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Design for Cleanability: A Human/ Eco-Centred Partnership

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Design for Cleanability: A Human/ Eco-centred Partnership

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Abstract: Few people enjoy a mess. Fewer still like to clean one up. Globally, users and institutions spend billions on chemical cleaning products to clean bathrooms, kitchens and more, hopefully as quickly as possible. Machines help diminish the chore of cleaning altogether, especially for clothes and dishes. While cleaning behaviour is motivated by divergent parameters, such as social pressure and fear of health repercussions, cleaning is neither a popular activity nor are the cleaning chemicals used often good for our water, air or soil. In addition, cleaning carries time costs. Fortunately, design can help by alleviating the amount of cleaning needed by the products we use to the clothes we wear. Design can also influence colour, material and finish selection which in turn can avoid discoloration and premature disposal. In essence, this letter presents a general call for design educators and designers to focus more on cleanability in design: for reasons of human empathy and environmental stewardship.

Keywords: Human-Centred Design; Design for Sustainability; Design for Cleaning; Circular Economy; Design for Repair

Introduction

Last year, more than 40 billion USD were spent on products to clean the spaces where people work and live, in addition to products used daily, from clothes to vehicles (Statista Research Department, 2021). After the Covid-19 pandemic, more frequent cleaning habits endured, likely in response to lingering concerns about infection (Bettenhausen, 2022). Sprays, powders, liquids and more are used to remove dirt, dust and discoloration while leaving behind a more pleasant odour. At the same time, most of these cleaning chemicals end up going down the drain, into water systems, the soil or the air, many with environmental consequences (Patel & Moore, 2017, United States Environmental Protection Agency, 2023; Sabharwal, 2015). Further, substantial water use is needed for cleaning and rinsing. Fortunately, a greater percentage of cleaning chemicals are becoming cleaner- natural, biodegradable and non-toxic (Kronthal-Sacco & Whelan, 2022). This is helpful but not enough. As a dedicated cleaner who has developed cleaning products for multinational chemical companies, it is clear that design is also to blame. Design that needs to be cleaned often makes the problem worse. So many products, even some of the most popular and best-selling, soil easily and are hard to clean. This can also lead to frustration and the disposal of such products before the end of their useful life. Some of this is, of course, intentional. For years much has been written about “planned obsolescence” (Papanek, 2005; Bischop et al., 2022) or the intentional profit-driven practice of designing products to fail to influence consumers to toss and buy replacements. At the same time, calls for designing products and maintaining them for longevity have also gained momentum (Chapman, 2020; Russell & Vinsel, 2014). Between these competing interests for profit and environmental stewardship, ongoing work is needed to define new business models that encourage repair.
Happily, more attention has focused on cleanability in recent years with some success. In healthcare environments, cleaning medical equipment has long been an imperative to avoid cross infection. In domestic contexts, home improvement experts now focus on the impact of design decisions on cleanability (Fenton, 2021). Building on these precedents, this letter urges designers and design educators to consider Design for Cleanability as an integral part of their design methods and discourse. Design for Cleanability integrates with existing sustainability frameworks, notably the Circular Economy (Ellen MacArthur Foundation, 2017). In particular, the Circular Economy champions longevity through maintenance and repair to prevent products from entering the landfill. In essence, Design for Cleanability is a branch of design for repair which has been cited as a critical emerging criterion for design education. (Özkan & Wever, 2019) As an outcome, Design for Cleanability thereby supports environmental goals and people simultaneously by creating an improved user experience. Therefore, when designing a shower, stove, keyboard or a hat, designers should think about what happens when people sweat, cook, spill a coffee, or water is left behind for days in rooms without adequate ventilation. This letter provides a few specific well-known examples. Most likely, the readership has many more of their own.

**Example 1: The Bathroom**

Unsurprisingly, bathrooms rank as the least desirable room to clean (American Cleaning Institute, 2018). Toilets, showers, sinks and other features of bathrooms attract dirt and worse. Many toilet designs have a flat ceramic surface onto which the toilet seat and lid comfortably rest. This level surface also attracts hair, water and other bodily fluids. Often this surface is wider than necessary to be functional as a seat support platform. After a day of use during a family visit, this surface of a toilet’s anatomy is often soiled. Cleaning around the lid’s hinges, especially if they are mechanically exposed, creates extra cleaning effort. Could, for example, a toilet be designed with a much narrower seat platform to prevent dirt and debris from collecting in the first place?

Showers, too are also frequently soiled, in this case by the effect of standing water. Mildew collects everywhere, especially in windowless or otherwise poorly ventilated bathrooms (Figure 1). Shower curtains, glass doors and tile routinely attract black deposits of mildew which are often difficult to remove. Further, they collect in tight ninety-degree corners and especially in tile grout. Tile, is of course popular aesthetically, but grout can be difficult to clean once it begins to turn black. One-piece shower units, on the other hand, have rounded corners with no joints leaving few opportunities for mildew to develop (Figure 2). Many more examples exist— from the sink to the tub and more. Can one-piece showers with rounded corners be as aesthetically desirable as tile while maintaining their cleanability?

![Image 1](https://example.com/image1.jpg) ![Image 2](https://example.com/image2.jpg)

*Figure 1. Bathroom tile grout is notoriously hard to clean as residual moisture encourages mildew over time. (Surname, 2011). Figure 2. A one-piece plastic shower is less luxurious than tile but can help prevent mildew from developing and thereby reduce the amount time and cleaning agents needed to clean. (Surname, 2023).*

**Example 2: The Kitchen Stove**

Cooking and eating can be one of the most pleasurable moments of any day or weekend. Cleaning up after cooking is a different story. The design of kitchen appliances, especially stoves, can often be difficult to clean. Grill or restaurant-style cast iron stove tops, popularized in the 1990s for their ‘prosumer’ design, can also be exceptionally challenging in this regard. Oil, grease and other by-products of cooking finds nooks and corners on these kinds of stove designs which after a few hours require time and effort to clean. Further, porous and textured surfaces of cast-iron also introduce difficulties in wiping down. Altogether, these design decisions encourage users to rely on heavy duty chemical cleaners, just as they do in the shower. Induction cooktops contrast in their design with their smooth, wipeable simplicity. In this case, there are no valleys, ridges or other features into which cooking debris can fall or
stick. Few examples are better than these two design approaches to illustrate Design for Cleanability (Figure 3 and Figure 4).

Figure 3. At left, a recently cleaned restaurant-style cook top is notoriously hard to clean after cooking. (Kennedy, 2022). Figure 4. At right, in contrast, smooth induction cooktops are more easily wiped down quickly after cooking. (Goedeker’s, 2014, https://www.flickr.com/photos/goedekers/12992718893).

Case Study 3: Surface Soiling and Discoloration

Beyond durable goods and appliances, soft goods, electronics and other product categories abound with examples of design decisions that lead to difficult cleaning. Many elastomeric products, especially plastic handles with over moulded synthetic rubbery grips can absorb oils from hands and cooking, resulting in discoloration. This premature wear, that is difficult or impossible to clean, often results in products being discarded before the end of their useful life. Some plastics when lightly coloured, can also yellow over time (Figure 4 & Figure 5). This condition which is often a result of material and colour choice, is difficult to clean and also frequently leads to premature disposal. Finally, sweat and other by products of human skin can stain garments irreparably (Figure 6).

Figure 4. Image of an HP Scanner designed by the author in 2005 whose white plastic top has since yellowed. (Kennedy, 2023). Figure 5. Image of aftermarket power cables yellowing over time. Discoloration of lighter plastics is often uncleanable. (Kennedy, 2023) Figure 6. The synthetic material of the brim of this baseball cap has a sweat stain which persists stubbornly after being laundered several times. (Kennedy, 2023).

Integrating Design for Cleanability in Design Education

Building upon literature which introduces concepts of repair in university design briefs (Özkan & Wever, 2019), cleanability can be treated as a new dimension of circularity or as an extension of design for repair and reuse. Either way, the following design considerations can be included in lecture material and project design briefs that prompt students to consider material selection and end-of-life (EoL) strategies (Ellen MacArthur Foundation, 2015). While cleanability themes have only been introduced generally in industrial design coursework at the author’s university Virginia Tech, the following criteria were shared with students in projects during the autumn semester of 2022 and 2023.
Design for Cleanability Criteria (August 2022):

**Debris Effects:** What happens when designs are exposed to crumbs, soil and other small-sized solids that can lodge into cracks and crevices and become difficult to clean out or extract?

**Fluid Effects:** What happens when designs are exposed to water, oil and human bodily fluids? This varies depending on the environment and context: Cooking, Bathing and Clothing

**UV Effects:** What happens when designs are exposed to sustained ultraviolet light from the sun? Consider effects of UV rays on fabric dyes and hard plastics, including yellowing and fogging.

In two projects especially, design for cleanability was particularly relevant (redesigning light switches to encourage users to turn them off and redesigning manual push carpet sweepers to be relevant today). Especially with the carpet sweeper project, design for cleanability became essential for success—the class was presented with a 100-year-old Bissell carpet sweeper purchased on eBay whose rotary brushes were full of hair and hard to clean, impairing sweeping efficacy. Part of the class assignment was to analyse and take apart the antique sweeper and more recent models, analysing how to make them work effectively for longer. Cleanability emerged as a central principle.

**Conclusion**

During the design and development of products and their use cycles, cleanability is too often overlooked. Geometry, material and colour definition are not only aesthetic, functional and human factors considerations, they are also cleanability considerations. In contemplating design criteria in design education contexts and professional design practice, cleanability deserves greater focus. Cleanability is both valued by users and essential to a circular economy. However, while cleanability is conceptually similar in many ways to questions of repairability and refurbishment, it might be harder to quantify. This might present challenges in legal definitions under emerging right to repair legislation. After all, dirty and soiled products might continue to function despite their appearance. Defining what is considered ‘clean’ can also be subjective and needs greater clarity if Design for Cleanability principles are to be adopted successfully. The initial criteria presented above represent a first step towards formal definitions and guidelines for cleanability. Undoubtedly, much more work needs to be done. Kitchen tools and appliances, electric toothbrushes, clothing, furniture, vehicles and many other categories can be further analysed in terms of cleanability to build on these proposed criteria. Along with other efforts to support circular economy goals by extending the useful life of products and protecting natural resources, Designing for Cleanability merits equal focus and consideration. In so doing, users will also be thankful if cleaning becomes easier too.
References


About the Authors

Brook Kennedy is a designer, researcher and inventor whose career spans human-centred industry design practice and academia. Currently he is a professor at Virginia Tech in the USA where he explores topics in BioDesign, Circular Economy and sustainable futures.