

# **Colour and Colorimetry Multidisciplinary Contributions**

**Vol. XVII A**

Edited by Andrea Siniscalco



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## **The Colours of Sustainability: how materials CMF Design can guide sustainable perceptions and behaviours**

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### **Abstract**

The growing interest in sustainable production is a trend driven by increased awareness of the need for a change in today's way of designing, producing, consuming, and living. Thanks to renovated attention, different materials have been developed from a sustainable perspective, from natural to recycled, compostable and recyclable resources. The material's origin, intrinsic qualities and the processes used often give them unique sensory attributes but with aesthetic identities not always coherent about their sustainability implications. In designing their functional, sensory, and aesthetic characteristics, sustainable products and materials must find their own identity according to their potential life cycle.

As a multidisciplinary mediator, the designer can evaluate materials and product optimal life cycle, set functional and aesthetical criteria, select materials and suppliers, optimize processes, and keep attention to design materials aspects as a means of communication. CMF design can support aesthetic-sensorial thinking to model sustainable products in the materials and design sector. Colour represents a key element: together with material and finish can lead to defining the aesthetic and sensory qualities supporting a sustainable identity, perceptions, and behaviours. This paper will explore CMF as a tool for "materials design" with a close look at the colour and how it can drive sustainable perception in today's heterogeneous and complex emerging materials context. Boundaries and guidelines for the use of colour will be applied according to materials' life cycle (source, processes, user and context, end of life) to generate greater awareness for designers wishing to select, design or apply sustainable materials in design projects.

**Keywords:** CMF Design, sustainable colors, sustainable design, aesthetic, perception, behavioral design.

### **Introduction**

The concept of the industrial designer was born around 1920 when the need to make products more attractive on the market through new shapes and decoration began to emerge (Dobers and Strannegård, 2005). The figure of the designer grew increasingly, becoming a point of reference for companies and acquiring more and more technical skills. In the 1980s, product offerings focused no longer on the purely technical and aesthetic aspect but on what the artefact communicated: lifestyle. Over the years, consumption increasingly concentrated on the immaterial dimension of the product, becoming an 'experience' in the 21st century (Gardien, 2014). However, this model based on sales and aggressive marketing that encourages constant product launches, favouring a continuous turnover of products, is no longer a viable path. The climate emergency we are experiencing only partly contributes to the construction of ecological and sustainable thinking (Kong *et al.*, 2014).

It's complicated to define the 'sustainability' of a product because this cannot be measured through a single parameter but with many parameters on different layers (Wilkes, 2016). Therefore, since it is not universally measurable, it cannot be communicated effectively except by resorting to banalisation that minimises sustainability itself.

The average consumer, unconscious of the issue's complexity, can't fully understand the meaning and possibilities that a sustainable product should have and therefore tends to belittle and undervalue products that could have less impact on the planet. This fact often happens because, compared to traditional products, sustainable ones are not perceived as durable and performing. So, consumers tend to prefer traditional ones because they can understand and appreciate them as a consumption habit.

Therefore, the attention to the product's environmental impact is significant, and the appearance will gain increasing importance since it arouses emotions in the consumer and has consequences on the market. The consumer's choice happens quickly on average and is entrusted more to instinct. The exploited sense, and lately also abused, is sight. Indeed, we live in a society of images. Through our eyes, we understand and absorb the world around us (Locher *et. al.*, 2010). The sight sense allows us to orient ourselves in the world as human beings and ensures our survival. Just think how just looking at the fruit, we can decide whether it's edible or not: we can judge object properties through the knowledge we create during our lives. Observing a product, it is possible to make an initial assessment of its physical characteristics: imagine the sensation it can give us when we touch it and hypothesise its heaviness and sound (Fleming, 2014). Sight, therefore, allows us to have a global perception of the physical properties of an object and consequently also of the material: its colour, texture, transparency, glossiness, etc. A general principle of aesthetic pleasure derived from sight lies in symmetry, unity, proportion, complexity and colour.

### **The aesthetic of sustainability**

The trend towards more sustainable consumption links to the need to succeed in constructing an aesthetics of sustainability: an implicit language that can communicate the sustainable value of a material or product. Today we see on the market several attempts to communicate the philosophy of the product through material or communication choices. Thanks to a renovated sensibility, on the market is possible to find sustainable materials from natural and recycled resources, from waste or by-products. Because of their origin and processes used these materials are often characterized by unique sensory qualities.

The Swedish government declared as early as the beginning of 2005: "Products and artifacts should be designed in a sustainable way and with an aesthetic that contributes to that we use them for longer time periods in our households" (SOU2005:51, 2005). Aesthetic is thus acquiring a crucial role in raising consumer awareness and steering sustainable behaviours. Zafarmand (Zafarmand *et al.*, 2003) has made a significant contribution to the search for an aesthetic of sustainability, coming up with seven main aesthetic attributes that can promote a sustainable product.

**Aesthetic durability** - This aspect emphasises the importance of achieving an aesthetic finish that does not compromise its beauty over time. So, the design considers the change in colour over time (e.g., objects made of polymeric material) and enhances the variation. The attention to the passage of time with appropriate design could increase the object value by creating an emotional bond between the artefact and the user.

**Aesthetic upgrade-ability and modularity** - Modular design offers the possibility to upgrade and replace certain parts of one's product. In this case, the colour can become a characterising element, allowing to change the product's appearance without replacing it. Modular design allows a product to be used for longer, saving resources and energy.

**Simplicity and minimalism** - When designing a sustainable product, it is essential to follow the principles of 'Design for Simplicity', emphasising the minimal use of material and composition that allows easy disassembly. However, this choice couldn't cause oversimplification in the user's eyes but must remain valuable. In this case, the colours and finishes selection could become fundamental to succeed in giving to a simple product the right aura of preciousness, creating emotion and empathy between user and product.

Logicity and functionality - Being able to guide the user to the correct use of the product not only allows positive interaction but also prolongs the object's life since it is not misused. Colour can lead to proper usage through a language that creates a durable and functional aesthetic.

Natural forms and materials (naturalness) - The design of a sustainable product should be inspired by nature since 'in nature, forms and materials are perfectly fitted to the functions and everything has a permanent dynamic aesthetic'. The natural forms' use, materials and colours can strengthen the relationship between user and product. So, the public it's increasingly environmentally aware and able to reconnect with the harmony of nature.

Local aesthetic and cultural identity - Sustainability also involves an ethical and social dimension. Designing to enhance locality and cultural identity allows us to create products that reflect the values of a community and are imperishable. The use of patterns and colours characteristic of certain cultures are timeless and strengthen the bond with the territory.

Individuality and diversity - A sustainable product respects people's individuality, aesthetic tastes and diversity. Designing flexible, modular and easily adaptable artefacts allow for greater product attachment and longer use than the traditional ones. Colour and visual textures can easily differentiate products, making them suitable for different communities and cultures without creating new pieces and artefacts, investing materials and energy.

Therefore, due to the complexity of defining a sustainable aesthetic: a single answer cannot be the solution. Indeed, as Sarah Wilkes et al. (2016) argue: the perceived sustainability of a material cannot be reduced to a set of measurable physical properties, nor can it simply be attributed to cultural preconceptions. The sustainability of a material depends on our criteria and how we perceive the problems. These vary not only over time but also for community and education.

### **CMF Design**

Design CMF stands for Colour, Material and Finish. The term, coined in the 1980s by Clinio Trini Castelli, has become an indicator of a discipline that, over the years, has involved more and more designers and professionals (Lucibello, 2005). Starting in the 1980s/90s, with the development of an experiential type of consumption that aimed to diversify the offer using eclectic, dynamic and ornamental aesthetics (Gardien, 2014), CMF design has made it possible to diversify the offer by adapting it to the different needs of the market. The first example of "Material Design" in design culture has been "Neolite" (Manzini and Petrillo, 1991), which was the adventurous heterogeneous plastic recycled in search of an "own identity". From here came the concept of materials soft qualities design to determine materials identity and the subject of material design intersects for the first time directly with the theme of sustainability. In CMF design, it is indeed important to respect not only the project's own requirements, but those of society. The dichotomy between technical and anthropological aspects is peculiar to this discipline since it also appeals to emotional and socio-cultural elements (Becerra, 2016). The CMF analysis links to trends reflecting the societies of the moment of a given time and place, customs, colours and traditions. CMF design tools and methodologies have become an integral part of the design, especially in sectors with a very high complexity level in scale and detail, such as in the world of sports and automotive. The CMF design process progresses with several steps, from defining the context and personas to defining a CMF strategy, dividing up the parts and constructing explanatory mood boards of the project in all its details.

This discipline allows each constituent detail of the product to be analysed and kept under control in its colour, material and finish. The possibility of checking and simultaneously having an overall view of the product provides value to the artefacts by balancing the technical, aesthetic, and functional aspects (Becerra, 2016). The product value, usability, appeal, and the user's attachment are all features passing through the perception of the artefact, and thus CMF design elements.

The material is the essence of the product, and its selection has always been relevant in defining the product itself. Through the material, the designer determines the form, but also its processability and consequently its cost. On the other hand, the finish, very often taken for granted, is the point

where the user encounters the artefact, expanding the sensorial relationship begun through sight. The outermost surface can communicate sensations of hot, cold, rough, smooth, etc., sometimes creating surprise in those who touch or interact with the product for the first time (Del Curto *et al.*, 2010). But among the CMF elements, colour firstly captures the consumer's attention and initiates cognition. Colour is the first element we perceive, and according to E. Bullough (1880-1934), the human reaction to colour can be of three types: objective type, preference for a specific kind of colour; associative type, appreciate or not colours relating to aroused sensations; psychological type, the association between colours and taste, like green for nature-like trends.

But colour has not only the function of the first element of interaction. As already indicated above, it becomes a significant element not only for the perception and emotions it arouses towards a product but also for more technical and functional aspects: usability, performance, value, ability to adapt to the passage of time, and interaction with the user.

### **Sustainable perception**

In reflecting on perceptions of sustainability, various research has been carried out concerning consumer relations and correlating objects with definitions of quality and naturalness. Achieving this is an ambitious objective since materials' soft qualities are complex to correlate to physical parameters (Figuerola *et al.*, 2016) and even more with intangible meanings as sustainability is.

In the first study, Petersen and Brokhaus (2017) investigated consumer attitudes towards two versions of music headphones and rubbish bags. The two product typologies featured a version made of traditional material and a 'green' version characterised by natural/pastel colours and irregular visual texture. In both cases, it was evident how the aesthetic appearance of the products influenced the overall perception of the object. The natural colours, along with the imperfection-creating textures, lead the consumer to assume that the product is more environmentally sustainable. But while these features enhance the perception of sustainability, they also diminish the perception of quality and performance of the product itself.

Elvin Karana, on the other hand, allowed its panelists to choose objects or materials that reflected the concepts of 'natural' and 'high quality' (Karana, 2012). Thirty products were collected for each attribute and then analysed according to material properties, product appearance, the context of use and intangible aspects (mood, culture, values, emotions). The analysis showed that the two attributes are opposites in many aspects. Analysing the products attributed to 'natural', it emerged how natural colours in shades of brown/beige, visible fibres and grains, and imperfections are discriminating factors in the product choice since they confer uniqueness. In addition, warmer, rougher, and heavier materials are considered more authentic and natural.

In contrast, the 30 products that correspond to 'high quality' are characterised by cold, neutral colours veering between white, black, and silver. These refer to qualities like elegant, serious, chic, and masculine and reflect a clean, strong, and durable condition. Moreover, lightness, unlike 'natural' materials, would communicate the guarantee of high performance.

Therefore, starting from these considerations, it is not difficult to analyze the current scenario and imagine how the consumer's sensitivity is changing, and how color as a primary aesthetic attribute is today used as a lever in products to guide certain perceptions and behaviors.

In a study conducted by the authors (Sossini, 2020), the perception of different products and materials aesthetic was analysed, asking to 135 interviewed to choose the most sustainable relating to the visual perception. In the first group (Fig. 1), according to the sample interviewed, the two recognized as sustainable products are seats 2 and 3. From the picture, it's clear that the two seats fully reflect the characteristics illustrated by Karana (Karana, 2012): natural colours, imperfections and visible inclusions. However, the most remarkable part of this survey was that all the presented materials could be considered 'sustainable' in different ways since they were all bioplastics, recycled or composites with bio-based resins.



Fig. 1 – First group of analysed products

The second group of provided (Fig. 2) were images of materials samples. Again, all the materials were bioplastics or bio-based resins with fibres, except for number 3: a recycled fossil-based plastic. In this set of images, as the product architecture wasn't clear, it was more complicated for interviewed to judge the sustainable aspect. The sustainable-like material was material 4, with earthy colour, a rough and irregular surface and colouring. After material number 4, there are the number 5, composite with natural-coloured fibres; recycled material 3 with coloured inclusions that communicate the clear fossil-origin; material 1, linked to the milky and translucent colours, related to the now established use of PLA; material 6 with more traditional plastic colours; and finally material 2, which, due to its brilliance and iridescence, can't be associated to a natural material such as cellulose (of which it is made).

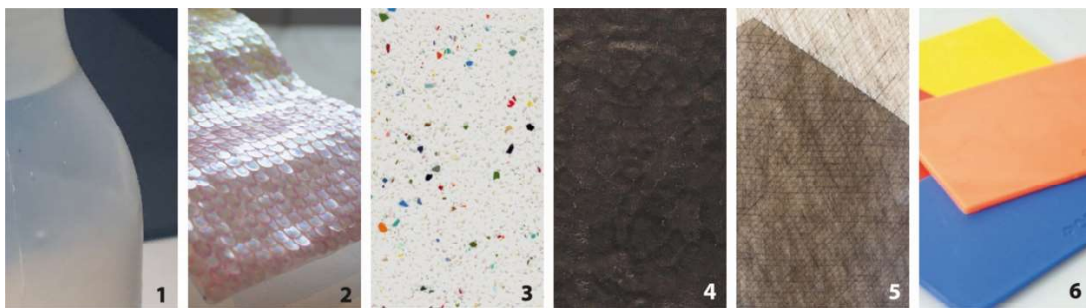


Fig. 2 – Second group of analysed materials

Therefore, it's possible to identify two distinct ways in which sustainable materials can present themselves on the market: by flaunting their 'imperfect' and irregular origin; or by imitating a traditional natural material while completely concealing their source. The former exploits natural colours ranging from brown and beige shades to green ones with irregular, matt finishes. On the other hand, when they conceal their origin, they draw on traditional materials, favouring brighter colours without irregularities, or whites and blacks, transparencies, and glossy finishes.

However, neither approach seems to communicate effectively with the consumer. Materials that express their naturalness, in fact, place a strong emphasis on green aesthetics, which may not always be appreciated, because they are often linked to low-quality but high-cost concepts. Conversely, materials that hide their natural origin do not clearly convey the difference from conventional materials. In both cases, the result is that material appreciation is limited to niche user groups in societies.

### Sustainable behaviour

The designer, as a multidisciplinary mediator, should guide the consumer towards the correct use of a product and mid-long term sustainable behaviours. Good design involves the abilities to respect the environment and the use of resources at all production and use stages, to share and communicate values with consumers, and to raise awareness and educate. Being able to design for sustainable behaviour through materials means guiding consumers to different roads: reduce resource consumption, maintain, and adapt their product to the passage of time, optimize product use, etc.

Of course, the change must follow the product effectively sustainability in the different use scenarios (Santi, 2021).

In this case, the aesthetic of sustainability, seen above with Zafarmand (2003), acquires an intentional objective, powerful and rich of ethical considerations. The material use in a product must be evaluated through sustainability metrics varying the possible use scenarios. And according to best one, the correct aesthetic should be considered.

The first behaviour that a material can steer is the attractive one, causing purchase: communicating properly, using colours, materials, finishes and shapes to arouse a positive emotion in the buyer is fundamental when dealing with conscious materials.

Moreover, materials and their aesthetics can act on the keeping behaviour extending product life, preservation over time; upgradability, which through certain modifications increases the value of the product; and reuse. Another group of behaviours, on the other hand, encourages awareness and the development of a green attitude in the consumer to guide them towards a more long-term circular lifestyle. In this sense, there is a propensity toward more sustainable product consumption, compared to traditional alternatives, energy and resource saving, and the impulse towards experimentation that can facilitate the meeting between users and materials.

Lastly, especially meant for the short-life products, a group of behaviours is related to renewability, connected to the correct disposal of products to favour recycling or the most suitable disposal.

From the analysis carried out by the authors (Santi, 2021), three different strategies for the aesthetic of bio-based and compostable materials in product sector emerged - Show, Highlight, Hide (Fig. 3) - through which aesthetics can express and guide sustainable behaviour.



Fig. 3 – Sustainable behavior strategies

Show - wishes to be honest and fair with the true nature of the materials used. In this case, the link with nature is communicated, favouring pastel, yellowish colours, milky transparencies, tiny inclusions, and rather rough, irregular, and matt surfaces avoiding additives and applied finishing layers. Organic and new forms are used to emphasise a novel use of material. The strategy should be applied to encourage proper disposal as the material tries to communicate its true nature; to raise awareness and favour the use of sustainable materials; through new forms, it could promote upgrading, finding new applications and increasing the value of the product itself.

Highlight - this strategy has an aggressive language to emphasise the imperfect nature of the products and, if necessary, communicate with expressive graphic language. In this case, the colours are still natural but darker, rougher, and very irregular due also to untraditional or craft processes. The aesthetics are reminiscent of DIY materials with raw and incomplete surfaces, natural textures, and basic shapes. In the case of composites, the fibres will be of significant size, sometimes giving a certain roughness to the surface. This aesthetic screams the origin of the material: it can allow for the proper allocation and, if necessary, even the separation between different materials. The graphical appearance could favour a non-conventional message identifying users' green attitude. The very raw nature of the product should encourage it to be kept, as the user could value the uniqueness of the material, inducing experimentation and recreating materials or objects like the one purchased by upgrading scraps and by-products.



Hide - in this last strategy, the designer can deliberately conceal the material origin. Obscuring the real nature could favour the high-quality perception, a long-lasting user experience, and a non-disruptive purchase behaviour. Hiding the source of the material also goes through imitation, both natural and synthesised materials. Indeed, this is a recurrent and warning strategy frequent on the market with cases where bioplastics imitate traditional plastics. They should be presented with bright colours, transparencies, glossy, homogeneous colours and surfaces, with visual and tactile textures created through moulds. Alternatively, new materials imitate other naturals, creating a paradox since bioplastics or other composites often resemble stone, ceramics, or wood, even though sometimes they can be considered in this way even more 'sustainable'. In this case, the aesthetic strategy should be properly studied with the product, function, evaluating sustainable usage scenarios favouring life extension behaviour, upgrades, and reuse.

As stated above, the materials aesthetic attributes are powerful mediator between product and consumer. The ethical concerns in material use must be considered. The best scenarios of behavior and use of materials and products can be evaluated by comparing them in the environmental assessment phase. Aesthetic strategies can be molded around them by continuously experimenting with the consumers' perception in a constantly changing reality.

### Conclusions

The search for an aesthetic of sustainable materials is one of the crucial points for product-user relation toward sustainability. If the traditional materials have yet their own identity, the emerging one as natural and recycled acquire different appearances. Given the complexity of the subject, sustainable aesthetic identity will probably be defined in a series of numerous facets. This paper presents an early reflection on how it is moving within CMF design.

Surely, there is the example of plastic: a recent material, compared to the traditional ones, which only since the 1950s has found its own identity (Karana *et al.*, 2015). Plastics did not have the characteristics of the then-known materials, heaviness, gloss, and hardness. On the market, they tended to aesthetically imitate materials already accepted by society - such as wood and marble. It was only after Tupperware's innovation that plastics began to be appreciated for their intrinsic properties and the possibility of using bright colours. Of course, even for emerging sustainable materials, it will still take years before they are accepted and appreciated, not only for their environmental potentialities but also for their functional, sensory, and aesthetic characteristics.

Environmental demands and societal trends are moving towards new product models and a new consumer taste. Looking at their circularity, sustainable materials aesthetic can guide the user towards a new lifestyle. The designer as a mediator and generator of innovative visions should coordinate this transition, evaluating and encouraging the application of sustainable materials to raise awareness and guide the user towards behaviour that can enhance the culture of sustainability.

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