Design for Repair as a Strategy to Foster Sustainable User Behavior: A Case of Undergraduate Product Design Studio

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Abstract. Increased frequency of product replacement in a consumerist society eventually leads to unbearable sustainability problems. Manufacturing and sales-focused linear economies give insufficient concern to the use phase and afterlife of products. Fewer consumers engage in the practice of repair to increase product longevity. On the contrary goal of a circular economy is producing less waste through increasing connections between product lifecycles, which makes product afterlife a crucial debate. In the circular design literature, modularity, material selection and disassembly properties of products are often highlighted. However, the practice of repair is often neglected in sustainable product design researches. This paper focuses on design strategies to enhance the reparability of products to support circular user behavior. Major design strategies to change user behavior towards repairing are discussed. The process and outcomes of undergraduate product design focused on design for repair presented.

Keywords: Design for Repair, Circular Design, Sustainable Behavior, Design Studio

1 Introduction

Running a linear economic model in a resource-limited environment creates serious consequences on nature such as global warming, invasion of plastic particles and massive waste [1]. Manufacturing and consumption activities globally push the environmental borders of the planet into a new stage for all beings. At the age of Anthropocene related crisis, in addition to our decisions on the use of materials and energy, overconsumption plays an important role in sustainability [2]. Beyond having ethical and environmentally friendly choices of material and energy consumption, we might need to reduce the speed of consumption itself in order to achieve meaningful progress towards sustainability [3].

Fundamentally, Circular Economy (CE) criticizes unrealistic promises and unbearable consequences of the linear economic model. The concept is not a new idea and its theoretical foundation was established with the notions of industrial ecology, industrial symbiosis, and cradle to cradle [4]. The philosophy of cradle to cradle

departs from the concept of waste, which differs in natural cycles and human-made technocycles. A biological cycle refers to organic nutrients flowing and transforming in the system while the technical cycle is explained as inorganic or synthetic materials in the system [5]. In this complex cyclic logic, profit is derived not only from selling artifacts but also the flow of materials [6]. Design for resource conversation, slowing resource loops, and whole system design are vital for circularity [7]. Moreover, two fundamental objectives of a CE are slowing the loops and closing the loops [6], [8], [9]. Slowing down loops means reducing the frequency of material and energy transactions, and are critical for keeping a balance between technocycles and biocycles. The design of a product and its components is an important intervention point for slowing the cycles and closing the loops. Since the concept mainly derives from connecting material and energy flows as cycles, the literature on circular design often discusses the physical aspects of products for closing the loops [10], [11]. However, strategies like dematerialization, design for repair and design for sustainable behavior are also valuable for reducing purchasing frequency.

However, repairing is a critical but often neglected activity in design studies. Thus, as a part of ongoing research exploring design for repair strategies, this study reviews circular design literature to understand the role of repairing. The study presents an undergraduate design studio experience focused on applying design for repair strategies.

2 Product Design Strategies for Circular Economy

The product design discipline developed itself by fostering the progress of the linear economic model for decades. Besides a dedicated focus on the needs and wants of users, designers undertook the responsibility for the growth of the business by increasing sales. Following the great depression in the USA, the design community embraced the idea of planned obsolescence for the sake of economic growth. The idea was intentionally shortening the life of consumer goods in order to increase repurchasing rates. Eventually, it became a standard approach for the design and development of products in various industries. Enterprises long experienced the growing profit margins based upon the ever-increasing speed of transactions that shadowed enormous waste production for decades.

Following the rise of environmental concerns globally, the role of designers also covered tasks dealing with the cost of products on social and environmental sustainability. The green design approach concentrates on intervention through energy efficiency and the use of green materials. A more holistic approach arrived later as design for sustainability, which focuses on products, services, and user behaviors. Lifecycle analysis and footprint calculations were the main measurement tools for green design and design for sustainability. However, both approaches have never truly challenged the linear economic system. At this point, the circular design opens a new perspective by considering the system through cycles. Moreover, the success of an intervention is relatively clear since a loop is closed or open. Virtanen et. al. [5] offers a material library for closing loops. The literature focusing on CE in the context of product design underlines six broad design strategies [12]-[15];

- Design for Attachment and Trust,
- Design for Durability and Longevity,
- Design for Standardization,
- Design for Adaptability and Upgradability,
- Design for Ease of Maintenance and Repair
- Design for Disassembly and Reassembly

Design strategies listed above focus on both before and after the purchase of products. User motivation for repair is related to most of the strategies listed above. Literature indicates that lack of product user attachment and trust also raises potential decisions towards replacing the product with another one. Adaptable and upgradable products have more chances of satisfying the changing needs and desires of users. Today, with the open fabrication tools such as a table-top CNCs and 3D printers, online manuals and DIY websites, users are much closer to hacking their existing products according to their needs and desires.

Durability is an attribute often derived as an outcome of the design and development decisions given at the manufacturing phase. In contrary to planned obsolescence, enterprises may focus on delivering ultimate durable products. But, eventually all products prone to failure and need maintenance. Companies such as Mud Jeans keep ownership of garments while selling the use of products and supporting users with free repair services. Rise of social media and extensive use of the internet, product sharing platforms became an alternative way to circulate products and to extend the product lifespan. Design decisions towards reparability have to involve aftersales services and online user communities to benefit from user involvement.

3 Design for Repair and Upgrade

Maintenance as a practice aims to retain in or restore the product to a state in which ordered functions are performed. While maintenance focus on keeping a product functioning as it is, upgrading is a process of enhancing the original design specifications including functional capabilities and cosmetic condition. Repairing can be understood as an activity that belongs to the practice of maintenance. The principal idea of repairing is to reanimate a nonfunctioning product. Repairing doesn't involve upgrading while some upgrades could be classified as a repair. Repair is not necessarily an environmentally friendly way of intervening in a nonfunctioning product [15]. Some products consume much more material and energy during the use phase compared to their manufacturing phase. For instance, continuous repair of the same fossil fuel car instead of replacing it with an electrical car may not be an environmentally friendly decision. However, often extending product life through repairing and upgrading is still a valuable choice compared to recycling which is a lover value loop closing activity. Van Nes and Cramer [16] underlines following design strategies for improving the reparability of products;

- division of fast and slow developing parts
- division of fast and slow wearing parts
- changeable appearance

- enhanced upward and downward compatibility

Repair and upgrade usually handled by the manufacturer company through aftersales services. Post-purchase phase lifecycle hacking and repair is a promising concept for involving users into sustainability goals [17]. However, repairing a product is often not a preferable practice for today's users [18]. Thus, design strategies should also focus on features fostering repairing habits. According to Lilley et al., [18] customer's lack of confidence or knowledge to repair, high cost of aftersales service and low cost of retail prices, planned obsolescence and design that prohibits user's ability to repair are important factors limiting users to engage repair.

As summarized so far, in the literature strong emphasis is given to product design and engineering approaches. However, the symbolic meaning of products and product-person relationships, and product attachment are also crucial for slowing cycles at the post-purchase phase. In the case of repair, there are several reasons to be explored why a consumer decides towards replacing old products. Human decision-making process is not a clear cognitive process and often habitual elements are more influential than rational causes [19], [20]. Identity and lifestyle act as symbolic representations during decision-making towards buying [21]. Consumers tend to replace their goods because of wear and tear; improved utility; improved expression and new desires [16]. Often only objects with strong bonds are not replaced such as family heirlooms [22]. In order to redesign a product to create better attachment, the following strategies are suggested [22], [13];

- using memories and factors to evoke memories such as smell
- pleasure and enjoyment
- self-expression and uniqueness
- usability
- sensory design
- superior appearance
- utility and reliability
- product personality
- group affiliation, encouraged social contact
- involving users in the design process

Physical attributes such as standardization, use of simple disassembly tools and techniques, and modularity are important design principles. Moreover, products and services should be designed to invite users physically and emotionally for the practice of repair, instead of excluding them from the product. The next section of the study aims at creating a better understanding of design for repair through the examination of an undergraduate design studio process.

4 A Design Studio Experience

Seven undergraduate students were engaged in design for repair and upgrade studio for eight weeks in Spring 2018. The design brief focused on exploring redesign strategies for non-repairable electrical consumer goods sold in the market. Each participant defined a product line that is often not repairable by the user when the

product is faulty or broken. Products included project were; steam iron, sandwich maker, filter coffee machine, headphones, shaving machine, digital camera, and hand blender.

Several research methods employed including netnography, online questionnaires and semi-structured interviews. Through the research, students illustrated the most common reasons for obsolescence. The main goal was to overcome reasons of obsolescence as much as possible to extend the product lifespan. A product autopsy phase executed and documented by design students followed by think-aloud repair task executed by a user representing the target consumers. Students run four weeks of re-design workshop in order to reduce or replace; faulty parts, items subjected to break potentially during assembly and disassembly, complex tools needed for the practice of repair. The idea was making the product as easy to repair as changing batteries of remote control. Additionally, students were expected to bring ideas for perceived obsolescence. In sum, students used following approaches to achieve the goal;

- Encouraging users with repair and upgrade process with online services and dedicated social networks for exchanging product parts, repair hints and DIY experiences
- Replacing intimidating or fragile parts with easy to disassemble ones in order to encourage the user to approach confidently to the product with available tools.
- Providing an aesthetic box which both keeps the headphone and guides user during the repair activity.
- Encouraging users to build their own headphone experience through product intervention points such as upgradable audio equipment matching user's taste of music, variable wooden rings which helps users to customize their products.
- A new, repairable cable connection element that used to be the most common and breaking point of headphones.

Repairing is an act of creation and design for repair also brings another layer for designers to act creatively. Starting a design project with a brief intentionally focusing on redesigning to foster repair was challenging but also self-instructive for students. Differentiating planned obsolescence and perceived obsolescence were challenging for some of the products such as digital cameras. Moreover, some products were not welcoming user attachment by their function-oriented nature such as hand blender. In this case, students were not really creative to improve users' emotional bonding with the product. The task of bringing back a product into use aesthetically, critically and functionally underlines designers' role beyond the purchase phase.

5 Conclusion

Design for repair and upgrade is a valid challenge for both designers and businesses pursuing CE. The challenge dictates us to redesign consumer goods in a way that both physically and emotionally promotes the act of repair. Closing the loops and slowing cycles in natural and technical systems necessitates changing our design decisions towards product life extension rather than planned obsolescence. Embodying products with green materials is not a sufficient act to achieve goals of

circular design. Designers have to think beyond green materials and energy efficiency. In such a circular system each element of a product has to be nutrient for other cycles. Thus, designers have to think at least two scenarios for each element; reuse and recycle. Moreover, the design of a product should favor life extension and reuse of parts than recycling. Extending product life by durable design is not sufficient for overcoming the obstacle of perceived obsolescence. Fewer users are attached to their product which makes it difficult to convince them mending. As a holistic approach design for repair involves product and service interventions aiming at enabling user behavior change towards committing to act of repair.

Noticeably, this strategy needs a paradigm shift in the business as usual. Profiting not only from selling goods but circulating materials could be an opportunity for the business. Fortunately, several business cases illustrate successful and profitable examples of life extension and repair. Patagonia's "Worn Wear" repair program provides repair service and a platform for marketing repaired products of the company. HP's Z1workstations with their modular design constitute an example of introducing the notion of repair for products that embodies a rapidly changing technology. The company also supports consumers with online guides and manuals for encouraging them to repair and upgrade. Increase in DIY and product fixing videos on the internet, repair dedicated websites such as iFixit facilitates user behavior change towards attachment to the product.

Integrating repair strategies at the undergraduate design education might help to shift future designers' mindset on CE and also provide them a new field of creative interventions. Designers need to explore new ways to expand the economic, physical and psychological limits of repairing. Further studies on the subject might focus on elaborating technical and economical limits and intervention points for mending.

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