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Material light: exploring expressive materials

Abstract The control of material appearance has become richer than before, giving designers new expressive freedom. Designers need tools and techniques to handle this freedom when designing products. We present a simple but powerful technique to explore material expression in the conceptual phase of the design process. Colours and patterns are projected on foam and paper models to enable designers to quickly visualise and judge materials in context of the products shape.

Keywords Foam modelling · 3D graphics · Material studies · Conceptual design · Tangible interaction · Augmented prototyping

1 Introduction

In contemporary design a trend can be seen towards differentiating products through the use of expressive materials. Apple differentiates its consumer products from its professional products by using white and aluminium, respectively. Cell phones are a playground for using expressive materials such as dual tone and glow in the dark effects. Cell phones also seem to head towards mass customisation through the use of special materials in the snap on covers. Material appearance can be varied relatively easily compared to shape and nearly independently of mechanical properties.

At the same time designers need tools to handle this new-found freedom. The current tools do not suffice [1]. Visualising materials is time consuming, in both drawings as on physical and virtual models. Computer visualisations of materials can be rich and quick, but selecting and creating materials in computer-aided design tools is complex. The interfaces have oftentimes a high cognitive load, almost like programming, and do not match with the perceptual and associative way of thinking.

When searching for materials, designers use samples from manufacturers to select and specify material expression. Samples are made of the actual material and are convenient to experience, specify and communicate expression. In interviews we have seen that designers keep collections of samples to browse and get inspired [2]. As shown in Fig. 1, most samples contain shape details to help judging on expression; however, predicting how the material of a sample will look on the shape of the product is imagining.

In general materials do not allow playing with or prototyping, in the way designers can when exploring shape. Materials in product design are therefore oftentimes an afterthought and chosen in the final stages of the design process. For these reasons we aim to develop new tools that support playing with materials in the context of the products' shape. We think designers benefit from using new media in the tools. The tools are aimed at the early design stage when the first shapes are being explored. The tools should fit in techniques that support not only the visualisation of material on shapes but also the process of searching, creating and selecting materials.

The material light set-up presented in this paper augments physical models by projecting rich computer-generated visualisations. At the same time it tries to avoid the complexity of the computer graphics interfaces, by making use of the designer's collection of samples.

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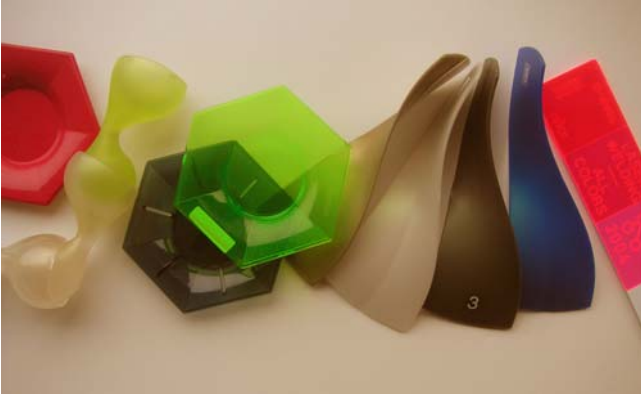E-mail: d.p.saakes@io.tudelft.nl
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2 Design

Our objective of the material light set-up is to support the form creation phase, when materials are put into the design loop. Designing consists of iterative loops of

Fig. 1 Designers keep collections of material samples to browse for inspiration

creating and interpreting (Fig. 2). The aim is to maintain thinking in this loop and try to avoid lags, such as rendering materials or waiting for paints to dry.

2.1 Scenario: the technique

A group of designers take their foam models and samples to the material light set-up. On the table (see Fig. 3) they select materials from the sample collection and put that on the reader. The projector illuminates the foam models on the table with the patterns and colours of the samples. By manipulating the foam model on the table, designers experience the effect of the material "flowing" on the object. They change models and samples and explore various combinations. Some samples contain user interface elements and product labels that appear on top of patterns.

The result, illuminated models, is photographed to document shape and colour combinations.

2.2 Implementation: the system

The material light system has two components: visualising materials on foam models and selecting materials to visualise. The system is built on the TRI set-up [3] as
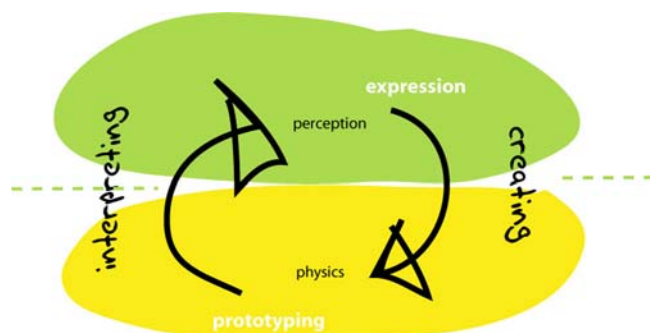
shown in Fig. 3. TRI has a table with an overhead projector that projects the computer-generated images. The table itself is transparent, so only the objects on the table are illuminated, not the table itself. White and matte objects such as foam and paper models are suitable for illuminating with light (Fig. 4).

Materials are selected by putting a sample on one of the two readers. Each sample has an rfid tag glued on the back and the system recognizes the material by the id of the tag. The material of a sample, the colour and pattern, is scanned in advance and prepared for projection. Once a sample is placed on a reader the corresponding image is projected.

2.3 Related work

Projecting images and video onto physical objects is attractive and has been used by artists for a long time; Peter Greenaway uses projections as an integral part of his visual style and storytelling, as in the movie "Prospero's books".

Various systems exist that project computer-generated images on 3D physical objects. Most systems require a pre-scanned 3D object to match the virtual with the physical model in order to accurately project materials, except for the illuminated clay project by Piper et al. [4]. He solves the need for a pre-scanned model by using a laser scanner that interactively scans the clay. Landscape designers can deform the clay, and the virtual projection conforms to these changes.

Using physical objects for displaying computer graphics has been explored extensively in the shader lamps project [5]. Raskar uses multiple projectors to project 3D computer-generated images on physical objects, with the aim to extend the fidelity of the visualisation. By 3D tracking, the position and orientation of the augmented physical objects can be moved freely. By

Fig. 2 The iterative design loop
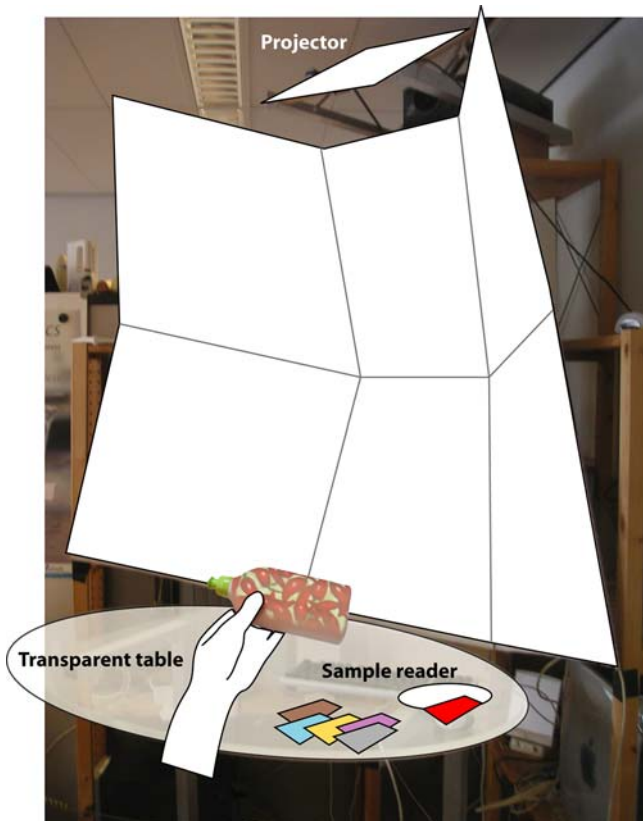

Fig. 3 Designers using material light

Fig. 4 Material light on the TRI set-up

also tracking the viewer, viewer-dependent properties of materials such as reflectivity can be visualised as well.

The use of illuminating mock-ups in a design context has been shown by various authors. Verlinden [6] augments a rapid prototyped scaled-down model of a car with materials and shape details such as lamps and hub caps in order to evaluate the model. With the texture brush of the Atelier Project [7], architects can paint texture and colour on a scaled model of a design as part of the material study.

2.4 Visualising materials

The material light tool projects materials as flat 2D images on the table without any tracking or knowledge of the 3D object; this is in contrast with the systems discussed above. This gives freedom to the exploration: models can be switched, combined and changed freely. The shape of the object is part of the search in the early design phase. When the object is examined on the table, rotated and moved, the patterns of the projected materials deform. The deformed patterns give a "shrink wrap packaging" look and feel, which adds to the fun of trying out materials. The roughness and ambiguity are virtues in the conceptual phase.

Furthermore by not using 3D graphics we avoid the extensive technology to calibrate the physical with the

virtual in both space and time. Without knowing the location and geometry of the model we can add enough richness and added value (Fig. 5).

2.5 Searching and selecting materials

Browsing through a collection of samples is a nice and rich way of selecting and reviewing materials compared to the slider and library-based interfaces of most CAD programs. Using the samples is a direct, tangible manipulation similar to using physical icons such as graspable bricks [8]. But the main advantage is that the actual sample directly conveys more material properties such as roughness and thermal conductivity than the visualisation alone.

In addition to the tags that "flood-fill" the objects we also added tags with brand labels and user interface elements, such as keypads and displays. These elements are layered on top of the projection.

2.6 Scanning new materials

A tempting idea that came up while testing the system was scanning in new materials during the search. Participants wanted to scan the fabrics of their clothes and images from magazines.

Given the added value of layering labels and user interface elements, we chose to project images instead of scanning pattern patches to flood-fill the projection.

A digital camera was added to the system to capture high-resolution images of the contents on the table. Projecting multiple materials and experiencing combinations of materials do enhance the tool just like the layering.

Fig. 5 Illuminating foam using the deformation of patterns as a virtue

3 Conclusions and future work

Various systems exist that use augmented prototypes to judge and evaluate product concepts. Our system has a focus on browsing and playing with projections rather than striving for an accurate 3D visualisation.

The sample-based input allows designers to quickly browse through materials and experience the effect on foam models. The camera allows combining and mixing existing materials on the fly.

Groups of people can interact with the system; anyone can take over control. Interacting through physical objects on the table allows the users to use their perceptual motor skills.

In a small test we asked teams of undergraduate students to use material light during a regular design course. They were enthusiastic and preferred it over their current techniques. This reaction is encouraging. We now plan more tests in a professional context, where we extend the scanning facilities to further bridge the physical/virtual divide and embed the tool in the form creation process.

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