Exploring Product Design Innovation through Repair Techniques: Insights from Knowledge and Experience

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Abstract

Repair has been a longstanding activity in human society. However, in modern times, the production strategy of "planned obsolescence" has led to a decline in product quality and lifespan, resulting in closed and non-repairable products. Additionally, advertising manipulates consumers' desires, leading them to prefer replacing old items with new ones rather than repairing them. This has resulted in issues such as overconsumption, massive waste, and recycling challenges. Nevertheless, many DIY repair enthusiasts promote repair activities through communities and online media, highlighting the joy and creativity of repair. This unique relationship of care between people and objects extends the life of products and alters their original appearance and function, creating new possibilities to meet consumers' needs. This study analyzes actual cases to explore how DIY repairers innovate during the repair process, reinterpret old items, and elucidate the interaction between people and objects. Furthermore, it argues that repair activities represent a radical approach to mitigating waste and are crucial for advancing sustainable development.

Keywords: repair, product design, sustainable development, DIY culture.

1. Introduction

REPAIR was once an ordinary daily task in ancient societies, encompassing activities such as mending torn clothes and fixing table legs. However, these tasks have largely faded from contemporary life. Today, the repair of consumer products is typically managed through after-sales services, including warranty centers and repair shops or logistical support within infrastructure and manufacturing industries. A comprehensive system of professional specialization has gradually shifted the maintenance responsibility away from users, who now often rely on outsourcing these tasks to specialists or choose to discard and replace items. The saying, "Out with the old, in with the new," aptly captures this shift. Due to planned obsolescence strategies and aggressive marketing, once-durable products have declined, and designs have increasingly favored short-lived, easily replaceable items, weakening the intimate relationship between users and their possessions.

Nevertheless, a significant number of DIY repair enthusiasts are working to reclaim these ancient skills of caring for their belongings. The proliferation of Internet resources has facilitated the formation of numerous community groups that strongly advocate for repairing and reusing items.

This movement highlights the unique interaction between people and their possessions, such as the care and attention given to objects, as well as the creativity displayed in repairing and improving them. This resurgence of interest in repair has prompted a reevaluation and critique of modern product design practices.

Current product design research predominantly focuses on the interaction between humans and objects, emphasizing aspects such as production, consumption, and usage while rarely addressing the aspect of product repair. This study reviews theoretical perspectives from various scholars and corroborates them with observed case studies to establish an interpretive framework for understanding the phenomenon of product design repair. First, this paper will detail the repair work components, including the motivations and purposes behind undertaking repairs, the repairers' knowledge and skills, and the products' reparability. Second, it will explore the obstacles posed by planned obsolescence to contemporary repair efforts. In response to these challenges, various community groups promote DIY repair practices. Finally, the paper will examine how this DIY repair movement can be integrated with product design, forming an innovative and critically reflective design methodology.

Through this discussion, this study aims to clarify how the design field should regard and utilize the power of repair. Furthermore, it seeks to explore the potential for innovative repair applications in product design, addressing the question: How can the latent innovative power of repair be harnessed to create more comprehensive solutions beyond existing approaches like green consumption and recycling? This is the central inquiry that this study intends to explore.

2. The Nature of Repair

Timing and Purpose of Repair

Maintenance and repair are essential human survival skills, driven primarily by two factors: the continuous struggle against inherent material decay and the failure of objects to meet users' expectations. The need for maintenance and repair arises from the damage and deterioration of objects. Repair is necessitated by material decay, wear and tear, biological erosion, and human errors, which result in the “death” of objects. Such issues can be mitigated through ongoing repair efforts [1]. This struggle against the inevitable decline of the material world aligns with Jackson's concept of “broken world thinking,” which posits that the world is inherently flawed and humans can only seek new possibilities for order by continuously repairing, modifying, reconfiguring, and reorganizing material and social systems [2]. The drive to counteract failure and decay propels civilization forward.

In addition to physical deterioration, repair becomes necessary when objects fail to meet users' expectations. Such “faulty” objects may not be physically damaged but may prompt users to employ modifications, appropriations, or recombinations to create new functionalities. Examples include converting an unused stairwell into a cabinet or shortening a cumbersome keyboard tray to accommodate a monitor. This type of repair is categorized as “everyday design” [3]. This form of “adaptation” transcends original design constraints, fostering change and innovation [1]. Thus,

repair can serve as a flexible means of adjustment, transforming the original design of objects and unlocking new possibilities.

Uncovering Memories and Stories through Repair

Throughout human civilization, many artifacts from past eras have been preserved. These objects evoke contemporary memories and carry numerous stories that can be uncovered and interpreted through repair. Fallan discussed how restoring old bicycles reconstructs their physical form and human memory. This included personal memories of riding and maintaining the bicycle with his father during his youth, collective memories symbolizing the popular culture of the 1970s, and reflections generated during the repair process. The repaired object thus becomes a mediator that triggers and carries memories, connecting the user, historical recollections, and the object itself. The durability of an object encompasses not only its functionality but also the emotions and culture attached to it, developed through the practice of repair [4]. This is also evident in the research by Rosner and Ames, where a man repairing an antique wooden radio and an elderly couple seeking help at a FIXIT repair station for their 50-year-old malfunctioning toaster both aimed to preserve objects imbued with significant life histories and memories. They feared that these memories would be lost along with the discarded items [5]. Therefore, repair could be described as a "bridge across worlds," suggesting that repair can expand spaces and functionalities, protect objects from decay and crisis, extend their durability, and give them a new appearance. This "bridge" connects the values and meanings that objects carry from the past to the present [2].

The Craftsmanship in Repair

Maintenance and repair are not merely forms of physical labor but are crafts imbued with artisanal skill [6]. Craftsmanship can be defined as the expertise, skill, and artistry involved in the methods and techniques used to transform raw materials or semi-finished products into finished goods. It encompasses both the practical know-how and the creative processes that contribute to the quality and aesthetic of the final product. Denis and Pontille used Pickering's concept of the "dance of maintenance" to describe the process of dismantling unified physical objects into disparate parts, treating them, and reassembling them to locate the source of the problem [7]. Early repair technicians had to independently fabricate and improve faulty components to replace and repair items [8]. In the study by Gregson et al., respondents were observed planing, sanding, and varnishing old tables, effectively refurbishing them [9]. Thus, the overlapping techniques between repair and manufacturing craftsmanship include disassembly and reassembly, component fabrication, and refurbishment methods.

Craftsmanship provides spiritual satisfaction, as manual work demonstrates an individual's tangible impact on the world, affirming their existential value [6]. Craftsmanship involves humans' sensory and emotional experience, offering manual stimulation and helping to reclaim the tactile and emotional experiences neglected since the Industrial Revolution. Today, the emotional experience and independent creative spirit of craftsmanship are also viewed as remedies against the alienation of labor in industrial production.

3. Requirements and Obstacles of Repair

Product Maintainability

Repairing objects relies on both the skill of technicians and craftsmen and the design features of the objects themselves. The most crucial aspect of repair is the ability to disassemble the object, a concept referred to as “maintainability” [7]. Standardized and modularized product designs facilitate the replacement of damaged components. In addition to structural design, the material characteristics of products also play a significant role. Several materials that are easier for individuals to repair: flexible materials, substitutable materials, and salvageable materials [3]. These materials are more amenable to mending, reusing, or repurposing. Besides, the lifespan of products is heavily influenced by social, cultural, and economic factors and that manufacturers and designers cannot precisely predict actual repair conditions, necessitating the consideration of the users' social conditions [5]. Therefore, product maintainability is a collaborative effort between designers and users.

Challenges of Planned Obsolescence

Capitalists often view planned obsolescence as a strategy to promote repeated consumption and increase profits. This approach has led to a rise in consumerist societies, where products are designed with limited lifespans and are challenging to repair. The concept of planned obsolescence, a practice involving manufacturers and designers, dates back to Bernard London's 1932 economic recovery proposal. This proposal aimed to limit product lifespans to stimulate consumption and rejuvenate the market. Rapid technological advancements have shortened market lifecycles for electronic products. For example, Apple's iPhones and MacBooks feature non-replaceable batteries, complicating repairs [5]. These methods as “black boxing,” where products are designed with rivets, heat-sealed casings, and other techniques that hinder disassembly, void warranties upon user tampering, and eliminate compatibility across different product generations [8]. Graham also criticizes closed designs that lack transparency, contributing to significant electronic waste issues [1]. Additionally, concealing or oversimplifying fault information is another tactic to obstruct repairs. For example, while early car engines included dipsticks to measure oil levels, modern cars only have maintenance warning lights, which do not provide precise information [6]. This concealment of fault information misleads car owners into believing they are relieved of maintenance responsibilities, increasing their reliance on dealerships.

Planned obsolescence strategies impact product maintainability by influencing product lifespans through various factors, including design, technological changes, repair costs, household wealth, resale value, functionality and aesthetic quality, fashion, advertising, and social pressures [10]. Product discard decisions can be categorized into “absolute obsolescence,” caused by product failures, and “relative obsolescence,” driven by consumer psychological decisions. Cooper further identified three distinct forms of obsolescence: technological obsolescence, where new models with superior specifications attract consumers, making old models seem outdated; economic obsolescence, where consumers compare the residual value of an item against maintenance costs; and psychological obsolescence, where advertising and marketing stimulate a desire for new product appearances, functions, and symbolic values [10]. Leonard, in “The

Story of Stuff," highlighted two common tactics used by capitalists: planned obsolescence and advertising [11]. On one hand, practices such as lowering product quality, making products non-repairable, creating disposable items, making new and old models incompatible, and pricing repairs higher than new products contribute to a "use and discard" mentality. On the other hand, sophisticated advertising tactics persuade people to buy more things by aggressively promoting new products with more features, new styles, and colors, using fashion and psychology to drive purchases. Leonard asserted that corporate decision-makers, industrial designers, economic planners, and advertisers must be held accountable.

Removing maintainability from product designs and misusing advertising and marketing has resulted in severe waste pollution and infringed upon consumer rights. This commercial, ethical issue demands attention and necessitates reflecting on how repair can be integrated into the design to create more sustainable solutions.

4. The Culture of Repair: Rediscovering the Value of Objects

The Growing Trend of DIY Repair

The emergence of the DIY repair trend, which originated in the 1950s in response to material scarcity and resource shortages, has evolved from a necessity into a leisure activity that enhances everyday life. Today, it has transformed into a significant movement addressing issues such as non-open product designs by manufacturers, monopolized repair resources, and the decline of traditional repair services. The rise of the Internet has facilitated this movement by enabling like-minded repair enthusiasts to connect and collaborate. Social media have played a crucial role in creating a repair culture that transcends geographical and temporal boundaries, integrating various professional fields and diverse repair techniques.

Many community groups now advocate for repairing and reusing items rather than constantly purchasing new ones. They utilize blogs and social media to gather support and promote their activities. For instance, the "Urban Repair Station" blog (see Figure 1) showcases repair shops tucked away in the alleys of Taipei City that offer services for various items, including household appliances, wooden furniture, bicycles, and clothing. The website provides detailed information about the craftsmen and their services and organizes engaging lectures and workshops (see Figure 2). By making repair accessible to the general public and demonstrating the enjoyment and sense of achievement that comes from repairing, these efforts encourage greater interest and participation in repair activities.

Figure 1. Blog homepage of City Repair Station

Figure 2. A craftsman at City Repair Station refurbishing a wooden cabinet for the public

Another notable example is the "Platform21" from the Netherlands (see Figure 3), established in 2006 by a collective of designers as a design information platform. Platform21 organized public exhibitions, seminars, lectures, workshops, and research and issued a manifesto with the provocative slogan, "Stop recycling, start repairing." This initiative aims to encourage the public to actively repair their own items, thereby altering the conventional relationship between users and products. Platform21's approach is characterized by experimental and imaginative designs,that highlight repair as a product of creativity and ingenuity. Each repair project is presented as a unique achievement (Figure 4), reinforcing the idea that repair processes are distinctive and innovative experiences. The platform advocates for a shift away from traditional consumerism, urging individuals to challenge the notion of predetermined product lifespans and to explore new possibilities for extending the functionality and lifespan of items as amateur designers and repairers.

Figure 3. Platform21 website

Figure 4. Repair work by Platform21

Although Platform21 ceased operations in 2009, the DIY repair trend has continued to thrive and expand globally. A prominent example of this movement is the "Repair Café" initiative, which also originated in the Netherlands (see Figure 5). Founded in Amsterdam in 2009, there are now over 400 Repair Cafés worldwide. These cafés— from workshops to exhibition booths—serve as locations where customers can bring broken items for repair, participate in the repair process, or learn new skills. Volunteer repairers, many of whom were former customers, provide their services, allowing everyone to gain repair skills. According to the organizer of the Repair Café in Brighton, UK, "repair is not only a political and creative act but also a symbol of independence and capability. Additionally, repair helps build community awareness and reduce resource waste." Repair Café aims to maximize the value of items before they are recycled, integrating repair and maintenance into local economies and civic consciousness. Founder Martine Postma views Repair Cafés as crucial components of a circular economy.

Figure 5. Repair Café in Berlin

The rapid proliferation of Internet media has facilitated interactions among DIY repair enthusiasts through social networking sites and has made free DIY repair tutorials more accessible. For example, the renowned iFixit repair guide website (see Figure 6), founded by Luke and Kyle in 2003 at California Polytechnic State University, was established in response to their difficulty finding open repair manuals for iBook laptops. They created and published their own free guides online,.which continue to offer teardown and research guides for Apple products and encourage user submissions. Today, iFixit covers a broad range of items, including Apple computers, gaming consoles, phones, household appliances, cars, and various electronics. Additionally, iFixit sells DIY repair toolkits and parts. Their repair manifesto, "If you can't fix it, you don't own it," highlights that self-repair surpasses recycling, reduces replacement costs, teaches machinery principles, and optimally utilizes resources. This platform has undoubtedly inspired many to explore self-repair options as an alternative to discarding or replacing products.

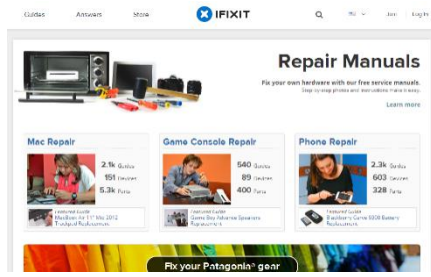

Figure 6. iFixit repair guide navigation page

Through these community websites and designers' efforts, many people are actively working to regain the ability to maintain and repair their objects. Repair transcends mere functionality; it introduces innovative opportunities and challenges established values. Deeper implications of repair warrant further exploration and discussion.

From Practice to Research: The Significance of Repair in the Field of Human-Computer Interaction

The obsolescence resulting from the denial of product maintainability is a significant concern within the Human-Computer Interaction (HCI) field. Blevis introduced the concept of Sustainable Interaction Design (SID), which merges principles of green design with interaction design [12]. Blevis proposed two key principles for interaction design: first, innovations must anticipate the eventual disposal of the product to prevent technical obsolescence; second, products should be designed to support remanufacturing and reuse, ensuring sustainable operations. He noted that digital products are often discarded prematurely, particularly when software upgrades render hardware obsolete. To mitigate environmental impact, Blevis advocated for a modular design that facilitates upgrades and repairs. However, he acknowledged that aligning sustainable interaction design with business interests might be challenging. Therefore, he urged designers to focus on developing behaviors and service processes that promote sustainability.

In addition, Jackson & Kang explored how objects are designed, sold, used, repaired, discarded, and repurposed. They emphasized that these processes introduce a new value to objects. By observing and interviewing device artists, Jackson and Kang examined behaviors related to the repair and reuse of waste [13]. They discovered that when artists reassembled and repaired old objects, they created pieces that transcended the original design and function. The processes of curiosity and improvisation led to surprising and aesthetically pleasing outcomes. They argued that the creativity and imagination involved in repurposing existing objects are often overlooked in HCI but are essential for sustainable development.

Similarly, Maestri and Wakkary highlighted that in the human-computer interaction dynamic, repair becomes a creative and adaptive activity when users possess the ability and authority to modify objects. The global rise of the DIY repair movement underscores a resurgence of this ancient craft, inviting individuals to reclaim and reinvent their repair skills.

5. Conclusion: Repair as a Critical Perspective in Sustainable Design

Individuals often become skeptical and distrustful of product design when engaging in DIY repairs and encountering product failures, leading to a new form of DIY design activity known as "hacked design." Hertz identified a significant connection between repair and hacked design, defining "hacking" as traditional repair and the creative modification and transformation of existing systems to address inherent issues [14]. Rosner and Bean examined the IKEA Hacking movement, where IKEA furniture components were repurposed into unconventional, humorous creations. They observed that the concept of hacking has evolved: while computer hackers exploit software flaws, product hackers focus on correcting inherent defects, enhancing functionality, and personalizing mass-produced items—innovation characterized by originality and uniqueness [15].

"Hacking" serves as a method to uncover design flaws, requiring a deep understanding of relevant technologies, materials, and theories. This process involves sensory cognition—continuous interaction between the body and materials/tools—and employs "reverse engineering" to dissect and analyze the underlying purposes of designs. Applying hacking principles to design involves revealing hidden components and operational processes within products, exposing limitations and inconveniences imposed on users [16]. "Hacked design" disrupts the closed nature of traditional products, dismantling the power dynamics between designers and users [15]. Hertz advocated a skeptical approach toward new technologies, promoting market disruption, social liberation, and self-realization [14]. Similarly, Rosner and Bean emphasized the lessons from IKEA Hacking, highlighting the importance of critical thinking and participation in DIY culture activities to merge creative thinking with repair work, and foster new collaborative design models [15].

These discussions reveal that "hacked design" integrates sensory cognition, storytelling of repair, crafting skills, DIY participation, and creative appropriation, all underpinned by critical thinking to re-examine existing products. This approach seeks to uncover the secrets within products' "black boxes." Hacked design merges the spirit of repair with design methodologies, offering new interpretations and innovative outcomes. Therefore, the potential of repair thinking and skills in product design should not be underestimated. These skills involve creating something from scratch and critically addressing existing issues to improve and enhance. Through repair practices, product malfunctions are addressed, and the fundamental design is scrutinized to better meet user needs, environmental ethics, and social sustainability.

The examples of repair applications discussed in this study offer crucial insights: past design thinking has often operated under the assumption that "new is better," leading to excessive consumption and consequent resource depletion and environmental crises. Designers must undertake transformative actions to rectify and address these issues, seeking sustainable design principles. When repair is integrated into product design, its innovative implications extend beyond creating new items to reshaping human-object relationships. This approach allows products to evolve, improve continuously, and interact closely with people, embodying the essence of sustainable development.

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