Materials and Design 31 (2010) 2932–2941

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

A tool for meaning driven materials selection

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ARTICLE INFO

Article history:
Received 4 November 2009
Accepted 14 December 2009
Available online 21 December 2009

Keywords:
H. Selection of materials
E. Properties of materials
Meaning
Expressive characteristics
Emotional design

ABSTRACT

There are several tools used in materials selection processes by designers. However, they are mostly engineering based tools, which are dominated by numerical (or technical) material data that is mostly of use in embodiment or detailed design phases of new product development. On the other hand, product designers consider certain aspects such as product personality, user-interaction, meanings, emotions in their material decisions. In this regard, existing tools and methods do not fully support designers in their materials selection processes. This paper describes the development of a new materials selection tool holding the idea of [meaning driven materials selection]. In addition, the paper consists of a study conducted to create data for a dummy application.

1. Introduction

In most of the materials selection sources, an analytical approach is followed [1–3]. In an analytical approach, a set of objectives and constraints are defined. Afterwards, the properties of a number of existing materials are analyzed based on the defined objectives and constraints. The candidate materials are then selected. Ashby and Cebon [4] sum up the materials selection activity in four main steps: (1) translate the design requirements as constraints and objectives, (2) screen the material world to identify materials that cannot do the job, (3) rank the materials that can do the job best, and (4) explore the top rated materials. In that sense, materials selection is carried out (consciously or not) as a design activity, involving the phases *concept creation* (by formulating material objectives and constraints, and arriving at candidate materials), *testing* and *comparing* candidate materials, and making a *detailed selection* with technical specifications.

The four steps described by Ashby and Cebon [4] summarize the traditional materials selection approach promoted in engineering design. Constraints and objectives are mainly determined by technical requirements and materials are selected accordingly. In product design, however, materials should not only fulfill technical requirements but also appeal to the user's senses and contribute to the intended meaning of a product. These concerns are introduced to the domain of design with alternative approaches such as *design for experience* [5], *pleasure in design* [6], *design for emotions* [7] and *multi sensory design* [8]. Product designers are responsible for taking these concerns into account in order to use materials efficiently to transfer certain meanings. In other words, materials are selected for creating certain experiences with their physical entity as well as intangible characteristics. Following this notion, ***materials selection in product design*** in this paper is defined as the selection of appropriate material(s) for designed products by considering related design criteria such as manufacturing processes, availability, cost, function, shape, use, as well as meanings, associations, emotions, characteristics of users, cultural aspects.

Designers who intend to create certain meanings through the materials of their products are confronted with the difficulty that there is not a one-to-one relationship between material properties and intended meanings [9]. Combinations of different properties evoke particular meanings for specific users within specific contexts. This statement is introduced with the Meanings of Materials (MoM) model (Fig. 1) in Karana's PhD thesis [10]. The model presents the *meaning of a material* as a relational concept in which *material*, *product* and *user* are jointly effective. Furthermore, a set of related aspects are identified and tested in a series of studies, such as sensorial properties, manufacturing processes, shape, function, gender, age, expertise and culture [10]. Following the MoM model, this paper describes the development of a tool, namely [Meanings of Materials] tool, which aims to assist designers in manipulating meaning creation in materials selection.

The following section reports on the two main steps that were followed in developing the Meanings of Materials tool: (1) the structure of the tool (order of actions) and (2) the content of the tool (generating data and presenting the outcome. At the end of this section, the proposed tool is summarized. In the third section, a study is conducted in order to generate data for a dummy application. The paper ends with a comprehensive discussion on the results of the conducted study.

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doi:10.1016/j.matdes.2009.12.021

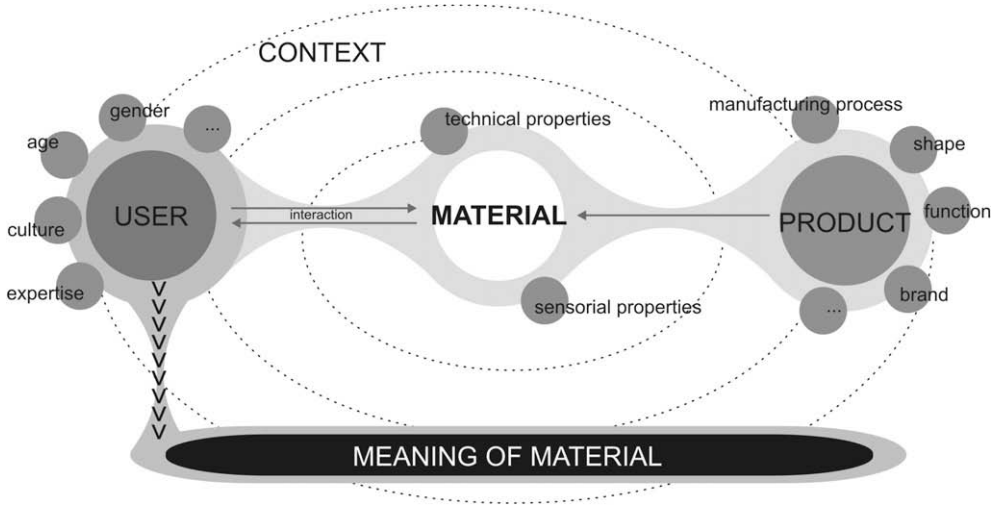

Fig. 1. [Meanings of Materials] Model [10].

2. The [Meanings of Materials] tool

When people are asked to describe a certain material, they frequently refer to its expressive characteristics and these characteristics are grounded in different aspects of materials (and products). A particular material of a product, for instance, might express professionalism predominantly through its shiny, robust and smooth properties and the product's sharp-edged geometry. Herein, shininess, robustness, smoothness and sharp-edge geometry cooperate and jointly contribute to a material's expressive character. Expressive characteristics (or meanings, variously called figurative or abstract characteristics, see [11]) are not factually part of a materials' physical entity or appearance (i.e. a material is not literally feminine or masculine) [9].

A meaning of a material is evoked by the interactions between product aspects (such as shape, function) and material properties, with respect to how and in which context the material is used and who the user is, and can change over time. Thus, a meaning of a material cannot be reduced to a single property or a single sensory domain [10]. Therefore, it is not possible to define simple design rules for a certain material–meaning relationship. Nevertheless, there are some patterns that identify how materials obtain their meanings [10]. A material, for instance, may express *professionalism* when it is smooth and dark (coloured), when its used in an office environment and when certain technical properties are combined for enhancing its function (e.g. combining strength and lightness). We assume that a designer who can understand these relationships (which we may call 'meaning evoking patterns') can more deliberately (or systematically) manipulate meaning creation in materials selection processes. In order to make designers capable of finding these patterns, a tool should first familiarize designers with the key aspects (such as shape, user, manufacturing processes) that play an important role in attributing meanings to materials. The tool should convey the idea that many meanings can be attributed to many materials dependent on different products and contexts.

The three major aims of a proposed [Meanings of Materials] tool are: (1) to familiarize designers with the main components (or factors) of the Meanings of Materials model, (2) to show which aspects (under main components) play an important role for certain meanings (such as sensorial properties, gender, culture, shape), and (3) to stimulate designers to find the relationships (or patterns) between these aspects and meanings. In this way, we aim to encourage designers to systematically involve meaning considerations in their materials selection processes. This approach is termed ***meaning driven materials selection*** in this research. For the three goals listed above, we aim to provide designers with a collection of material examples (as material samples or materials embodied in products) that have been selected by a number of individuals who think that each material example expresses a certain meaning. In this way, the intention is not to provide designers with explicit design rules but rather to encourage designers to make their own conclusions by analyzing the selected materials.

2.1. Step 1: the structure of the tool

Scholars in the materials and design domain, underlie the need for a materials selection tool to support designers in their materials selection activities at early stages of the design process (i.e. concept creation) [12–15]. The tool was therefore required to be informative, inspiring and appealing to designers. In order to achieve this, a level of interactivity in the tool was sought: the aim is to construct a database derived from a number of people who are asked to select materials expressing certain meanings. They are asked to provide a picture of the materials they selected and to explain why they thought that the material they selected expressed the given meaning. Then, they are asked to appraise the selected material in terms of sensorial properties via five point scales.

In approaching the proposed tool, designers ware expected to have in mind the meaning(s) they would like to create through the material(s) of their designs. From this standpoint, it is important to provide designers with a number of material examples presented alongside explanations made by the individuals who select the materials and point out their associated meanings.

In the completed MoM tool, designers can navigate through selected materials and explanations. Furthermore, the MoM model and a list of important sensorial properties of materials are presented in the tool to guide designers in their analysis of the selected materials. The main assumption is that: even though each case (comprising a single person's explanation of the meaning they attribute to a certain material) is unique, designers will be stimulated to combine the cases and identify meaning evoking patterns. The materials selection process, aided by the MoM tool, is intended to finalize with an idea(s) of a material(s) conveying a certain meaning.

The MoM tool incorporates 76 meanings, which are identified as material relevant meanings that designers are likely to want to convey through the materials of their products [16], in order