Research on the value of CMF design in industrial products

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Abstract: With the development of information and IoT (Internet of things) technology, the product form gradually flattened, resulting in the design space of physical hardware becoming smaller and smaller, and the traditional industrial design method seems to enter the bottleneck period. CMF design, as a new product derived from the subdivision of industrial design industry, is different from the traditional industrial design ideas. It takes color, material and finishing process as the breakthrough point to carry out product design innovation. This paper first discusses the value and importance of studying CMF design from the perspectives of product appearance, user experience, manufacturing, cost control and business strategy, and puts forward suggestions that enterprises can try to find innovation opportunities from the perspective of CMF, so as to realize the competitive advantages of low cost, short cycle and fast update speed through CMF, and better promote the development of industrial design industry.

Keywords: industrial product design; cmf design; design value; industrial design industry

1. Introduction
CMF (color, material, finishing) can be understood literally as color, material and finishing process. In the field of modern design, “it refers to a new knowledge system, design method and profession, that is, CMF design method and CMF designer profession, which are widely used in automobile, home appliance, electronic consumer goods and other industries, with product color, material and finishing process as the breakthrough point.”(Li, 2019, P.2)

The concept of CMF design may be new to many people, but its related content can be traced back to the Bauhaus period. “...Johannes Itten (1888-1967), an important teacher of Bauhaus, once discussed form, color, material and texture through practical work...”(He, 2019, P.114). In the 1980s, “...with the rapid development of electronic industry and manufacturing industry, household appliances, electronic products and automobiles gradually become an important part of human life...”(Li, 2019, P.3). Limited by the slow update of core technologies, the homogenization of most products’ functions, the inability
to make essential breakthroughs in appearance modeling, and the self-requirements of enterprises to continuously launch new products, the new design thinking with color, material and finishing process as the starting point has gradually become an important factor in improving the competitiveness of industrial product appearance design. With the development of time, more targeted and more commercialized CMF design concept is emerging.

In some enterprises, in order to better complete the design scheme, the work of industrial design is gradually subdivided, and then a clear and fixed CMF design post emerged. At the end of the 20th century, Volkswagen, Philips, Motorola, Samsung and other international enterprises took the lead in establishing their own CMF design team. At the beginning of the 21st century, some large enterprises in Asia began to realize the importance of CMF design. Haier, Lenovo, GAC, Midea, Hisense, Siemens (China), Gree and other companies have set up CMF designer positions. In recent years, we can even see some professional organizations providing CMF design consulting services. All of this shows that as a new product of the design industry, CMF has been paid more and more attention by enterprises and gradually stepped on the path of professional development.

2. Definition of CMF design

Although CMF design concept appears relatively late, it is closely related to industrial design. According to the definition of industrial design given by the International Council of Societies of Industrial Design (ICSID) in 1980, “industrial design refers to the mass-produced industrial products that give new quality and specifications to materials, structures, forms, colors, surface processing and decoration by virtue of training, technical knowledge, experience and visual experience.”(Wiki pedia,2007) It can be seen from this definition that in fact, half of the early work of industrial design is related to CMF design, but at that time, there is no clear and accurate definition of CMF design in the industry.

With the increasingly professional development of the industry, now the concept of CMF design can be clearly and accurately defined:

CMF is a highly integrated design method and work category integrating creativity and management, which is different from the way of traditional industrial design. CMF design is based on aesthetics, material engineering, economics and management, closely related to popular trends. It takes color, material and finishing process as the breakthrough point to carry out innovative design, and creates innovative products that meet the design needs and user experience by achieving a high degree of unity of art and technology. (Design wind,2017,Para.4)

In addition to the three elements mentioned in CMF literally, there is also an important element that potentially affects CMF design, namely pattern. The four elements of pattern, color, material and finishing process are inseparable, which jointly act on the product and play an important role in meeting the function needs and improving the user’s sensory experience. In brief, the following aspects should be paid attention to in the process of design and production transformation of these four elements:
• Color: “Color is the most intuitive and emotional element in the appearance of products.”(Hsiao, 2014, P.613) The elements that affect color design include hue, lightness and saturation. In the design work, designers need to follow the relevant color matching theory and method, master the popular trend at all times, and then combine the brand’s market positioning to design, and finally convert the color scheme into the production language to the factory.

• Material: “Material is the material basis of product form and the carrier of product function and structure.”(Ferro, 2020, P.2) In the field of industrial design, the commonly used materials are metal, plastic, rubber, wood, ceramics, glass, etc. The selection of the main materials of the product should generally meet the strength requirements of the structural design.

• Finishing process: Finishing process here mainly refers to the surface treatment process, “specifically refers to the process operation of mechanical, physical and chemical treatment of the surface layer of the material after processing and forming.”(Brian, 1999, P.34) Common surface treatment processes include cutting, grinding, polishing, stamping, sandblasting, etching, coating, plating, etc. This requires that CMF designers not only understand the professional knowledge, but also have rich factory site experience, and can communicate well with workers.

• Pattern: Pattern can be brought by the material itself, or it can be the result of the two-dimensional pattern or three-dimensional texture formed on the product surface after the surface treatment process, which is specially designed according to the requirements of decoration or function. Pattern is an integral part of CMF design, which can improve the user’s visual and tactile experience (Figure 1).

In the practical work, according to the work content and requirements of CMF design, the design process can be divided into three stages, namely, trend research stage, design proposal stage and production transformation stage. Its main task is, first of all, the designer studies the industry trend, and gets an insight into the future market opportunities to develop a trend research report. Then, according to the trend report and the company’s positioning, the product definition is made and the design scheme is proposed. Finally, the factory implements proofing, quality monitoring and schedule control for the plan, and
finally produces the products in batches.

To sum up, it can be thought that CMF is a subdivision industry of industrial design. It is a new design method and profession integrating trend research, design, engineering and supply chain. “It relies on the market development trend and user demand, pays attention to practice, science and art, and helps the product form a unique competitiveness…”(Li, 2019, P.7), and brings greater business value to the enterprise.

3. Why should designers conduct research on CMF design

Although it can be seen that some of the world’s leading industrial design enterprises or companies have established professional CMF design teams, this is far from enough. On one hand, the scale of research on CMF design is not large enough, which shows that most enterprises and design practitioners are still not aware of the importance of CMF design. On the other hand, it is also the most important thing that with the development of information technology and the increasing demand of users for product functions, the trend of the development of science and technology products becomes to use touch screen interaction or virtual interaction as the main way to achieve functions. Therefore, the focus of most product research and development has shifted to software development, leaving less and less design space for product physical hardware, so more and more product models tend to be flat, simple and homogeneous.

In view of the current situation of this industry, the following questions must be considered: Is there still room for innovation in industrial design? Or is it necessary to carry out innovative design of product appearance? In order to answer these questions, this paper attempts to analyze them from the following two aspects.

3.1 From the perspective of product appearance design

Take the mobile phone as an example. If the smart phones of the mainstream brands in the current market are put together without lighting the screen, most of the mobile phones are similar “black boxes” in appearance, so it is difficult to identify the brand of the mobile phone at a glance. There is a fact that people can’t forget the impact of the fashionable, simple and unique appearance design of the iPhone 4 when Apple launched it in 2010. This work can be regarded as a milestone in the history of industrial design, but also triggered a new trend of modeling design. However, in the next few years, it is hard to see which mobile phone can bring such a shock in the appearance design. It shows that conventional industrial design ideas have begun to appear powerless.

At the end of 2018, Huawei launched the P20 mobile phone with gradual Aurora color on the back of the mobile phone for the first time (Figure 2). Different from the way in which the design focus is always on Modeling and structure, Huawei P20’s appearance design focuses on color, material and finishing process, and adopts “…the advanced PVD (physical vapor Deposit) vacuum gradient coating technology (Figure 3) creates a charming gradient “Aurora band” on the back of the phone…”(Baidu Encyclopedia, 2018, Para.3) which is a design idea
never appeared in the history of mobile phone design. Therefore, within ten seconds after the P20 conference, “Huawei’s sales volume of more than 100 million yuan has become understandable...” (Home of mobile phone, 2018, Para.1). And with the passage of time, it has also shown a long-term and better market performance in the product market of the same period. At the same time, Huawei has successfully achieved the uniqueness of the brand through this new design scheme. When you see someone walking on the road with a mobile phone which has gradually-changing blue and purple color you can quickly decide that is Huawei P20 without checking the brand logo.

Of course, the success of Huawei P20 in business may have other factors, “but it is undeniable that its innovative design in CMF has brought inspiration and new ideas for traditional industrial design, and also brought huge innovation space for designers.” (Chen, 2019, P.110)

3.2 From the perspective of user experience

Data shows that facing a wide range of products, “users only need 7 seconds to determine whether they are interested in this product” (Wang, 2015, P.310). The detailed chart shows (Figure 4). In just 7 seconds, 32% of the people will take function as the main purchasing factor, 20% will choose price, the remaining 8% will be affected by other factors, and 40% will choose products according to appearance. Generally, color, material and finishing process are the most important and intuitive elements that affect the appearance. This shows that before using a product, “users will judge whether they are interested in it through the color, material and finishing process of the product” (Liu, 2017,P.133). Facing the same product function and price, most consumers will determine their purchase behavior based on the appearance of the product and our subjective feelings. Therefore, it can be thought that CMF is the most expressive part of a product and the most infectious element for users.
Of course, CMF not only gives the product durability, beauty and quality, but also brings deep emotional experience to users. These experiences come from visual, auditory, tactile and olfactory senses. For example:

- In mobile portable devices, the application of sanding technology on the surface of parts contacting with the palm of the user will bring people a sense of security (increasing friction can make the portable products not easy to get rid of their hands).
- Office products with high brightness and low saturation can bring a sense of relaxation to white-collar people who are anxious and stressed. Statistics show that “people will feel depressed when they are in a low brightness color environment for a long time, and will always feel excited when they are in a high saturation color environment for a long time” (Hsiao, 2008, P.911).
- Using wood or cloth on electronic products can reduce the sense of technology and increase the affinity (Figure 5).
This kind of delicate and suitable CMF design method on the product hardware appearance will always inadvertently strike a chord among users, make the user get used to and rely on this feeling, and then achieve the effect of improving the user stickiness of the product. This kind of delicate and deep emotional design thinking is just what is easy to be ignored in the traditional industrial design.

4. The value of CMF design

In the process of product production and development, CMF design can not only solve some practical quality problems, but also help enterprises reduce production costs, and strategically bring a lot of business value for enterprises.

4.1 Control product quality through CMF design

In the process of product development, due to processing technology and other reasons, there are often some expected effects that cannot be achieved, which will affect the overall quality of the product. For example, as is known to all that most mobile phones with metal body often shield the mobile phone signal and affect the call quality, so the common practice is to divide the metal and embed a thin rubber strip in the gap to reduce the interference of metal to the mobile phone signal. But this will destroy the original continuous and concise overall sense of product modeling, which can be said to be “...the aesthetic concession made in the process of pursuing product realization in order to meet the functional requirements...” (Das, 2019, P.441) (such as iPhone 6, Huawei mate s, shown in Figure 6).

But from the perspective of CMF design, we can still control the appearance quality of products without changing the overall plan. For example, a piece of rubber can be “metallized” through color, material and finishing process to reduce the difference between it and surrounding metal materials. The realization method includes two paths:

1. Electroplate and spray on the rubber strip to make its surface metallized.
2. When making rubber strip, mix pearlescent powder or metal powder into it to make it look closer to metal texture.

Specifically, designers can realize the control of product aesthetics and quality by forming visual metallization on the rubber strip through CMF design ideas (such as Meizu Pro 5, Huawei EF 7, shown in Figure 6).
4.2 Control the cost and time of research and development through CMF design

In the later stage of product development, if cost reduction is needed, it will basically be realized by changing the CMF design scheme, which is also the fastest and most efficient way. For example, “the material of the product used to be metal, and later it was found that the plastic can also meet the structural strength through the handboard test, so there is a chance to change it into plastic material” (Nellippallil, 2018, P.11). Or, “before the surface treatment of the product, it was electroplated, and later it was found that painting can achieve the same effect” (Polyanskii, 2014, P.13). Because electroplating is more expensive than painting, in order to save cost, it is possible to replace painting process.

For a product with a long lifecycle, sometimes the product designer of the project is basically off the case. If there is a new market demand at this time, CMF designers can directly make color scheme, then take it to the customer for confirmation, and then reverse it to drawings for direct production. This not only reduces the workflow, saves time, but also greatly reduces the design cost and increases the competitive advantage.

4.3 CMF design helps enterprises develop business strategies

In addition to brand positioning, in order to use resources more safely, effectively and reasonably, designers can make different design strategies for products in different fields from the perspective of CMF design. For example:

- Home appliance industry: the focus of home appliance products is plasticity, security and durability. Then the main body of the product will be made of plastic material (about 80% of the whole body material), because the plastic is insulated and has high plasticity; some parts that are often in contact with keys and fingers are mostly made of metal (about 20% of the whole body material), because the corrosion resistance should be considered due to the high frequency of use (Figure 7).
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Figure 7  CMF design strategy of household appliances

- Electronic consumer goods industry: most of the electronic consumer goods pursue texture, intensity and sense of technology. Taking mobile phones as an example, from the perspective of cost, medium and low-end mobile phones will use plastic body (about 40% of the market), because plastic is cheap and light, and easy to bring a sense of intimacy; The high-end mobile phones usually use a metal integrated body (about 30% of the market). In addition to the strength and sense of technology brought by the metal itself, processing technology is also more difficult which make the mobile phones made of metal materials more valuable. The rest of the mobile phones will use ceramic and glass materials for its design strategy (about 30% of the market, Figure 8).

Figure 8  CMF design strategy of consumer electronics

- Automobile industry: as a large commodity, automobile has always been an important carrier for consumers to reflect their personality, taste and identity, so they will be extra cautious when purchasing. Due to different factors such as age, occupation, gender, education level, living environment and culture of consumers, everyone has different feelings and needs for cars. Taking color as an example,
a successful automobile appearance color design can not only help automobile enterprises to well divide the consumers, but also help enterprises to reasonably allocate and use resources, and focus limited human, material and financial resources on the market segments. At the same time, it can also form the brand’s unique color symbols and give full play to the maximum economic benefits. For example, according to the purchasing power of users, the automobile market can be divided into high-end, middle-end and low-end markets. Statistics show that “the high-end market prefers low saturation and neutral colors such as black, white, gray, brown and blue.” (Hsiao, 2016, P.104) The number of hue and color saturation in the middle-end market will increase, while the color in the low-end market is the most abundant. (Figure 9).

Another effective approach is that enterprises can also stimulate the consumer market by updating the CMF design scheme. Data statistics show that the marketing activity of a new product is usually only 3-5 months. Stimulating the consumer market and mastering the initiative in the market competition can be achieved by updating the product CMF design. For example, Apple launched the iPhone 7 in September 2016, but the market performance...
was weak. So five months later, Apple launched a red iPhone 7 that works with a public welfare project called red. The new red version iPhone has injected new vitality into Apple’s sluggish sales, not only expanding the brand’s influence, but also driving Apple’s share price to a new record. This is an effective way to stimulate the consumer market by changing CMF program.

5. The future and challenges

With the development of CMF design research scale and specialization, the division of labor in CMF design industry becomes inevitable. Due to the complex discipline background involved in CMF design and the different work contents and requirements of design procedures in different stages, new changes may occur in the industry, including: 1. There are a large number of independent trend research institutions specialized in the research of color trend, material trend, process trend, pattern trend or product trend, which provides opportunities for some small and flexible entrepreneurial companies. 2. The leading research and development of new materials will become more and more valuable, and CMF material suppliers will become more and more active, gradually changing from the role of cooperation to the role of joint development in the business cooperation with the brand side.

In terms of processing technology, with the development of material technology, spray free materials may one day be able to directly complete the surface treatment process of products through 3D printing. Combined with the characteristics of 3D printing without mold and rapid prototyping, the surface of industrial products may not need to be processed again to obtain a variety of exquisite texture, which can improve production efficiency and reduce environmental pollution.

In the education industry of colleges and universities, with the emphasis of enterprises on CMF design, more and more colleges and universities will undoubtedly begin to set related disciplines or professional courses. Only by continuously cultivating a large number of CMF design talents, the CMF design position gap can be continuously filled in the enterprise. However, various processing technologies and production methods are needed to be familiar with to carry out CMF design research. But most colleges and universities do not have such facilities and conditions. This is the problem and challenge that colleges and universities must face if they want to develop CMF design education.

6. Conclusion

With the rapid development of information and IoT technology, the product form is gradually flattened into the trend of industrial design in the information age, and CMF design undoubtedly provides a broader innovative prospect for the limited space of industrial product appearance design.

Of course, the development of CMF design is not to overthrow the traditional industrial design. For users, CMF design is concerned about the emotional consumption needs of users.
It will not replace the role of modeling design, structural design, functional design and user interface design in traditional industrial design, instead on their basis, it can give products more delicate quality and use experience. For enterprises, “CMF design cannot replace the important role of conventional industrial design in the development of enterprises, but it can effectively make up for the competitive disadvantage of slow product iteration speed in the conventional design mode.” (Li, 2019, P.19) Enterprises can try to find innovation opportunities from the perspective of color, material, finishing process, pattern and so on, and finally realize product innovation through the competitive advantages of low cost, short cycle and fast update speed.

However, there are still many imperfections in the current CMF design industry. It needs more responsible and powerful groups to join in. At the same time, the industry also needs to give more tolerance and help new entrants or those who are about to enter the industry. In this way, we can help the industry progress by internal and external cooperation and multi-party cooperation, so as to promote the better development of the industrial design industry.

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