

# The Application Management of Cultural Heritage Color Symbols in Contemporary Design: A Case Study of Mogao Grottoes Murals

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## Abstracts

The Mogao Grottoes in Dunhuang, a famous cultural heritage recognized by UNESCO, record every stage of the spread of Buddhism in China and preserve many ancient murals with historical research value. This study uses a questionnaire survey and case analysis to analyze the consumption situation of the Dunhuang cultural and creative market and the public's attention to commodity color, which proves that the color symbols of Mogao Grottoes have excellent market value. Secondly, the representative murals of the Sui-Tang Dynasty (AD581-907) in Mogao Grottoes are selected, the color of the images provided by the official digital platform is analyzed, and the characteristics of color matching of different contents of the murals are summarized.

The feasibility of three primary color matching methods in Mogao Grottoes murals in modern product design is evaluated based on color science, cultural research, and design principles. This paper discusses the application of color symbols of cultural heritage in the design of cultural creative products in contemporary museums. In order to protect and inherit cultural heritage, this paper integrates the ancient complex color symbols into the modern design to establish more possibilities for the protection and development of cultural heritage.

**Keywords:** The Application Management; Cultural Heritage; Color Symbols in Contemporary Design; Mogao Grottoes Murals

## Introduction

Cultural heritage is a valuable treasure left by history for humanity, with high research value. The surviving material cultural heritage serves as precious historical records and includes fascinating artistic works, which modern people love. Among the artistic methods such as patterns, lines, colors, and materials, color is the most expressive way to reflect emotions and ethnic aesthetics. As civilization advances, modern people pay more attention to the spiritual pleasure of harmonious colors, and the relationship between color symbolism and psychological needs becomes increasingly close. In art, color has surpassed the concept of physics and has become a cultural symbol that conveys the meanings of time, culture, and emotions. In the 1930s, German philosopher and founder of cultural philosophy Ernst Cassirer, along with Susanne K. Langer, established the "symbolic theory of culture," which distinguishes humans from animals by the specific "meanings" conveyed through the construction of language, mythology, art, religion, and other forms, thereby changing the world (Ernst Cassirer, 2004 : 105). For visual art, using color is an aesthetic need and is related to cultural and emotional associations, making it a special cultural symbol. Charles Sanders Peirce, the founder of American modern semiotics, proposed the semiotic trichotomy of Icon,

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Index, and Symbol based on the relationship between sign and object. He believed that the richness of symbols lies in the organic combination of the three (Justus Buchler Ed., 1955: 96). color possesses all three characteristics simultaneously. It has a decorative function for images, and the meaning of the same color can change with the "context." The relationship between color and meaning, as a "special symbol," has always been the research focus. If we manage and apply the color symbols left by cultural heritage, it can help revitalize these silent cultural artifacts.

The Dunhuang Mogao Caves, located in the northwest region of China, are a renowned world cultural heritage site. They have been preserved for over 1600 years and contain a vast collection of colored sculptures and mural paintings, documenting every stage of the spread of Buddhism in China. The existing murals cover an area of 45,000 square meters (Dunhuang Academy of Arts, 2007: 83). From its inception, the murals of the Mogao Grottoes have been subject to a dual influence, incorporating both the chiaroscuro techniques from India and Central Asia, as well as the profound "Five Colors" aesthetic perspective deeply rooted in the entire Chinese culture. These dual influences have culminated in the Mogao Grottoes murals, the world's most complete collection of colored murals.

Consequently, they have embodied the "living color standards." (Qin et al., 2018, p. 98). Among the various periods, the most remarkable ones are the Sui and Tang dynasties (A.D. 581-A.D. 907), as recorded in the "Number of Caves Excavated in the Mogao Caves during the Sui and Tang Dynasties" in the Dunhuang Art Encyclopedia published in 2020 and during this period, excavated 363 caves, accounting for two-thirds of the total, representing the golden age of Dunhuang cave art (Fan et al., 2020, p. 178). The murals from this period represent traditional Chinese aesthetics and establish a complete color system, providing abundant references for Chinese painting and modern design.

In the early 20th century, "Dunhuang Studies" emerged as an independent discipline with archaeology as its foundation. Chinese scholar Yin Ko Chen called it a "new trend in world academia" (Qu, X.2016: 46). In the 1980s, Dunhuang Studies expanded from history, anthropology, and Buddhist studies to art. However, due to limitations in color sample extraction techniques., color research only gradually became enriched in the 21st century. Professor Zhou Dazheng believed that using color in Mogao Grottoes murals was superior to other painting techniques (2000). Shi Weixiang mentioned in a research anthology that the beauty exhibited by mural colors represents the highest need of the human soul and reflects human nature, sociality, temporality, and regionalism (2002).

With the advancement of accompanying technology, official institutions such as the Dunhuang Research Institute have published a series of high-definition cave art albums and professional books and established digital museums and online virtual caves. These professionally calibrated images provide more avenues for information retrieval in fine arts, materials science, and image studies. They address issues such as the inability to sample colors in the caves due to a lack of lighting equipment, the inability to take photos inside the caves, and the limited number of cave visits. Additionally, they provide more references for Cultural Creative Product Design. Today, the Mogao Grottoes are not only a popular tourist attraction but have also spawned a series of related products such as Dunhuang cultural creative merchandise, Dunhuang dance and music performances, Dunhuang decorative paintings, and the "Cloud Travel Dunhuang" app. These products extend from ancient relics to modern life, forming a cultural and artistic ecosystem with development potential and driving the economic

development of the entire northwest region. This article focuses on the management and application of cultural heritage color symbols in modern design, proposing effective methods for the application and management of color symbols to help establish culturally branded products with regional effects and promote the sustainable development of the Mogao Grottoes cultural heritage.

### **Research Objectives**

1. The main objective of this study is to analyze consumer behavior in the Dunhuang cultural and creative market to derive new insights into the application of cultural heritage symbolism in contemporary design.
2. we aim to extract color samples from mural image data to understand the color schemes used in the Dunhuang grottoes during the Sui and Tang dynasties. These color samples will serve as a color reference for designing products related to cultural heritage.
3. we will explore the significance of color management in cultural heritage.

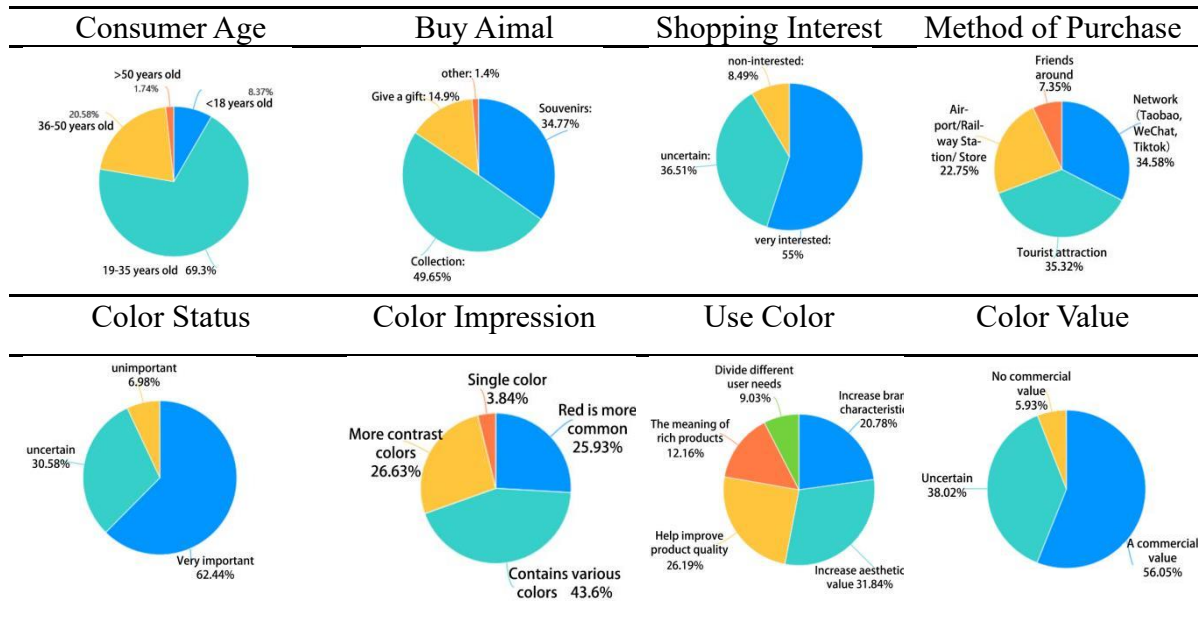
### **Research Methodology**

This study used two methods: questionnaire survey and color extraction. Firstly, use the questionnaire to understand the consumer behavior of the public in the Dunhuang cultural and creative market and to grasp the respondents' perception of the colors of the Mogao Grottoes murals. Then, representative works of the Mogao Grottoes from the Sui Dynasty to the Tang Dynasty (A.D. 581-A.D. 907) were selected from picture albums and digital image materials and classified according to these works' time and creative mindset. Finally, using different color symbols in modern design was verified through product effect demonstrations.

#### **Step 1: Dunhuang Cultural and Creative Consumption Patterns and Dunhuang Color Identity Survey**

With the development of tourism, more and more tourists come to Dunhuang, and buying a certain amount of tourism commodities has become the choice of most people. Consumers' purchasing goals, price, and demand determine the product design trend. Under this premise, from July 2022 to January 2023, the author selected five stores selling cultural and creative goods in the Dunhuang area, conducted questionnaire survey on consumers who came to visit and buy the goods, and distributed questionnaires online simultaneously, obtained 235 offline questionnaires, 900 online questionnaires, and recovered 1095 valid questionnaires. Table 1 shows the consumption of Dunhuang cultural and creative goods and the public's recognition of the color of goods and draws the following conclusions:

**Table-1**, consumer behavior and color recognition survey results of Dunhuang cultural and creative products



(1) The consumer profile and consumption purposes of the Dunhuang cultural and creative industry have changed.

According to the survey, the age group of 19-35 shows the highest interest in cultural and creative products, accounting for 69.3% of the total respondents. This age group primarily consists of college students and salaried individuals with a monthly income of around 4,000 RMB. Additionally, 49.65% of consumers collect these products for themselves, shifting from previously gifting small items to friends and family. Younger consumers place a higher emphasis on the quality and level of the products, with 55% of respondents showing a strong interest in exciting and practical products.

(2) The Internet has provided more purchasing channels for Dunhuang cultural creativity.

During this research, the widespread transmission of COVID-19 within China significantly impacted the tourism industry. To cope with the situation, official organizations like the Dunhuang Research Institute increased their investment in B2C online sales, providing purchasing channels for cultural enthusiasts. As of January 2023, the Dunhuang Research Institute has two stores on Taobao, with 110,000 and 539,000 followers, respectively. Many products have monthly sales of several thousand units, and 34.58% of consumers are willing to purchase products online. The beautifully designed webpages, short video ads, and live stream ads effectively showcase every detail of the products. At the same time, the B2C sales model provides more channels for disseminating Dunhuang artworks, increasing the audience's longing for Dunhuang tourism.

(3) Color provides immense potential for developing Dunhuang cultural and creative products.

In a survey on the importance of color in Dunhuang, 62.44% of the respondents believe color is the most prominent feature of Dunhuang's cultural and creative products. 56.05% of the participants expressed that the colors in Dunhuang murals have significant commercial value and are willing to purchase well-designed products with recognizable color symbols. Furthermore, among those who have visited Mogao Caves, everyone agrees that the murals have left them with a profound impression of colors. 31.84% of the respondents believe that color can enhance aesthetic value, and 26.19% think that color helps highlight the cultural characteristics of products. However, from the perspective of cultural product design and management, products themed around Dunhuang and Mogao Caves follow different color usage habits, which weakens the brand recognition of "Dunhuang" and affects consumers' awareness of the products.

### **Step 2: Extracting Color Samples from the Mural Paintings of the Sui-Tang Dynasty in the Mogao Grottoes**

Anthropologist MacLaury proposes that a mental reliance on spatial and temporal analogy mediates between the neural responses to the sensation of colors and their verbal categorization (Maclaury et al., 1995, p. 43). In addition to following religious principles, the study of the color symbols in the Mogao Grottoes' murals from the Sui Dynasty to the Tang Dynasty (A.D. 581-A.D. 907) can also be approached from the perspective of the psychological state of the creators when depicting different content. Modern product design can apply these symbols by understanding the color expressions of different content. This study will select digital images from [www.e-dunhuang.com](http://www.e-dunhuang.com) and combine them with mural works from books such as "The Selected Dunhuang Murals" (Zhao S., 2021, p. 23) and "Dunhuang Decorative Pattern" (Fan, J., 2016: 78).

### **Research Scope**

The collected mural materials will be categorized into three groups based on the psychological states of artistic creation.

**The First Category:** the saying of the saying related to the Shakyamuni Buddha.

The core theme of the Mogao Grottoes is murals in caves from different periods. A common characteristic is that the painters need to portray the majesty, inclusiveness, and beauty of the Buddha with a devout mindset. With established composition and color techniques, this theme's murals were already well-developed during the Sui and Tang dynasties (A.D. 581-A.D. 907). For example, to depict the hierarchical differences in the Buddhist world, the Buddha Shakyamuni is often seated at the center of the composition, wearing a red or ochre-colored monk's robe with minimal accessories, conveying a sense of dignity and nobility. On the other hand, the surrounding bodhisattvas wear robes in four primary colors - earth yellow, earth red, stone green, and stone blue - with more flowing ribbons and tassels. Their attire is represented with fluid curves and contrasting colors, capturing the movement of their garments in the wind.

**The Second Category:** Life paintings of the people influenced by Buddhism

During the Sui and Tang dynasties, the most distinctive feature of mural paintings, apart from Buddhist activities, was their "vividness." Magnificent court dances and performances, scenes of noble officials traveling, details of people's daily lives, realistic portraits of benefactors, and depictions of natural landscapes all serve as valuable cultural heritage for us.

These events and figures outside Buddhist activities added a sense of reality to the paintings, bridging the gap between Buddhist practice and the general public and expressing the creators' admiration for a good life.

**The Third Category:** Includes bold and vibrant decorative paintings

Decorative painting is one of the essential categories of Mogao Cave murals during the Sui and Tang dynasties (A.D. 581-A.D. 907). Based on the blank spaces left on the cave walls, the most common ways of decoration are "caisson patterns" on the ceiling and "vignette patterns" on the edges. The small-scale images depicted in dimly lit caves allow the creators to express themselves through colors, and the intricate and exquisite paintings convey the spiritual joy brought by the Buddhist world.

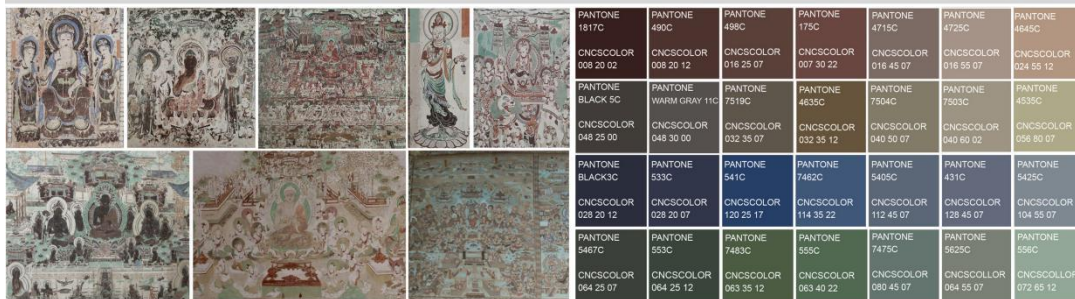
Based on the psychological states of the three types of artistic creation mentioned above, we have classified all the data, as shown in Table 2.

**Table 2:** The Sui and Tang Dynasties (A.D. 581—A.D. 907) Mogo Grottoes mural data classification.

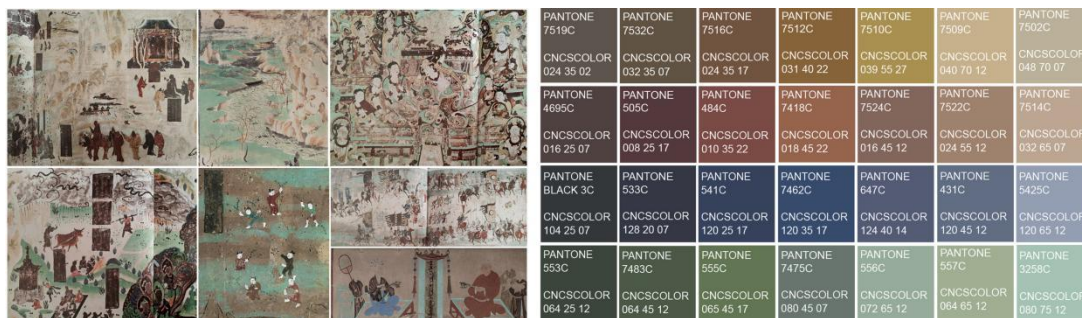
Category	Time	Cave
Buddhist story painting on behalf of "solemn and faith"	Sui Dynasty (A.D. 581—A.D. 618)	390 cave、420 cave、305 cave
	Tang Dynasty (A.D. 618—A.D. 907)	322 cave、57 cave、220 cave、321 cave、320 cave、172 cave、194 cave、217 cave、45 cave、172 cave、320 cave、112 cave、159 cave、12 cave、196 cave
People's daily-life paintings on behalf of "easy and reality"	Tang Dynasty (A.D. 618—A.D. 907)	220 cave、323 cave、23 cave、103 cave、172 cave、112 cave、156 cave、17 cave、12 cave
The decorative pattern on behalf of "personality and aesthetics"	Sui Dynasty (A.D. 581—A.D. 618)	407 cave、390 cave、427 cave、little lotus patterns
	Tang Dynasty (A.D. 618—A.D. 907)	329 cave、209 cave、Lotus caisson patterns、Flying caisson patterns、172 cave、Cave roof decoration、217 cave、172 cave、Flame decoration、Lotus pattern decoration、159 cave

Next, we will use the "eyedropper tool" in Adobe Photoshop to accurately extract the colors from the murals. We will arrange each group into seven shades based on the four primary hues (red, yellow, green, and blue), resulting in a color palette of 28 squares. After this step, we will organize the collected artwork from Table 2 into Figure 1, Figure 2, and Figure 3. The

color samples extracted from each group will be labeled with the commonly used 8-bit color codes for the computer design and the RGB color values commonly used for web pages, following the references from colortell.com.



**Figure /1/** Buddhist story representative mural color extraction (some pictures)  
 Mogao Grottoes in Sui and Tang Dynasties (A.D. 581-A.D. 907)  
 Source of the picture: [www.e-dunhuang.com](http://www.e-dunhuang.com) Tools: Adobe Photoshop software



**Figure /2/** People's Life representative mural color extraction  
 Mogao Grottoes in Sui and Tang Dynasties (A.D. 581-A.D. 907)  
 Source of the picture: [www.e-dunhuang.com](http://www.e-dunhuang.com) Tools: Adobe Photoshop software



**Figure /3/** Decorative patterns of murals  
 Mogao Grottoes in Sui and Tang Dynasties (A.D. 581-A.D. 907)  
 Source of the picture: [www.e-dunhuang.com](http://www.e-dunhuang.com) & Decorative pattern of Dunhuang various dynasties in Dunhuang Tools: Adobe Photoshop software

## Research Findings

1. The investigation shows that the murals of Mogao Grottoes in Dunhuang have left a profound impression on most people. From the color samples extracted from the above three groups of image data, we can see that their lightness and chroma present noticeable color differences:

Figure 1: Buddhist story paintings predominantly feature dark and muted color tones.

Most of the Mogao Caves murals depict the beauty of the Buddhist paradise, reflecting people's imagination of "gods" and their beliefs. The color palette in this category is mainly composed of colors with medium to low brightness and medium to low saturation. No excessively vibrant colors give a sense of tranquility and weight to the visual experience. This color scheme is particularly suitable for portraying calm and authoritative content.

Figure 2: People's daily-life paintings focus on medium lightness and purity.

The murals on this topic can be seen as paintings that depict "reality." Integrating Buddhism and secularism was the most prominent feature of Buddhist development during the Sui and Tang Dynasties (A.D. 581-A.D. 907). The Mogao Caves, the originally serene places for meditation, enlightenment, and preaching, are depicted as lively spaces with many dancers and performers. The symbolism of color is also widely seen in the murals, such as using vibrant colors to depict lively children and using blue materials to represent noble patrons. Young maidservants are portrayed in yellow clothing with hints of green, symbolizing youth and vitality. The extracted color samples show that this category of colors maintains harmony with the color scheme of Buddhist scenes but also incorporates small areas of medium lightness and medium purity to enhance the contrast and increase the viewers' sense of closeness.

Figure 3: Decorative patterns with high lightness and high chroma are predominantly used in these paintings.

The decorative patterns in the Mogao Grottoes during the Sui and Tang dynasties (A.D. 581- A.D. 907) were exquisitely adorned with contrasting colors to create a vibrant and colorful effect. These patterns, located on the roofs or at the junctions of the artwork, had fewer restrictions, allowing the creators to incorporate their own emotions. The color samples in Figure 3 show that the most commonly used color combinations in the decorative patterns were high lightness and low chroma colors, low lightness and medium chroma colors, and medium lightness and high chroma colors. The bold and exaggerated contrasting colors left a lasting impression and have become the most iconic visual symbol in the design of Dunhuang cultural and creative products.

2. From the perspective of color management, the management and application of the color accumulated in the murals of Mogao Grottoes still need to face the following problems:

(1) Dunhuang cultural and creative goods started late, and color development takes time.

As early as the 1970s, the world began to pay attention to the development and application of museum cultural and creative products; China started, in the late 1980s, to develop the museum business. In 2016, the Chinese government listed the Dunhuang Academy as one of the museum's first cultural creative product units. With the support of policies, Dunhuang's creative products began to develop rapidly in recent years, and more research is needed to develop creative products with color themes.

(2) There are many Dunhuang culture and creation types, and the color standards need official support.

From the perspective of management, overly rich product types must abide by their own industry rules, and different media carriers have their color presentation methods:

- For example, painting adopts the blending method of pigments.
- Print uses CMYK four-color standard.
- Multi-screen media takes the brightness of RGB color mode as the highest criterion.

For example, metal tea cans and silk scarves have different coloring processes. Therefore, managing and unifying the colors of Dunhuang Mogao Grottoes and professional research must be connected to promoting and supporting official institutions.

(3) Dunhuang cultural creation must build a brand image with color.

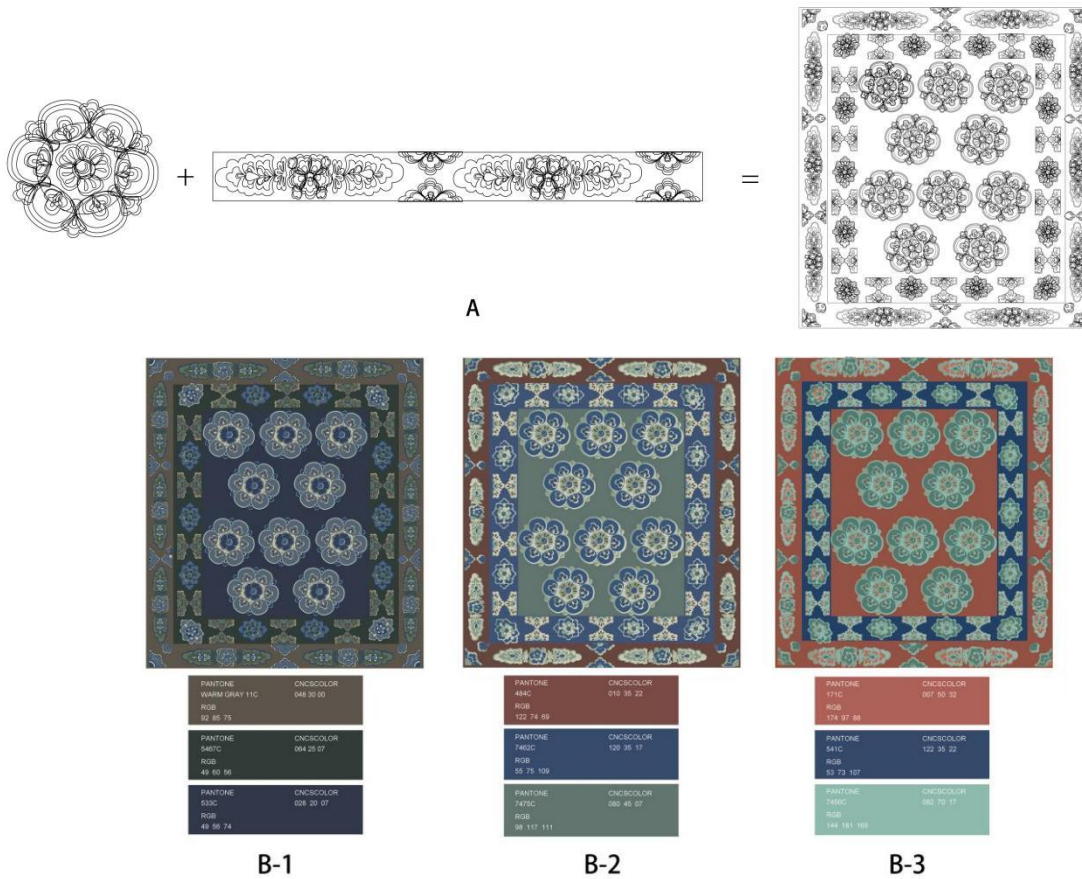
A strong brand image can enhance consumer trust and influence purchasing behavior. Using graphic symbols, color combinations, text language, and materials to shape a brand can help products stand out from fierce market competition. The Dunhuang Mogao Grottoes, as a cultural symbol in northwest China, can only be widely recognized by the public and "revitalize" cultural heritage by establishing its brand image. Utilizing the directness and symbolism of mural color symbols, connecting visual and psychological experiences with modern design, and adding characteristics of subjectivity, distinctiveness, and aesthetics are also the core elements of product competition (Liu Guohua, 2015:1).

## Discussion

In modern society, the use of color is more diverse and is no longer affected by class and belief, and scientific color concepts will guide designers to better use color. According to the color characteristics summarized by the research results of this paper, we try to combine the colors used in the three creative minds with modern product design and intuitively feel the visual differences caused by the same pattern with different colors.

### (1) Design Concept

Using the most common lotus flower motif found in the Mogao Caves murals, We arranged it in a regular pattern within a specific range. We combined it with vignette patterns around the edges to create a complete design, as shown in Figure 4-A. Then, We added the color samples and color schemes extracted from the three mural categories to the base pattern individually. When combining colors, We maintained the color using dark and muted tones, medium lightness and medium purity, and high lightness and chroma. These resulted in three different styles of base patterns: B-1, B-2, and B-3. We then applied these patterns to different products to experience the visual differences that Dunhuang colors bring to modern cultural and creative designs.



**Figure /4/** illustrates the selection and composition of the underlying pattern (A) and the coloring effects (B). B-1 represents a calm and robust appearance, B-2 conveys a sense of closeness and harmony, while B-3 portrays a sense of freedom and spontaneity.

## (2) Product positioning

The Dunhuang region was once an important trading hub along the ancient Silk Road in China; tea and silk were the most common commodities. Therefore, we primarily selected tea packaging boxes and Dunhuang silk scarves from Dunhuang cultural and creative products for this color experiment. Considering the price range of these two products, the tea boxes are priced at approximately 30-50 Chinese yuan per box, while the silk scarves range from 100-200 yuan. These two products represent the Silk Road and cater to a broader range of consumers. When the shape and material are the same, color becomes a crucial factor influencing consumer purchasing decisions.

(3) Product color design



**Figure /5/** uses the Dunhuang style tea box of the Sui Dynasty-Tang Dynasty (A.D.581- A.D.907) Mogao Grottoes

Incorporating the design from Figure 4 into the prototype of the product resulted in Figure 5 and Figure 6. In Figure 5, using subdued and less saturated colors created a subtle and elegant effect for Package A. Package B had a slight variation in brightness and saturation, giving it a natural and comfortable feel, suitable for everyday display and enhancing the ambiance. Package C constitutes the most prominent presence among the three product sets, with its pronounced use of contrasting colors contributing to a distinctive regional style that incorporates characteristic hues reminiscent of Chinese ethnic minorities. This particular color scheme is notably well-suited for accentuating the distinctiveness of the youthful demographic.



**Figure /6/** incorporates the color scheme of Dunhuang silk scarves from the Sui and Tang dynasties (A.D. 581-A.D. 907).

Figure 6 shows cases of the color effect of the soft-textured Dunhuang silk scarf. In this set of prototype images, we can observe how the silk's texture perfectly displays the characteristics of different color combinations within the same pattern. For instance, when a calm and heavy color scheme is applied to scarf A, the understated colors weaken the contrast, giving a more mature and stable feeling suitable for slightly older women. When scarf B uses

a different color scheme, the brightness and purity of the colors are closer to everyday life, with harmonious color contrasts that are suitable for most urban women. Lastly, scarf C adopts a free and bold color scheme, similar to a tea canister, making it eye-catching with a strong visual impact. This scarf has the most substantial decorative effect and is more suitable for individuals who prefer single-color accents or have a fashionable personality.

In conclusion, whether it is tea canisters or Dunhuang silk scarves, when using calm and rich color schemes, the niche attributes of the products will be more prominent, and the quality and grade will be more outstanding. Male consumers and mature urban women will be more willing to purchase. When both products use a friendly and approachable color scheme, the stable and vibrant colors will increase consumers' favorability and identification with the products, and the range of consumer groups will also be more comprehensive. Both products' final set of colors employs contrasting and bold color schemes full of exotic ethnic features. These daring and vibrant contrasting colors have become the most favored color styles for consumers who pursue individuality.

## **Recommendations**

Cultural heritage is the precious wealth left to us by history. Now, when we go to appreciate the murals of Mogao Grottoes, there is no religious "worship" psychology. Most people have an appreciative attitude toward ancient art. However, in Dunhuang Mogao Grottoes, many murals are inevitably destroyed, oxidized, and even fade after thousands of years. However, those fresh images, colorful colors, and the combined colors are still clearly visible. Through these color symbols, we can not only understand the creative state of artists in the past but also guide modern design with the help of color language.

This paper focuses on the characteristics of color matching of murals in the Sui and Tang dynasties of Mogao Grottoes. It is a significant period in Chinese history and the stage of forming its color system after cultural integration. Although this study is rigorous, following each inference step, some things could still be imperfect. For example, the images in this study are sourced from digital images and printed materials provided by the official Internet, which may have color deviations from the actual objects. However, as an attempt, in this process, we not only understand consumers' color demands for cultural heritage-related products but also find a balance point in the development and utilization of human cultural heritage by combining theory with experiment and discovering the commonality of inheritance between human emotions.

In the future, this study will continue to use PANTONE color, the color of China Popular Color Association, RGB color, and computer hexadecimal color code to establish its representative color card for the murals of Mogao Grottoes. Using color cards to manage this treasure house of cultural heritage can not only provide a color reference for modern product design but also be more suitable for the digital display of color information, perfectly solve the color difference problem in the physical production process, and provide designers with new ideas for color design.

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