DESIGN FOR CIRCULAR ECONOMY: DEVELOPING AN ACTION PLAN FOR SCOTLAND

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ABSTRACT
Design for a circular economy is rising up the policy agenda at multiple levels of governance – European, national and regional. Within Europe, interest in the transition to a circular economy is driven by the need to address the increasing environmental pressures brought about through the traditional 'take-make-consume-dispose' production model, to become more resilient to resource scarcity and volatile commodity prices, and to enhance the competitiveness of European business through cost savings and development of new markets. However, transition to a circular economy will be a complex process and a policy framework that creates favourable conditions for the public and private sector to adopt circular principles is needed. In developing such a framework, it is crucial that the views of stakeholders are appropriately represented. Design is an approach to problem-solving that can be applied across the private and public sectors to drive innovation in products, processes, services, society and even policy-making by putting people first.

This article explores how design methods can be used to develop policy proposals that are tangible, realistic and seek to align market and government needs. By transposing established theory on innovation ecosystems, this research has mapped the Design for Circular Economy Ecosystem in Scotland, explored the systemic strengths and weaknesses and co-developed a set of actions with key stakeholders. Using design methods, twelve actions have been developed focusing on the themes of: (1) business support and finance; (2) skills and education; (3) promotion and awareness; and (4) policy and regulation. Furthermore, the actions are broken down by scope according to whether it is groundwork, instigating change, or systemic change.

Scotland is one of an increasing number of European regions that are accelerating progress towards a more circular economy through design. Following the adoption of the European Commission's 2015 Circular Economy Package, a number of good practices can be drawn from the experiences in Scotland for other countries and regions looking to build design capacity.

1.0 INTRODUCTION

1.1 THE NEED FOR A CIRCULAR ECONOMY IN EUROPE

European policy-makers currently face the twin challenges of addressing decreasing resource security and increasing environmental degradation, much of it rising from the prevailing 'take-make-consume-dispose' linear industrial economy model (Taranic *et al.*, 2016). The scale of the problem facing the European Union is significant: since 1900, there has been a 10-fold rise in global resource extraction and there are predictions that globally, resource use may double by 2030 (EAA, 2016). Much of European industry relies heavily on imports of natural resources; increasing global competition for these materials puts business at risk from potential price volatility and interruptions in supply (Defra & BIS, 2012).

Meanwhile, whilst there has been an increase in resource efficiency across Member States in recent years, and associated reductions in environmental pollution, this does not take into account the impacts in the countries where materials extraction takes place (EEA, 2015). For the European Union to meet the vision set out in the Environmental Action Programme of 'living well within the limits of the planet' by 2050 (EAA, 2016) and meet its commitments to the UN Sustainable Development Goals (Taranic *et al*., 2016), it is clear that a radical change to the dominant economic model is necessary. Over the last decade, the concept of the circular economy has gained traction worldwide as an alternative economic model that can go some way towards addressing these challenges whilst boosting the competitiveness of European industry via the development of new forms of business (Ghisellini *et al*., 2016). The Ellen MacArthur Foundation (2015b) describe the circular economy as 'a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows'.

1.2 THE EU CIRCULAR ECONOMY ACTION PLAN

Moving towards a circular economy is a policy area that links many key EU priorities including jobs and growth, investment, climate and energy, sustainable reindustrialisation, innovation and social cohesion. In December 2015, the Commission adopted the EU Action Plan for the Circular Economy (European Commission, 2015a), identifying seven action areas:

1. Production (including product design and production processes)
2. Consumption
3. Waste management
4. Enhancing the market for secondary raw materials
5. Sector-specific actions in plastics, food waste, critical raw materials, construction and demolition, biomass and bio-based products
6. Innovation and investment
7. Monitoring.

Within the Action Plan, there is a strong emphasis on the role of product design in the circular economy. Specifically, it advocates the principles of design for durability, repair, upgrade and remanufacture, addressing the issue of planned obsolescence and enabling circularity through extended product lives, reuse and remanufacturing as summarised in Figure 1. These principles are well established, but how they are applied and how effective they are in achieving the aims of a circular economy is dependent on the activities of other stakeholders (Hatcher *et al*., 2011; Bakker *et al*., 2014; Lovins, Braungart & Stahel, 2014; Shenkel *et al*., 2015; Leider & Rashid, 2016; RSA Great Recovery, 2016). For example, the shift towards the circular economy, opening of new markets and greater involvement of designers will require insurance that the necessary skills are available in the labour market and therefore, the involvement of educators and training organisations. The Commission will support job creation through its Green Employment Initiative and through the New Skills Agenda for Europe. The key driving forces for these actions are businesses and consumers. Figure 2 illustrates the breadth of stakeholders who may potentially affect their impact on the transition to a circular economy.

The initiatives at EU level also need to be complemented by local, regional and national authorities: Member States and Regions are encouraged to develop their own action plans for implementation, and an increasing number are doing so: these include England, Wales, Scotland, Catalonia, Denmark and the Netherlands (Ellen MacArthur Foundation, 2015a).

This raises a fundamental question about how policy-makers can best develop Design for Circular Economy action plans that reflect the interests of the multiple stakeholders.

[Insert Fig 1 here]

Figure 1: Circular economy approaches enabled through product design strategies

[Insert Fig 2 here]

Figure 2: Circular network diagram (RSA Great Recovery, 2016).

1.3. DESIGN-DRIVEN INNOVATION

In 2013, the EU Commission Growth Directorate adopted the EU Action Plan for Design-driven Innovation, stating that:

"A more systematic use of design as a tool for user-centred and market-driven innovation in all sectors of the economy, complementary to R&D, would improve European competitiveness. Analyses of the contribution of design show that companies that strategically invest in design tend to be more profitable and grow faster"(European Commission, 2013).

The Commission is encouraging all Member States and regions to develop Design Action Plans. Between 2012 and early 2016, Design Action Plans have been adopted by governments in Denmark, Estonia, Finland, France, Ireland and Latvia (Whicher, 2016).

The purpose of the Action Plan for Design-driven Innovation is to embed design in innovation policy in EU Member States. Included amongst its aims are: 'promoting design-driven innovation in industries to strengthen Europe's competitiveness', and 'promoting new collaborative innovation strategies and practices that enable new business models' (European Commission, 2013). The Design Action Plan adopts a broad definition of design as an approach to problem-solving in both the public and private sectors, advocating the use of design "methodologies, tools and techniques that can…boost the value of new goods and services…drive business model innovation, organisational innovation and other forms of non-technological innovation…[and address] complex and systemic challenges". The EU's Circular Economy Action Plan has been developed to meet the key political priorities of jobs, growth and investment (European Commission, 2015b). As such, it is ostensibly a plan for sustainable innovation. A transition to a circular economy means a whole system change. There is a need for innovation not only in product design, production methods and technologies, but also in policies, business models, financing and consumer behaviours (Ellen MacArthur Foundation, 2015a). At present there is limited overlap between the EU Action Plans for Design and for Circular Economy. In particular, the Circular Economy Action Plan appears to overlook the value of design at the strategic level. This study set out to address this by developing a design-driven circular economy action plan in Scotland.

1.4 DEVELOPING A DESIGN FOR CIRCULAR ECONOMY ACTION PLAN FOR SCOTLAND

The Scottish Government has shown a clear desire to accelerate progress towards a more circular economy by 2050, as evidenced in the actions put forward in 'Safeguarding Scotland's Resources' (Natural Scotland, 2013). The Scottish Government's delivery body Zero Waste Scotland is funded to support delivery of the Scottish Government's Circular Economy Strategy and the EU's Circular Economy Action Plan. Scotland's well-developed sustainable economic growth strategy, ambitious plans to achieve zero waste, the existence of industry-focused enablers Zero Waste Scotland and Resource Efficient Scotland, and an early mover advantage from work carried out in food and drink, textiles and oil and gas decommissioning mean that Scotland is in an ideal position to reap the rewards of encouraging design for a circular economy. Without designers (Be they in-house or in design agencies), manufacturers and producers understanding and valuing the importance of circularity to the same extent as policy-makers, uptake will be stunted. Between February and April 2015, Zero Waste Scotland commissioned PDR and the Design Council to develop a Design for a Circular Economy Action Plan, building design-driven innovation into a circular economy action plan. The action plan was developed based on innovation ecosystems theory, which is discussed in Section 2.

2.0 INNOVATION ECOSYSTEMS THEORY

Innovation policies are based on an analysis of the Innovation Ecosystem – the actors and initiatives driving innovation in a country or region. Since the 1980s, theory on Innovation Ecosystems, propounded by scholars such as Freeman (1982, 1995) and Lundvall (1985) has been progressively advanced and consolidated. It hinges on the rationale that innovation is the result of a complex interplay of actors and initiatives within a network (ecosystem) and that policy intervention can be justified by the lack of interactions (systems failure). An Innovation Ecosystem is a framework of analysis for addressing the innovsyion performance of a country or region. The concept of an ecosystem is interdependent: any one aspect must be analysed within the context of the system as a whole. In examining ecosystems, there is no universal standard that draws the approach together, and no common approach for attaining an optimal system (Sharif, 2006). According to the Department of Business, Innovation and Skills (2011), the 'UK innovation ecosystem contains deep and varied capabilities in science, technology, creativity and design'. Finland was the first country to adopt the concept of an innovation system to inform innovation policy in 1992 (Sharif, 2006) and it was also the first country to adopt the concept of a Design Ecosystem to inform national design policy in 2013 (Finnish Ministry of Employment and Economy, 2013). Previous research has indicated that design policies should be based on an analysis of the Design Ecosystem (Whicher & Walters, 2014). Arguably, the systems failure rationale could also be extended to the domain of design for circular economy. By transposing established theory on Innovation Ecosystems, the concept of a Design for Circular Economy Ecosystem is proposed. This Ecosystem fuses aspects of the Innovation and Design Ecosystems.

[Insert Fig 3 here]

Figure 3: Relationship between innovation, design and circular economy ecosystems

Limited research has been undertaken on the relationship between the Innovation and Design Ecosystems in a country or region. Accelerating progress towards a circular economy encompasses aspects of the Innovation and Design Ecosystems. At the intersection between the Innovation, Design and Circular Economy Ecosystems, the notion of a Design for Circular Economy Ecosystem is proposed. A previous study that mapped Design within Innovation Ecosystems in Wales and Scotland (Whicher & Walters, 2014), identified nine components of the Innovation and Design Ecosystems: 1) Users, 2) Support (such as mentoring programmes for industry), 3) Promotion (trade fairs and festivals), 4) Actors (innovation centres, science parks, networks and clusters), 5) Policy, 6) Funding (grants and subsidies), 7) Research, 8) Education and 9) Suppliers (such as R&D personnel and designers). This research adopted the same components to analyse the Design for Circular Economy Ecosystem. The components of the Innovation, Design and Circular Economy Ecosystems are outlined in Table 1. Arguably, the apparent lack of coordination between the Innovation, Design and Circular Economy Ecosystems could mean that none of the three ecosystems is performing to its full capacity. By analysing aspects of the three Ecosystems, researchers and policy-makers can identify insufficient interactions between actors and initiatives, which may be a limiting factor in maximising the utility of each Ecosystem.

Table 1: Components of the Innovation, Design and Circular Economy Ecosystems

	Components	Innovation Ecosystem	Design Ecosystem	Circular Economy Ecosystem
Demand	1. Users	Private, public and citizens	Private, public and citizens	Private, public and citizens
	2. Support	Innovation support programmes	Design support programmes	Innovation and design support programmes
	3. Promotion	Trade fairs, festivals, exhibitions	Trade fairs, festivals, exhibitions	Trade fairs, festivals, exhibitions
Supply and demand	4. Actors	Innovation centres, science parks, networks, clusters	Design centres, networks, clusters	Innovation and design centres, science parks, networks and clusters
	5. Policy	Innovation policy	Design policy	Circular economy policy
	6. Funding	Subsidies and grants	Subsidies and grants	Subsidies and grants
Supply	7. Research	Universities and innovation centres	Universities and design centres	Universities, design and innovation centres
	8. Education	Primary, secondary and tertiary	Primary, secondary and tertiary	Primary, secondary and tertiary
	9. Suppliers	R&D personnel	Designers	R&D personnel and designers

The implications are that by modelling the Ecosystem and investigating the interactions and interdependencies, academics and government can assess the performance of an Ecosystem

and propose policy actions to enhance their productivity and interconnectedness. By identifying components of the system that are lagging behind, government investment can be targeted to stimulate the supply or demand for design for circularity within the system.

3.0 METHOD

This study adopted the 'Double Diamond' (Design Council, 2007) design process framework for analysing the Design for Circular Economy Ecosystem in Scotland. A design process is not only for developing new products and services: increasingly, the approach is being adopted as a framework for conducting research and even developing policies (Blessing & Chakrabarti, 2009; Whicher, 2016). The Double Diamond is the most commonly used framework for design research and it is analogous with processes used by designers both in industry and government. According to the Design Council: 'The Double Diamond is formed from four distinct phases: Discover, Define, Develop and Deliver. Each phase consists of a series of iterative loops with exploration and testing of ideas'. Broadly, the Discover phase can be considered as a scoping stage to understand the current state of play. The Define phase focuses on analysing user needs. The Develop phase involves jointly developing and testing solutions with users. Finally, the Delivery phase includes refining and validating findings with users prior to full-scale implementation. The process is a highly exploratory and applied approach to research with emphasis on actively involving research participants. Due to the solution-driven nature of the project, and the necessity to empathise with the needs of the stakeholders, a design process was adopted to frame this research. By assigning a specific task to each phase of the design process, a number of outputs were produced. By closely involving the beneficiaries – those upon whom the action plan will impact – the research team were able to construct a shared understanding of user needs and jointly develop targeted actions. Table 2 describes the approach adopted to develop the action plan.

Table 2: Research methods and outputs in the design research process

Design phase	Research method	Output
1) Discover - understanding current state of play	Performing a stakeholder mapping of current industry, education and design initiatives based on scoping interviews.	A stakeholder map of the Design for Circular Economy Ecosystem in Scotland
2) Define - analysing user needs	Conducting semi-structured interviews (n17) with business owners, designers, academics and policy-makers.	A user needs assessment of the barriers and opportunities of design for a circular economy in Scotland
3) Develop - jointly developing solutions with users	Facilitating two workshops with expert stakeholders (n25) from industry, the design sector, academia, government and third sector.	An initial set of actions were developed based on the strengths and weaknesses of the Design for Circular Economy Ecosystem
4) Deliver - refining and validating	Submitting the actions to a peer review panel for scrutiny.	A refined list of 12 actions endorsed by leading experts

The project was guided by a management team that consisted of the Circular Economy Manager and Design Project Manager at Zero Waste Scotland, the Heads of Policy and Ecodesign at PDR, and the Head of Policy and Research at the Design Council. In order to achieve the aim of the project, it was necessary to engage with a selection of organisations

and individuals that would potentially be affected by the resultant policy actions. The management team considered the components of the aforementioned Design for Circular Economy Ecosystem as a starting point for the identification of a wider stakeholder group.

As part of the 'Discover' phase, a stakeholder mapping of actors and initiatives related to design and the circular economy was performed. The purpose of the stakeholder mapping was to perform a stock-taking of current industry, design and education initiatives such as business support programmes, design promotion activities and skills development opportunities. The stakeholder mapping was conducted through six scoping interviews with two representatives from Scottish Enterprise (the main business support organisation in Scotland), Creative Scotland (a key design promotion organisation) and Skills Development Scotland (the primary skills development agency). The stakeholder mapping led to the identification of 114 actors and initiatives related to design and circular economy in Scotland. The actors and initiatives were presented in a visual schematic of the Design for Circular Economy Ecosystem. The stakeholder mapping informed a representative and robust candidate selection criteria for the interviews , workshops and peer review panel.

The Define phase capitalised on the Discover phase to analyse the needs of industry, design and academia in developing the Design for Circular Economy Action Plan. To gather insight, semi-structured interviews were conducted with four enterprises, five design agencies and eight stakeholders representing government, academia and skills development. The enterprises were selected based on their recent participation in Scottish Enterprise business support programmes where a major emphasis within the project was design for circular economy. The design agencies were selected as suppliers on a Scottish Enterprise roster of agencies mandated to provide design for circular economy expertise. The other interviewees were selected based on their prominence in policy or education initiatives. The interviews (n = 17) enabled a user needs assessment of the barriers and opportunities of design for a circular economy in Scotland and lasted between 50 and 90 minutes. The interviews were recorded and key insights and quotes were transcribed. Using content analysis, the insight from the interviews was coded thematically. The coding informed the four thematic focus areas for the workshop: 1)business support and finance, 2) skills and education, 3) promotion and awareness and 4) policy and regulation.

The Develop phase consisted of two workshops, held on 26th and 27th March 2015 in Glasgow and Edinburgh respectively. The workshops included a range of stakeholders representing industry, design, education, government and the third sector. Table 3 provides an overview of the number of representatives from each stakeholder group.

Table 3: Numbers of representatives from each stakeholder group attending the workshops in Glasgow and Edinburgh

	Enterprise	Design	Education	Policy	Third Sector	Total
Glasgow	3	3	4	4	1	15
Edinburgh	2	2	3	0	3	10

The workshop consisted of three creative activities to engage participants in active discussion. In the first activity, participants were asked to examine, refine and validate the stakeholder map of the Design for Circular Economy Ecosystem. Having explored the actors and initiatives in the Ecosystem, the second activity involved participants in identifying barriers and opportunities to design for circularity in the four thematic areas of business

support and finance, skills and education, promotion and awareness and policy and regulation. The third activity was a facilitated co-design activity building on the barriers and opportunities identified: participants jointly generated a set of actions to address barriers and capitalise on opportunities. Over seventy ideas were initially developed, which were then consolidated according to priority, impact and cost. A list of twenty-six policy actions was selected and further categorised according to cost of intervention.

For the Deliver phase, the list of policy proposals was scrutinised by the management team based on the remit of Zero Waste Scotland and associated delivery partners. This resulted in the final selection of twelve tangible and realistic actions addressing the four thematic areas, broken down in scope according to whether the actions represented preparatory 'groundwork', 'instigating change' or 'systemic change'. The revised list of actions was submitted to a peer-review panel for scrutiny. Ten peer review panel members were appointed from across the stakeholder groups. The purpose of the peer review panel was not only to provide a robust screening procedure, but also to create a cohort of engaged stakeholders who could support the implementation of the actions. Using a design research method facilitated consensus building amongst diverse stakeholders and ensured that the proposed policy actions were informed by the stakeholder needs.

4.0 RESULTS

Through engagement with a wide variety of stakeholders in Scotland, it has become clear that the role of Zero Waste Scotland in this arena should be to act as a facilitator for change towards circular design thinking across a wide range of the economy, rather than prescribing action in focused sectors. In the short term, the greatest scope for change in the way products and services are designed in Scotland lies in niche manufacturing across a wide range of sectors. In the medium to long term the biggest opportunities for Scotland lay in producing bolder, more forward-thinking designers through the education system, and lobbying for the right European policy landscape for designers and business leaders who understand the importance of designing for a circular economy to be able to be commercially successful. The following actions have been concluded upon following an extensive engagement exercise with Scottish industrialists, designers, academics, policy-makers, educators and advocacy groups. The actions are divided into four thematic areas:

- Business support and funding
- Skills, education and research
- Promotion and awareness
- Policy and regulation.

Furthermore, the actions are categorised into three 'types', which can go some way to influencing prioritisation within the Zero Waste Scotland Design Team. They are:

- Groundwork – prerequisite actions for the successful implementation of further actions.
- Instigating change – actions that can have immediate influence on the extent to which circular design thinking is employed in Scotland.
- Systemic change – actions that enable circular design thinking to be embedded within the Scottish economy over a longer timeframe.

4.1 Business support and funding

Table 4: Summary of the Actions under Business Support and Funding

Type	Action	Outputs	Stakeholders
Groundwork	Build capacity in design for a circular economy among business support advisors	Provide online support materials and train business advisors in designing for circularity.	Scottish Enterprise, Highlands and Islands Enterprise, Business Gateway, Resource Efficient Scotland, local authorities and Interface.
Groundwork	Develop an online toolkit for the design community, industry and business support personnel	Develop an open source repository for circular design and ecodesign toolkits on the ZWS website including examples of products, services and business models that embrace design for circularity and educational materials.	All providers of open source toolkits. Business support organisations, designers, education institutions and enterprises.
Instigating change	Promote the circular economy in design support programmes such as vouchers and mentoring	Promote design for circularity within the Scottish Enterprise 'Design Vouchers'. Examine the feasibility of establishing an in-depth intervention programme such as 'Design Mentor' focused on design for the circular economy.	Scottish Enterprise, Highlands and Islands Enterprise
Instigating change	Develop tangible working links between design researchers in HEIs and SMEs	Provide grants for companies to fund a doctoral or post-doctoral researcher in design to engage in systems thinking. Establish Knowledge Transfer Partnerships (or similar instrument), to facilitate knowledge exchange between academia, design agencies and industry.	Education institutions, design agencies, enterprises and Interface.

Interviewees and workshop participants frequently cited business support and funding as a prime motivator for increasing business and designers engagement in design for a circular economy. Although grants and mentoring were highlighted as a priority, all designers and enterprises interviewed stressed the need for low levels of bureaucracy. Support for designers to move towards circular design thinking also featured strongly. It was further felt that both business advisors and designers would benefit from a set of resources to promote circular design to SME clients. Case studies with data would provide an economic rationale for companies to invest in design for circularity. According to different design agencies interviewed:

> "If it's not in the client brief, I won't be hiring specialist expertise to integrate circular economy considerations into the product development process."

> "There are so many funding programmes to help businesses grow but there are no programmes with a specific emphasis on design for the circular economy as a priority."

> "I would access government grants to start a conversation with clients and enable an SME to understand where design for circularity could strategically add value to their firm. But the administration has to be simple and the release of funds has to be fast because these are usually the blockages."

In Scotland, there are a number of funding programmes developed to mitigate the initial risk of commissioning design expertise but they tend to limit design projects to the low hanging fruits such as branding. There is an opportunity for this to be followed up by a more strategic programme making a larger design intervention and encouraging an overarching approach to design-driven innovation. According to Scottish Enterprise, there is low take-up of some existing design programmes because business advisors do not direct SME clients to these programmes. This was iterated by a number of enterprises:

> "Currently, a company must have a self-driven desire to change towards circular design thinking, if vouchers are made available to them they have an incentive that can kick-start a much longer process of change."

> "We are actively pursuing getting into art and design departments in universities to get new perspectives on our products and services in order to drive down waste. Mechanisms for doing so such as awards and small grants would help us enormously."

The recommendations for preparing the groundwork to promote design for circularity in business support and funding programmes focused on building capacity among business support advisors and collating toolkits, case studies, resources and data available to them. There are a number of business support organisations in Scotland including, among others, Scottish Enterprise, Highlands and Islands Enterprise, Business Gateway, Resource Efficient Scotland, local authorities and Interface. These organisations have teams of business support and innovation advisors who engage directly with enterprises. These business advisors tend to be generalists lacking technical expertise in design and circular economy. By providing online support materials and training these business advisors in design for circularity the innovation specialists are more likely to promote design to their clients. By targeting the organisations that act as intermediaries with enterprises in Scotland, the business advisors can raise awareness of design and stimulate demand for circular economy activities.

Building on the groundwork, there were two additional proposals for instigating broader change including embedding design for circularity in existing business support programmes such as vouchers and mentoring as well as facilitating knowledge exchange between academia and industry. As a result of the actions, Scottish Enterprise integrated design for circularity as an eligible cost within their 'Design Vouchers', a new initiative started in May 2015. Companies can access up to £5,000 to work with a designer for the first time to develop a design for circular economy strategy. Within the first six months of the programme, over 100 companies had accessed Scottish Enterprise's Design Vouchers. The 'Design Voucher' programme will enable a large number of companies to benefit from a relatively light-touch intervention; ideally, design for circularity would also be integrated into the more strategic programme 'Design Mentor', where companies benefit from

coaching from a designer over a longer period of time in order to implement an innovation (product, service or new business model). Based on the interview feedback, there was also appetite from companies to engage with academic institutions. There are already publicly funded programmes, such as Knowledge Transfer Partnerships, to funding doctoral or post-doctoral researchers in small to medium-sized enterprises. There is an opportunity to foster strategic collaboration between academia, design agencies and industry through these or similar initiatives to build capacity for design and circular economy in businesses while creating a knowledge feedback loop with universities.

4.2 Skills, education and research

Table 5: Summary of the Actions under Skills, Education and Research

Type	Action	Outputs	Stakeholders
Instigating change	Develop educational materials for cross-university use to increase importance of circularity in Scottish design undergraduate degrees	Develop a set of materials or guidelines that encourage undergraduate designers to consider lifecycle thinking and sustainability as a core aspect of all projects and a key criterion for assessment.	Education institutions.
Systemic change	Embed circular design thinking in the primary and secondary education system	Integrate circular economy and systems thinking into the design and technology curriculum in Education Scotland's 25 'Pilot Schools'. Provide continuous professional development opportunities for teachers in designing for circularity. Sponsor a design for a circular economy competition for school pupils.	Education Scotland, local authorities, primary and secondary schools, Pilot Schools.

It goes without saying that everything possible should be done to encourage circular design thinking in Scotland's existing economy and design community in order to achieve national policy goals on waste and innovation. However, arguably, the largest opportunities for systemic change in Scotland lay in the next generation of designers, thinkers, industry leaders and academics. Young people currently in the primary, secondary and tertiary education systems must leave with an understanding that the western throwaway society is not sustainable in an environmental, social or commercial sense. The following actions are designed to ensure that next the generation of Scottish designers see real sustainability as normal when interacting with clients, that the next generation of Scottish industrial leaders do not think of sustainability as a necessary annoyance but a central pillar of resilient business, and that the next generation of Scottish academics lead in progressive design thinking. At present there appears to be a skills gap in terms of design for circularity. For example according to one design agency:

> "Some design graduates have to almost be retrained to be able to operate in a commercial environment and understand what materials can be used in different processes."

In essence, sustainability literacy among design graduates is perceived to be low. There was a general sentiment among designers and academics that the university curriculum needs to be reinvigorated as graduates do not have a basic understanding of the role of design in the circular economy. As such, workshop participants proposed that educational materials for cross-university use should be developed to increase the importance of circularity in Scottish design undergraduate degrees. If a systemic change is to be accomplished, resources and guidelines must be produced that encourage design students to consider lifecycle thinking and sustainability as a core aspect of all projects and this should also be made a key criterion for assessment. Cross-disciplinary learning for designers with engineers, material scientists and business students should be encouraged. Enterprises as well as educators are also recognising the value of design and circularity principles within the education system:

> "Action for producing Scottish designers and business leaders who understand the importance of a circular economy needs to be firmly rooted in the primary and secondary education systems, otherwise it is too late."

> "We are aiming to make sustainable design a core cross-cutting subject in craft, design technology, business and geography in secondary schools."

Preparing younger generations of designers and industry leaders for a future in which circularity is embedded in design thinking should start now with a structured and concerted effort to engage schools in the subject. Making sustainability a matriculation criterion in all design, technology and engineering projects throughout education enables a generation of young Scottish designers to design for circularity as a 'norm'. A combination of three approaches can help build momentum in the Scottish primary and secondary education system; embed design for circularity into the pilot schools system, provide continuous professional development (CPD) to teachers and host a schools design for circular economy competition. Education Scotland has designated 25 pilot schools to test innovative curricula and sustainability should be embedded as a core criterion in design and technology classes. A series of CPD events for teachers in design for a circular economy should be hosted prior to the beginning of the academic year targeting design and technology teachers. The design for a circular economy competition should champion inclusion and 'awards for all' (i.e. every school achieves through involvement in the competition). The competition would use the momentum gained from increased teacher understanding through CPD and increased student engagement in the pilot schools to its advantage, making success in its first year more realistic. It is likely that primary schools will have the greatest engagement, so the competition should be geared to accommodate young learners by using simple examples (e.g. compostable packaging, furniture designed for disassembly).

4.3 Promotion and awareness

Table 6: Summary of the Actions under Promotion and Awareness

Type	Action	Outputs	Stakeholders
Groundwork	Facilitate a network to foster design for a circular	Bring together key 'enablers' in the design community, higher education, education support,	Key stakeholders identified in the Design for Circular Economy Ecosystem

	economy in Scotland	policy and industry and foster links between them through creative events. Use these connections as the basis of developing new pilot projects in key industries.	
Instigating change	Integrate design for circular economy into awards criteria	Engage with award providers to establish a 'Design for a Circular Economy' award within existing design awards such as Lighthouse Design Impact Awards and Scottish Design Awards.	Lighthouse, Scottish Design Awards
Systemic change	Assess potential for a Scottish product/service ecolabel that encourages sustainable design	Assess potential for a Scottish Review the strengths, weaknesses and up-take of existing ecolabels (der Blaue Engel, EcoLogo, EU Ecolabel, Bluedesign) to assess the benefits of a Scottish label. Identify the accreditation criteria and the cost of accreditation to business. Conduct market research on the potential value of the label to businesses.	European Commission, Scottish Government, retailers, market analysers, existing labels

The notions of 'getting the right people around the table', increasing the 'interconnected' nature of conversations about circular design, and joining up designers, industry and academics were frequently repeated throughout the engagement process. A strong, well-managed and expanding network was seen as vital to the proliferation of design for a circular economy in key sectors. Increasing awareness through tangible case studies and trusted awards initiatives were also recurring themes. According to designers:

> "For start-ups, spin-offs and entrepreneurs with a good idea, access to a network with strong case studies of how circular design can be used to make a commercially viable product or service is crucial."

Zero Waste Scotland could play an active role in facilitating a network and identifying key 'enablers' in the design community, higher education, business support, and policy-making, as well as key industry sectors. In particular, business leaders with a genuine desire to develop their sustainability credentials can act as a conduit through which to engage with more and more areas of the Scottish economy. A strong, if small, nucleus of interested parties is more likely to begin the process of embedding circular thinking in the design community and key industries that have a potential to be more circular such as food and drink, textiles, high value manufacturing, oil and gas decommissioning, life sciences, chemicals, aerospace and energy. Without a strong and organised network of individuals pushing the concepts of designing for a circular economy, many of the further actions identified here will be extremely challenging to complete successfully, and thus this should be considered a 'groundwork' action. The expansion of the network will require concrete examples of best practice where designing for a circular economy has uncovered business

advantages and designers have successfully considered ecodesign when interacting with a client. It is crucial that such best practice is collated as soon as possible and is communicated in a way that showcases the cross-sectoral nature of designing for a circular economy. According to businesses:

> "Companies that 'get it' tend to have had positive experiences with using design as a solution to waste issues – the net needs to widen to bring in more businesses."

> "A 'Sustainably Made in Scotland' label has the potential to add something more for Scottish industry than European-level labels due to the strong national identity, but accreditation must not be a laborious process."

Two further recommendations for raising awareness and building understanding included integrating design and circular economy into award schemes and assessing the potential for a Scottish product/service ecolabel that encourages sustainable design. Zero Waste Scotland should seek to become involved in the existing design awards structure by sponsoring (and potentially judging) a new award within a successful design award initiative such as the Lighthouse Design Impact Awards or the Scottish Design Awards. This approach alleviates the risks involved in setting up a new award, and increases the chance of design agency participation through the prestige of the award. This in turns increases the likelihood of the design community actively suggesting ecodesign approaches to clients as they see successful designs winning awards from bodies they know and trust. According to the Ecolabel Index (2016), there are currently 89 ecolabels in use in the UK, ranging from the voluntary EU Ecolabel scheme aimed at encouraging businesses to sell products 'kinder to the environment', to the Forest Stewardship Council, On-Pack Recycling Label and CarbonNeutral. There are currently no labels designed specifically for products designed in Scotland, but there is an analogous system in the Scottish building sector, where sustainability labels are required of new buildings in Scotland under the Building (Scotland) Act of 2010. It is possible that a label that signifies 'Sustainably Made in Scotland' may resonate with businesses, designers and consumers in industries that are typically associated with Scotland (e.g. textiles, food and drink). Such a label would enable Scottish manufacturers to gain an 'early mover' advantage as European legislation on ecodesign moves from focusing on energy use to incorporate material use. A feasibility study for a Scottish ecolabel based on circular design thinking would need to be conducted and should review existing relevant ecolables and their strengths, weaknesses and resultant uptake, identify who would be responsible for verifying the label, identify the accreditation criterion, examine the cost of accreditation to business and how that affects uptake and conduct market research on the potential value of the label to business including engagement with end users.

4.4 Policy and regulation

Table 7: Summary of the Actions under Policy and Regulation

Type	Action	Outputs	Stakeholders
Systemic change	Identify the key legislative barriers to, and opportunities for, circular design in Scotland	Examine legislative barriers to design (both products and services) for a circular economy across key sectors. Scope out where Scotland could have an early mover advantage against incoming	Scottish Government, European Commission

		EU legislation. Explore feasibility of voluntary extended producer responsibility schemes in niche Scottish manufacturing industries.	
Instigating change	Engage with European Commission to position Scottish examples as best practice in design for a circular economy in Europe	Engage with the Innovation Policy for Growth Unit and Sustainable Industrial Policy Unit within DG GROW to promote Scottish initiatives as examples of best practice and provide input for working documents, policy initiatives and funding calls on design and innovation.	Scottish Government, European Commission
Instigating change	Encourage the inclusion of ecodesign/ design for a circular economy in sector strategies	Engage with the Creative Industries Partnership Group to make design for a circular economy a priority in the creative industries strategy. Engage with sector representative developing sectoral action plans and strategies to encourage life-cycle thinking.	Scottish Enterprise, sector leadership organisations, Creative Industries Partnership Group

Design is an important voice in the movement towards circular economy-friendly policy and regulations that enable niche opportunities to become a widespread to systemic change in the way products and services are made and used in Scotland. It was felt that although policy for a circular economy is very well developed in Scotland, there were still barriers to companies designing products with the whole life cycle in mind, and that the Zero Waste Scotland Design Team should make sure Scottish success stories are seen as best practice on a European level. According to designers:

> "There are many examples of design for a circular economy in Scotland but they need to be promoted in government and policy circles. Scotland could be a benchmark for good practices in Europe."

> "Legislation and regulation is both a positive and a negative. Where designers are ahead of the curve we can capture niche markets but where we are behind regulation becomes a drain on resources."

According to industry:

> "Sector leadership bodies have a responsibility to drive change towards sustainable design within their networks."

It is therefore recommended that a thorough examination of the legislative barriers to design (both of products and services) for a circular economy across key sectors is carried out. Furthermore, a scoping of where Scotland could be at an advantage as an early mover against incoming EU legislation would outline long-term, systemic opportunities for Scottish industry and design. This work could include issues relating to sustainable procurement,

voluntary extended producer responsibility schemes in niche Scottish manufacturing industries, Scottish laws and accreditations that hinder repair due to high cost, product standards, warranties and open-source repair manuals, packaging standards for full recoverability in Scotland and accreditation systems for recycled components and products.

It is pertinent here to consider the likely future changes in Scotland's relationship with the European Union in the light of the UK's recent referendum vote to leave the European Union. The so-called 'Brexit' process has caused considerable confusion with regard to the future of the circular economy in the UK. At the time of writing, it appears that the UK will pursue an exit strategy from the European Union that does not seek to preserve access to the single market; under these circumstances, the EU's circular economy package would cease to apply in Scotland. However, the UK will be looking to negotiate new trade agreements with individual Member States post-Brexit. Within individual trade agreements, the UK would still have to meet EU product standards, which are likely to be shaped in future by the Circular Economy package. We argue that this makes it even more important for Scotland to align legislation to enable a circular economy. Scotland's travel towards a circular economy should not be put on hold whilst the terms of the UK's exit from the European Union are being negotiated.

Furthermore, Brexit provides the opportunity for Scotland to shape its own circular economy; whether this is a 'clone' of the package adopted across Europe, or has characteristics reflective of its particular economic and industrial environment is for the Scottish Parliament to decide. In this situation, the ability to set circular economy targets without first requiring consensus across Member States may, provided targets are sufficiently ambitious, strengthen Scotland's existing 'early mover' advantages and ensure that goods produced there are 'export-ready' when trade agreements are finally in place.

That is not to say that Brexit is automatically positive for the circular economy. To truly enable a circular economy in Scotland, the interaction between environmental, education, trade and industry and fiscal legislation must be considered. Whilst the actions proposed in the circular economy package fall largely into the remit of the UK's environmental policy makers, the 'jobs and growth' agenda that frames it is largely managed by trade and industry departments. In Scotland this is complicated by the fact that the Scottish Government has devolved responsibility for environment and education, but the UK Government reserves responsibility for international trade, financial services and research councils. Without strong commitment across all these policy domains, the broader innovation benefits of a circular economy may not be realised. However, there are strong indication that UK policies will also support a circular economy. England's environmental policy-makers, the Department of Environment, Farming and Rural Affairs is continuing to work towards the implementation of the circular economy, and UK BEIS (the Department for Business Energy and Industrial Strategy) has recently published an Industrial Strategy paper that says the government will "work with stakeholders to explore opportunities to reduce raw material demand and waste in our energy and resource systems, and to promote well-functioning markets for secondary materials, and new disruptive business models that challenge inefficient practice" (BEIS, 2017).

There was also a proposal to engage with the European Commission to position Scottish examples as best practice in design for a circular economy in Europe. The European Commission has a role to play in stimulating demand for circular design among SMEs. There are an increasing number of ecodesign and design-related policies at EU level including Ecodesign Directive (2009), Eco- Innovation Action Plan (2011), Design-driven Innovation

Action Plan (2013) and Circular Economy Action Plan (2015). However, many of these policies appear to be completely disconnected to complementary policy agendas. It was suggested that Zero Waste Scotland could play a role in ensuring that the European Commission has a joined up approach to design, innovation and the circular economy through examples of good practice in Scotland. This could also increase Scottish representation in European funding bids relating to design for a circular economy. However, in the light of Brexit, it is unlikely – at least in the short-term – that Scotland will be at the policy negotiation table. The situation regarding access to EU funding once the UK is no longer a Member State is also unclear and it may be that the potential increase in representation cannot be realised.

Finally, there was also an action pertaining to encouraging the inclusion of ecodesign/design for circular economy in sector strategic plans and events. As important as it is that the design community is able to 'push' for more circular design thinking with their clients, in reality it is the openness of the business client to the idea that defines its success. Actions such as the design for a circular economy network encourage a 'pull' from industry, but in the short to medium term the penetration of such a network into the SME community in key sectors and product lines is likely to be low. Encouraging sector representatives to include circular design thinking in their communications with the business population and external documents, such as sector strategic plans, is a sensible way of ZWS facilitating an increased 'pull' from industry. Currently, there are fleeting mentions of whole-life design thinking in the plans, although there are some areas of progress. For example, the Chemicals Sector Strategic Plan, the Technology and Engineering Sector's 'A Framework for Action' and the construction industry document 'Building for the Future' all cite efficient use of resources when designing to produce a minimal lifetime carbon footprint and advocate the use of sustainable design and whole- lifecycle thinking. However, it is unclear the extent to which the sentiments expressed in the strategic plans filter through to SMEs, so engagement with sector bodies, leadership organisations and authors of the reports in order to gauge their influence on SMEs is an important step. As such, case studies of design being used to drive circularity within the sector should be presented at sector-specific events organised by the sector leadership organisations.

5.0 DISCUSSION

The concepts of Innovation and Design Ecosystems have been constructive for policy-makers and academics seeking to develop evidence-based policies and action plans. Through this research, the concept of a Design for Circular Economy Ecosystem has been proposed and tested as an approach to developing targeted policy actions. Conventional public consultation processes tend to involve a large number of people in online surveys thus generating quantitative data from which broad generalisations can be made. The advantage of taking a design approach to developing policy proposals was that it generated deep insight albeit from a smaller sample size. The process used visual prompts and creative techniques such as the visual map of the Ecosystem to stimulate inclusive and productive debate among policy beneficiaries. The four stage design process of 1) understanding current state of play; 2) analysing user needs; 3) jointly developing solutions with users and 4) refining and validating proposals with users constituted an iterative approach to policy-making where ideas were generated, tested and refine at multiple stages. Through the interviews, workshops and peer review panel, there was a continuous peer review process constructing, deconstructing and reconstructing proposals with key stakeholders. By mapping the existing stakeholders and initiatives in the Design for Circular Economy Ecosystem, identifying the strengths and weaknesses and jointly developing proposals to

capitalise on the strengths and tackle the weaknesses there was an holistic approach to policy development examining supply and demand. However, it should also be acknowledged that there are some limitations to the approach. Small sample sizes inevitably raise the challenges of selection bias and representativeness which in turn impact on the validity and reliability of the insight generated. In a workshop scenario, it is important to ensure balanced participation among users to avoid the predilection for the most dominant voices to steer discussion. Nevertheless, the process demonstrated that design approaches can contribute to transparent and inclusive policy development at a time of dwindling public confidence in public governance.

The challenge is to mainstream circular economy principles into existing education and policy interventions so that it is not seen as an add-on but an integral part of how companies think about design. For this to happen it is essential to build both capability in the design community as well as the appetite amongst business to stimulate innovation in the design and manufacture of products and packaging. In terms of business support and funding, the actions focus on up-skilling the business advisors who deal with SME development in Scotland as they are the clearest conduit for increasing business engagement in designing for a circular economy. Based on interviews, there is demand for online resources and online training materials. It is crucial to have resources with Scottish case studies on designing for a circular economy available to business advisors as well as online training materials for those who may not be able to attend face-to-face training sessions. Proposals in the areas of skills, education and research focus on the next generation of designers and business leaders and equipping them with the knowledge of the imperative for sustainability. Arguably the most crucial action underpinning many other actions for promotion and awareness is the establishment of a network of enablers to champion design for circular economy. For policy and regulation, there is a need to include circular economy design and life cycle thinking in Scottish sector strategy documents and promote these principles through sector events. The Commission encourages member states and regions to strengthen innovation for the circular economy through smart specialization strategies and use the Cohesion Policy funds for the circular economy initiatives. In the coming years, it can be anticipated that a growing number of EU Member States and Regions will develop Design for Circular Economy Action Plans. Irrespective of the future position of Scotland in the EU, their development of a 'Design for Circular Economy' Action Plan can provide important direction in this process.

REFERENCES

Bakker, C., Wang, F., Huisman, J. & den Hollander, M. (2014). 'Products that go round: exploring product life extension through design'. Journal of Cleaner Production 69, pp. 10 – 16.

Blessing, L. & Chakrabarti, A. (2009). 'DRM, a Design Research Methodology'. Springer-Verlag: London, UK, p.9.

Defra & Department for Business Innovation and Skills (2012). 'Resource Security Action Plan: Making the most of valuable materials'. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69511/pb13719-resource-security-action-plan.pdf [Accessed 25 Jan 2017].

Department for Business, Innnovation and Skills (2011). 'Innovation and Research Strategy for Growth', London, UK.

Department of Business, Energy and Industrial Strategy (2017). "Building our Industrial Strategy". Available at https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf [Accessed 30 Jan 2017].

Design Council (2007) 'Eleven lessons: managing design in eleven global companies', London, p.10.

Ellen MacArthur Foundation (2015a). 'Delivering the Circular Economy. A Toolkit for Policy-makers', June 2015. Available from: https://www.ellenmacarthurfoundation.org/assets/downloads/government/EMF_TFPM_FullReportEnhanced_11-9-15.pdf [Accessed 10 Aug 2016]

Ellen MacArthur Foundation (2015b). 'Circular Economy Overview'. Available at: http://www.ellenmacarthurfoundation.org/circular-economy/overview/concept [Accessed 10 Aug 2016].

European Environment Agency (2015). 'The European Environment – State and outlook 205: A comprehensive assessment of the European environment's state, trends and prospects in a global context'. Available from: http://www.eea.europa.eu/soer [Accessed 25 Jan 2017].

European Environment Agency (2016) 'Circular Economy in Europe: Developing the knowledge base'. Available from: http://www.eea.europa.eu/publications/circular-economy-in-europe [Accessed 25 Jan 2017].

European Commission (2013). 'Implementing an Action Plan for Design-driven Innovation in Europe', SWD(2013)380, 23.09.2013, Brussels, Belgium.

European Commission (2015a). 'Closing the Loop – An EU Action Plan for the Circular Economy', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2015)0614, Brussels.

European Commission (2015b). 'Towards a Circular Economy'. Available at: https://ec.europa.eu/priorities/jobs-growth-and-investment/towards-circular-economy_en [Accessed 26 Jan 2017].
Finnish Ministry of Employment and the Economy (2013). 'Design Finland Programme. Proposals, Strategy and Actions', Helsinki, Finland.

Freeman, C. (1982). 'Technological infrastructure and international competitiveness', paper submitted to the OECD Science, Technology and Competitiveness Group, August 1982, Paris, France.

Freeman, C. (1995). 'The 'National System of Innovation' in historical perspective', Cambridge Journal of Economics 19 (2), pp. 5 – 24.

Ghisellini, P., Cialini, C. & Ulgiati, S. (2016). 'A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production 114, pp. 11 – 32.

Hatcher, G. D., Ijomah, W. L. & Windmill, J. F. C. (2011). 'Design for remanufacture: a literature review and future research needs'. Journal of Cleaner Production, 19 (17 – 18), pp. 2004 – 2014).

Leider, M. & Rashid, A. (2016). 'Towards circular economy implementation: a comprehensive review in context of manufacturing industry'. Journal of Cleaner Production, 115, pp. 36 – 51.

Lovins, A., Braungart, M. & Stahel, W. A. (2014). 'A New Dynamic: Effective business in a circular economy'. Ellen MacArthur Foundation Publishing.

Lundvall, B-A. (1985). 'Product Innovation and User-Producer Interaction', Aalborg University Press, Denmark.

Natural Scotland. (2013) 'Safeguarding Scotland's Resources – building a more efficient and circular economy'. Report prepared for the Scottish Government.

Prendeville, C., Sanders, C., Sherry, J., and Costa, F. (2014) 'Circular Economy: Is it enough?' Report prepared by PDR at Cardiff Metropolitan University for Welsh Government Waste Strategy Branch.

Schenkel, M., Caniels, M. C. J., Krikke, H., & van der Laan, E. (2015). 'Understanding value creation in closed loop supply chains – Past findings and future directions'. Journal of Manufacturing Systems 37 (3), pp. 729 – 745.

Sharif, N. (2006). 'Emergence and development of the National Innovation Systems concept', Research Policy 35, pp. 745 – 766.

Taranic, I., Behrens, A. & Topi, C. (2016). 'Understanding the Circular Economy in Europe, from Resource Efficiency to Sharing Platforms: The CEPS Framework'. July 2016. Available from: https://www.ceps.eu/system/files/SR%20No143%20Circular%20Economy_0.pdf [Accessed 25 Jan 2017].

The Great Recovery (2016). 'Designing for a circular economy: Lessons from The Great Recovery 2012 – 2016). Available from: https://www.thersa.org/globalassets/pdfs/reports/the-great-recovery---designing-for-a-circular-economy.pdf [Accessed 26 Jan 2017).

Whicher, A. & Walters, A. (2014). 'Mapping Design for Innovation in Wales and Scotland'. Report prepared by PDR at Cardiff Metropolitan University for the Welsh Government Innovation Team and Scottish Enterprise Innovation Team and funded by the Arts and Humanities Research Council.

Whicher, A. (2016). 'Benchmarking Design for Innovation Policy in Europe', Doctoral Thesis, Cardiff Metropolitan University, July 2016. Available from: http://pdronline.co.uk/files/download/c14bb3593162199 [Accessed 10 Aug 2016]