Material Design Workshop

Playing, exploring and designing materials in products

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Abstract: In the early stage of product design, designers make fluid and extensive use of external representations to support their creative process. Sketching and modeling are used to quickly explore a product's shape and configuration. Material aspects of a product are, in comparison, explored completely different, and are selected rather than created. Colors, textures and graphics, are selected by examples found in existing products, samples, or while browsing magazines or the web. We have developed a creative design technique in which we have designers do exactly the opposite. In a two-hour session designers "create" materials in a quick and playful way, while they "select" the spatial arrangement of the product out of a discrete set of shapes. We report of two workshops in industry where we applied this technique. In each workshop we used the materials designers already had, e.g. their moodboards, models, example products, and collections of visual materials. Based on the considerations that went into designing these workshops, the observations during the workshops and the results of the workshops, we derive a few considerations for tools and techniques that aim to support designing materiality in the early stage of product design.

Key words: Creative group workshop, Material, Product Design, Design Tool

1. Introduction

Figure 1. A visual impression of the workshops.

Designers use and produce a large variety of physical and digital media to represent designs during the design process. The materials designers use range from inspirational collections of visual materials, quick sketches, to full-fletched working prototypes to study user behavior. Some of these representations are detailed and precise, whilst others are rough and rudimentary. Some representations are detailed on aspects, others, provide overview. Schön [1] describes the interaction with external representations as a conversation between the designer (architect) and the sketch, in which thoughts are externalized into sketches, and the sketches are reinterpreted into new thoughts. Sketches, i.e., rapid, incomplete, and ambiguous externalizations are recognized as key tools to support design thinking by individuals [2], and groups [3]. Cardboard and foam models can be regarded as 3D

sketches [4,5,6], which appeal to the human perceptual and motor skills [7], and support intuitive understanding of complex geometrical and physical relationships [8].

Although the aforementioned techniques support representing shape and dynamic behavior, they provide less help with explorations of surface qualities such as materials or graphics. In current practice early in the process, there is a focus on shape and function; materials are explored separately from shape with the help of moodboards and material samples. In the detailing stages shape and material come together with refined models, visualization and computer aided design tools. In this paper we describe a creative design workshop to explore material rather than form or interaction. The workshop we propose aims to bring together material samples, models and visualizations to allow playing with both material and shape expression. By means of two workshops we facilitated in practice we show that the workshops will generate new ideas that, at least to some extent, can be attributed to this integration of materials and shape early on in the process.

2. Related work

In our work, we build upon the tradition of creative workshops that start by doing, rather than thinking [9]; participants build things and act out scenarios. In the "interaction relabeling technique" [6] the mechanical interaction of readymade objects are mapped to possible interactions of an electronic device to be designed. Using a readymade object widens the designer's view on possible interactions as a creative confrontation technique. Sanders & William [10] describe another technique that makes use of physical objects. Their Velcro modeling kit consists of user interface elements partly covered with Velcro that can be easily assembled into products. In their workshops the toolkit facilitates communication between designers and users, the basic idea is that people are better able to express their wishes and dreams when they are building things.

We also build upon the attempts to enrich the design process with new media tools. The Tangible Project Archive [11] is a mixed reality environment for presenting and collecting materials. The archive consists of a physical collection of objects that contain a barcode associating the object with digital materials such as videoclips or usage information. By placing objects in a so-called organizing zone, the associated digital material is shown on a large display. Ehn & Linde use digital media to enhance the physical collections of materials designers already have, and these samples could be used to select materials for an augmented model of the designed product. Augmenting materials, sample collections with digital could provide inspirational similar as in material books for inspiration.

The Mixed Object Table [12] is a prototype that incorporates rich media in the design studio of architecture students. The Mixed Object Table is an augmented tabletop to be used with physical models of the building to be designed, augmented with projectors in various configurations. One projector illuminates the table's surfaces and is used to display floor plans or scenery surrounding the physical objects. With the Texture Brush [13] the physical objects on the table can be colored with textures. Another projector projects photos of the building's intended surroundings on a large wall display. Binder & Matcovic's approach shows the advantages of experiencing designs in their context. However the Mixed Object Table interface is based on typical Computer Aided Design techniques used in the detailing stages of design and together with the complexity of a multi projector camera setup: it limits the freedom of exploration as found in the previous mentioned projects.

3. The tool

Previously we developed a tool called Skin [14] that aims to support designers in exploring materials, shown in Figure 2. Skin projects colors, patterns and graphics on physical objects, in order to provide a rapid preview of a material in the context of the products shape. Skin makes use of projected augmented reality similar to Raskar [15] and Binder [12], but whereas the prior art focuses on the fidelity of the presentation, Skin focuses on the early creative stage of designing products: offering fast, non-committal and generative ways of representing similar to sketching. Skin contains the bare minimum of control that on the one hand makes it fast and open and allows participants to adapt it to their way of working, but on the other hand makes it miss functionality for detailing designs. Limitations of our approach is that materials can be explored only in the visual domain with a focus on patterns and graphics and through the simple projection setup projected patterns suffer from deformation (although so far this has not been a limiting factor for our participants) and it is hard to go back to earlier conceived concepts.

Figure 2. The Skin tool consists of a projector mounted on the side of a table, a small mirror bends the light over the table so that object on the table are illuminated. A camera on a swiveling arm captures physical materials for projection. Physical and digital materials are mixed and scaled using paddle controllers (on the right).

The Skin tool consists of three tabletop areas**, the object table** for illuminating models, **the material palette** for mixing materials, and the **collection space** to store materials. The object table and material palette are grouped together to allow shifting activities between the two, whereas the collection space was placed in the vicinity. Skin makes use of existing materials designers have readily available, their models, samples and collections of visual materials both digital and physical. By means of a camera physical materials can be captured, composed and scaled. Digital materials can be loaded through an USB key and with a paddle controller, scaled and browsed through. The resulting mix is real time projected on the model(s). Figure 3 shows a few examples of objects illuminated with materials on skin during the workshops.

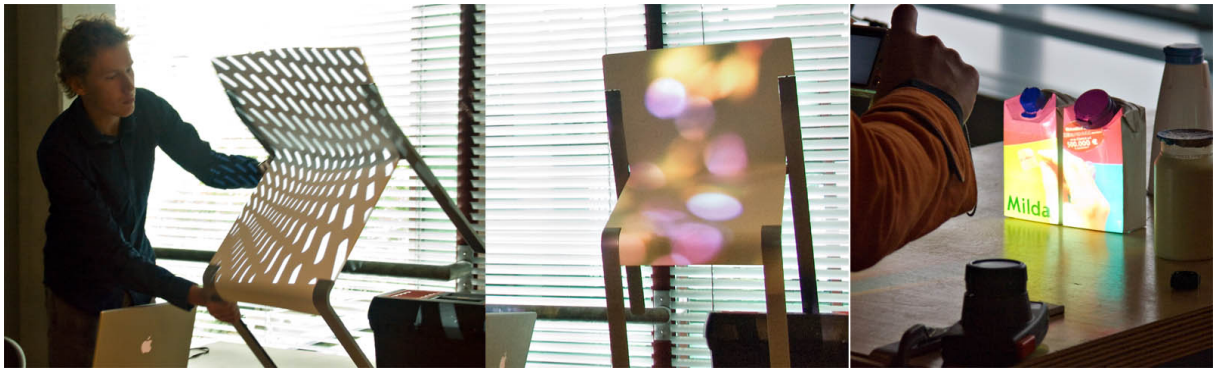

Figure 3. Examples of concepts made during the workshop. The white models are colored with projected light, created by digital materials (left and centre) and physical materials (right)

Skin is fairly easy to build with standard components, and the software is freely available on our website. Skin has been applied in a variety of design studios with both individual designers, design teams and artists, and was found [16] to bridge the gap between collages and samples on the one hand and computer aided design on the other hand.

4. The workshop

A typical Skin session, shown in Figure 4, consists of collecting material followed by a generative step of mixing materials and models. Concepts generated in the generative step are captured with a digital camera.

When developing Skin [14] we observed two styles of manipulation that we dubbed browsing and detailing. Browsing is skimming through a collection of inspirational artwork, similar to browsing through a magazine or surfing the internet for inspiration. The basic idea is to confront the model with a pattern/graphic and to experience the effect. Detailing artwork consist of manipulating artwork or material into detail, e.g. scaling, changing colors, mixing materials, in order to find a good match between material and shape.

During the generative step participants take many pictures, and we found need to cluster these in a separate step. Therefore, following the generative step the pictures are collected and the ideas are organized on a large wall display, similar to spreading out physical sketches and grouping them into concepts.

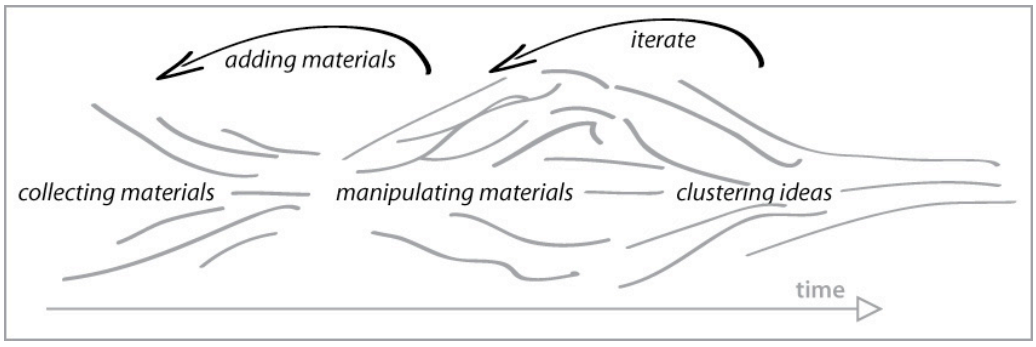

Figure 4. Prior to the workshop materials are collected, digital images, samples, models, magazines. During the workshop the models are colored with materials on the skin setup, concepts are captured with digital cameras. After the generative (diverging) skin step the photos of the concepts are organized on a large digital drawing board.

4. Method

For this study we selected two companies in the field of designing consumer goods, a design firm and a large multinational with an in-house design team. The companies were sourced in the network of the ID-Studiolab in Delft. The criteria for selecting a company were: working in teams, having a design project available in the stage of the first physical manifestations with models, having prototypes available.

Table 1. The workshop setup.

10 minutes	Introduction team members
20 minutes	Warm-up exercise with the Skin technique

Up to 60 minutes	Generative step (diverging)
10 minute	Break (to collect pictures and preparing the clustering step)
About 30 minutes	Clustering step (converging)
30 minutes	Reflection on Skin

Two weeks before the workshop we sent the participants an email linking to an online video [16] of Skin, to give them a rough idea of the workshop contents. A week prior to the session we visited the company to prepare the visual materials for the design session. If necessary, models were painted white to make them suitable for projection. We specifically asked to collect physical and digital materials. Brand graphics were printed and cut out. Digital images and patterns were added to Skin's digital collection.

We started each workshop with a short introduction round and a warm-up exercise to familiarize the participants with Skin. The manipulations in the video were demonstrated live: browsing and scaling of digital materials, moving physical objects to align them with the projected graphics, browsing physical artwork and mixing physical and digital artwork. After that we engaged the participants in a small warm-up exercise of designing a family of earthenware to be designed for a fictional fruit-yogurt brand.

The actual skin generative step was planned for 60 minutes, with the goal to create many new ideas for the project at hand. Following a short break, to give the facilitators time to collect the pictures taken. The clustering session following the Skin session was planned for about 30 minutes.

The workshop was concluded with a reflection on the Skin technique. We reflected on how the technique fit in their design process (what did they like/dislike, would they use it, how did it differ from their regular practice) and on the user interaction (what worked well, would they change). This was an open discussion, chaired by the facilitator.

Each Skin workshop was held on location, in the company. All sessions were videotaped using a single camera located in a corner to unobtrusively capture both the model and material interaction spaces; being non obtrusive. The facilitator was assisted by a technical facilitator and a photographer to capture the context of the workshop.

We analyzed the video of all the steps including the reflection step. The videos were transcribed and the material manipulations in Skin session were fully annotated: For the material palette we indicated the following transactions: material added, removed, manipulated and scaled, both digital as physical; For the object table: object added, object removed, and manipulated.

5. Design agency workshop (design team)

The first workshop took place at FLEX/theINNOVATIONLAB (Flex), a large delft based design agency. Flex was founded in 1989 and has about 30 designers. Flex designs a large variety of professional and consumer products. When we contacted Flex they immediately wanted to apply the workshop to a chair they were designing at that moment. They had just prototyped a model, and were about to design the material.

Four designers participated in the workshop, of which one had previously collected a number of samples of organic materials he wanted to apply, and one had, on our request, browsed the internet for digital images.

The digital collection of 99 images contained a wide variety of imagery including wall paper patterns, abstract figures, to photos of food and flowers and figurative paintings.

Since one of the designers had selected the pictures, clicking through the images and experiencing their effect on the chair often gave positive surprises. The surprise effect was mentioned in the review, they liked the speed of

which the chair was textured and the fact that it was like zapping through television channels: *"bang, and you have a completely different chair!"*

Several discussions about the quality of the materials took place. Scaling the images to the extremes evoked discussions about print versus pattern and texture, wherein the designers disagreed, their discussion continued during the clustering session.

Other discussions went beyond the visual domain and included the manufacturing process, how to weave or silkprint certain patterns, about metal meshes and embossed fabrics. A striped pattern created by tiling a small fabric, evoked discussions how the pattern/graphic could enhance the shape of the chair: *"the plain leaf pattern emphasizes the legs nicely compared to this noisy pattern"*

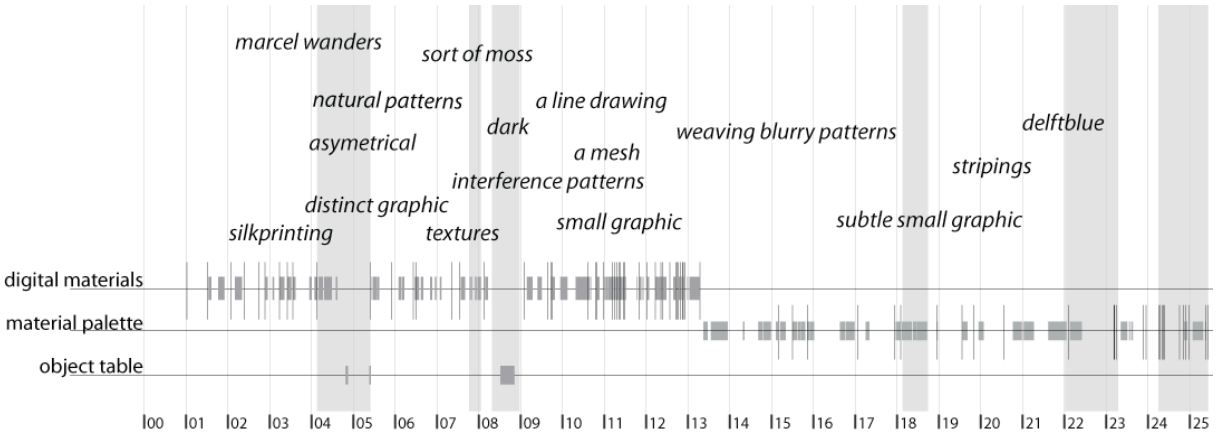

Figure 5. A graphical overview of the session activities. In the first 13 minutes the designers browsed and scaled digital patterns. The last 12 minutes they used the camera to explore physical materials. On the top the discussion summed in keywords, then the activity of digital materials, a vertical line depicts a "next image" an area depicts "scaling". The **material palette** line an area depicts moving/scaling materials and a vertical line adding removing materials. The **object table** line is relatively clear of activity, on a few occasions designers grabbed the chair and moved it around. The light gray areas depict the detailed manipulation.

As shown in Figure 5, in the first 13 minutes they explored with digital patterns. The mean time to experience, scale and photograph a pattern is 20 to 30 seconds. A pattern is rejected within 3 seconds. 47 images were visualized, of which 15 were immediately rejected, which results in a mean material evaluation time of 24 seconds. Obviously with only browsing and scaling there is not so much room for detailing. Detailing occurred on two occasions where the designers moved and rotated the chair in order to line up the material. On one other occasion they found a pattern that they carefully, subtly scaled and discussed the implications of the graphic in relation to the proportions of the chair.

The Skin session took about 25 minutes in which the designers took about 42 pictures, of which in the clustering session they selected 17 ideas, clustered in 7 groups.

6. Workshop in a multinational corporation (multidisciplinary team)

Unilever is a multi-national corporation that owns many of the world's consumer product brands in foods, beverages, cleaning agents and personal care products. The European packaging design team is located in Vlaardingen the Netherlands and provides design services to various brands.

A typical project starts with a creative group session with a multidisciplinary team with participants from brand management, marketing, engineering and user research. Based on the results the design team then builds a small number of prototypes that are communicated back to the brand manager. They always produce physical models, because it is their experience that in communicating their design proposals to marketing, the graphics and packaging have to be made explicit. Once a project receives a "go ahead", a technical design process is started and at a latter stage the graphics are outsourced to an external design firm in a separate process. The goal of this workshop for Unilever was to generate new ideas for a dairy product for a specific market. Today, all dairy products have similar form-factors and graphics, which makes the Unilever brand less recognizable. Therefore the starting point was to look for new packages, while keeping the materials and graphics (which were strictly defined) in the current style.

The workshop took place in a large conference room and had six participants, three Vlaardingen based designers, one Vlaardingen based technical packaging expert (informed outsider), a packaging expert from the product division and the brand manager. Prior to the workshop we collected the existing brand artwork, and disassembled it into the graphical elements, which we printed on various sizes. Some of the artwork, such as texts was printed on transparent sheets. The participants were asked to bring inspiring packages to the workshop.

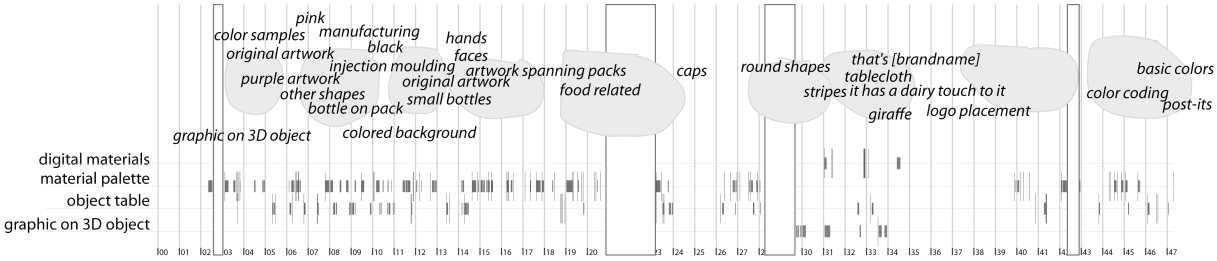

Figure 6. A graphical overview of the session activities. Compared to the design team session, (figure 5), this session was almost twice as long. The team came up with an unforeseen use of cut out brand graphics; they glued them on the physical models (graphics on 3D object). There were a couple of breaks with technical issues depicted in white boxes. The light gray areas depict concepts.

The participants started by exploring the existing artwork on various packages. Soon it became clear that the graphics were not so strictly defined as was assumed by the designers. An unexpected and surprising result of the workshop was that after the workshop the participants felt that they could achieve their goals by changing the graphics and keeping the existing package. Without a workshop like this they would not have thought of changing the graphics, as they would have outsourced the graphics immediately.

Compared to the design team workshop (Figure 5), this workshop (Figure 6) was almost twice as long. Except for a few minutes (30-33) the session was dominated by manipulating physical materials. The team came up with a for us unforeseen use of cut out brand graphics: they glued graphics on the models while still projecting over them. The session also contained a large amount of shape manipulation: testing various packages and groups of packages. The discussion between the participants was far more extensive than in the skin session and spanned

many subjects, and they took more time to generate and detail their concepts. A few concepts happened by accident: when manipulating the physical artwork the hand and finger of one participant was visualized on the pack, and made them try and play with faces and hands and cutlery as graphics.
We identified seven distinct concepts during the Skin session, and in the review they selected 29 photos in 5 clusters.

7 Discussion

In both workshops the initial ideas about the materials of the product at hand drastically changed during the workshop and provided a novel look into the materials the designers already had. The workshop provided an explorative phase in between the conceptual and the detailing phase.

Even though we started out with the same workshop plan for both workshops, the context of the workshops were very different. The flex team consisted of designers that had worked together for a long time, whereas in the unilever team not all participants were designers and they were from various departments, which meant that there was more focus on getting a shared understanding. This resulted in a slower process. The Flex chair assignment was more straight forward, a material for the seating area on an existing chair design, whereas the unilever assignment was earlier in the process with much more design decisions to make, including shape, materials and graphics, as well as functional solutions. In addition, the full-sized chair in the Flex workshop was less likely to be manipulated than the small bottles and containers of the Unilever workshop.

Within these two workshops with very different qualities, each team adapted the Skin technique to their own practice, however when we zoom in on the detailed analyses of their behaviour similar patterns of browsing and detailing can be found.

For certain products Flex would like to have their clients participate in a Skin session, in order to jointly explore the product brief. The Unilever team figured that they would use Skin sessions to better brief designers from external graphics design firms. The participants of both workshops expressed that they would not easily share the results with their clients resp. marketing because of the picture quality, and mainly the noisiness of the background. A neutral background, or a for the product relevant background would be preferred.
Nevertheless following the workshop the marketing people of Unilever had requested the result photos made during the workshop to communicate the concepts, not as an “as is” but as a possible way for packages. In this instance, the designers told us that the “sketchy” nature of the photos made it clear that it was not a finished concept.

When comparing this technique to computer aided design and drawing tools, all designing participants expressed that working was faster and more intuitive. “*Sure, we can do the same by applying decals Solidworks [a solid modeler] or by making masks in Photoshop but then you automatically take much more aspects into account. here you are experiencing and playing.”* [a designer at Flex]. *“In CAD tools you have to consciously add an image, apply it, and those steps require you to think of the applicability of the picture before you see it. Here I was often surprised by the effect of a particular on the chair”* [Flex designer] and *“Usually I would have done a*

similar process.. but than in Photoshop.. printing it and gluing it on the pack… But that would cost us some days after a workshop... this is maybe less refined but you have far more options that you can easily reject" [Unilever designer]. Similar to brainstorms, many concepts that were created were easily rejected in the review session.

Both teams felt the clustering step was essential and talked about multiple iterations or merging both techniques. *"We definitely want to iterate and go back to Skin"* [the Unilever engineer in the review] *"Actually I want to try stuff right now."* The analyses of the current workshops shows spans of about 15 minutes what might suggest multiple iterations of generating and clustering steps of 15 minutes.

All participants expressed additional tools to be added to Skin. Both teams expressed the need for a clear button to make a picture, because in the current workshop, they feel a break in their creative flow when they have to take a picture to capture a result. In the packaging design the designers of Flex suggested to add layers, controls to manipulate colors, whereas the marketing and engineers at Unilever were looking for tools to see their design in shelve environments by copying multiple packs and performing the workshop in a store environment.

8 Considerations

Based on the results of the workshops, our observations and the feedback from the designers in the review session we formulated five considerations:

1) Minimize the time to experience and iterate.

In both workshops participants expressed that they would prefer multiple short rounds of ideation and reviewing. Minimizing the efforts neccesary to experience a concept allows for an energizing creative process of generating ideasand interpreting the consequences.

2) Maximize the opportunity to make chance connections

Many of the results participants made in the workshop originates from artwork or combination of artwork used in a totally different way than intended when they selected the artwork.

3) Group accessible; make sure that everybody can express themselves.

In our Unilever session we worked with a large group. This meant that a few people where directly working on the tool, and other people had a more observing role. This is not necessarily bad as long as different people take during the course of the session. However, it may lead to the outside group loosing interest and attention.

4) Encourage play

One observation all the facilitators had was the playfulness and enjoyment the participants experienced in the workshop, compared to the workshops they experienced before that were more verbal orientated.

5) Make it impossible to detail and beautify designs. Yet, make the results look attractive

Detailed tools as found in e.g. Photoshop lead to early crystallization of concepts, thus preventing the discovery of new directions. This is no problem in Skin, as it is impossible to detail designs using Skin. However, the Skin projections are attractive, it is a pleasure to look at them, and they grab attention.

In conclusion, the process of creating materials and selecting shapes allowed for a more inclusive conversation between the members involved, Leading to better understanding of the design problem and desired directions for solutions.

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