

Emerging material experiences

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The emergence of new materials offers opportunity for achieving new material experiences.

This was the simple statement that served as the starting point for this Special Issue of *Materials & Design*, which seeks through its eight contributory articles to explore the notion and practical realization of 'Emerging Material Experiences'. In the material infrastructure of today's world, whether in products, buildings, or other creations, we see a great variety of materials offered as 'better' alternatives to convention (e.g. bio-based plastics, piezoelectric textiles, temperature sensitive polymers, advanced ceramics). As a priority, the pursuit of 'better' in newly developed materials should make sense from the perspective of bringing a utilitarian and environmental advantage. Yet, when embodied in daily products, a new material also brings the possibility of new sensations, thoughts, feelings, and behaviours, which play a crucial role in the material's ultimate commercial success. We argue that designing with new materials through the lens of 'materials experience' is a powerful strategy to introduce those materials to societies through applications that make sense and give sense, and hence possibly shorten the gestation time of materials innovation. Take early examples of ready-made salad bags made of bio-based plastics (e.g. PLA). The crispy sound of the packaging material was different than we were used to: sharp, loud, and a little annoying. This made us develop different behaviours around the package, e.g. tearing it up as quickly as possible to prevent continued annoyance of the material sound. On the other hand, the same crispy sound can be considered an analogue of the crispy freshness of the salad — resulting in a sensorial congruity between the packaging and the content.

In a very broad sense, we can be captivated by material qualities and excited by their application; we can take great pleasure in their existence, or we can be extremely uninspired; we can witness the passing of time as graceful ageing or as material degradation. Materials can appear to be 'alive': they can sense and respond, and change state; they can show different 'faces' depending on applications and circumstances; they can remain personal and appropriate over time. Materials can reflect fashions in a particular era, or they can exhibit timelessness. Materials may draw us into an artefact or push us away. These examples briefly illustrate the multifaceted system that underpins the material experiences that we have with, and through, the materials of products [1–3]. The phrase 'materials experience' acknowledges that while experiences may originate from—or be moderated by—a wide variety of sources, one of the prominent sources is the physical reality of a product: the wood of the table, the plastic of the kitchen utensil, the leather of the handbag, or the glass of the building façade. Academic foundations for this area of work can be traced back to Manzini's pioneering work on interrelations between materials, creations and experiences [4]. He laid critical foundations for what has subsequently developed

into a body of work concerned with 'designerly' ways of using materials to positively affect user experiences.

A fascinating and complicating issue is that material experiences are not absolute. Using one material across multiple applications will result in a multitude of user experiences. Conversely, realizing one application through a variety of different materials will result in a different set of di-verse experiences. Designers clearly have opportunity to effect desirable experiences through materials, though operationally this is far from straightforward. It implies that a designer's vocabulary and understanding of material properties should include both engineering (numerical/encoded) and experiential (sensorial/descriptive) perspectives, as well as a comprehension of their interrelations [5]. But this is only part of the concern. Designers must also have a firm grip on the ways in which materials lead to experiences, and how designing for material experiences can be embedded into routine design practice. By virtue of familiarity with the materials used, some material experiences are easier to comprehend and mobilize. However, the potential experiences of the unfamiliar, the unusual and the rare emerging materials are often challenging to envision and to design for.

In the platforms where emerging materials are discussed (e.g. DiaBSmart, <http://www.diabsmart.eu>; DAMADEI, <http://www.damadei.eu>; and Light.Touch.Matters, <http://www.light-touch-matters-project.eu>), we see an ever increasing number of examples that illustrate challenging couplings of materials science, design, engineering and social sciences for a common purpose of 'design for meaningful material experiences' [6]. In other words, the borders between these professional disciplines fade as they work together on the common endeavour to find meaningful applications for a newly developed material at hand. In practical terms, this translates to a mutual respect and cooperation between communities, on the one hand, for the 'design of materials', and on the other hand, for the 'materials of design'. This evident duality of interpretation that the title *Materials & Design* admits provided the motivation for the journal editors to encourage the exploration of this topic through a series of studies included in the Special Issue. In fact, over the last decade, design communities are continually evolving their ability to contribute to the design of materials [7, 8], where materials experience studies and/or 'design-driven innovation' strategies [9] are proposed as a conceptual starting point in the material (driven) design process.

Within this Special Issue we asked authors to prepare articles that collectively illustrate how 'emerging materials' can lead to new user experiences, drawing upon perspectives from design, social sciences, materials science and engineering. For this Special Issue the focus of the journal was deliberately shifted away from the technical issues of materials development towards personal and social implications of materials, asking questions such as: *How do/will emerging materials*

and material technologies shape our daily experiences with products?, What is the role of designers in manipulating these experiences in a meaningful way?, What are, and what will be, the key issues affecting designers' material choices?, and How will all these issues affect the design process?

In the arena of design, and reflected in the submissions to this Special Issue, we observe two fundamental themes that drive material decisions and applications. Accordingly, these trigger the emergence of new material experiences: (1) *sustainability concerns*, which cross a wide range of topics from the aesthetics of sustainability to valorising waste to express naturalness in materials, from do-it-yourself materials to materials that age gracefully; and (2) *technological advancement*, which covers an array of topics from rich material interactions through smart materials to slow technologies.

'Sustainability and materials' is of course a wide-ranging and crucial subject for the current era. The designer's role within sustainability discourse and practice has in recent times focused on the 'aesthetics of sustainable design' as a fundamental notion. When looked at from the perspective of materials use, one of the aesthetic expressions discussed repeatedly in the design for sustainability domain is whether a material of a sustainable product expresses 'naturalness'. Krista Overvliet and her co-authors touch upon this subject in the first article of the Special Issue, arguing how perception of naturalness has a strong impact on preferences of textile products. They present an empirical study in which 44 different pieces of textile, made of wool, cotton, acrylic and polypropylene, were custom-woven as experiment stimuli. The textiles varied in fibre origin (i.e. what the textile was actually made of) and yarn type (fine versus thick).

Alongside naturalness, another aesthetic movement within sustainability is gathering pace: that of imperfection. Products that fit into an imperfect aesthetic through material choices are aimed at gratifying people's senses through unique aesthetic features, sometimes by resembling material effects that occur in nature. These products are intended to become materially special to people, for example by viewing the traces of life that a material can carry as part of its valued aesthetic beauty [10]. For this Special Issue, Weston Baxter and colleagues develop new understanding of how people appraise used objects and the mechanisms driving contamination. In doing so, they explore the aversion that people can have towards engaging with used objects, through the principle of 'indicators of use'.

The acceptance and valorisation of imperfection, linked with other phenomena important in our present society such as the democratization of personal fabrication technologies and the rising desire of individuals to personalize their products, offers great opportunities to experiment with advanced, distributed and shared production processes and to design new materials. The article contributed by Valentina Rognoli and her co-authors introduces the notion of Do-It-Yourself (DIY) Materials, which are created through individual or collective self-production practices, often by techniques and processes of the designer's own invention. They can be totally new materials or modified or further developed versions of existing materials. The authors group their findings under two main categories: (1) DIY new materials, which focus on creative material ingredients (e.g. a material made of dried, blended waste citrus peel combined with natural binders); and (2) DIY new identities for conventional materials, which focus on new production techniques that deliver new expressions for existing materials without necessity for new 'ingredients' (e.g. 3D printed metal).

Complementing the theme of sustainability concerns, the technological advancement of materials (e.g. having superior properties, such as conductivity, sensing, thermal stability, and mechanical resistance) along with paradigm shifts in manufacturing technology (e.g. additive manufacturing, desktop printing) open routes to new material experiences. Blaine Brownell in his article argues that the physical materials and processes of today reveal a growing application of information technology enhancements. Hence such materials and processes effectively represent a kind of expanded matter

(x-matter) with increased capabilities not found in their traditional, unembellished counterparts. He provides a holistic evaluation of this phenomenon and its future implications, particularly from the perspective of material-focused fields such as architecture and product design. His article offers a concise proposal for a comprehensive framework within which to understand the evolving relationships between matter and information.

Mikael Wiberg, on the other hand, offers ways of moving forward in interaction design by developing: (1) a unique form-giving practice; (2) an artistic and research-driven explorative account; and (3) the growth of systematic knowledge in HCI (human-computer interaction). He draws attention to articulating "the materiality of interaction" as a key to understanding emerging material experiences, suggesting that this is increasingly realized through computational re-activation of traditional (analogue) materials, such as paper or wood.

At the intersection of sustainability concerns and technological advancement, Natasha van der Velden and her co-authors provide a critical view of the environmental aspects of smart textiles. They invite us to re-consider our 'smart' material choices when the principal aim is (only) to create 'wow' effects. They present a life cycle assessment (LCA) of a wearable smart textile device for ambulant medical therapy. They use the Eco-costs approach to compare the LCA-results of the original prototype design against various eco-redesign options. Based on their findings, they suggest that one possibility to reduce negative environmental impact is the replacement of silver based conductive yarns by copper based alternatives, or the use of acryl instead of wool. They argue that studies concerning '*how materials are experienced*' would support designers in understanding whether the material used as an environmentally sensitive alternative in a certain case (e.g. acrylic) would elicit targeted user experiences as good as the originally considered material (e.g. wool). In fact, Krista Overvliet and her co-authors also explore this particular question within the first manuscript of this special issue.

The two closing articles for this Special Issue on Emerging Material Experiences are not directly tied to either of the two main themes that we have identified. Instead, they are concerned with widening the 'toolkit' for research and practice in design for materials experience. Sarah Wilkes and colleagues review evidence in favour of using isomorphic sets of material stimuli as tools to bridge disciplinary gaps between designers and materials scientists. They show how these isomorphic sets and their accompanying experiments can be used to translate between the two communities, and to systematically explore the relationship between the technical attributes of materials and subjective experiences of their sound, taste and feel.

Finally, the article by Fazıl Akın and Owain Pedgley makes a critical review of an important and growing resource amongst materials and design communities: the 'material library'. These are collections of material and product samples located in organizations worldwide that allow designers to make hands-on appraisals of material properties, which in turn can inspire or influence material decisions for design projects. The authors argue that physical sample interaction must be central to any initiatives to support design for material experiences.

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