PLATE
Product Lifetimes And The Environment

Lightfastness Natural Color Database: A tool for designing evolving effects on textile surface through sunlight exposure

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Introduction

Since the onset of the 21st century, there has been a notable decline in the lifespan of textile products in the Western world, despite a twofold increase in consumption within the clothing and upholstery sectors from 2000 to 2015 (Ellen MacArthur Foundation, 2017; ZeroWaste, 2024). This trend of frequent renewal has resulted in excessive ressource waste and a threefold surge in the exportation of used textiles from Europe (Ellen MacArthur Foundation, 2017). Current initiatives aimed at reducing this waste mainly concentrate on the end-of-life phase of the product lifecycle, particularly through recycling efforts. However, it is reported that 87% of these textiles end up being incinerated or sent to landfills after their final use (Laitala and al., 2015), rendering these efforts actually ineffective.

Cosmetic obsolescence as one of the reason for end-of-life textile products

Research exploring the motivations behind the renewal of textile products has underscored factors associated with cosmetic obsolescence (Kumar and al., 2023). Consumers tend to discard one item in favor of another that is perceived more aesthetically pleasing, attractive or socially valued (Guien, 2021), even though the product remains functional.

This phenomenon emphasizes the necessity to prioritize sociological challenges over technological ones (Rogers and al., 2015) in the pursuit of reducing material production, energy consumption, and environmental degradation by over 90% by 2040 (van Ness & Cramer, 2005). In this context, a recognized approach for prolonging the lifespan and decelerating the consumption cycle of textile products, involves designing items that can adapt alongside their owners, thereby enhancing their emotional and economic value over time (Chapman, 2005; Lilley and al., 2019; Nobels and al., 2015). Taking into account user's desires for change in the renewal of textile products, can practice-based research utilize signs of aging to suggest renewal over time, thereby extending the lifespan of these products ?

Integration of wear into textile product design as a way to build 'narrative experiences' to extend lifespan

In this regard, it is noteworthy that the perceived aging of textile product surfaces is generally deemed undesirable by both the industry and consumers, despite being a natural characteristic of most materials (Talman, 2019). Nonetheless, some forms of wear are positively perceived when associated with a patina, which is regarded as an aesthetically pleasing surface quality (Haug, 2017). Although this socio-cultural phenomenon applies to a limited range of objects (such as leather armchairs or blue-jeans), it indicates that surface wear can indeed contribute to extending product lifespans. On this point, studies on user responses to material aging show that changes that occur gradually (Manley et al., 2015) on materials of natural origin (Nobels et al., 2015) are likely to be perceived neutrally or positively.

Consequently, this article seeks to examine the extent to which surface degradation can be perceived positively as a patina, focusing specifically on the wear parameter of discoloration due to sun exposure. The chromatic reactions generated by exposure to the sun (as a photo-oxidation phenomenon) are commonly evaluated in the industry using accelerated aging machines in order to eliminate colors that would be considered non-resistant. In this research framework, we

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consider them, on the contrary, as means of realizing surfaces that evolve over time. More precisely, the possibility of gradually lending behaviors to a surface that, familiarly, does not change, induces the possibility of building "narrative experiences" (Chapman, 2005) and, thus, contributing to the longevity of a product (Grimaldi, 2017).

Natural dyes lightfastness as a way to design evolutive textile products surfaces : a methodology

Utilizing the same metrological testing instrument, the colors are analyzed with the aim of predicting their behavior over the duration of use rather than employing a discriminatory control approach. A series of one hundred tests involving natural dyes applied to silk and wool yarns were subjected to artificial exposure to establish a "chromo-chronological" database (figure 1), documenting their reactions to sunlight. Subsequently, these colors were examined using a spectrophotometer to assess changes in hue, saturation, and luminance for each reference sample. With this data, a chromo-chronological color chart was developed in the form of both 3D and 2D models for use by textile designers. In this regard, it is interesting to note that the students who tested this design method relied only on the database samples, excluding the 2D printed reproductions.

Through practice-based research in textile design, the database has facilitated color exploration aimed at creating textiles that exhibit both appearance and disappearance effects over time exposure. The intention to create a monochrome surface capable of revealing a pattern or design has modified the conventional approach to color reproduction. Traditionally, the goal is to reproduce the shade of a sample through successive adjustments in a linear process. In our case, the research focuses on achieving the same perceived shade from two coloring resources (hues on the same fiber) that react differently to prolonged exposure to sunlight. The search for the same color thus occurs through successive adjustments on the two colors, in order to increasingly restrict a chromatic perimeter. When these two threads present the same perceived color, we can therefore create a monochrome textile surface. Over the period of sunlight exposure, the contrast between these two colors will increase, allowing the predetermined design to emerge (figure 2).

Figure 1. Evolutive rug Green law square, wool threads before (left side) and after (right) exposure to natural sunlight during 6 months, Chateauroux. ©Ramage

Conclusion

This paradigm shift, which reinterprets the phenomenon of discoloration as a means to design evolving textile surfaces in their ability to reveal patterns or images over time. The chromo-chronological data base has enabled the development of textile prototypes (weavings and carpets) demonstrating this concept. While current research on integrating wear parameters into design for extended product

Figure 2 Extract from the Chromo-chronological database, silk threads on paperboards exposed to artificial sunlight during 50, 40, 30, 20, 10 and 0 hours. ©Ramage

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lifespan lacks concrete methods — even if a lot of studies attempt to have a better understanding of consumer's responds to patina and surface degradation (Lilley & al., 2019; Manley & al., 2015) — this study highlights the potential of storytelling within product experiences to foster user attachment and extend product longevity (Grimaldi, 2017). By incorporating evolving and surprising visual changes into textile surfaces, we aim to capture user attention and create a more memorable experience (ibid.). This evolving surface behavior can establish a narrative, imbuing the textile with emotional significance and potentially mitigating factors that contribute to textile product remplacement, as consumer boredom and weariness (Zouaghi, 2017). However, further research is needed to understand how users perceive discoloration within a design contexte, building upon existing perception studies (Lilley & al., 2019; Manley & al., 2015).

Although the research methodology focused on understanding and subsequently predicting the surface reactions of materials — so that these can be integrated into the manufacturing process for the creation of evolving objects — highlights the significance of developing predictive tools, as guarantee for graceful aging throughout the lifespan of products.

Acknowledgments

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