Material experience: the future of material selection for product design

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Abstract

It has become more and more important to consider the future material selections in product design. The material choices influence on the user perception and hedonic experience qualities, but they affect also product qualities such as recyclability and durability. Understanding the user experience with materials can help us to design for more sustainable transformations. In this paper, we address the topic of material experiences through user research. In our research, we focus on four characteristics in the material experience: arctic, classic, expensive and cheap, and present two user studies investigating the user experience with materials in products. The first study utilized the material probes method, and included a user test in which the participants could explore and feel different materials: glass, metal, leather, plastic, concrete, and wood. The second study consisted of individual interviews of eight (8) people. As salient findings, we report that wood, glass, and leather were perceived to represent classic and arctic, whereas plastic provoked negative reactions. With plastics, an interesting contradiction was found when people still often used plastic products to describe an expensive product category.

Author keywords

Design materials; material probes; user experience; user studies.

Introduction

Designers' work can be said to focus around creating new products and solutions for people to use, and their work is visible in every sector of life with different consumer products. However, it is recognized that today we live in a world where the population grows and consumption is constantly increasing, creating problems with the over consumption of natural resources, pollution, and waste, and an urgent pressure to change this development. As a result, we are more focused on the environment and sustainability. According to Maleque & Salit (2013), the environment and factors affecting it are featured increasingly in design; this shows in how materials are chosen, manufacturing processes, life cycle thinking and in material development. Environmental values and sustainable growth are also significant factors in marketing of these products (Maleque & Salit, 2013, 70), and drive for design for transformation and nature friendly solutions.

Product designers and industrial designers work integrally with different physical materials. Materials are an essential part of the user experience with tangible products, and their selection influences on the product's outlook, durability, usability, price, and recyclability. Material choices are thus an important part to consider in the design phase, and understanding how people perceive the materials provides useful background information for these choices.

We investigated the user experience with product design materials with two different user study methods. The first study utilized the material probes method, and included a user test in which the participants could explore and feel different materials: glass, metal, leather, plastic, concrete, and wood. In the second study, interviews were conducted with eight (8) people, who also presented product examples of their choices. Our work contributes in understanding the user perceptions of material qualities and user experience, and can provide insight and inspiration for product designers and researchers who are interested in materiality as part of the user experience.

Material Experience

User Experience with Materials

User experience (UX) is a central concept when designs are assessed, and it goes beyond the definition of usability - efficiency, effectiveness and user satisfaction - which has traditionally been the key concept when user interface design goals are set (Law et al. 2008). User experience design does not consider only the instrumental value of the interactive artifact. It highlights also hedonic aspects, and that emotion and affect have important roles in the holistic perception. These include factors such as aesthetics, emotional engagement and stimulation (Hassenzahl & Tractinsky, 2006). User experience is studied with user-centered design methods, which can be applied in design and evaluation phases (Hassenzahl & Tractinsky, 2006; Häkkilä, J. 2020, p. 68).

Even though design education is changing, and the methods and tools in the field have generally moved to fast modeling methods such as 3D printing and laser cutting, design

students still need a good knowledge of materials and practical experiences (Johansson & Konttinen, 2021, 90). The skill of producing successful and insightful design requires knowledge of previous solutions from a contextual and historical level (Falin, 2011, p. 122). Only with sufficient understanding of the effects of material selection, can we have an impact on the future of product design.

Also, successful product development requires a deep understanding of users' preferences. Design is one way to concretize users' needs and make products easier to use, more functional and sustainable. Today, a designer is expected to have good empathy skills, so that they understand user needs and at the same time can push their own opinions aside (Huotari, Laitakari-Svärd, Laakko & Koskinen, 2003, pp. 9-25). Understanding user experiences with materials can be a tool for change and transformations.

According to Karana (2010), the material is a very essential part of the product and the material experience created through the product is multifactorial. When people interact with products, their senses are in contact with the product's materials, which mainly provide visual and tactile stimuli. The environment and previous experiences also have their own influence on how materials are perceived (Karana, 2010, p. 23.) Designers need to be aware of the overall picture affecting users' experience with physical products and materials. Materiality plays a central role also with tangible user interfaces, since materials can be experienced thru touching and haptic feedback. Nevertheless, according to Häkkilä & Johansson (2018) materials also affect the visual design and the style of the products. Therefore, the designer can promote values and create associations with material selections (Häkkilä & Johansson, 2018, p. 36).

Materials and Designing for Nature Positive Transformation

Design educators are creating a foundation for the future by teaching tomorrow's designers. Preparing design students with knowledge about the importance of material selections for product design can make a difference towards a nature positive transformation. Nature positive transformation is an essential requirement in the future design. This is simply because a turn towards more sustainable solutions must happen in order to give Earth as the living planet a chance to flourish also in the future. The future of the entire planet is greatly affected by the ongoing development trends, which are of great concern. These include the overuse of natural resources, global warming, increasing population, urbanization and the socio-economic challenges of consumer society. Different measures and campaigns have been developed to increase the awareness of the issues. As one illustrious example, Earth Overshoot Day has been announced as a measure to describe the overuse of natural resources and the planet's capability to recover from the toll the humans are putting on the biocapacity. It is calculated for each year by Global Footprint Network, and marks the day when Earth's biocapacity suffices to provide for the Ecological Footprint of humankind. In 2022, the Earth Overshoot Day was on the 28th of July.
Sustainability needs to be addressed with a wide spectrum of solutions across the society, since it has been recognized as a key challenge. According to Ljungberg (2007), developing more sustainable products can be affected in part by the material selections. However, the material selection process today is complicated and challenging, since there are virtually countless options available. Designing products for a sustainable future gives the material selection and the designer even more significant role.

Study I – Material Probes

Method

In the first phase of our research, material probes were used as a qualitative data gathering method. Material probes method in the context of interaction design has been described by Jung and Stolterman (2010), who addressed the topic of materiality related to digital artifacts. The method was developed to provide understanding on how people perceive different material qualities, and to feed to the discussion on how these observations and desires could be incorporated into the design. Jung and Stolterman employed a three-step procedure, which included asking the study participants to tell stories of memories related to physical artifacts, playing with material samples while speculating on their preferences, and comparing the physical and digital artifact experiences (Jung & Stolterman, 2010). The material probes method was later adapted by Häkkilä et al. (Häkkilä, He & Colley, 2015), who studied the experience with natural materials by providing tangible samples and assessing them with product reaction cards based on the Microsoft PRC set (Benedek & Miner, 2002). Here, product reaction cards provided a set of predefined words, from which the participant could choose the terms best matching their experience with the physical material probe.

In our study, we adopted the material probes method by concentrating on the second step of the original procedure by Jung and Stolterman (2010). Here, we introduced study participants the material samples as tangible, physical bits they could touch.

Study Set-up

The material probe method used in our first study consisted of seven material probes and the questionnaire which had three questions for each material sample (probe). We chose seven hard materials, and decided to name and label the material samples (probes) in the test situation alphabetically (a, b, c, d, e, f, and g) to minimize pre-existing opinions related to different materials. The material probes are presented in Figure 1 and consisted of the following materials: glass, metal, leather, plastic, concrete, cardboard, and wood.

Figure 1. Material probes in the Study I:
A. glass, B. metal, C. leather, D. plastic, E. concrete, F. cardboard, and G. wood

Each study session lasted for approximately 40 min, and included the following steps:

- Completing a background questionnaire.
- Interacting with each material probe in turn.
- Following a Product Reaction Cards (PRC) based methodology (Benedek & Miner, 2002), for each material, selecting three (3) terms from a list of 14 that best described what the material 1) felt like and 2) looked like.

» Rating the materials on a 5-point Likert scale against the categories: arctic, classic, expensive, and cheap.

A total of 22 participants (15 female, 7 male; aged 20–41, with the average of 27 years) took part in the study. Participants were predominantly university design students and staff.

Results

The tactile and visual sensations evoked by the material samples are presented in Figure 2, which summarizes the answers for the questions posed with the material probes: "How does the material feel?", and "What does the material look like?". Figure 2 presents the three most common PRC terms selected for each material.

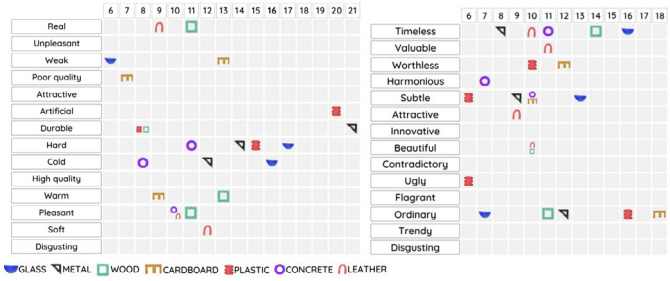

Figure 2. Three the most frequently chosen PRC terms for each material to describe 1) how the material felt like (left), and 2) how the material looked like (right).

The test participants' associations between the materials and categories arctic, classic, expensive, and cheap are present in Figure 3. Wood, glass, and leather were perceived to represent classic and arctic, while concrete, plastic, metal, and cardboard did not fit these categories so well. Wood, glass, and leather were perceived almost equally as classic and arctic materials. Leather was perceived as the most expensive material. Plastic and cardboard were perceived as the cheapest materials compared to the others used in the material probes.

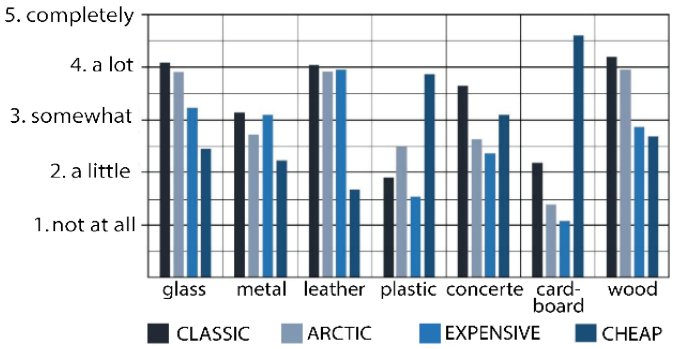

Figure 3. The average of the results of how participants combine materials with the categories arctic, classic, expensive, and cheap.

Study II – Interviews

Method

The second phase of the data collection consisted of interviews. The interviews were run as a separate study, with different participants as the first, material probes study. The interview method is suitable for situations where the answers are relatively unknown, and where the researchers are interested in bringing out comprehensively different viewpoints (Millar & Tracey, 2009, p. 80). Different kinds of probes can be used as an integral part of an interview in order to provoke memories and to stimulate the interviewee to speak more (De Leon & Cohen, 2005). De Leon and Cohen (2005) call non-verbal, tangible probes as object probes. Object probes are artifacts which are used explicitly to generate verbal responses, and they can be selected by the researcher or the study participant him/herself. Object probes can be for instance photographs, which can help participants to verbalize their memories and observations. For instance, Collier and Collier (1986) have pointed out how photography can support ethnographers in conducting interviews and thus in collecting richer data from field studies. Our interview study took inspiration from the material probes method by Jung and Stolterman (2010), who asked people to tell memories related to different materials. In our study procedure, we utilized objects and photos selected by the participants as part of the interview.

Study Set-up

The interviews were supplemented with product examples chosen by the participants, and the material experience was observed through the selected products. Prior to the interview, the participant had to choose one product from their home for each category: Classical, Cheep, Expensive, and Arctic. We also instructed that the examples should not be any clothing or anything eatable.

T study included the following steps: The pre-task, a background questionnaire, and nine ready-made questions, which the participants received before the interview situation. Each interview lasted 30–40 minutes and was conducted via video calls. Altogether eight participants (7 female, 1 male, 27–61 years, average 40 years) took part in the study. All persons interviewed had some kind of connection to the Finnish Lapland.

Figure 4. Pictures of the products which participants had chosen for the categories arctic, classic, expensive, and cheap.

Results

All the product examples are shown in the Figure 4. there found also the products main materials. In the "arctic" category, the products included many sports equipment that are used in the (sub)arctic region. The products chosen to fit the definition of "classic" consisted mainly of products related to home and living, excluding musical instruments. The products chosen to fit the definition "expensive" consisted mainly of electronics products. The product choices defined as "cheap" were justified by the affordability of the purchase price. Two products of this group were self-made.

Discussion

About the Findings

Material experience is a very wide and subjective matter, influenced by a large number of factors, such as the user's values, cultural background, previous experiences, age, gender and senses. Also, the user's financial situation affects how materials are experienced, especially when defining them as either expensive or cheap. Therefore, designers need to take the target group into account when choosing the product materials.

Based on the research regarding expensive materials, it can be concluded that people consider technical products expensive, because of their cost and for not being long-lasting in respect to their price. This is a well-known problem, and the principles of sustainable development are nowadays not implemented in all technical devices. It is especially interesting to discuss the "arctic" qualities of product design based on this study. The material and product choices of the arctic category showed a clear connection to natural materials. The functionality of the materials and the match with the use cases in the arctic region came to the fore. Of the categories used in the study, arctic was the only one that was a region-related category. It may be that the functionality of a material is easier to understand if it can be linked to a certain area or conditions. This would provide an interesting line for further research.

Plastic is a material that divides people's opinions, as noticed also in this study. Participants experienced plastics very negatively, both through physical experience and mental images. In interviews, however, a result contradicting this observation emerged, as many of the objects in the "expensive" category were, to our surprise, plastic.

The findings indicated that design has a rather large importance in how users experience the material and how they see and feel about it through the products. Plastics as a material is not perceived as expensive, rather the opposite, but it is used in many products that are expensive. The designer's choices affect how the user is experiencing different products and materials. The designer should take the target user group into account already when choosing the materials for the design, as the perceptions on different material qualities may differ between user groups. However, these factors are not fully controlled by the designer alone.

About the Theme Transformation for Nature Positive

The development of new materials has an important role in the future in replacing the existing harmful ones. Designers should be educated about new, more sustainable materials to be able to make better choices for product design, as they do have a role in transforming the physical artifacts to be more nature positive. Consideration of nature comes in quite seamlessly in arctic design, since the design is strongly influenced by the surrounding environment (Häkkilä & Johansson, 2018). Also the effects of climate change are specifically apparent in the arctic areas. For the nature positive transformations, it is promising to note that plastics, which have gained a lot of negative publicity for the waste problem it has created, also provoked negative results from the participants in this study.

Limitations and Future Work

We acknowledge that our study is limited by the sample the participants. The results might have differed somewhat if the same users would have selected to do both of the studies -material probes as well as interviews, or if the study had been conducted in different culture. However, as the research addressing the perception of design materials is at the core of product design, we believe our study provides some interesting insights to the topic. For future research, the observed contradictions e.g. with plastic as design material would be an interesting topic for future research.

Conclusions

In this paper, we have presented a two-phased qualitative research investigating the user experience with design materials. As salient findings, we report that wood, glass, and leather were perceived to represent classic and arctic, whereas plastic provoked negative reactions. With plastics, an interesting contradiction was found when people still often used plastic products to describe an expensive product category.

Based on the research results it can be concluded that some materials provoke a more nature positive user experience. Especially in the arctic category, natural materials such as leather and wood emerged. In the study, the product choices of the arctic category were combined with the conditions of the (sub)arctic region. In the selection of materials, wood, leather, and glass were chosen as arctic materials, which was also observed in the arctic product choices regarding leather and wood.

References

Benedek, J., & Miner, T. (2002). Product reaction cards. Microsoft.

Collier, J., & Collier, M. (1986). *Visual anthropology: Photography as a research method*. UNM Press.

De Leon, J. P., & Cohen, J. H. (2005). Object and walking probes in ethnographic interviewing. *Field Methods*, 17(2), 200-204.

Earth Overshoot Day. https://www.overshootday.org/about-earth-overshoot-day/ Last accessed Jan 3, 2023

Falin, P. (2011). *Praktinen diffuusio. Muotoilu asiantuntijuuden alueena ammatillisen identiteetin näkökulmasta*. Rovaniemi: Lapin yliopisto, Taiteiden tiedekunta.

Huotari, P., Koskinen, I., Laakko, J. & Laitakari-Svärd, I. (2003). Käyttäjäkeskeinen tuotesuunnittelu: Käyttäjätiedon keruu, mallittaminen ja arviointi. (9-25). Taideteollinen korkeakoulu.

Häkkilä, J. (2020). Vuorovaikutuksen ja käyttäjäkokemuksen muotoilua pohjoisissa olosuhteissa. In *Puheenvuoroja arktisesta taiteesta ja muotoilusta*. (s. 67-73) Jokela,T., Nikula, S. & Häkkilä, J. (eds). Lapin yliopisto.

Häkkilä, J. & Johansson, M. (2018). Arctic Design for a Sustainable, Technological Future. *Relate North. Art and Design for Education and Sustainability*. (32-51). Edited by Jokela, T., Glen, C.

Häkkilä, J., He, Y., & Colley, A. (2015). Experiencing the elements: User study with natural material probes. In *Proceedings of INTERACT 2015* (pp. 324–331). Cham: Springer. doi:10.1007/978-3-319-22701-6_24

Hassenzahl, M., & Tractinsky, N. (2006). User experience-a research agenda. *Behaviour & information technology*, 25(2), 91-97.

Johansson, M. & Konttinen, K. (2021). Finnish Design Academy - etäyhteistyö lasimuotoilun opetuksessa. In *Muotoilun avaimet älykkääseen teollisuuteen ja liiketoiminnan ketterään kehittämiseen*. (80-93) Edited by Satu Miettinen. Teknologiainfo Teknova Oy. Helsinki.

Jung, H., & Stolterman, E. (2010). Material probe: exploring materiality of digital artifacts. In Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction (pp. 153-156).

Karana, E. (2010). *Meanings of materials*. LAP LAMBERT Acadamic Publishing.

Law, E., Roto, V., Vermeeren, A., Kort, J., Hassenzahl M. (2008). Towards a Shared Definition of User Experience. In *Proc. CHI 2008*, Special Interest Groups (SIGs). ACM.

Ljungberg, L. Y. (2007). Materials selection and design for development of sustainable products. *Materials & Design*, 28(2), 466–479.

Maleque, A. M., & Salit, S. M. (2013). *Materials selection and design*. Springer.

Millar, R., & Tracey, A. (2009). The interview approach. *Auditing organizational communication: A handbook of research, theory and practice*, 78–102.