



## The Impact of CMF Design On Product Design

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### Abstract

The continuous advancement of information technology and the Internet of Things is leading to a reduction in size. This trend seems to be pushing the conventional industrial design process toward a bottleneck. Color, Material, and Finish (CMF) design, a specialized field within industrial design, diverges from the conventional emphasis on the form and function of objects. Traditional industrial design predominantly concerns itself with shaping the physical attributes and practical utility of products. However, CMF design intricately navigates the tactile and visual dimensions of color, material, and finish, elevating the sensory experience of a product. This discipline goes beyond mere aesthetics, giving meticulous consideration to how a product feels and looks as a whole. Through deliberate selection and harmonious integration of colors, materials, and finishes, CMF design strategically enhances a product's allure, user engagement, and market positioning. CMF design centers on the sensory and visual elements that define a product's identity, influencing consumer perception beyond utilitarian functionalities. Product design innovation begins by considering the color, material, and finishing technique. The first section of this article covers the value and importance of analyzing CMF design from the perspectives of product appearance, cost management manufacturing, user experience, and business strategy. It guides how businesses can explore innovation opportunities from a CMF perspective, securing competitive advantages through short cycles, rapid modernization, and cost-effectiveness. Leveraging CMF contributes to the advancement of the industrial design sector, leading to a gradual flattening of product forms and expanding the realm of physical hardware design.

**Keywords:** industrial and product design; CMF design, color; material and finish; Design

### Introduction

Throughout each moment, CMF surrounds us, influencing our lives from the awakening of our senses to the moments we drift into sleep. It impacts our mood, comfort, and desires. Personally, my engagement with CMF begins the instant I open my eyes, contemplating objects, shapes, colors, textures, and patterns, considering their visual and tactile elements. What is CMF? It stands for Color, Material, and Finish—a trio of letters inspired by our senses: sight, touch, and spontaneous sensations in our daily lives. Commonly used in the industrial field, CMF focuses on a product's form, surface, and decoration, crafting the user's visual, tactile, and sensorial experience. Whether it's a car, mobile phone, sneakers, or even a pen or face tissue, CMF design shapes our interaction with everyday products. Take a moment to observe your

surroundings—the mobile phone in your hand, the chair and table you sit at, the light fixture above you—all designed with CMF in mind. Think about the careful craftsmanship that went into the CMF of your phone, the smart material placement in the chair and table that support you, or the artistic decision made in the light fixture that emits a soft glow overhead. CMF design has an impact on seemingly commonplace items that we use on a daily basis. CMF improves our interactions and experiences in everything from the smooth touch of a smartphone to the sleek appearance of a car. [1]

Also, a product's appearance, feel, and behavior will affect how functional and valuable it is considered, regardless of whether it is intended for consumer or industrial customers. Three criteria are used in product development: finish, material, and color. Industrial designers and CMF designers work

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together to bring color, texture, and finish to created objects. Among their responsibilities are trend and material mood boards, presentations, color matching with spectrophotometers and gloss readers, and color matching with the human eye.[2]

CMF creates every part of a project and weaves itself across the whole development process, inspiring design from the outset. It is the use of a product's aesthetics to elicit an emotional response, enhancing the consumer's brand experience. It's not only a completed product design. It adheres to the design process, whether it is investigating colors and materials or developing a palette that, whether digitally or physically, depicts pattern, texture, and color depth. We can advise where and when CMF design is required as we are integrated into the design process, and we can provide value..[3, 4]

### **History**

Originating from industrial design and product development, CMF design, an acronym for Color, Material, and Finish design, centers on enhancing the visual and tactile elements of a product. It delves into the aesthetic and sensory dimensions, marking its inception in the early 20th century as industrial designers expanded their focus to encompass the holistic aspects of product design, moving beyond mere form and function.[4, 5]

During the mid-20th century, advancements in production techniques granted designers increased flexibility in choosing materials and finishes. The introduction of novel materials and manufacturing methods facilitated greater innovation in the visual aspect of products. CMF design gained prominence, particularly in the automotive and consumer electronics sectors, where there was a focus on crafting goods that connected with consumers on an emotional level.[5]

As a differentiator in competitive marketplaces, CMF design became increasingly important in the second half of the 20th century and into the 21st. As businesses realized that consumers wanted items that were not just useful but also beautifully designed and produced, they started to set up CMF design teams inside of different design firms and organizations. In contemporary times, CMF design plays a crucial role in various sectors such as home goods, automobiles, fashion, and consumer electronics. Designers utilize a diverse range of materials, colors, and finishes to meet consumer preferences, evoke specific emotions, and align with brand identities. The field of CMF design is in constant evolution due to the influence of emerging technologies and sustainable materials, reshaping the sensory experience, visual aesthetics, and customer interaction with products.[6]

With the use of digital technology, CMF design has advanced even further in recent years.

Designers now have the capability to accelerate the design process by simulating and visualizing diverse color schemes, materials, and finishes through the use of computer-aided tools. Additionally, there is a heightened emphasis on prioritizing eco-friendly materials and production techniques in CMF design, reflecting the growing importance of sustainability in this field.[6]

As we celebrate the one-year mark of our conversations, it's crucial to acknowledge that CMF design continues to evolve, adapting to changing consumer preferences, technological progress, and environmental considerations. The interplay of color, material, and finish remains a pivotal element in crafting products that not only fulfill users' functional requirements but also resonate with their emotions and desires.[7]

Looking into the future, CMF design holds numerous fascinating possibilities. Advancements in responsive surfaces and smart materials have the potential to completely transform the tactile and visual aspects of items. With a growing public awareness of environmental issues, the integration of sustainable techniques into CMF design is likely to become more prevalent.[4]

Moreover, the burgeoning industries of wearable technology and smart home appliances will pose a challenge for CMF designers as they strive for the seamless integration of style and functionality. The multidisciplinary nature of CMF design, drawing from technology, psychology, and sociology, remains pivotal in shaping people's perceptions of their environment. It serves as a reminder of the dynamic nature inherent in design disciplines, including CMF design, and their continual adaptation to societal, technical, and ecological advancements as we mark this significant milestone in our conversations.[7, 8]

### **What's the CMF design**

Color, Material, and Finish design **Figure 1**, commonly known as CMF design, represents a specialized facet of product design. This discipline focuses on the meticulous selection and arrangement of finishes, colors, and materials to enhance both the aesthetic appeal and functionality of a product. In the of CMF design:-[9-11]

#### **Color**

involves choosing a color scheme that aligns with the user's preferences, the product's brand identity, and contemporary market trends.

- Material:

entails choosing the materials employed in the construction of the product. This encompasses considerations for durability, the overall sensory experience, and texture.

## Finish

Encompassing surface treatments and textures, such as matte or glossy finishes, CMF design contributes to both the visual and tactile aspects of the product. This design discipline plays a pivotal role in crafting a cohesive and visually appealing product that resonates with the target audience. It extends beyond mere aesthetics, influencing, brand identity user perception, and the user experience. [9]

## Definition of CMF design

The perceived value and functionality of a product, whether designed for industrial or consumer use, are significantly influenced by its appearance, tactile qualities, and operational behavior. These integral aspects of product development collectively fall under the umbrella term Color, Material, and Finish **Figure 2**(CMF).[12]

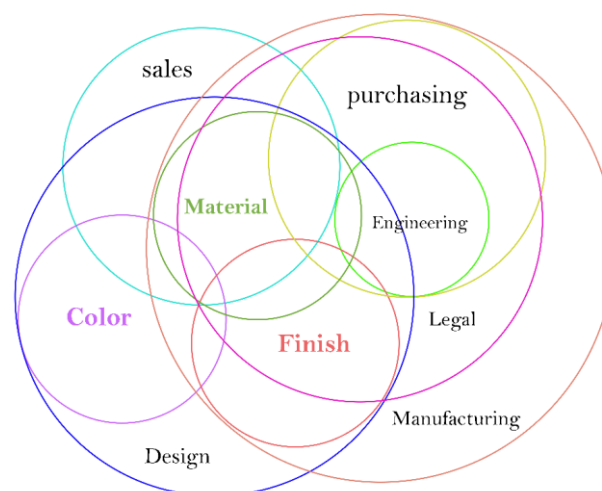
A subset within the realm of industrial design, referred to as Color, Materials, Finish (CMF), focuses on the chromatic, tactile, and decorative attributes of spaces and products. CMF significantly influences the sensory experience of interacting with objects, determining whether they exude qualities of sturdiness or delicacy, luxury or affordability. The choice of finish and materials becomes pivotal in optimizing not just the visual and tactile appeal of a product but also its practical features, including ergonomics and ease of maintenance. Throughout the product development process, engineers and designers meticulously align CMF design decisions with end-user expectations and the specific context in which the product will be used. [12]

As a product design progresses to full-scale production, the specifications related to Color, Material, and Finish (CMF) gain significance. It is essential to communicate CMF requirements clearly to the manufacturer to ensure the preservation of the initial design concept and maintain brand consistency in the final product. Clear communication of CMF specifications is crucial for accurately replicating the intended visual and tactile qualities, safeguarding the product's alignment with the envisioned design and brand identity throughout the manufacturing process.[12, 13]

## Color

When contemplating a product, color is frequently the initial aspect that comes to one's thoughts. Certain companies, such as Ferrari with its iconic red, Makita with teal, and John Deere with green, have linked their brand identity closely to specific hues. To ensure seamless communication between the designer and the manufacturer and prevent any loss of intended elements, various color schemes have been established over time.[14]

The prevalent tools employed to establish consensus on color standards are the Pantone Matching System and the RAL Color System. Designers and engineers based in the United States commonly rely on the Pantone Matching System, whereas RAL enjoys popularity in various parts of Europe. Manufacturers engaging with a global clientele typically possess familiarity with both systems. Color is typically integrated into prototypes through either painting or by manufacturing parts with inherent color. When opting for parts with color embedded within them, the primary techniques involve direct printing or the RTV casting of pigmented materials such as urethane, silicone, or epoxy.[14]



**Figure 1:** Example of Holistic CMF Design

## Material

When selecting materials, mechanical engineers and industrial designers typically collaborate to ensure that the ultimate product is not only aesthetically pleasing and tactually satisfying but also functional and readily manufacturable. The conventional "family, genus, species" classification system serves as a framework for understanding the types of materials suitable for a given product. It's akin to requesting a meal with a particular creature when you desire something to be crafted from plastic. In theory, you'll get what you asked for, but the likelihood of receiving precisely what you envisioned is minimal.[15]

Materials exhibit varying capacities for accommodating colors and finishes. Metals, for instance, offer a more limited range of color possibilities but can often be transformed through processes such as polishing, brushing, or blasting to alter their appearance. On the other hand, plastics are highly adaptable, with the ability to undergo changes in both color and texture during the production process and within the mold, making them the most easily modifiable materials.[15]

The utility and ultimate cost of a product are markedly impacted by its material specifications. For example, SLA (Stereolithography) 3D printing proves especially beneficial in crafting components that closely resemble actual, final production materials. This is made possible by the versatility of photopolymer resins, which can be engineered to possess a diverse array of mechanical qualities. Form Labs resins, for instance, are employed to replicate materials like silicone rubber, polypropylene, ABS, and glass-filled polymers using SLA 3D printing technology.[15, 16]

## Finish

The finish of a part plays a crucial role in determining its texture and appearance. It affects how light interacts with the part, influences the tactile experience for the user, and can impact the ease of cleaning if the part becomes dirty. For example, while glossy surfaces may appear stunning when a product is initially unboxed, they might wear down over time, potentially looking less appealing than a textured surface.[17]

Textures for die-cast or injection-molded products are commonly incorporated directly into the molds. This means that the molded section inherits the specified texture, ensuring uniformity throughout the entire piece. Various standards, such as those established by VDI, SPI, Yick Sang, and Mold Tech, are utilized to describe the surface textures of plastics.

However, it's essential to recognize that the depth of the texture can impact the design of the

part. For instance, if a component features a rough texture, it may exhibit a stronger adherence to the mold compared to a glossy surface. This consideration might necessitate incorporating sloping sides or a more intricate mold design to ensure the manufacturability of the item.[17]

Similar to color schemes, the consistency of surface finishes has been guaranteed through the establishment of industry standards over time. These standards are tailored to specific production methods or material classes. For instance, the Society of Plastics Industry (SPI) has developed standards for plastic parts, while organizations like the American Society of Mechanical Engineers (ASME) or the International Standards Organization (ISO) may have established standards for metal parts. These guidelines ensure a systematic approach to achieving and maintaining desired surface finishes across various manufacturing processes and materials.[17]

Plastic molding standards recommend incorporating minimal draft angles into a part to ensure precise and consistent appearance. These standards are typically embodied in extensive volumes containing various textures molded into them, made up of molded plastic sheets. Given their significant cost, it is crucial to handle these books with care to prevent any damage. These standards encompass a wide range of texture choices, including some rather unconventional options such as wood grain or the intricate PlayStation insignia carved onto controllers. Despite their uniqueness, these textures are part of the guidelines aimed at achieving specific aesthetic and functional outcomes in molded plastic parts.[18]

The SPI (Society of Plastics Industry) Standards employ a nomenclature system that combines letters and numbers to characterize the surface appearance and feel of the final plastic part. SPI offers various options for surface treatments, spanning from high gloss to untreated "as machined" surfaces. On "as machined" surfaces, witness markings from the cutting tools may be visible. There are instances where machined surfaces, including those with witness markings, are utilized on concealed interior surfaces of components. This approach is sometimes adopted to manage tooling costs, especially when the treated surfaces are not visible to the end user, as in the case of injection-molded or plastic products.[18]

Metal components offer fewer texturing possibilities compared to other materials. To impart a rough texture, they can be subjected to tumbling with polishing chemicals, resulting in a glossier appearance. Alternatively, blasting with varying sizes of glass beads or sand grains is another method to achieve a textured finish. Specific brushes on machinery can also be employed to create a uniform striped pattern on the metal

surface. For powder and electro coating procedures, there are typically a few texture options available, including matte, eggshell, and gloss. These options provide a range of surface finishes, allowing for customization based on the desired appearance and functional requirements of the metal components.[19]



**Figure 2:** Color, Material, and Finish

### **CMF design principles**

CMF (Color, Material, and Finish) designers adopt a strategic design approach that integrates optimal materials, colors, and details to imbue the product with both emotional and functional values. These designers formulate CMF strategies for product design through a comprehensive analysis of emerging materials, markets, technology, and lifestyle trends. The synthesis of these insights into the design process establishes a critical relationship between the conceptualization of the product and its distinctive attributes, contributing to the creation of differentiating components within the product.[20]

Prototyping plays a crucial role in the actual development and commercialization of products, as it allows for the integration of design skills, technology, and manufacturing processes. CMF (Color, Material, Finish) designers, evolving into seasoned professionals catering to global clients, actively participate in the entire product lifecycle—from conceptualization to manufacturing—introducing novel emotional values to consumers. The design principles of CMF emphasize a deliberate and methodical approach in selecting and arranging these components. Here are key principles in CMF design:[20]

#### **User-Centricity**

Consider the desires and preferences of the intended audience. Colors, materials, and finishes should be relatable to users, enhancing their overall experience.

#### **Cohesiveness**

Ensure a harmonious synergy among color, material, and finish selections to forge a unified and cohesive design that effectively communicates a distinct and clear message.

#### **Functionality Integration**

Incorporate CMF selections with a focus on functional considerations, ensuring that chosen materials and finishes not only contribute to the aesthetics but also enhance the usability and durability of the product.

#### **Trend Awareness**

Keep abreast of current design trends while striking a balance with timeless elements, resulting in a design that feels contemporary yet possesses enduring appeal.

#### **Cultural Sensitivity:**

Take cultural influences and preferences into account when choosing colors and materials to ensure that the design resonates on a global scale.

#### **Sustainability**

Adopt sustainable materials and processes as a testament to a commitment to environmental responsibility, meeting the increasing demand for eco-friendly products.

Applying these principles empowers CMF designers to craft products that are not only visually appealing but also functionally effective, aligning with broader design goals..[12, 20]

### **The importance of CMF**

The success of a hardware product is influenced equally by its aesthetics and functionality. The visual appearance, tactile experience, and behavioral aspects of a product play a crucial role in determining both its functional and perceived value. These combined aesthetic features are encapsulated in CMF, which stands for Color, Material, Finish. CMF dictates whether a product feels luxurious or inexpensive, robust or delicate. Defining CMF early in the product design phase is critical, as it shapes the manufacturing and post-processing processes. Clear communication of CMF specifications to manufacturers is essential to preserve the original intent of the product. The significance of CMF design lies in its profound impact on various facets of product development and user experience. Here are key reasons highlighting its importance:[21]

- **Visual Identity and Branding:** CMF choices play a pivotal role in shaping a product's visual identity, aiding in the establishment and reinforcement of a brand's image. Through consistent and thoughtful application of colors, materials, and finishes, CMF design contributes to the creation of brand recognition.[21]
- **User Experience Enhancement:** A well-executed CMF design goes beyond aesthetics;

it elevates the overall user experience by influencing the visual and tactile aspects of a product. This enhancement can significantly contribute to user satisfaction and foster brand loyalty.[22]

- **Market Differentiation:** In a saturated market, a distinctive CMF design serves as a distinguishing factor, setting a product apart and making it more memorable and appealing to consumers. This uniqueness can be a crucial element in gaining a competitive edge.[23]
- **Emotional Connection:** Colors and materials have the power to evoke emotions and shape perceptions. Through CMF design, designers can craft products that resonate emotionally with users, fostering a deeper and more meaningful connection between the user and the product.[24]
- **Functional Integration:** Going beyond aesthetics, CMF design takes into account the functional aspects of materials and finishes. This thoughtful integration enhances the usability, durability, and overall performance of the product, ensuring a holistic and well-balanced design.[25]
- **Trend Relevance:** Remaining current with design trends is crucial for CMF designers. Adapting to evolving tastes and preferences is essential to ensure that products stay relevant and attractive to the target audience. This adaptability is key to maintaining a product's appeal in the dynamic landscape of consumer preferences.[26]
- **Cultural Sensitivity:** Taking cultural influences into account in CMF design ensures that products can appeal to a global audience. This approach acknowledges and respects diverse preferences and aesthetics, contributing to the product's acceptance and success in different cultural contexts.[27]
- **Innovation and Creativity:** CMF design promotes innovation in material selection, finish techniques, and color application, fostering creativity in product development. This emphasis on inventive choices contributes to the continuous evolution and improvement of products, pushing the boundaries of what is possible in terms of aesthetics and functionality.[28]
- **Sustainability Considerations:** CMF designers are playing an increasingly vital role in promoting sustainability by opting for eco-friendly materials and finishes. This aligns with the escalating demand for environmentally conscious products, reflecting a commitment to responsible and sustainable design practices.[29]

- **Overall Product Perception:** The collective impact of colors, materials, and finishes significantly shapes how consumers perceive the quality, value, and uniqueness of a product. This influence plays a pivotal role in guiding purchasing decisions, as these aesthetic elements contribute to the overall appeal and perceived worth of the product.[30]

In essence, CMF design is essential for creating products that not only possess a visually appealing aesthetic but also align with brand values, meet user needs, and stand out in a competitive market. It represents a holistic approach that carefully considers both the form and function in the process of product development.[30]

### Color design

Expert designers and painters possess a deep understanding of the principles guiding the creation of visually appealing and attention-grabbing color schemes. However, the application of systematic guidelines that incorporate these factors has not received as much attention in the field of Color, Material, and Finish (CMF) design. The use of semi-transparencies in visualization, often employed to reveal occluded objects, further complicates matters and imposes additional constraints on the selection of a color palette due to the resulting color mixing effects. In contrast to previous approaches focused on exploring continuous-range density data through perceptual color maps, our framework applies color design principles to effectively depict characteristics in pre-classified data.[31]

Crucial for product design, our paper introduces a system designed to facilitate color design. This proposed system consists of five components: an element for assessing color harmony, a segment for combining colors, a module for judging color scheme images, a section for generating image descriptions, and finally, a part for comparing images.[32, 33]

### What's the color?

Typically, dictionaries define color in negative terms, such as "the visual property of light not related to lightness, saturation, texture, glossiness, or translucency." However, these formal definitions tend to downplay the profoundly positive impacts that color exerts on our species. From a survival perspective, color is a critical sense in distinguishing between ripe and unripe fruit, identifying safe versus hazardous meat. It also informs us about the strength of a cup of coffee, the richness of tomato puree, and the quality of beer or honey. Moreover, color enhances the complexity and immediacy of intricate visual information, as seen in warning signs and maps. Color is the



defining element for entities like football teams, snooker balls, and political parties. Its symbolism permeates the realms of great art, national flags, and corporate branding, influencing not only aesthetics but also mood and performance, while also dominating the landscape of fashion. As sensory-driven beings, we, as intellectual animals, derive a substantial amount of information about the world through our eyes, making color a pivotal aspect of our daily lives. One of its most intriguing characteristics lies in its elusive quality, proving difficult to replicate accurately in robotic gear or mathematical software. Despite these challenges, research into the intricate functionality of color remains robust and enduring.[33-44]

Moreover, the realms of industrial design and product design have extensively employed color. In product design, color stands out as one of the most vital elements in attracting buyers, complementing other considerations like texture, style, shapes, and functionality. Despite the presence of numerous theories—such as those by Goethe, Chevreul, Ostwald, Munsell, Itten, Kandinsky, Hård, and Sivik—that propose strategies for crafting harmonized color schemes, commonly known as color harmony theories.[45-47]

### Psychology of color

In product design, color psychology significantly impacts consumer perception, emotions, and behavior **Figure 3**. Understanding the nuanced psychological effects of color can empower designers to make intentional choices that enhance the overall user experience. The subsequent overview outlines common associations linked to specific colors and explores their potential impact on product design. [36, 48-51]



**Figure 3:** Color psychology, Color meanings, Color wheel

#### **Red**

Associations: Passion, excitement, energy, love, urgency.

Applications: Red is attention-grabbing and frequently employed to convey urgency or importance. Its association with passion also makes it a common choice in the food industry, where it can stimulate appetite.[52]

#### **Blue**

Associations: Trust, calmness, professionalism, reliability.

Applications: Blue is frequently chosen by brands seeking to convey trustworthiness and dependability. With its calming effect, it is commonly employed in the tech and finance industries..[53]

#### **Green**

Associations: Nature, growth, freshness, health.

Applications: Green is linked to nature and the environment, making it a common choice for products associated with health, wellness, and sustainability.[54]

#### **Yellow**

Associations: Happiness, optimism, warmth, attention-grabbing.

Use Cases: Yellow is a vibrant and attention-grabbing color. It can convey a sense of energy and optimism. However, it should be used carefully as it can be overpowering in large doses.[55]

#### **Purple**

Associations: Royalty, luxury, sophistication, creativity.

Use Cases: Purple is often associated with luxury and creativity. It's used in products where a sense of sophistication or uniqueness is desired.[56]

#### **Orange**

Associations: Energy, warmth, enthusiasm, creativity.

Use Cases: Orange is a high-energy color that can convey enthusiasm and creativity. It's often used in products related to adventure and excitement.[57]

#### **Black**

Associations: Elegance, sophistication, authority, mystery.

Use Cases: Black is often associated with luxury and sophistication. It can convey a sense of authority and is commonly used in high-end products.[58]

#### **White**

Associations: Purity, simplicity, cleanliness, openness.

Use Cases: White is clean and minimalist, often used in products where simplicity and openness are key, such as tech products.[59]

It's crucial to recognize that color perceptions can be influenced by cultural and individual differences. Therefore, designers should take into account the target audience and cultural context when selecting colors for product design. Moreover, the context in which colors are employed, including their combinations and the overall design, plays a substantial role in shaping the user experience..[58, 59]

### **Culture of color**

Color is a pivotal element in the composition of goods, services, packaging, logos, and various marketing materials. It serves as a valuable tool for shaping and upholding a company's reputation among consumers. The authors delve into the exploration of customer preferences regarding different colors and color combinations, drawing insights from an extensive eight-country study. The findings reveal both cross-cultural similarities and differences in color choices, illustrating connections with specific meanings. In the context of product logos, the research highlights that certain combinations of colors consistently convey particular connotations, while other pairings suggest complementary meanings. The authors discuss the implications of employing color management strategies to establish and sustain corporate and brand identities in global markets.[60-63]

Cultural exchange can result in a shared identification of color names grounded in the significance of color across various cultures. As Jung (1964) articulated, symbols encompass terms, names, or even images that, while familiar in everyday life, carry specific connotations beyond their conventional and apparent meanings. These symbols allude to something elusive, obscure, and unknowable. Building upon Jung's ideas, Fontana (1994) further observed that certain types of symbols contribute to a global language. The images and their meanings manifest in analogous forms, retaining comparable significance across diverse cultures and over centuries. In Jung's theory, this symbolism constitutes "the natural expression of inner psychological forces." Nonetheless, Jung's conceptualization of symbolism only partially explains the intricate and diverse symbolic vocabularies observed in different cultures.[64]

Color has never been universally used or interpreted in the same manner across cultural boundaries. Different colors often carry distinct symbolic connotations. For instance, yellow is

linked with the West in the Mayan civilization of Central America, while in Buddhist tradition, it signifies "humility" and "renunciation." In northern Europe, yellow is associated with "deceit" and "cowardice," whereas in China, it represents the color of imperialism. The root of these variations lies in the creative constraints of the human mind, influencing the symbols chosen to represent archetypal energies. The natural world further contributes to the diversification of this cultural process. Over time, color names are often shaped by the cultural elite. For instance, the color white has long been linked to concepts of virginity and purity in Western societies. This exemplifies how cultural contexts and historical perspectives can significantly influence the interpretation and symbolism of colors.[64, 65]

Color data derived from Osgood et al.'s 23-culture semantic differential research on emotional meanings reveal commonalities in color perception transcending cultural boundaries. Notably, the emotional impact of the color RED is quite pronounced. Colors like WHITE, BLUE, and GREEN are perceived as positive, while BLACK and GREY evoke negative sentiments. RED and BLACK are associated with strength, while YELLOW, WHITE, and GREY are perceived as weaker. RED is linked to activity, while BLACK and GREY are considered passive. The component of brightness, as reflected in data on WHITE, GREY, and BLACK, is closely tied to both negative potency and favorable evaluation. The analysis encompassed eighty-nine previous studies on color and emotion. These findings, along with the scarcity of exceptions in both our data and the existing literature, broadly support the notion that there are robust universal trends in the attribution of emotional meanings within the realm of color.[66]

### **Material design**

The utilization of resources is evolving, with people now engaging a broader array of materials and doing so at an accelerated pace. In fact, projections indicate that the quantity of materials required in the next fifteen years could potentially equal the cumulative amount of materials consumed over the entirety of human history. This estimate is based on the ongoing trends in global production and the continual increase in population.[67]

Material selection stands out as a pivotal stage in the product design process, wielding significant influence over the production of sustainable goods. Life cycle engineering (LCE) emerges as a premier method for choosing materials with sustainability in mind. However, it's worth noting that LCE is a resource-intensive process both in terms of cost and time. Selecting the optimal material for a sustainable product entail conducting this operation



across a vast array of potential materials, presenting an economic challenge that may not be feasible in practice. A more practical approach would involve initially implementing a preliminary filter on the suggested materials to generate a condensed list of potential candidates. Subsequently, Life Cycle Engineering (LCE) can be applied to the alternatives identified through the preliminary filtering process. Environmental friendliness serves as a suitable criterion for the early screening of options, given its paramount importance as a sustainability concern. This method allows for a more efficient and targeted utilization of resources in the material selection process for sustainable product design.[68]

The author of books such as "Transmaterial," Brownell is an architect who contends that certain products, processes, and materials are reshaping the landscape of materials and our physical surroundings. In scrutinizing the current state of architecture and design, Brownell observes that the majority of designers still tend to prioritize traditional materials over the latest innovations.[69]

Throughout history, the exploration and discovery of new materials and technologies have consistently served as a catalyst for human innovation and the initiation of new projects. The integration of these novel materials and technologies has been closely intertwined with aesthetic trends and the evolution of art, as evidenced by the history of design. Notable examples include the Art Nouveau movement, which embraced materials such as glass, molten bronze, and forged irons; the Styling movement, which incorporated steel, aluminum, and foundries; and the Pop movement, which made use of polymers in its creative endeavors.[70]

In more recent times, the discovery of new materials has played a pivotal role in driving the creation of new items. For instance, the development of high coercive force magnets facilitated the production of mobile phones, while high-purity glass played a crucial role in their manufacturing. The creation of transistors became possible with the availability of high-purity silicone. Presently, advancements in chromic materials—capable of changing color in response to light, temperature, electrical activation, chemical environments, and applied stresses and deformations—are opening up new possibilities for innovation.[71]

### **Finish design**

In the context of product design, the term "finish" refers to the final stages of the process, where the design undergoes meticulous polishing and refinement to prepare it for the manufacturing phase. The following outlines key elements involved in finalizing a product design:[72]

#### – Detail Refinement :

Guarantee that all design particulars are precisely defined and polished.

Inspect for any inconsistencies or irregularities within the design. [73]

#### – Materials and Manufacturing Considerations :

Conclude the selection of materials for the product. Take into account manufacturing

processes and ensure the design is well-suited for mass production. [74]

#### – Prototyping and Testing

Create prototypes to assess both the functionality and aesthetics of the design.

Collect feedback from users or stakeholders to incorporate necessary adjustments. [75]

#### – Documentation

Generate comprehensive design documentation encompassing specifications, drawings, and any other essential information required for production. [76]

#### – Final Design Review

Perform a comprehensive review of the entire design to identify any last-minute issues.

Ensure that the design aligns with the initial goals and requirements. [77]

#### – Presentation and Communication

Develop presentations or documentation to effectively communicate the design to stakeholders, clients, or production teams. [78]

#### – Handover to Production

Supply the production team with all essential files and information to initiate the manufacturing process. In essence, completing a product design involves guiding the concept through a meticulous and thorough process to convert it into a finalized, manufacturable product. This phase often necessitates collaboration among designers, engineers, and other stakeholders to ensure a seamless transition from design to production. [79]

### **The value of CMF design**

The design of a product's color, material, and finish (CMF) holds significant importance in determining its overall success and acceptance in the market. This design aspect involves a meticulous evaluation and selection of tactile and visual components that contribute to the product's look and feel. Thoughtful CMF design substantially enhances a product's visual appeal. This involves choosing the optimal combination of colors,

textures, and finishes that resonate with the target market while maintaining aesthetic allure. The aesthetic appeal of a product plays a crucial role in attracting customers and influencing their purchase decisions.[80]

Beyond aesthetics, CMF design plays a pivotal role in establishing and sustaining a brand's identity. Consistent use of specific colors and materials across a product line contributes to a cohesive brand image, fostering consumer awareness and loyalty. Moreover, CMF decisions exert a substantial influence on the tactile experience of using a device. The look and feel of materials can enhance customer satisfaction and comfort, contributing to an overall positive user experience.[81]

Furthermore, CMF design serves as a strategic tool for market differentiation. Products offering unique CMF options and standing out visually are more likely to attract customers and secure their loyalty in a competitive market. This design feature has the potential to distinctly set a product apart from its competitors. Another dimension of CMF design involves the emotional bond between a product and its consumers. Designers can craft goods that connect with customers on a deeper emotional level, as colors and materials have the ability to evoke specific feelings.[82]

Perceived quality is another aspect influenced by CMF design. The utilization of premium materials and finishes can positively impact users' perceptions of a product's overall quality, conveying a sense of luxury and durability. CMF design ensures that products remain contemporary and appealing to a global audience by staying attuned to design trends and cultural preferences. This adaptability is crucial for sustaining the viability of a product line and aligning it with evolving customer demands. Additionally, consumers can enhance the uniqueness of their products through customization options offered by CMF design. This feature is valued by customers for providing a layer of distinctiveness and catering to individual preferences.[83]

In conclusion, judicious choices concerning finishes and materials enable manufacturers to economize, facilitating efficient production without compromising the perceived value of the product. Essentially, CMF design is a multifaceted approach that considers the tactile, emotional, visual, and cultural aspects of a product, aiming to create items that are not only visually appealing but also resonate with consumers. This comprehensive approach ultimately contributes to the success of the product in the market.[84]

### **The future and challenges of CMF**

The inevitability of the division of labor in the CMF design field becomes apparent with the expanding scope and expertise in CMF design research. Given the intricate disciplinary background necessary for CMF design and the diverse tasks and specifications involved in design processes at different stages, the industry may witness new developments, such as:[85]

1. The abundance of independent trend research institutes that specialize in studying color, material, process, pattern, or product trends provides numerous opportunities for small and flexible entrepreneurial businesses.
2. The importance of spearheading new material research and development is set to increase, prompting CMF material suppliers to intensify their efforts as the focus on collaboration in business partnerships with brands progressively evolves towards joint development.

Advancements in material technology may enable spray-free materials to directly undergo the surface treatment process through 3D printing in terms of processing technology. The integration of 3D printing into surface finishing could eliminate the need for additional treatment of industrial item surfaces, leveraging the benefits of rapid prototyping and Mold-free 3D printing to achieve a diverse range of attractive textures. This has the potential to enhance production efficiency and reduce environmental pollution.[85]

As businesses increasingly emphasize CMF design, it is anticipated that more colleges and educational institutions will begin offering professional courses or programs in related disciplines to meet the growing demand for expertise in this field. Consistently addressing the gap in CMF design positions within a company necessitates the ongoing development of a large number of CMF design talents. However, conducting CMF design research requires proficiency in various processing technologies and production techniques, which many schools and universities currently lack. If educational institutions aspire to advance CMF design education, addressing this challenge becomes imperative.[85]

### **Conflict of Interest**

The authors declared no competing interests in the publication of this article

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### تأثير تصميم CMF على تصميم المنتج

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### المستخلص:

تقدم التكنولوجيا المعلوماتية المتقدمة وإنترنت الأشياء المستمر يؤدي إلى تقليص الحجم. يبدو أن هذا الاتجاه يدفع عملية التصميم الصناعي التقليدي نحو نقطة ضيقة. التصميم اللوني والمواد والتشطيبات، وهو مجال متخصص في التصميم الصناعي، يتفرع عن التركيز التقليدي على شكل ووظيفة الأشياء. يهتم التصميم الصناعي التقليدي في الدرجة الأساسية بتشكيل الصفات الفيزيائية والفائدة العملية للمنتجات. ومع ذلك، يقوم التصميم اللوني والمواد والتشطيبات بالابحار بشكل دقيق في الأبعاد الحسية والبصرية للون والمادة والتشطيب، مما يرفع المستوى التجريبي للمنتج. يتجاوز هذا التخصص الجمالي بحثاً، ويعطي اهتماماً متأنياً لكيفية شعور المنتج ومظهره ككل. من خلال اختيار ودمج مدروس لون و مواد وتشطيبات، يساهم التصميم اللوني والمواد والتشطيبات في تعزيز جاذبية المنتج، وإشراك المستخدم، وتحديد موقع السوق. يركز التصميم اللوني والمواد والتشطيبات على العناصر الحسية والبصرية التي تحدد هوية المنتج، وتؤثر على تصور المستهلك بوصفها بعيداً عن الوظائف الأدواتية. يبدأ الابتكار في تصميم المنتج عن طريق النظر في اللون والمواد وتقنية التشطيب. يتناول الجزء الأول من هذه المقالة قيمة وأهمية تحليل التصميم اللوني والمواد والتشطيبات من وجهات نظر المظهر الناتج وإدارة التكاليف والتصنيع وتجربة المستخدم واستراتيجية الأعمال. يرشد كيف يمكن للشركات استكشاف فرص الابتكار من وجهة نظر التصميم اللوني والمواد والتشطيبات، وتأمين المزايا التنافسية من خلال دورات قصيرة وتحديث سريع وكفاءة تكلفة. يساعد استثمار التصميم اللوني والمواد والتشطيبات في التطور في قطاع التصميم الصناعي، مما يؤدي إلى تسطيح تدريجي لأشكال المنتج وتوسيع مجال التصميم الهاردوير الفعلي..

**الكلمات المفتاحية:** التصميم الصناعي وتصميم المنتجات؛ تصميم CMF، اللون، المادة والتشطيب، التصميم..