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Fiberness, reflectiveness and roughness in the characterization of natural and high quality materials

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ABSTRACT

The use of environmentally sensitive materials – such as bio plastics and natural fiber composites – is one of the most prominent means of the deployment of sustainable product design. Available literature covers the environmental performance of such materials, their suitability as an alternative to regular ones, developments in their physical structure, their cost and diverse applications. Nevertheless, a stark gap can be found in literature articulating how users appraise these materials. In appraisals of environmentally sensitive materials, the characterization of two particular meanings plays a significant role: naturalness and high quality. In this paper, we present an empirical study where we delve into the understanding of three material aspects: fiberness, reflectiveness and roughness, as well as their individual and collective influences on the characterization of natural and high-quality materials. Drawing on the results of this study, we discuss the challenges for sustainable product designers and the critical pathways to follow accordingly.

1. Introduction

The materials contained in every-day products are mediums, intended to provoke particular user experiences, concerning our 'sensory' appreciation (i.e. it feels good to touch, it feels warm, it is smooth, etc.), what they mean to us (i.e. it reminds me of my sister, it is modern, it is used in professional environments) and what they elicit from us (i.e. it surprises me, it makes me relax). These are highly intertwined, subjective, time and context dependent attributes. One might think that a particular material is very modern because it feels smooth and cold, whereas someone else might think that the same material looks traditional because his/her grandmother possesses it. Nevertheless, we might still detect certain 'material-meaning patterns' for a specific user group, showing what kind of traces they follow to ascribe meanings to a particular material (Karana, 2009, 2010). This paper delves into the patterns to identify the attribution of *natural* and *high quality* to materials: why these two meanings?

In fostering easy acceptance and consumption of sustainable products, a wider, holistic approach which considers how these products are appraised in societies, how they please one's senses, what kind of meanings they evoke, should be taken into account. These socio-cultural and psychological aspects largely affect consumption of sustainable products in societies (Mont and Plepys, 2008; Papanek, 1995; Vezzoli, 1999; Zafarmand et al., 2003; Walker, 2006). 'Design for sustainability' entails certain aesthetic features we recognize and associate with such products; for example, reduction of the components, avoidance of colorants, use of re-cycled parts, ease of disassembly, etc. Scholars in the domain describe this phenomenon with various terms such as 'total beauty' (Datschefski, 2001), 'green aesthetics' (Saito, 2007), 'sustainable beauty' (Hosey, 2012) and 'aesthetics of sustainability' (Rognoli and Karana, 2014). They emphasize that 'sustainable products' should have strong, unique and self-expressive aesthetic features, that are recognized and appreciated by societies. Otherwise they may remain curio items unsuitable for mass acceptance (Saito, 2007). Aesthetics of materials, which embody products, are accentuated as the key to expressing environmental credentials or sustainability of such products.

One particular expression commonly used to express sustainability through material aesthetics is 'naturalness' (Walker, 2006; Overvliet and Soto-Faraco, 2011; Goodman, 2012; Karana, 2012). In many daily contexts, materials displaying 'naturalness'[1] have the potential to be preferred over un-natural ones (Overvliet et al., 2008; Rozin, 2005). What criteria do we use when deciding

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[1] It should be recognized that even if a material is inherently natural it could still carry certain properties that makes it to be appraised as un-natural (or vice versa).

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whether or not a particular material is natural? We could think of various visual properties (such as color, gloss), or tactile properties (such as roughness and softness) as being critical ones, which will certainly play a significant role. In our daily interactions with materials (of products) however, these properties are never extracted from a whole, or they are not individually assessed. Our appreciation of a material as 'natural' is a result of a complex process shaped by our previous experiences, by who we are, in which context we assess the material, etc. Think of a 'wooden' product as an example: its type (e.g. purple wood, which genuinely has a purple color), its form (e.g. it might have a rather unusual form which we cannot associate with wooden products), its context of use (e.g. we can interact with it within a futuristic night club) can all affect the extent to which we consider a particular wood as 'natural'. Thus in exploring the attribution of a certain meaning to a material, it is crucial to delve into the interrelationships of these aspects as variables.

On the other hand, the expression of 'Naturalness' may not be enough on its own to determine the commercial success of a material or a sustainable product; its perceived quality will inevitably play an important role in a number of contexts. We might have a preference for a roughly finished wooden table, but we may prefer a high-quality, finely processed mobile phone case even though it is made of an inherently natural material. The predominance of automation processes and quality controls have led to the almost total elimination of errors and imperfections (Rognoli and Karana, 2014). We associate quality with perfection in production, and we tie a strong aesthetic model to it. We can recognize natural fibers and their composites as materials having significant untapped potential for product designers and as having good sustainability credentials (Rognoli et al., 2011). However, in order to meet consumers' demand for a particular aesthetic appearance linked to perfection and high quality, they are subjected to extensive finishing processes that utilize large amounts of energy, water, toxic chemicals, etc (Saito, 2007). The 'Perceived Quality' of products and its pivotal role on consumption patterns in societies has long been studied in strategic product development (Aaker and Jacobson, 1994; Bhuian, 1997; Garvin, 1984). In contrast, a stark gap can be found in literature, articulating when a material is appraised as 'high-quality'. In fact, this gap has become evident in the use of bio-based materials (e.g. bio-plastics, natural fiber composites, etc.) in daily products, which, in terms of quality, try to compete with regular petroleum-based plastics (Karana, 2012).

Available literature covers the environmental performance of such materials, their suitability as an alternative to regular ones, developments in their physical structure, their cost and diverse applications (Alvarez-Chavez et al., 2012; Du et al., 2004; Jayaraman et al., 2011; Khoramnejadiana et al., 2011; Kim and Sharma, 2012; Lopez et al., 2011; Mumtaz et al., 2010; Piemonte, 2011). Nevertheless, acceptance of these (emerging) materials and what they mean to people is rarely discussed. What kinds of material aesthetics are highly valued? When do people think that a particular material is natural? Are natural materials perceived as high-quality materials? When does a material express naturalness and high quality simultaneously? With regards to these questions, what are the main challenges for sustainable product designers?

In a previous study, we explored some of those questions raised above (Karana, 2012). We could show that there were independent, congruent and contradictory aspects in the creation of natural and high-quality meanings. One very strong independent aspect we obtained was the visible fibers of the selected natural materials. The significantly contradictory ones, which were reflectiveness and roughness, were depicted as the most challenging ones in the creation of the desired meanings. In this study, we attempted to substantiate these findings with empirical research by delving into our understanding of the effects of these previously detected properties (Karana, 2012) – fiberness, reflectiveness and roughness – and their inter-relationships on the attribution of 'high-quality' and 'natural' meanings to materials. We created varieties of these material properties embodied in two different products: a tray and an I-Phone case. The results are expected to contribute to the 'design for sustainability' scholar and practice with guidelines for manipulating material properties in a powerful way to the fostering of sustainable product consumption.

2. Attributing meanings to materials

Developments in materials science and manufacturing technologies have enhanced the variety of applications for materials. People encounter versions of a particular product made of different materials or the same material embodied in different products. This has led to an unavoidable transformation of meanings attributed to a certain material. A single material, polypropylene for instance, may be evaluated differently when it is embodied in kitchenware rather than an office accessory. Manzini (1986, p. 3), in his book *The Material of Invention*, also emphasizes that new technologies have radically altered the meanings that once endowed materials with cultural and physical depth. Accordingly, traditional sayings such as *wood is cozy*, *metal is aloof* or *plastic is cheap* are less relevant and strict in today's design practice. Materials obtain different meanings in different products.

The term 'Meanings of Materials' in this study relates to what we think about materials and what kind of values we attribute after the initial sensorial input in a particular context (Karana, 2009). We attribute meanings to materials on the basis of the characteristics of a situational whole in which materials are experienced. In this study, *characteristics of a situational whole refer to a* ***meaning evoking pattern*** in materials experience (Karana et al., 2008). After a number of conducted studies engaging different experiential methods, Karana (2009) explains the dynamic action between a user and a material in which the material obtains its meaning. A user with his/her particular characteristics interacts with a material of a product, appraises it and attributes a meaning (or meanings) to it. The attributed meaning will be (partly) based on the material's technical and sensorial properties and is affected by aspects of the product in which the material is embodied. A material's meaning can change, depending on the user–material interaction, which is affected by use and time. Each main factor (i.e. user, product, material) has a number of aspects (e.g. shape, manufacturing process, gender, expertise, etc.) that can influence the meaning attribution to materials. In addition, the context in which the material of the product is appraised may have a considerable effect on meanings attributed to materials. Taken together, these aspects may construct a 'meaning evoking pattern' for an individual. We assume that designers who can understand these relationships between the user, product, material and contextual aspect, can more deliberately (or systematically) manipulate meaning creation in their materials selection processes and ensure effective user experiences.

As emphasized before, in an earlier study (Karana, 2012), we presented the application of a Meaning Driven Materials Selection (MDMS) Method to explore when people think that a material expresses 'naturalness' and/or 'high-quality'. A group of people were approached to participate in a study where they were given the following three tasks: (1) select a material that you think is 'high-quality' (or expresses 'naturalness'), (2) provide a picture of the material you selected, and (3) explain your choice and evaluate the material on the given sensorial scales (see Karana, 2012). Analyzing the results, two meaning-material patterns were created with regards to the desired meanings. The created patterns showed the difficulty in evoking these two meanings simultaneously,