

# **HUMANISING THE PRODUCT-SERVICE SYSTEM WITHIN A CIRCULAR ECONOMY FOR PRODUCT DESIGN AND ENGINEERING STUDENTS.**

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## **ABSTRACT**

How do we avoid designing in the abstraction of organisational charts and system diagrams populated by text, symbols and icons to design for people, communities and the planet? To address this question, this paper discusses the integration of service design methods within a circular design process that encourages circularity thinking within product-service projects and enables students to: identify and communicate design opportunities from design ethnographic research; explore design opportunities as value propositions; identify and share the core values and proposed benefits of circular design opportunities; and to develop and present product-service concepts. Reflecting on product design engineering teaching practice within the context of current thinking in circular design and the circular economy, this paper presents an alternative perspective on visualising service-user journeys, stakeholder relationships and design propositions to enable design students to identify and explore innovative design propositions to circular design problems.

*Keywords: service design, product design, circular economy, circularity thinking, product-service-system, tools and methods.*

## **1 INTRODUCTION**

Designing for a circular economy introduces complex networks, collaborations, and relationships into the context of product design. Increasingly, the context within which young undergraduate and postgraduate students of product design and engineering are designing is represented not only by the customer or the user of their products, but also includes a wide range of stakeholders, services, and systems. As the design process expands from techno-centric and user-centric to include and reference the wider context of designing for people and communities within complex product, service, system, and environmental relationships of a circular economy, it becomes increasingly challenging for product design and engineering students to cope with and design within a more holistic and complex product-service-ecosystem. How do we avoid designing in the abstraction of system diagrams and stakeholder maps to design for people, communities and the planet? How do we humanise the systems while designing for the planet and a circular economy?

The multidisciplinary nature of designing for a circular economy requires product designers and engineers to investigate, understand and communicate a wide range of stakeholder relationships and interactions when developing their design propositions, building empathy and trust. Service design tools such as stakeholder and service ecology mapping visualise actor networks and product-service ecosystems; their relationships, interactions and behaviours, bringing the systems and actors to life. Service journey maps record observational research and can be used as analytical tools to build insights and visualise the key value propositions of the product-service design. Service blueprints visualise how different product-service pathways interact across time. Integrating these methods and tools into the product design process helps the product design engineering students see and communicate key insights from their research to share and communicate the circular value propositions offered by the design.

Reflecting on the work with postgraduate Product Design Engineering (PDE) MSc students has brought a new awareness and insights into the value of service design tools and methods when teaching design

process to students from a range of undergraduate backgrounds. Typically, our students come from undergraduate backgrounds in mechanical, electrical and electronic, production and manufacturing, and chemical engineering, as well as industrial and product design, applied mathematics and physics. Introducing service design tools and methods within a product design process has helped students research, identify, recognise, and understand who they are designing for as well as the wider context within which they are designing.

## **2 PRODUCT SERVICE SYSTEMS AND THE CIRCULAR ECONOMY**

When designing for sustainability, we have considered the social, economic and environmental context within which we are designing; considering efficient use of raw materials, aiming to reduce energy and waste in processing, manufacturing, transportation and use. Benefitting the environment and reducing impact on the planet, while still enabling companies to make a profit, pay fair wages, reduce costs in the supply chain and to consumers, while improving the local and global economy. Moving to a circular economy, the focus has evolved to reduce, reuse, repair, recycle resources and regenerating natural systems, placing the planet at the centre of the design process. Due to the complex nature of the systems involved it is easy to lose sight of people within these circular and regenerative systems. Service design offers tools with which we can make sense of complex systems, while keeping sight of the people (citizens, communities, stakeholders) involved.

The principles of a Circular Economy [1] state that we should: design out waste and pollution; keep products and materials in use for as long as possible; and regenerate natural systems. Designing a product for a circular economy context, we are faced not only by the relationships between people and the product, but also by the service that may support, deliver, or be delivered by or through the product. To design for use, maintenance, repair and reuse of a product requires more complex relationships to be considered in the life cycle of the product. Maintaining sight of the people we are designing for becomes increasingly difficult with end-users and key stakeholders being obscured within organisational charts and diagrams. When it is difficult for the designer to understand the relationships between the key people and organisations involved from the diagrams, then it is difficult to empathise with the needs and requirements of these stakeholders and identify innovative design solutions. Typically, in that situation a design student will end up designing within their own limited experience and place themselves at risk of designing a product that is inappropriate or misses an opportunity to resolve an interesting problem. Many product-service systems developed by students under the context of a circular economy to share or lease products are not automatically more planet friendly as they can encourage increased consumption and production by providing more people access to more products [2] – they are disguising a more linear take, make, use, dispose model, although here the use cycle may be extended across more service users, and the recycle/dispose cycle appears to be controlled by the service provider. Recognising the stakeholder relationships can help students identify where the circularity of a design can be improved.

Where approximately 80% of the environmental impact of a product is committed at the design phase, it makes sense to introduce product-service system and circularity thinking to product design engineering students early in their career to potentially improve the circular economy credentials of future products. Within product-service design and development, product designers and design engineers will work with a wide range of stakeholders within the organisation as well as outwith the organisation [3]. It is recognising the interactions and relationships between these stakeholders where service design tools can help.

### **2.1 Borrowing from Service Design**

Service design consultancies such as LiveWork and Engine in the UK have long recognised the need to see the people engaged with services and to understand the ‘highly complicated networks of relationships between people inside and outside the service organisation’ [4]. Borrowing from systems and actor network theories, service designers developed journey-maps, relationship maps and service blueprints to bring service ecosystems to life, capturing and communicating insights from research and observations, visualising people and their relationships within the service ecology. Early on, educators in product design and engineering recognised the value of service design and product-service-system methods to help students more deeply understand and empathise with the people they are designing for

and design more appropriate product-service solutions [5], [6], [7]. The integration of service design methods and tools within a circular design process enables students to identify and communicate design opportunities from design ethnographic research, explore design opportunities as value propositions, identify and share the core values and proposed benefits of circular design opportunities, and to develop and present innovative product-service concepts. As illustrated in Figure 1, it is important that the people observed through research are shown and represented within the service journeys, service ecology and stakeholder relationship maps, rather than by representing them with clipart and icons – so much information relating to activities, interactions and context is lost by doing so, and reduces the ability of the designers, and their audience, to build empathy with the people involved, their needs and requirements. When mapping the various relationships and interactions as a service blueprint, the various products and infrastructure that support the service-system are represented below the ‘line of visibility’ or ‘back-stage.’ For the stakeholder relationship map, the details of touchpoints and products supporting the service occupy the outer circles of the relationship map. It can be thought of as taking the service journey blueprint and distorting it into a flattened cone, where the service user journey is around the centre of the cone and the individual touchpoints and details that were at the bottom of the blueprint are now seen around the periphery of the flattened cone. This idea is developed further in Figure 4 where the circular design concept is seen at the centre and the product components are expressed around the circumference to identify and explore the ecosystems of circularity within the design project.

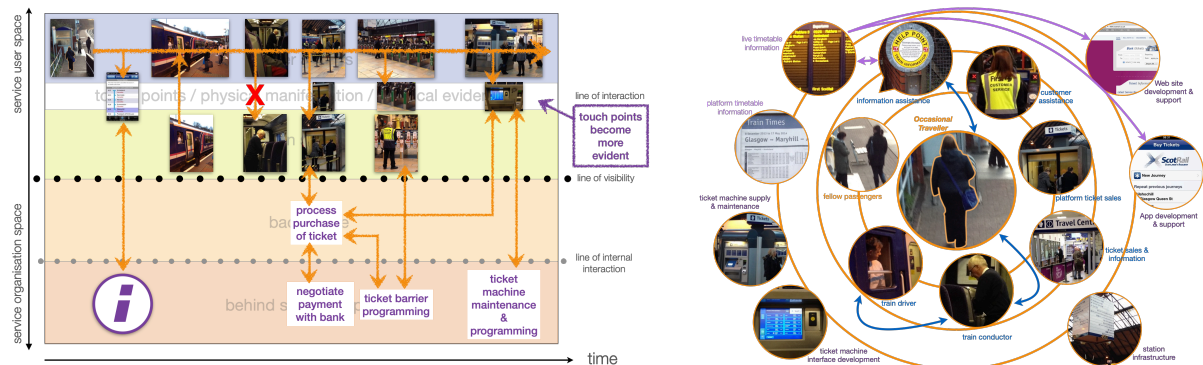


Figure 1, Mapping service journey/service blueprint < > stakeholder relationships

The importance of visualising the relationships is key to sharing information across multiple disciplines and stakeholders. For large groups of people, communities, organisations, etc., personas may be generated from within the stakeholders involved to ensure that as many people’s needs and requirements are represented. However, this does not mean that the personas are simply made up - people reading or being presented with the design research and propositions should be able to recognise their own needs and requirements represented within one, or more personas. Sharing information visually facilitates collaborative sensemaking and collective decision-making within teams and across organisations.

## 2.2 Borrowing from Circular Design

The Ellen MacArthur Foundation Butterfly Diagram [8] visualises the circular economy by representing material flow within the two main cycles of the biological cycle and the technical cycle. The RSA Great Recovery project [9] generated four design models from the technical cycle to represent Design for Longevity, Design for Service, Design for Re-use in Manufacture, and Design for Material Recovery, as shown in Figure 2. In a circular design context, product design would consider design for longevity and service, while also being aware of the need to design for repair and reuse with consideration of material choice to aid material recovery.

How consumers become emotionally attached to a product and how they behave with regards to looking after the product, maintaining and repairing it will affect the longevity of the product. A consumer’s need for ownership and reluctance to lease, share or re-use products is also likely to require some behavioural and attitude change if they are to embrace a more circular approach to product use [10], [11]. It is within this context especially where visualising the people involved within the circular design process enables the designers to empathise with them, understand their needs, requirements and behaviours, thus enabling them to design more appropriate products for people *and* the planet.



Figure 2. Four Design Models for Circular Economy. (Credit: RSA The Great Recovery)

### 3 HUMANISING THE SYSTEM

Getting out into the field to observe and experience how people behave requires some design ethnography skills, but more importantly observation and curiosity – curiosity not to settle for what you first saw, but to continue to observe and ask questions to understand and infer what underlying core issues led to what you saw. Combining first-hand observations with secondary research can place your observation findings within a larger social-political context. Extracting insights from the research and mapping out the information gathered for an identified topic or design opportunity, enables students to map out from the central topic to explore the insights into the design problem, identify the people and stakeholders involved within a specific context, and to generate ‘what if’ design propositions, Figure 3. By mapping out the design propositions along with all insights, people and context, it easier for the students to explore alternative what if propositions from the data presented on the propositions map.

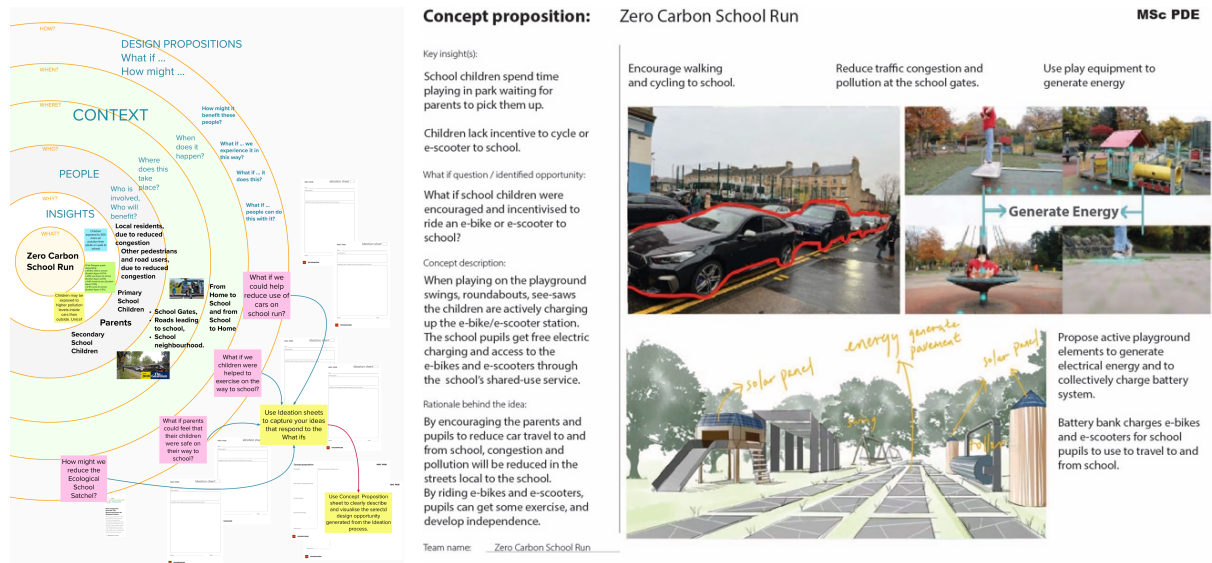
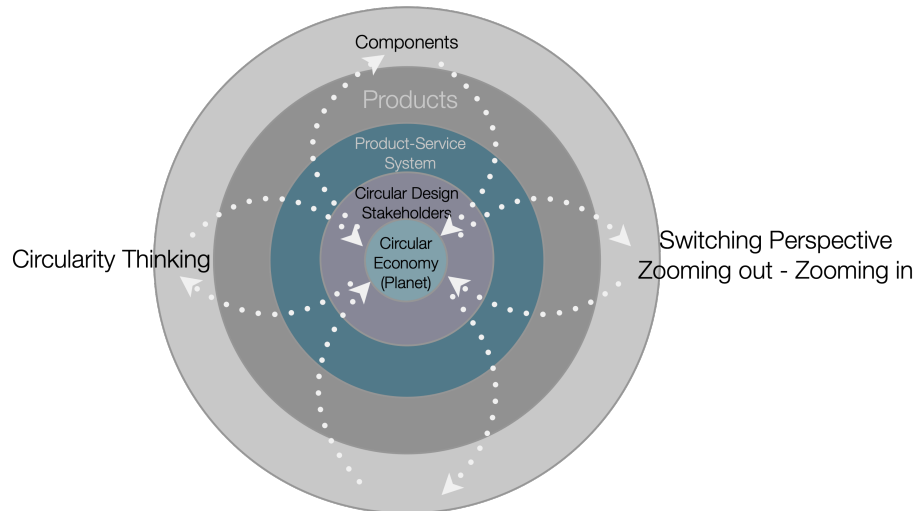


Figure 3, Identifying Opportunities > Generating Design Propositions

As shown previously in Figure 1, the service-user journey/blueprint can be used as an analytical tool to extract the relevant stakeholder relationships and to understand the interactions, transactions and negotiations between people and organisations. These stakeholder relationships can be used in conjunction with the four design models shown in Figure 2 to determine where opportunities might be found to improve the circularity of the product [12], [13]. The design proposition and relationship maps can then be used to zoom out and explore the wider context of a problem, or to zoom in and consider the details. For example, as illustrated in Figure 4, the circular economy topic is placed at the centre, similar to that shown in the proposition map in Figure 3. We can then explore in increasing concentric circles: the people, stakeholders and organisations involved in the circular design; the product-service

that delivers the design; the products of the service; and in the outer circle the components that make up the product. By applying circularity thinking [14], zooming in and out and switching perspective from planet to components we can then explore the ecosystems of circularity within our design. By considering each level from a circular economy perspective, each circle will carry the circular design principles of the previous circle just as fractals carry the information of the larger organism within nature.



*Figure 4, Mapping ecosystems of circularity*

## 4 CONCLUSIONS

Presenting students with open project briefs, rather than prescribed closed ones, has encouraged them develop design ethnography skills, and provides them with the skills and confidence to go out and engage with people to learn more about the core issues people experience, and to understand their needs, desires, requirements, and behaviours. Students are then better equipped to generate insights that lead to innovative design solutions, and by incorporating circular design thinking, the product design solutions will be more appropriate to the planet as well as to its inhabitants. By considering the planet (or appropriate elements of the environment) as a ‘persona’ we can change our perspective on a problem to see alternative design solutions [15]. For example, when students in a service design workshop were considering food waste, they found it difficult to determine the best course of action when considering the problem from the consumer’s perspective until they looked at the problem from the vegetable’s point-of-view. They had identified that by sorting out the ugly and misshapen vegetables and fruit, supermarkets were contributing greatly to food waste. When the students considered the effect of this ‘beauty pageant’ from the perspective of the fruit and vegetables, they were able to then create more innovative design solutions to reduce food waste. Designing with circular-based personas, rather than make-use-dispose, single-use personas, helps us to keep in mind the circular design principles that we are trying to achieve [16].

The benefits we have observed from introducing this approach to PDE postgraduate students have been that the students:

- Better understood the wider socio-economic context that they were designing within.
- Were able to make sense of complexity and identify design opportunities by using service design tools such as service journeys, blueprints, relationship mapping and personas.
- Developed their ability to visualise and design for multiple actors and interactions within a product-service system.
- Using service design tools facilitated collaborative design practices across their design and engineering disciplines.
- By adapting service design and human-centred design methods to circular design thinking, they were better equipped to tackle problems within a circular economy context and apply a more planet-centred design approach.



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