MATERIAL-INSPIRED DESIGN OPPORTUNITIES

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ABSTRACT
This study investigates ways to inspire designers' creativity and enhance the design process using product materials' tactility. Based on our previous study that implements a tactile experiment on tactile interactions with common and new product materials, we investigated the associated core emotions of the participants. We found the characteristics of the core emotions elicited by new materials are different from those elicited by existing materials. The new material produced more abstraction-based and original ideas and ways of thinking about material. In this paper we proposed an experiment that would investigate how to inspire original design ideas using materials, focused especially on materials' tactility. In this experiment, we will confirm the process of inspiration from product materials in detail.

Keywords: tactile information, tactile stimuli, materials inspiring thinking and creativity

INSPIRATION FROM TACTILE INTERACTIONS
In design, inspiration can be found in many different areas: visual, semantic, tactile, etc. Previous studies have focused on stimuli and support for designers, particularly in the visual domain (Westerman et al., 2007; Bouchard et al., 2009). However, touch is a core human interaction, and it allows users to obtain a direct and primary understanding of a product or material.

How tactile information affects the generation of design ideas is unclear, and whether tactile interaction can elicit more creative design ideas remains a current open question. Little is known about what designers use as sources of inspiration, and how they process information to generate ideas (Gonçalves et al., 2011). Understanding inspiration's role in creativity and thinking could help enhance creativity and improve the work of designers.

This study aims to investigate the possibility of designers' inspiration from tactile interactions with materials. The connection between inspiration from tactile interactions with new materials and original ideas and designers' creativity is in focus of the investigation. Such material-based inspiration could have practical applications in design education. There are specific design areas, such as clothing design, where the materials are regarded as a source of inspiration (Mete, 2006). Experienced designers use more often objects (i.e., tactility) as inspiration than novices (Gonçalves et al., 2011). However, tactile inspiration, which has been identified as important by previous studies (Westerman, et al., 2007), is difficult to achieve in the concept generation process.

To address this difficulty, this study proposes to inspire designers' creativity and enhance their thoughts about design using tactile interactions with new product materials. The analysis in the current study examines the results of a tactile experiment where participants' impressions from a set of existing product materials were compared with those from new material (Nagai and Georgiev, 2011).

BASIS OF THE CURRENT RESEARCH

STUDY OF PRODUCT MATERIALS
In a study of product materials, we investigated users' tactile interactions with common and new materials (Nagai and Georgiev, 2011). With regard to tactile interaction, we assumed basic habituation exists. Furthermore, we assumed that habituation to materials is connected with associations and imagination. Long-term use of certain materials may
affect the associations and impressions they produce. Thus, we investigated an impressionably new material from the viewpoint of emotions as well as several existing common materials. Ten participants took part in the conducted experiment. The test materials included metal, leather, wood, plastic, cloth, glass (base material), and a new micro-printed glass material. The new material was produced for comparison with existing materials in the experiment. This material was produced with patterned micro-print with acrylic resin on the surface of glass. It has the same visual characteristics as glass, but the tactile characteristics are different from those of glass (Nagai and Georgiev, 2011). Visual interaction with the samples was limited in order to focus on tactile interaction.

In the experiment, we obtained the free verbalizations of the participants when stimulated by each material’s tactility. In the further analysis of these free verbalizations, we focused on core emotions, because they relate to the intangible characteristics of materials.

**IN-DEPTH ANALYSIS**

Typically, the emotional design approach includes measuring semantics in the analysis of human impressions (Bouchard et al., 2009). However, this approach does not sufficiently explain the reasons for users’ or designers’ impressions. Consequently, we focused both on capture of the explicit impressions and on identification of underlying layer of emotions from tactile interactions with the materials. In our analysis of the experiment, we explored the associations behind each impression given by participants, and we defined them as core emotions. Associations are the stimulus words used to evoke the explicit impressions.

We employed a methodology based on a concept network to identify the core emotions that lie beneath the superficial impressions (Zhou et al., 2009). In practical terms, core emotions and impressions are associations that initiate a relatively high number of (associative) connections. This number of connections might be assigned as a weight. Highly weighted associations represent core emotions. These associations can be identified as association concepts via latent semantic analysis with an associative concept dictionary (e.g., the Associative Concept Dictionary, ACD; Ishizaki, 2007). Core emotions were identified by constructing concept networks and visualizing graphs of these concept networks.

After the core emotions were identified, we conducted a qualitative analysis. In order to analyze the captured core emotions qualitatively, we used a hierarchy-based classification of the identified core emotions. The network hierarchy of the WordNet concept dictionary was used for this purpose (Miller et al., 1990). The qualitative analysis is intended to help us understand the character of the core emotions and their possible role in evoking original and creative ideas. The core emotions were examined and classified according to shared general category. We found the following categories were particularly relevant and corresponded with the captured core emotions: (1) abstraction; (2) artificial object (or artifact connected with living space); (3) natural object (or physical entity).

The classifications and distribution of the core emotions in these categories are shown in Figure 1.

![Figure 1. Qualitative analysis of the core emotions](image)

**COMMON AND NEW MATERIALS**

The results clarify the role of core emotions from tactile interactions with the test materials. For example, the plastic, glass, and metal materials created core emotions that were strongly associated with artificial objects. Thus, we considered them as
A group of artificial materials. On the other hand, the leather, fabric, and wood samples evoked core emotions related to naturalness (natural materials). How did the new material (micro-printed glass material) compare to the common materials? The difference is evident from the much higher proportion of the abstraction-based core emotions (e.g. 41.4% vs. 16.7% of the base material—glass, Figure 1). Moreover, the abstraction-based core emotions of new material are greater proportion compared to the average natural and average artificial materials. The core emotions produced by interactions with the base and the new material are shown in Table 1.

**POTENTIAL FOR CREATIVITY**
In order to investigate the potential for creativity, we investigated how similar are the material and the core emotions as words. We performed two evaluations:

- Identified which of the core emotions are more dissimilar to material (the word ‘glass’). We used the shortest path between the two words in hierarchy of the WordNet (Miller et al., 1990) and indentified those core emotions more than 5 steps away from the word glass.
- Two experts evaluated which core emotions are original, i.e., not derived from something else. An evaluation of originality is commonly used as a part of creativity evaluations (Finke, 1996). The criterion for the latter classification was whether the core emotions were explicitly derived from (not explicitly associated with) the base and the new material respectively (Table 1). In the case of the new material, more core emotions were identified as dissimilar and evaluated as original.

**EXPERIMENT PROPOSAL BASED ON THE INSPIRATION POTENTIAL OF MATERIALS**
The experiment above investigated how tactile information affects the generation of design ideas. New materials were found to elicit more abstract-based and possibly more original core emotions. The following proposal describes a plan to investigate whether tactile interaction with the new material will elicit creative design concepts.

<table>
<thead>
<tr>
<th>Elicited impressions</th>
<th>Materials</th>
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<tbody>
<tr>
<td></td>
<td>Base material</td>
</tr>
<tr>
<td>Core emotions</td>
<td>Board, Cap,</td>
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<tr>
<td></td>
<td>Chopsticks, Cloth,</td>
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<tr>
<td></td>
<td>Dining table,</td>
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<tr>
<td></td>
<td>Fabric, Raw</td>
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<tr>
<td></td>
<td>cotton, Shell,</td>
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<tr>
<td></td>
<td>Stand, Table,</td>
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<tr>
<td></td>
<td>Work, Worry</td>
</tr>
<tr>
<td>Core emotions</td>
<td>Cap, Dining table,</td>
</tr>
<tr>
<td>identified as more dissimilar using concept dictionary</td>
<td>Fabric, Table</td>
</tr>
<tr>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>Core emotions</td>
<td>Chopsticks, Cloth,</td>
</tr>
<tr>
<td>evaluated as original by experts</td>
<td>Fabric, Raw</td>
</tr>
<tr>
<td></td>
<td>cotton, Work, Worry</td>
</tr>
<tr>
<td></td>
<td>54%</td>
</tr>
</tbody>
</table>

Table 1. The core emotions elicited by the base material and the new material.

**RESEARCH QUESTIONS**
The following research questions are related to the use of materials to inspire designers:

- Can materials that are new to designers inspire original ideas and contribute to creativity in conceptual design?
- Can the design process be enhanced by tactile stimuli, i.e., material interaction, and does this affect the way designers approach design problems?

**EXPERIMENT PLAN**
The experiment plan is outlined as follows:

- Identify new materials with the potential to inspire designers.
- Compare the tactile inspiration from the new materials with that of the common materials.
- Compare the creativity of the results (originality and practicality).

According to the stated research questions, we plan to compare the creativity and approach of designers. The objective of this future study is to analyze the differences in thinking styles and creativity of designers using new materials as stimuli. To achieve this objective, we will conduct an experiment with participation from design students. Based on the design-protocol analysis method, we will compare the creative outcomes of design ideas and thinking styles in a design session. In this
session, the participants will be asked to design a children’s toy that facilitates communication with family members. This task was chosen with the hope that it will prompt original and creative ideas. The participants will be required to explain their design proposals.

The analysis will comprise the following:

- A behavioral analysis of the participants that focuses on understanding their style of thinking and how they approach the assigned design problem. This analysis of the design-protocol sessions should reveal if important differences exist in the behavior; approach and style of thinking; and creativity of designers.
- An analysis of the creativity of the design outcome at the end of the design session—an expert evaluation of the originality and practicality of final design ideas (a common approach to evaluate creativity; Finke, 1996).

Moreover, to clarify the relationship between the new material stimuli and the participants, we will ask the designers for their impressions and their degree of engagement with the task. Their answers will be investigated to see whether they contribute to the creativity of the final design proposal.

CONCLUSION AND FURTHER RESEARCH

According to the results of the previously mentioned tactile experiment and in-depth analysis of tactile interactions, we found that the characteristics of the core emotions elicited from new materials are different from those of common materials. We found that new materials can elicit (1) more abstract-based; and (2) more original core emotions. The new material is more likely to elicit abstractions than the common product materials. It created different impressions than base glass material, which was made of the same base material as the new material. This difference can be translated into the increased number of original core emotions elicited by the new material.

Users described the attributes of the newly introduced material differently, and it can have additional function and implications (e.g., core emotion related to “doll” imply entertainment). These impressions could possibly create new emotions that are very different from existing ones. They could produce original ideas and ways of thinking about design. In other words, the new material could affect creative design.

Consequently, this study proposed a plan of experiment that would investigate how to inspire original design ideas (i.e., creativity) using tactile interaction with new product materials. The findings of this future study will be relevant to understanding the way tactile differences inspire conceptual design with regard to designers’ creativity. These findings could lead to improvements in creativity in the concept generation stage of the design process and serve as inspiration in real world design.

However, these conclusions are drawn based on a rather limited experimental basis of one new tested material. Further experimental verification is needed. The following open questions should be addressed in further studies of tactile-inspired creative design: Is it possible to systematically aid design using tactile inspiration; and What are the exact characteristics of “newness” in tactile material stimuli that inspire original ideas?

REFERENCES


