoyed taking things apart and having a look at what's inside. I had some really good conversations with some folks on other tables about the value of the material that they're pulling out of these products, these little circuit boards. I just wonder, "How much is that worth?". There's gold on it and there's a few capacitors on it. It's probably only worth a couple of pence, but when you start to deal in tonnes of this stuff it becomes quite valuable.

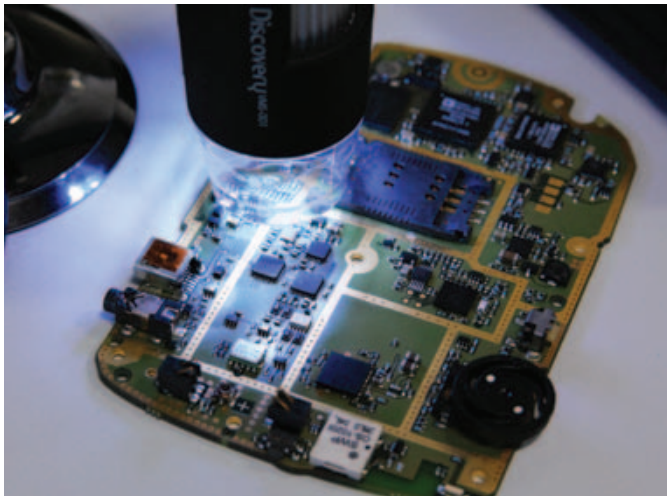
I've been told that a tonne of circuit boards is worth about 1,130 euros. That's a lot of money and will be of interest to lots of people. There is a much more upstream kind of conversation happening here, the designing, the engineering, the production, the sourcing aspects of business and business production – that's really good.

The Anthropologist

Adam Drazin,
UCL Anthropologist in Material Culture.

Twenty or thirty years ago, very few anthropologists were working on objects or materials as cultural in themselves. Now we are engaging more with design, because design is the way in which this interest in material culture can make a difference politically or socially. This engagement is in many ways a natural extension of what we have been saying for years – that the material world is important for political participation, for critique, for identity, for relationships, for practices. You can't continue to assert these kinds of things in the abstract, you have to engage with design at some point and design has to engage with anthropology.

What's very important to me is that this is not only about good design work but good social science. Sometimes in the past, the connection has been a one-way street, where an anthropologist does some ethnography 'for' design. Increasingly, iterative design methods are coming into anthropology, and they are good for some kinds of social understandings. Although you can't beat good old-fashioned modes of long-term participant observation in anthropology, you learn more when you begin to incorporate methods such as sketching, prototyping or iterative co-design.



Open Workshops
1. Geevor Tin Mine, Cornwall
2. Closed Loop, Dagenham
3. SWEEEP Kuusakoski, Kent
4. S2S, Rotherham
5. Cat Reman, Shrewsbury
6. Sheffield Hallam University
7. LMB Textiles, East London

Brokering Events (with the ESktn)
1. Engineers House, Bristol
2. The Midland Hotel, Manchester
3. Crown Packaging, Wantage
4. Recycling lives, Preston

Association Workshops
> Opening Minds, RSA
> The Aldersgate Group, RSA
> The EEF, London
> Green Alliance Seminar, London

Networking at the RSA
> Great Recovery Launch
> The Great Recovery Phase 2 Launch
> Redesigning the Future panel debate

The Consumer/User

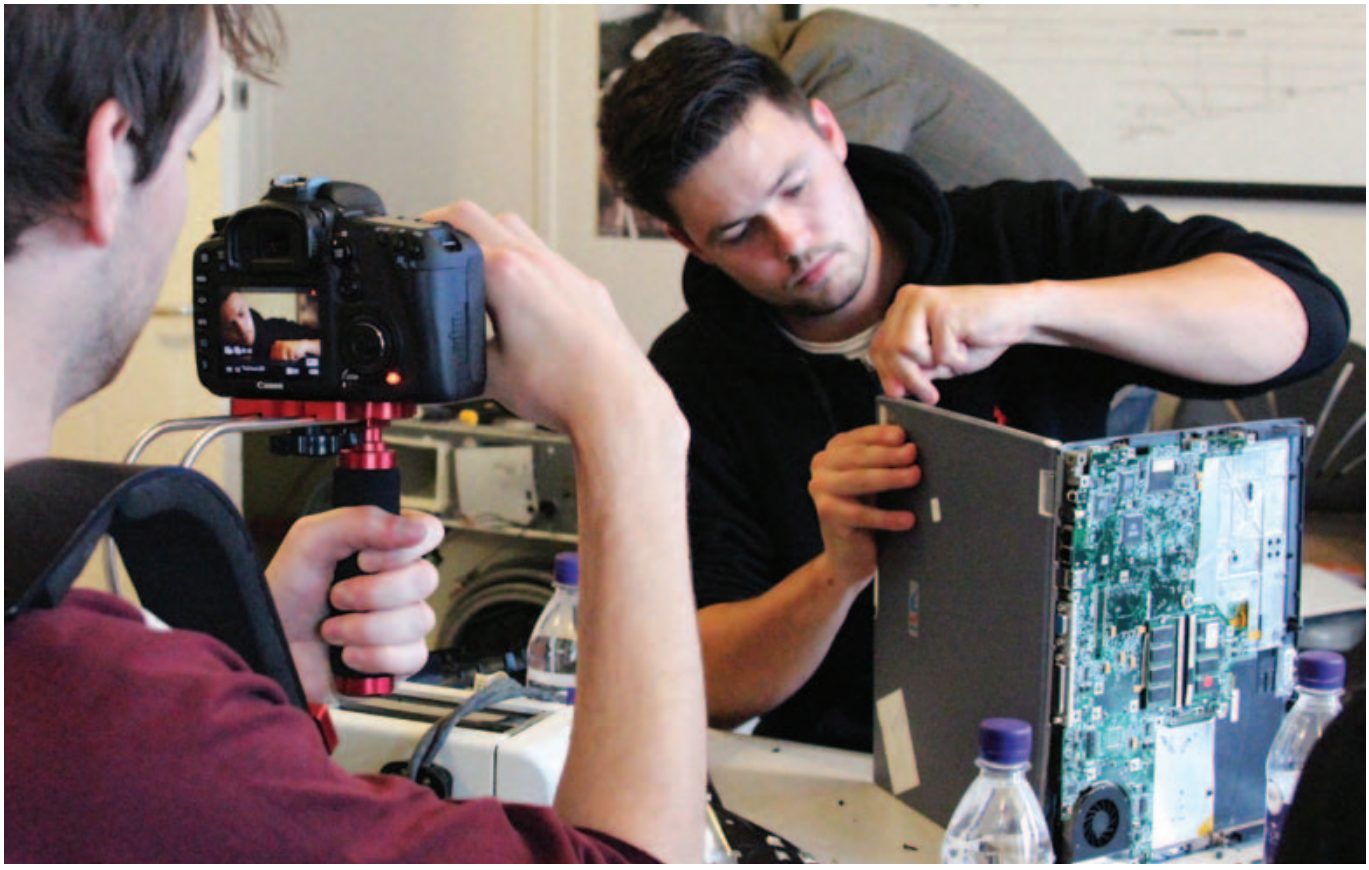
Andrew Foxall at the LMB Textiles workshop. Director of Foxall Studio, fashion brand consultancy.

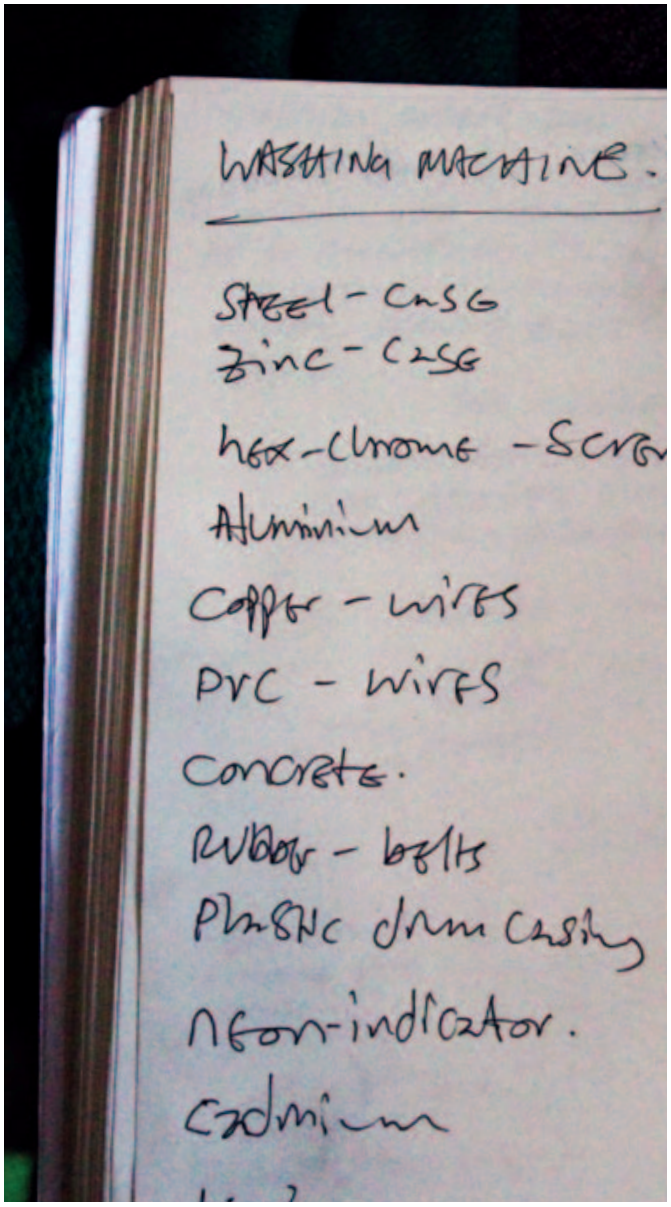
Sustainability has been a big buzzword in the fashion industry over the last couple of years, so any sustainable thinking is great for brands in high fashion right now.

We've been on a tirade about the front of the system, the consumer, where the products go in, and how corporations are having to completely change the way they sell and where their responsibility lies. The elephant in the room is the fact that it's a consumer problem.

Consumerism is the least sustainable thing we do, but what brand is going to want to slow down consumerism with the existing model to sell more and boost the economy?

You have industry magazines one week saying its all about sustainability and the next week it will be, "Government says let's open our shops later". It's a paradox. But here I started to hear a lot more about the design side. I had been so interested in the 'consumerism' issue that I had forgotten about the nuts and bolts of it all, literally the nuts and bolts, or the zippers and flies.





The Design Engineer

Sam Lanyon,
Director of Concept Shed.

My background is in electronic engineering and I'm interested in elegant solutions to things. A lot of these e-waste products aren't elegant solutions, so it's great to come to a room full of people that are looking at these products with a critical eye.

Generally consumers just consume, they don't stop and question. It's nice to pull things apart with people for whom it's really exciting and surprising. We can create some hope for this to become the norm. People should question and ask "What am I buying in this box?". They should look inside and say, "There's nothing in here, why am I paying this money for it?" or "This looks rubbish. It looks cheap and is badly made. I want something better, I want something that will last".

People are surprised when they take the lid off something. Like when they take the lid off the washing machine and ask "Why is it so heavy?". Because there's a load of concrete there as ballast for the drum.

Competition

One day, all this will simply be good design and we will no longer need to talk about it as an issue. If The Great Recovery can help us reach that point, by mobilising designers and all the other supply chain partners to the challenge, that would be a real win.

John Whittall
Technology Strategy Board

The Great Recovery has set out to demonstrate the urgency of developing a circular economy for a sustainable future, whilst strengthening the argument for inclusion of creative thinking in process redesign and the propagation of important technical expertise. The UK sits in a unique position of need and skills with its great heritage in making and manufacturing in the UK.

The aim of the programme's workshops has been to open eyes to the extraordinary new opportunities in designing for circularity. This in turn has encouraged those that have engaged with us to collaborate with others to submit high quality entries into the Technology Strategy Board's competition, "New Designs for a Circular Economy".

This open competition, aimed to stimulate innovation in design addresses two high-level challenges:

1. Reducing the global environmental impact of materials that we use.

2. Reducing dependence on key raw materials, the supply of which is potentially at risk.

The designer's oxygen is creative instinct rather than metrics. Yet those designers working on resource efficiency for big brands are being asked to tiptoe around the core product with a calculator. Here the carbon metric is king and reducing product weight by thinning a bottle or substituting a heavier material that may already have an established recycling infrastructure for one which has none (an 'eco pouch' being a case in point) is seen as a success.

These incremental changes are keeping people very busy whilst avoiding bigger, more complex issues. In contrast the TSB competition invites designers to use their full potential in redesigning not just single products, but, more ambitiously, whole systems and services. To quote Mark Shayler, "It's not about doing things better, we need to do better things".

The selected winners for the two rounds of the competition, in December 2012 and March 2013, were awarded up to £25,000 towards feasibility studies which tested new ideas and investigated new products and services that closed the loop.

Further competitions are planned in the subject area of resource efficiency, closed loop and supply chains with a strong emphasis on design collaborations.

TSB Designs for a Circular Economy – Competition Winners	
Alsitek Ltd	Substitution for non-recyclable fireproof foam and lightweighting for dematerialisation
Alterix Ltd	Large scale interactive multi-touch displays
Applied Nanodetectors Ltd	A new design for a handheld reusable non-invasive breath test for blood glucose monitoring and diabetes self-management
Autocraft Drivetrain Solutions Ltd	Electric Vehicle Battery Remanufacturing (EV BATT-RE)
Axion Recycling Ltd.	Outdoor media banners – Design for recycling
Bond Retail Services Limited	Feasibility Studies to implement the Circular Economy model in large retail food cabinets
Bottle Alley Glass	Glass bottles into construction materials
Clarity Sustainability	Reducing the Environmental Impact of Branded Event Communications
Dyson Ltd	Assessing the through life impact and understanding the implementation steps to using bio-polymers for Dyson products
Ecobond (Cymru) Ltd	The RE-Fab House – Enabling Re-Useable Construction
Ecocap Limited	Ecocap Ltd
Haydale Ltd.	Nano Particle Polymer Enhancement for Recycling Sustainability (PPERS)
Hugh Frost Designs Ltd	Freight*Lift palletless material handling system
Imperial Chemical Industries Limited	Project Recover: new life from old paint
KeepCup Ltd	Reusable Hashi made from Disposable Hashi Waste and Biopolymer
Kingfisher Plc	Return to Sender
Kingfisher Plc	Circular Design for an Economy Power Tool
Kingfisher Plc	ProjectBox
NewCatCo	Circular Design and Processing of Green Sustainable Products of Material Benefit
Phineas Products Ltd	Feasibility of Implementing a Circular Economic Business Model for Phineas Products
Powervault Ltd	A New Lease of Life for Expired Electric Car Batteries
Raw Studio Ltd	Modular Bicycle Frames
Re-Considered Ltd	Development of an innovative, reclaimed textile fibre furniture range
Re-worked Limited	Coffee Board: Designing an energy-light closed loop system for waste coffee and plastics
Rich Coles Packaging Associates Limited	Design of re-usable biomaterial packaging systems for the chilled meat and fish industry
Soltropy Limited	Investigation of the use of silicone sponge tube and design study of other components in solar thermal collector
Systematique Ltd	Closed-loop manufacture using recycled UK Polymer (CUP) – Systematique
The Agency of Design Ltd.	Closed Loop LED Bulb
The Agency of Design Ltd.	Connected closed loop kettle
Treebox Ltd	Servicing Greener Cities
Toyota (GB) PLC	Design requirements in product, process, organisation for End-of-Life Vehicle (ELV) to achieve Circular Economy State
Useful Simple Projects	Polarising designs: Redesigning neodymium magnets (NDM) for the circular economy
Useful Simple Projects	Design of new tools for closed loop manufacturing
We All Design	Project Recover and unBuild: Beyond WEEE regulation
4G Design	Sustainable Retail Design: A Closed Loop Life Cycle Assessment strategy

More ambitious design goals

One of the competition winners, Rich Gilbert, co-founder of The Agency of Design, made the case for more systemic design at the RSA Redesigning the Future panel discussion in April 2013. Recounting the design journey he went on to develop a proposal for the TSB competition, he expressed his dismay on visiting material recovery centres such as those that hosted The Great Recovery workshops.

The amount of time, effort and detail that product designers like Gilbert spend putting into their work is roundly mocked at the end of the device's lifecycle when it is destroyed by an all purpose crushing machine. "Should we," as Gilbert asks, "really design something to get shredded better? That doesn't seem like a very ambitious design goal."

Gilbert continues with this advice for fellow designers. "Make sure you redesign the right thing. A lot of human exertion goes into carefully designing and assembling products, but the disassembly is so crude – just smashing them up. The design challenge is more systematic."

The Resource Manager

Nick Cliffe,
Marketing Manager
at Closed Loop Recycling.

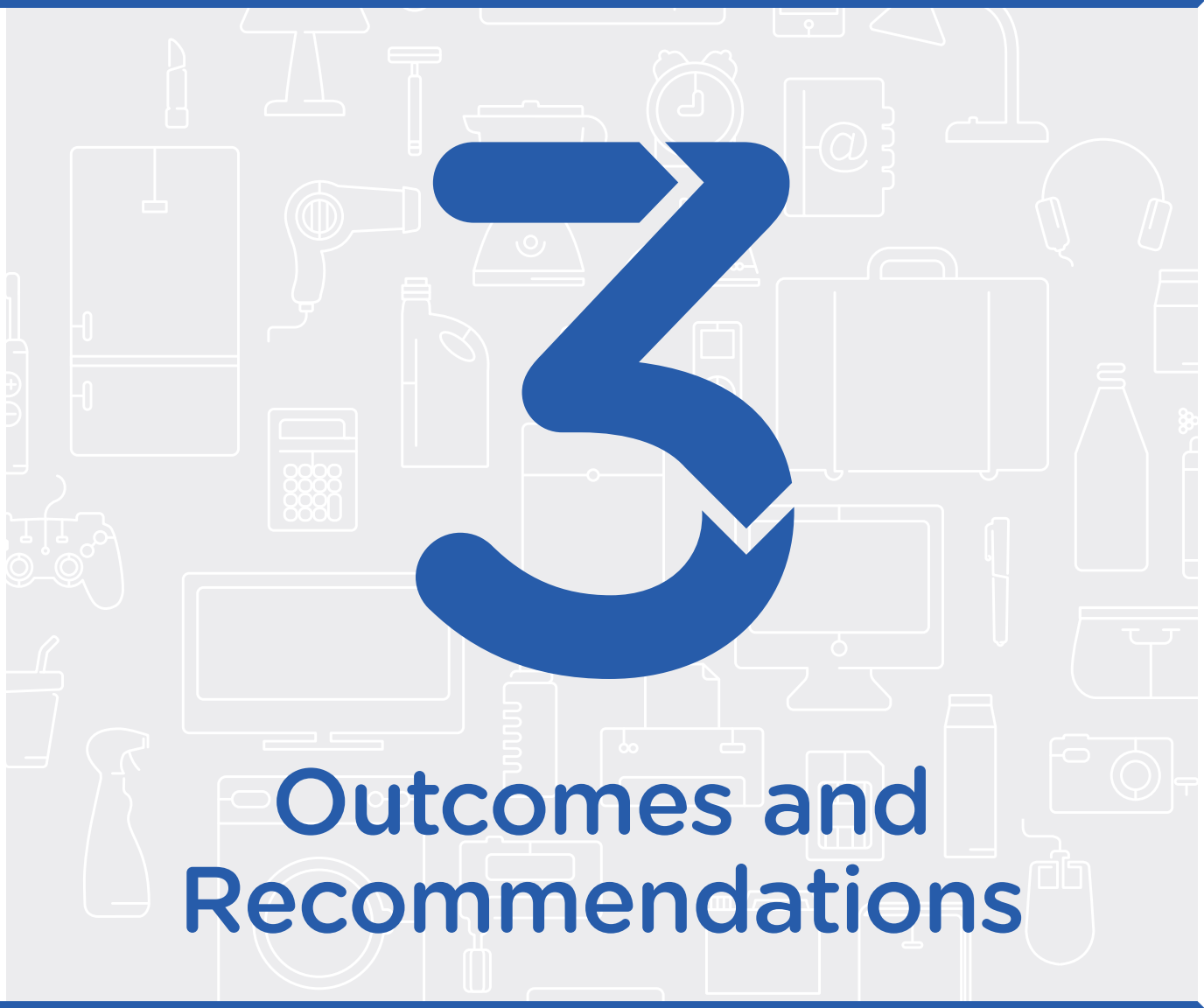
If we did more efficient presorting of plastic bottles then it would make a lot of machines we use at Closed Loop redundant. In Austria a 500 kilo bale will have 98 percent PET content. Their contamination levels are much lower. If you tell a German to put a PET bottle into a PET bin they tend to do it. But here in the UK co-mingled collection means we have so much pollution in our plastic bundles.

Some local authorities are stepping back from co-mingled collections. Let's look at this seriously. 25 years ago everything went straight into landfill. The waste industry had a very simple flow diagram – there was one arrow from the house to the dump. Now there are all sorts of routes to the recycling facility.

It's taken local authorities a long time to understand that they in effect are becoming more like oil companies, mining companies and forestry companies as we move towards the circular economy. They are the primary producers of recyclables.

As they gain a better understanding of the value of these materials, it informs their decision making. They have been very quick to outsource the problem to waste companies. Waste companies understand the value of recycled materials. The local authority charge the waste company per household – 75,000 houses in one local authority, £5.18 per house – that's the bill.

But the more switched on authorities say if I spend more time and money improving plastic recycling rate from 25 to 60 percent you are getting more value from your materials and a reduction in collection costs. You don't need many local authorities to come together to see them controlling enough plastic to build one of these Closed Loop facilities. It becomes all about value not volume.



3 Outcomes and Recommendations

Outcomes

Today we saw that every solution poses another problem. A great example was someone, with the best intentions, designed an ecological bamboo case for a computer that actually messes up the recycling process. I would never have thought of that. It's only when you come to workshops like this that you can then make informed choices about design".

Terence Woodgate,
Furniture and lighting designer,
Royal Designer for Industry

To date, the discourse around the possibilities of designing for closed loop manufacturing has been optimistic if, perhaps, overly simplistic. The myth that our single planet can provide the human race with unlimited natural resources has been dismissed and the business opportunity through closing the loop has been set out.

It is widely agreed that many of the materials that feed our production are increasing in scarcity. We may soon be reaching points of peak everything: oil, gas, coal, water, metal, and minerals. The race for resources is also playing a pivotal role in ongoing geo-political conflicts around the world. With all this information, surely the way we design our products and services can no longer disregard the continuous stream of materials into the landfill.

There is logic to solving current problems through better design for resource efficiency. Intellectually, most people involved in these discussions have understood the imperatives driving the UK towards circularity. And to do this there are many routes designers can take towards circularity, steered by the brief given and influenced by the client, the material processor, the brand, and the consumer.

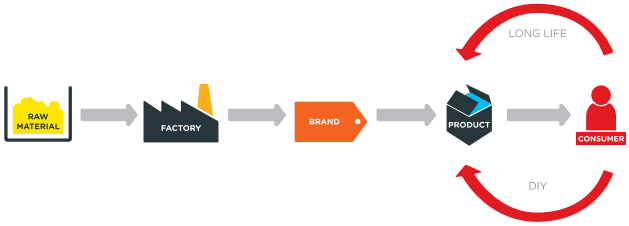
All require a system design re-think. In exploring the possibilities of designing for circularity and through the observations of the workshops, the Great Recovery has identified four main design strands that fit within the Circular Network.

Each has its own design considerations and challenges and its own network of collaborators who need to be involved in the design process. These four design models are set out overleaf.

The Four Design Models

1. Designing for Longevity:
This route is closest to the consumer/user and must therefore be designed to maximise the embedded material and energy from production stages. This is about designing products that last, are well crafted and well made so that people don't want or need to throw them away. Products on this loop should be designed to have a long life span, extended through user action of upgrade, fixing and repair. This kind of relationship requires readily accessible information and product service manuals. These products are designed to be taken apart easily without breaking any security seals or glued components. When they fall out of favour with the user they should be encouraged to pass them on. Products on this loop should be designed to be desirable in their continued workability and trusted as something that has a long and adaptable life span. They should also be designed with consideration as to how users attach themselves emotionally, highlighting a key role for anthropological insight.

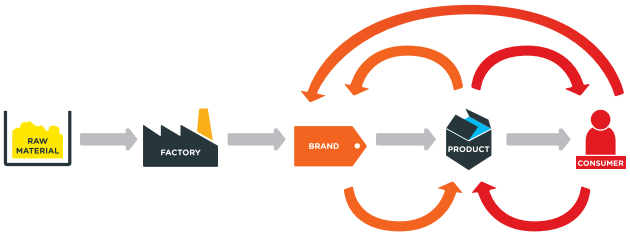
Design for longevity was pretty much wiped out by built-in obsolescence and access to cheap global production. However, the emergence of a new fixing revolution is questioning the consumer's attitude towards wanting the 'new and improved' before the 'old' has lost its shine. There are big barriers to overcome before longevity becomes a mainstream design option again. The biggest obstacle sits within the business model that creates profit from selling more units and where unit costs must be as low as they can, making material choice and quality suffer.



Obstacles like intellectual property laws and company secrecy around production methods hold up or complicate user fixability. Transparent supply chains and open-source operating manuals would open up huge opportunities for design.

2. Designing for leasing/service:
Digital platforms and changing consumer behaviours are allowing people to share and lease products as an alternative to owning or buying. Car sharing businesses are now a common and accepted practice, and this sharing model is rolling out to other products.

Service design is a growing area and is a key component to effective circular economics. It allows for higher specifications of design and materials that increase life and durability. The material stays in the ownership of the manufacturer as the product is never sold, so value is kept within the system.

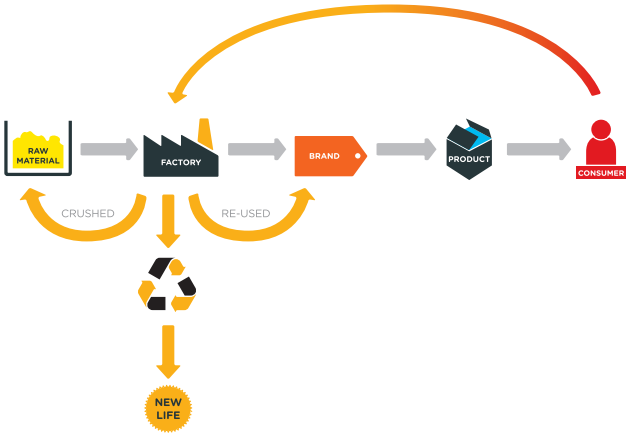


Sharing and leasing consumerism has its own design challenges, which mostly sit in the business model. If many people are sharing a product how do you design it differently? How can new warranties be redesigned to support these new industries? What incentives are put in place to make sure products, and more importantly their materials, get back into the system rather than being stuffed into drawers or lost in landfills? How can profit be created when there is no option of selling in the new and improved model in 12 months time? Currently services and repairs are not exempt from VAT. Making repair a tax-free service would bring immediate benefit and incentive to move to a leasing business model.

3. Designing for re-use in manufacture:
With current infrastructure that supports a 'crush and melt' method to waste management, pushing a 'design for disassembly' approach seems premature. The Great Recovery workshop highlighted the need for incentives for companies to invest in new toolings or factory jobs for deconstruction.

The re-capturing of material through new system designs that guarantee the return of the product into their material stream reduces a company's risk to increased price volatility. Increased Producer Responsibility (IPR) and new closed loop partnerships would push businesses to think further out from just their supply chains.

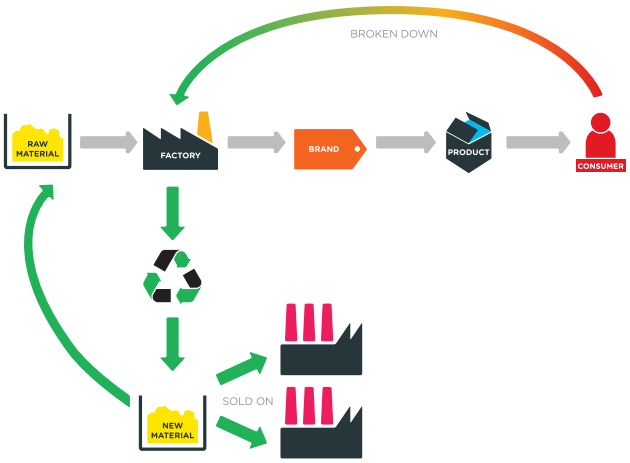
These types of business relationships known as 'industrial symbiosis' networks can offer opportunity



to design a closed loop system, where waste from one business is captured and used as raw material for another. Individual Producer Responsibility would help to switch the focus onto value of material rather than volume, and would incentivise investigation into designing products and services that brought old products back in to the manufacturing systems for service, fixing and upgrading. This is designing for longevity at a manufacturing scale.

Designers need to work more closely with the manufacturers to see where opportunity lies with smaller businesses. Government should address UK legislation where a product with a re-manufactured part cannot currently be sold as 'new' under the Trade Descriptions Act.

Designing for material recovery:
On the outer loop the fastest flowing products like packaging need to be fed into a recovery stream as soon as they have finished being used. This is the area where the UK is currently doing pretty well. Initiatives like the Courtauld Commitment on packaging coupled with increased resource costs have incentivised growth in the resource recovery businesses. Even so our lack of understanding in the design industry around effective material recoverability can create more waste through misinformation, which can contaminate valuable recovered materials.



Proper network dialogue between designer, resource manager and recoverer is key. Fast moving consumer goods (FMCGs) should be considered for redesign to match the capability of recovery facilities. This collaboration will bring innovation on both sides allowing for true material capture. The design brief must be strongly influenced by the end of life of the product. There should be restrictions, even phase-out of multi-material packaging that, because of the nature of the design directly impacts its effective recovery. Increased recycled material use should be normalised and accreditation bodies must help build the case for specifying more recycled materials by developing certification and metrics to level out material quality.

Material and Information flows
Sitting in parallel and with equal importance is the flow of information that makes the materials move from one process to another. At every point when material passes on, knowledge of what it is and where it goes next must be passed with it.

If the information falls away or is miscommunicated, material is lost or misplaced. An example of this can be seen in the conflicting recycling information from different local authorities which confuses and aggravates households, often leading to resignation and the default position of putting everything in the black bin.

With each of the four design routes within the circular economy, information flow plays a vital role: Within design for longevity, the user must have easy access to freely available information, in order to repair and upgrade so that their product has an extended life. Such objects may be passed to other users, so information must be passed on with them. When the product finally becomes irreparable the owner needs to know what to do with it.

For design for leasing, information builds up trust in the system. The user must know when and where to send the product back for upgrade or replacement, building up a long contractual relationship with the brand. A profitable lease model relies on additional services so trust and honest communication is key.

As with design for leasing, design for re-use in manufacture must have strong user/manufacturer information channels so that the used product goes directly back to the factory. This process could be encouraged through a deposit system or collection option, making return as hassle-free as possible. With design for full material recovery there should be no confusion that could result in contamination of the flows of material into the recovery facilities. Communication on what can and can't be recycled must be communicated clearly and there should be help at hand to make sure no valuable materials are lost.

Building systems that incorporate these flows get more challenging when considering longer-term products like houses. Some materials, for example steel, can stay in 'societal use' for long periods of time (compare a steel girder to a disposable coffee cup). At this point the design must build in a way where information can be carried over unspecified periods of time without becoming obsolete through technical advances, or unreadable through degradation, or gets detached from the material in question.

In all cases if the flow is working well there is little leakage. Fewer materials are lost and more opportunities are made with increased communication through the network.

Closed Loop Recovery facility

Within the factory process there are a myriad of hurdles to creating food safe recycled products. The Closed Loop facility system could be seen as a microcosm to the industrial system as a whole.

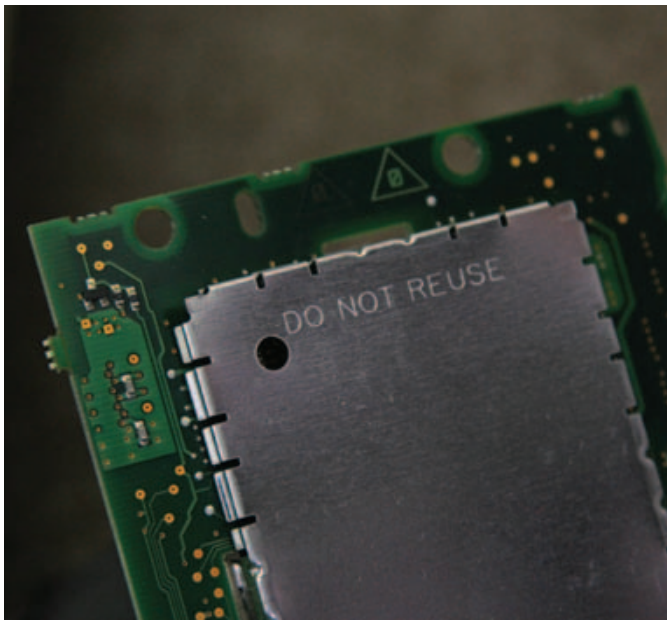
Plastic bottle recycling is constructed around consumer waste and the way it is collected. Closed Loop recycle PET and HDPE to food grade standard. These types of plastic are both widely collected through local authority collection systems. This is generally through either a 'co-mingled' method where all domestic recyclable materials are put together into one bag or a 'kerbside' system where the household sorts and the collectors separate into different compartments in the collection vehicle. Closed Loop have to navigate huge variation in quality and output from these schemes. They then have to negotiate what their clients see as consumer demand. For example, consumers don't want to buy their milk that is contained in a milk bottle that has a slight green tinge because they perceive it to be off. This tinge is an outcome of the recovery process, from the colour of the lids. The white HDPE is becoming tinged by our preference for semi-skimmed milk. We have confusion at the consumer level on whether to leave the green lids on or off. The recovery facilities are having to employ cutting edge technologies to counteract the inadequacies of an out of date service structures and this makes for an unstable system.

The next steps towards circularity
Through the workshops, The Great Recovery has collected a significant amount of commercial, industrial and creative insights into manufacturing, production and resource management. The principles of this learning can be applied across disciplines and industries in a knowledge transfer process, an ambition for the next stage of The Great Recovery project.

The 'design for circularity' diagram showing the four design models begins to break down the complexity of moving from a linear to a circular system. It gives designers and businesses a steer on how to think about their briefs and apply logic to the life cycle of each product, system or service they create.

The design models also categorise designers as problem solvers, providing four different frames in which to consider the best solution to their current creative challenge and points the way to the network collaborators who should be involved in their design process.

As Jonathan Chapman said at the RSA Redesigning the Future panel discussion "Design has always been about change and reinvention".[18] The question this report seeks to answer is how to ensure that this change and reinvention is not just an end in itself. Design must be used for the pursual of the triple bottom line, not just the short-term benefits of profit today. Good design has historically been defined around creating beautiful forms with exceptional functionality. It seems timely to add that good design must now also be circular in its material flow.



The Manufacturer

Ben Reed,
European Engineering and NPI Manager,
Caterpillar Remanufacturing.

At Caterpillar we are always looking for ways to spread the message about remanufacturing, and the difference between a properly organised industrial scale process like ours and the smaller 'refurbishment' or 'reconditioning' type outfits.

Doing this process in a factory environment with proper quality controls results in a superior product which we back every bit as much as the equivalent new components with the same warranty and support. In addition to spreading our message, we also wanted to learn about other companies and get a feel for how we sit in the circular economy.

The best part of hosting The Great Recovery workshop was realising just how good an example of the circular economy our business is. I always knew what we were doing was the right thing for the environment, but when I look at the challenges other industries face it was clear that we are more advanced than most.

If anything, it has strengthened our resolve to continue pushing the boundaries of salvage engineering and remanufacturing. We are already proud of what we do, and we know we can go further.

“As we see smarter technology, faster technology, more connected technology, our dependency on materials grows and our dependency on more exotic materials grows as well.

We’re very interested in how we can maintain supply of those materials to enable our business to function, to enable us to provide our markets with great technology. Of course there’s a business opportunity for us in being really good at, or building smart interpretations of, the circular economy inside our company.”

Neil Harris
Green Technology and Innovation Manager, Cisco

This report concludes with our initial recommendations from The Great Recovery project and our proposed next steps.

1. Skilling up the design industry

A. Prepare future generations of designers. Embed circularity in the design education system. Sustainable design must not continue to be left behind or added as a last minute thought. Make sustainability a matriculation criterion in every design and engineering degree. Encourage multi-disciplinary learning based on an understanding of the lifecycle of the products and services.

B. Encourage creative approaches. New and existing tools need to be realigned around the challenge of designing for circularity. Established tools like the teardown process are highly effective but not commonplace in design thinking.

C. Designers must be bolder and broader. New generations of system thinkers are needed. Designers need to re-set their definition of beauty to encompass the whole circular life of the materials and processes within their product and design out waste.

D. Re-kindle skills which are in danger of dying out. Encourage investment in capturing dying craft and trade skills in manufacturing and investigate their adaptation for emerging technologies.

Actions:

Develop further and higher education modules to integrate design for circular economy and systems thinking into a wide range of design curricula.

Develop an education programme that encourages cross-curricular learning, connecting designers with engineers, material scientists, anthropologists, marketeers and business students.

2. New business approaches

A. Redesigning the brief. Businesses must begin to develop design briefs around new business models that take account of provenance, longevity, impact and end-of-life. They must consider a circular approach.

B. Foster new technological partnerships between the design, suppliers and waste industries. Short lifecycle products such as FMCGs should be redesigned to prioritise full material recovery. Packaging design briefs must match the capability of our recovery facilities and where innovation occurs, it must occur on both sides.

C. Build incentives to develop and design new industrial symbiotic relationships in business. These systems could potentially bring great opportunities in new markets and create local partnerships and jobs. Investigate networks and information flows to enable these links to develop.

D. Shift the opinion that design is an ‘add-on’. Promote the Technology Strategy Board's competition requirements that partnered the skills of design and business to solve problems through the redesign of whole systems.

E. Investigate consumer behaviour and attitudes. Create new incentives around leasing and take back. Investigate growing models of consumption that work on collaborative sharing systems and develop new warranties and social trust systems that can be transferable to many products and services.

Actions:

Help businesses to develop briefs that incorporate resource efficiency and closed loop principles. Support the commissioning of effective design that incorporates circular economy principles.

Broker new dialogues between the designers, suppliers and the waste industries to instigate new collaborations for innovation around end-of-life, with an initial focus on packaging.

3. Networks: connecting and collaborating

A. Create access to new spaces that allow collaborative R&D for businesses and their supply chains to test, trial and design around circular principles and the four design models; design for longevity, design for leasing/ service, design for re-use in manufacture, and design for material recovery.

B. Investigate the common barriers to collaboration in circularity. Explore ways that can encourage frank business learning through the network. Explore the legal barriers and opportunities for closed loop collaboration.

C. From consumer to user. Build the debate around ownership and how we effect this in the approach to design, and build a movement to redefine the connection with the stuff we consume.

D. Open up supply chains to scrutiny. Question cheap global production through the advocation of transparent supply chains by supporting those that campaign and expose bad practice.

E. Move towards the designing out of built-in obsolescence in products through an investigation to the shift into business models developed around design for longevity.

Actions:

Create a physical space where industry stakeholders can come together to test product, systems and service design, supported by a network of expert consultants.

Develop design standards and tools to support closed loop design and continue to build the online library of open source information about closed loop design and the circular economy.

4. Pushing the policy

A. Multi-layered packaging which prevents or increases the complexity and cost of recycling should be designed out. At the same time, investment in innovation fully recoverable mono-material packaging should be supported to increase greater resource recovery.

B. Encourage the transparency of information. Too much knowledge is hidden and left to speculation. Open source service manuals will bring product transparency and allow designers to build in fixability, upgradability and longevity.

C. Redesign the systems. Transparency in process and supply chains will assist the redesign of systems, build consumer confidence and open up opportunity to make bigger resource efficiencies.

D. Laws and accreditation must be fit for circularity. Review the laws that hinder re-manufacturing with used components and that make repair an expensive option.

E. Investigate accreditation systems for recycled materials. Begin to comprehensively test recycled resource materials so that they have potential to attain grade quality levels that are equivalent to their virgin counterparts. This will build confidence for designers to specify and open up new markets for recovering and reprocessing.

Actions:

Open up dialogue with government around new legislation to encourage packaging design for full recoverability.

Encourage companies to provide full operating and repair manuals for all electronic products.

Enable discussions with the Circular Network and government which investigate the legislative barriers involved in moving to a circular economy.

Footnotes and Resources

Footnotes

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Resources

> Website: greatrecovery.org.uk

> YouTube: youtube.com/greatrecovery

> Pinterest: pinterest.com/greatrecovery

> Twitter: @Great_Recovery

> www.innovateuk.org/competition-display-page/-/asset_publisher/RqEt2AKmEBhi/content/resource-efficiency-new-designs-for-a-circular-economy

> Geevor Tin Mine – www.geevor.com

> Closed Loop – www.closedlooprecycling.co.uk

> SWEEEP Kuusakoski – www.sweeepkuusakoski.co.uk

> S2S – www.s2s.uk.com/group.html

> Aldersgate Group - www.aldersgategroup.org.uk

> Cat Reman – catreman.cat.com

> LMB Textiles – www.lmb.co.uk

> Sheffield Hallam MERI – www.shu.ac.uk/research/meri

Acknowledgments

RSA Team
> Sophie Thomas
> Nat Hunter
> Hilary Chittenden

The Great Recovery Workshops
> Mark Shayler, TicketyBoo
> Tracy Breeze
> Useful Simple Projects

Film Crew
> Paul Wyatt
> Joseph Luck
> Matthew McGregor
> Matt Holding

Technology Strategy Board
> Richard Miller
> Dr. Michael Pitts
> John Whittall

ESKTN and CIKTN
> Ben Peace
> Natalie Withenshaw
> John Henderson
> Claire Claessen

Workshop hosts
> Mike Simpson, Geevor Tin Mine
> Nick Cliffe, Closed Loop
> Justin Greenaway, Sweeep Kuusakoski
> Alan Dukinfield, S2S
> Dr Hywel Jones, Sheffield Hallam University
> Ross Barry, LMB Textiles
> Benjamin Reed, Cat Reman
> Andrew Raingold, Aldersgate Group
> Julian Kirby, Friends of the Earth

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Great Recovery Panel
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> Dr. Michael Pitts
> Judith Sykes
> Dan Epstein
> Julie Hill
> John Whittall

RSA Great Recovery Advisory Panel
> Nick Parker
> Keith Read
> Carol Jackson
> Adam Lent

Design Observer and photographer
> Leonora Oppenheim

Those with little knowledge of a subject always ask interesting and sometimes awkward questions, which expose our own limitations of knowledge, make us think and give us a different perspective on a problem or issue that we may not have previously thought of.

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