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# Cultural and Creative Design of Dunhuang Murals in Xixia Period Based on Deep Learning

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In today's era of innovation and the vigorous development of the digital economy, globalization and antiglobalization are intertwined, and cultural dissemination and integration are gradually expanding the influence and scope of the era; the revival and inheritance of traditional culture have become increasingly important in our country. The development of the creative industry is becoming more and more vigorous and full of vitality. Based on deep learning algorithms, this paper studies the cultural and creative design of Dunhuang frescoes in the Western Xia period. This paper analyzes the shortcomings of the current cultural and creative market and the characteristics of high-quality cultural and creative design, analyzes the principles of cultural and creative design of cultural relics, etc., proposes a generative confrontation network model, establishes a modern cultural and creative design model, and provides a three-level cultural model for cultural and creative design. The process is analyzed. In the evaluation and analysis of users, it is concluded that the integration of traditional culture design factor score is 4.80, conforming to the modern aesthetic situation is 4.63, conforming to the user's expectation of "elegant" is 4.73, and the comprehensive score is 4.72.

## 1. Introduction

In today's era where innovation leads the vigorous development of the digital economy, and globalization and antiglobalization are intertwined, the world is paying more and more attention to the cultural industry, and the development of traditional cultural resources is becoming more and more profound. Although my country's cultural industry is in its infancy, however, it is developing at a high speed with the second-largest growth value in the world. In this process, traditional culture has become more and more valuable and meaningful to the times. Taking Dunhuang cultural and creative products as an example, the current cultural and creative market is still shallow and narrow in terms of concept mining and practical application, which is far from enough to reflect the essence of excellent traditional culture and the value of life aesthetics. Therefore, inheriting, developing, developing, and developing the "new traditional cul-

ture" with new connotations in the new era, based on deep learning, the cultural and creative design of Dunhuang frescoes in the Western Xia period is an urgent and innovative development path that needs to be explored [1, 2].

In a study on cultural and creative design for cultural heritage, Kryvuts et al. analyzed the use of immersive methods to address conservation scene design issues through the use of 3D mapping and video projection in the design of exhibition spaces and projection onto the facades of architectural landmarks to display cultural heritage elements [3]. The specific characteristics of the content of such video projections and the artistic images they utilize depend on the functional purpose of the environment in which the interactive work is presented. Qyll examines the elements and processes involved in the visual construction of persona brands, and the personas that are key components of these brands [4], in pursuit of the research question: What graphic design strategies make persona brands successful? Focus not only on the role of vision

in personal branding and modern visual branding culture. The place and form of such cultural character branding in the character research field are also considered.

The main purpose of this paper is to study Dunhuang frescoes in the Western Xia period in today's cultural and creative design based on deep learning algorithms. This article mainly analyzes the shortcomings of the current cultural and creative market; summarizes the characteristics that modern high-quality cultural and creative design needs to meet: cultural, innovative, and popular; describes the principles of cultural and creative design of cultural relics; and establishes a modern cultural and creative design model, which is divided into three levels: the external device layer, the organizational form layer, and the cultural core layer.

## 2. Research on the Background Characteristics of Cultural and Creative Design of Dunhuang Frescoes

### 2.1. Deficiencies in the Current Cultural and Creative Market

(1) Although the current theoretical literature research on traditional culture is complex and numerous—for example, the theoretical research on the history of Dunhuang art philosophy and the history of mural art in my country has been relatively complete, and is still constantly improving, but it has not been able to organize and improve it. The theoretical system that can be applied to the actual design and developed and applied. As a result, the modern cultural and creative design theory and design practice in such traditional cultures are relatively separated. Common designs in the market mostly stay at the layer of external artifacts and organizational forms but fail to dig deep into the core layer of culture

(2) In the current market of traditional culture and modern cultural and creative design for the consumer group of their own ethnic group, most consumers' understanding of many traditional civilizations including Dunhuang culture and their sense of national cultural identity need to be improved urgently. Design is in a predicament that can neither impress local consumers nor enter the international market

(3) As far as the current design environment is concerned, most of the cultural and creative designs from inspiration to actual product formation mainly rely on the subjective emotions of the designers themselves and rarely combine rational analysis such as modern Kansei engineering theoretical models and data algorithm means, which leads to too much subjective emotion in the design

(4) Whether it is Dunhuang cultural and creative design or other modern cultural and creative designs based on traditional culture, the language of expression is usually too formal, and the means of expression are relatively simple, which are more commonly concentrated in application fields such as daily products and handbook stationery. There are few fields of combination of business models

In addition, even though my country's cultural service industry and cultural and creative industry are in the take-off stage, there is still a lack of a systematic model for modern cultural and creative design based on Chinese traditional culture. Therefore, a model of traditional culture that is universal, flexible, and simple and has high practicability applied to modern cultural and creative design is extremely valuable [5, 6].

### 2.2. Features of High-Quality Cultural and Creative Design.
Through the analysis of cultural and creative product design, it is concluded that the characteristics that modern high-quality cultural and creative design needs to meet are cultural, innovative, and popular; these three points are also closely related.

Culturalness refers to the utilization of traditional cultural elements and the inheritance of cultural connotations. While taking into account the tradition, it can be combined with modern culture, so as to bring about exchanges and collisions between cultures, reflecting innovation and cultural popularization.

On the one hand, creativity must take into account the cultural nature. It should not be fabricated out of thin air to lose the cultural connotation. Instead, innovation should be based on traditional culture and art. Now, many cultural and creative products still use the design method of direct use of traditional patterns. Traditional patterns are of course highly artistic. Value, but appropriation is not a real design, and it is also necessary to pay attention to the combination with the carrier in the application and make appropriate adjustments. On the one hand, we should pay attention to universality, while inheriting and disseminating traditional culture and using creative means to make it radiate new vitality and be closer to modern life.

Popularity requires rational use of culture and innovation. Cultural and creative design is ultimately used by people. Today, young people are the main user group of cultural and creative products. These groups of people have a higher degree of acceptance of culture and the pursuit of individual creativity. Therefore, it is necessary to choose a suitable carrier and use creativity in the design process to make cultural and creative products more acceptable, loved, and used by young people [7, 8].

### 2.3. The Principles of Cultural and Creative Design of Cultural Relics

#### 2.3.1. The Principle of Respecting the Authenticity of Cultural Relics.
Cultural relics are precious relics passed down by civilization, and they are also irrefutable evidence of national memory. The historical authenticity behind cultural relics cannot be tampered with or violated. The authenticity in the field of cultural relic protection is often based on a certain degree of integrity. When cultural relics are damaged or lost, valuable historical information should be explored as much as possible in the early stage of cultural and creative

design and development. The expression is not made up out of thin air but based on the remnants of cultural relics or historical records, which are summarized and refined and visually recreated [9, 10].

*2.3.2. The Principle of Technology Empowering Culture.* The advancement of science and technology, along with the improvement of productivity, brings vast imagination and possibilities to design. Ancient cultural relics are not the opposite of new technologies. The latter can often give the former new vitality and have enough energy to pass on history. The interactive and immersive experience of cultural and creative products will make rapid progress in stages, and the distance between the audience and cultural relics will also be one step closer.

*2.3.3. Principles of Emotional Fusion Function.* Cultural and creative products based on cultural relics organically unify culture and commodities to create functional and practical products. Emotional design has occupied an important position in product design. For cultural and creative design, the structural layout, operation mode, or functional realization of products are based on the needs of the behavioral layer, and the humanistic connotation of cultural heritage is transmitted and strengthened through design.

*2.3.4. The Principle of Multidimensional Differentiation.* Most of the existing brands of cultural and creative products are based on the cultural objects they are designed, and there is a lack of brands with cross-border and cross-cultural influence like Alessi. It is difficult to have a strong positive influence on the cultural creation of the Dunhuang Grottoes, although the cultural and creative product lines of the two have many similar categories. At present, we are in a society with excessive Internet communication, and we are actively or passively bombarded with a large amount of information every day. The homogenization of cultural and creative products is a common problem. For cultural and creative design, it focuses on potential customers rather than products and seeks to differentiate and fill "vacancies" in the market. Establishing the differentiated concept of "damage" and carrying out serialized extension development for cultural and creative products can greatly improve the communication efficiency of brand products and occupy the market segment space of existing cultural and creative products.

*2.3.5. There Is no Lack of Interest in Depth.* The cultural and creative design based on damaged cultural relics should reflect the historical context and deep cultural connotation behind it and not only convey cultural information from external forms. It is difficult to convey the profound historical and cultural value of cultural heritage if it is simply used for design, such as the ornamental shape of cultural relics, and emphasis is placed on the appearance of products. After investigation by the author, it is found that many cultural and creative products of cultural and blog have designed a lot of so-called "Q version," "cute," or low-age designs in order to attract and cater to young people. Teenagers are an important group that inherits the excellent culture of the Chinese nation, and they are also one of the key con-

sumers of cultural and creative products. In the face of such groups, cultural and creative products should shoulder the responsibility of auxiliary education, correctly guide the historical values of young people, and stimulate national pride. It is necessary to take into account the cultural depth in cultural and creative products and at the same time use vivid and interesting product design to attract consumers and achieve the purpose of educational communication [11, 12].

*2.4. Generative Adversarial Network Model.* The basic network model structure of a generative adversarial network is shown in Figure 1.

*2.4.1. Mathematical Principles of the Generative Adversarial Network Model.* There are many mathematical formulas used in the generative adversarial network model (GAN). For the convenience of the following description, the following mathematical symbols will appear:

Date: real data.

$P_{\text{date}}$: real data distribution.

$P_{\text{g}}$: data distribution after generator.

One of the principles of generative adversarial network models is KL divergence. For discrete probability distributions, the definitions are as follows:

$$D_{\text{KL}}(P\|Q) = \sum_i P(i) \log \frac{P(i)}{Q(i)}. \tag{1}$$

For a continuous probability distribution, it is defined as follows:

$$D_{\text{KL}}(P\|Q) = \int_{-\infty}^{+\infty} P(x) \log \frac{p(x)}{q(x)} dx. \tag{2}$$

In addition, one of the key mathematical principles of generative adversarial network models is maximum likelihood estimation.

(1) If the population $X$ is discrete

If the distribution law is $P\{X = x\} = p(x;\theta)$, $\theta$ is the parameter to be estimated, and $p(x;\theta)$ represents the probability of occurrence of $x$ when the estimated parameter is 0:

$$L(\theta) = L(x_1, x_2, \cdots x_n) = \prod_{i=1}^{n} p(x_i;\theta). \tag{3}$$

(2) If the population $X$ is continuous

Suppose the probability density is $f(x;\theta)$, and $\theta$ is the parameter to be estimated:

$$L(\theta) = L(x_1, x_2, \cdots x_n) = \prod_{i=1}^{n} f(x_i;\theta), \tag{4}$$

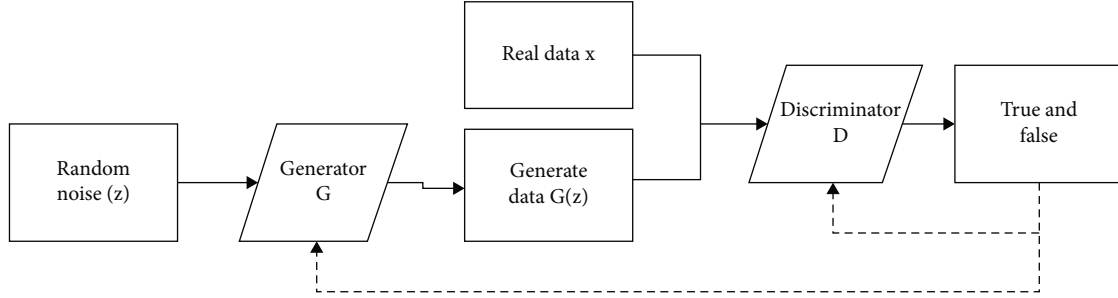where $L(\theta)$ is called the likelihood function of the sample.

FIGURE 1: Basic structure of a generative adversarial network.

## 3. Research on the Classification of Cultural and Creative Design Models of Dunhuang Murals

*3.1. Modern Cultural and Creative Design Model.* Here, we propose a universal modern cultural and creative design model that refines traditional cultural elements. Different from the design logic of traditional cultural and creative design that "looks at design from an artistic and commercial perspective," here, from the perspective of historical civilization, modern cultural and creative design based on traditional art is regarded as a multifaceted art problem, commercial problem, and historical and sociocultural issues. Taking the flying theme in Dunhuang fresco art as an example, this paper analyzes and studies the Dunhuang fresco art from the three levels of "external object layer-organizational form layer-cultural core layer" and extracts it in layers. The specific steps are shown in Figure 2.

The three levels are as follows:

Cultural core layer: according to the means of consulting materials, research, etc., to understand the historical changes and social background of the main culture of the study and refine the general design style and its reasons.

Organizational form layer: select a more appropriate expression method according to the market trend of similar products, the market trend of complementary products, and the overall design trend of society.

External device layer: integrate design elements and retain the corresponding $X$ elements according to the main design style keywords after dimensionality reduction.

*3.2. The Three-Level Cultural Model Process of Cultural and Creative Design.* In the process of extracting Dunhuang Feitian mural art in the design practice part:

At the cultural core level, we can deeply excavate the economic and social background of the evolution of art in different dynasties, combine it with the characteristics of art style and painting method, retain the core spirit and characteristics of Dunhuang traditional art culture, and retain and emphasize Dunhuang mural local color and national identity in art.

In the process of extracting the organizational form layer, the modern design language and expression form are crowned with the core of Dunhuang's traditional spiritual civilization, the existing design expression forms are classified from different dimensions, the user group is finely
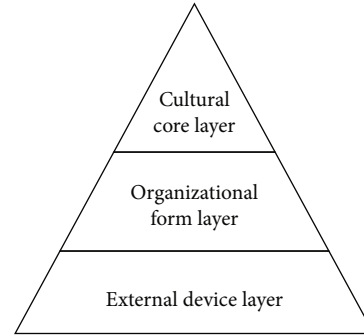


FIGURE 2: Three-level model of modern cultural and creative design based on traditional culture.

TABLE 1: Evaluation results.

| Evaluation standard | Integrate into traditional culture | 4.80 |
| | In line with modern aesthetics | 4.63 |
| | User expectations and satisfaction | 4.73 |
| | Overall ratings | 4.72 |

divided, and the appropriate product positioning is determined, so that the "New Dunhuang" cultural creation has a broad and clear expression, trying to balance the excessive entertainment characteristics of the modern market with the serious and obscure characteristics of traditional culture through design practice.

In the external device layer, the complex and multidimensional perceptual feature vocabulary can be reduced and grouped by the principal component analysis (PCA) method, and a multidirectional element table can be established for design practice for reference.

*3.3. Classification of Dunhuang Cultural and Creative Industries in the Market.* The cognition of the IP paradigm in this paper is based on its dimensions, which are roughly divided into single-dimensional, two-dimensional, three-dimensional, and four-dimensional + (multidimensional).

*3.3.1. One-Dimensional Design.* The single-dimensional representation of IP only takes time, space, or other single forms as the reference axis to fully interpret and interpret the target content, which can be in the form of words, language, myths and legends passed down by word of mouth,
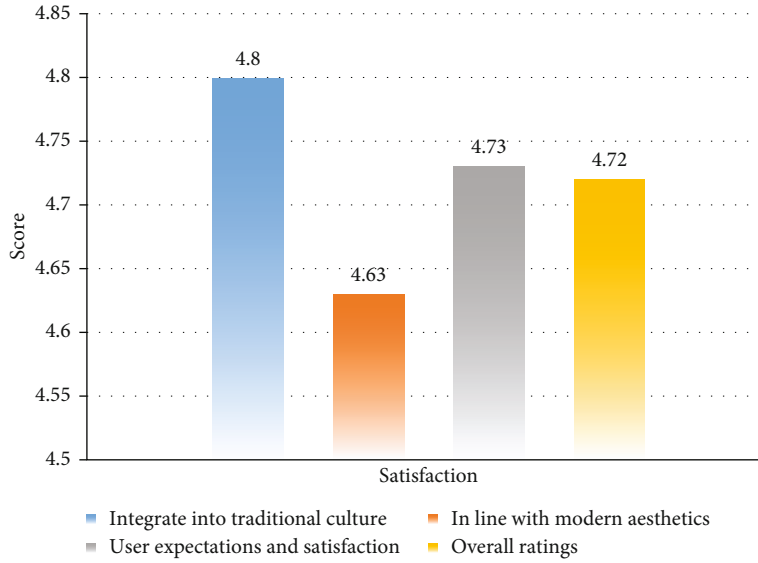
FIGURE 3: Analysis of evaluation results.

and musical tunes. Taking Dunhuang fresco art as an example, the single-dimensional expression derived from the content of Dunhuang frescoes includes melody music. For example, "Dunhuang" by the Twelve Women's Band uses folk music to reconstruct the gods and Buddhas dancing in the sky in the frescoes only from the auditory texture.

*3.3.2. Two-Dimensional Design.* Generally, graphic designs such as logos and logos, mural restoration, posters, postcards, and other pattern-based cultural and creative product designs are mainly used. It uses "visual effects" as the communication medium and expresses the creator's thoughts and information through the combination of words, texture symbols, patterns, etc., which has a visual impact and is an irreplaceable and extremely important link and step in creating cultural IP.

Taking the innovation of Dunhuang art culture as an example, the common two-dimensional expressions include artistic calligraphy and painting, restoration of frescoes and caissons, posters, postcards, peripherals of handbags, product packaging, and patterns on fashion. In the creative process, there are ways to create based on the extraction of abstract elements, such as extracting only the representative colors of Dunhuang, extracting abstract patterns from caisson wells and murals for application, and extracting abstract symbols or element units according to the main tonality of culture, etc. There are also ways to create based on figurative elements.

*3.3.3. 3D Design.* In the construction of cultural IP, 3D design can make people perceive and interact more intuitively from the senses such as vision and touch, and its characteristics are mainly reflected in the real three-dimensional tactility. Most of the three-dimensional expressions based on Dunhuang mural art are the design of Dunhuang-related peripheral products, Dunhuang-style architectural design,

TABLE 2: KMO and Bartlett tests.

| KMO sampling suitability quantity | | 0.618 |
|---|---|---|
| Bartlett's sphericity test | Approximate chi-square | 118.936 |
| | Degrees of freedom | 45 |
| | Salience | 0.000 |

interior design, exhibition hall design, Dunhuang colored sculptures, Dunhuang series of artistic image cosplay, etc.

*3.3.4. Multidimensional (Four-Dimensional +) in the Context of Fusion Media.* With the continuous development and improvement of productivity, technology, and service systems, service forms such as CIS system design, service design, interactive multimedia innovation, and exhibitions that rely on streaming media have emerged. Complex and diverse. A large part of the multidimensional expression design based on Dunhuang mural art focuses on the commercial cross-border, activities, performances, and other forms of cooperation with the brand.

*3.4. Develop Series of Cultural and Creative Products by Category.* Cultural and creative products are an important carrier of cultural connotation. If contextual connotation is compared to the soul, then cultural and creative products are flesh and blood. In addition to following design principles, cultural and creative design also needs to abide by brand values and concepts. The dynamic graphic design language in the digital age brings more possibilities for online cultural creation and also lays advantages and convenience for the dissemination and promotion of offline creative creation.

*3.4.1. Functional Cultural and Creative Products.* Cultural and creative products that meet the daily needs of consumers and have practicality take into account both

TABLE 3: Principal component analysis result table.

| Factor | Vocabulary group | Factor load | Total | Percent variance | Cumulative variation % |
|---|---|---|---|---|---|
| Factor 1 | Gorgeous-rustic | 0.893 | 5.467 | 54.669 | 54.669 |
| | Noble-common | 0.939 | | | |
| | Exotic-native | 0.803 | | | |
| | Optimistic-compassionate | -0.779 | | | |
| | Divine-human | 0.901 | | | |
| Factor 2 | Soft-tough | 0.827 | 2.610 | 26.079 | 80.766 |
| | Flamboyant-steady | 0.617 | | | |
| | Dynamic-static | 0.891 | | | |
| | Dashing-serious | 0.985 | | | |
| | Vigorous-mysterious | 0.771 | | | |
| Extraction method: principal component analysis | | | | | |
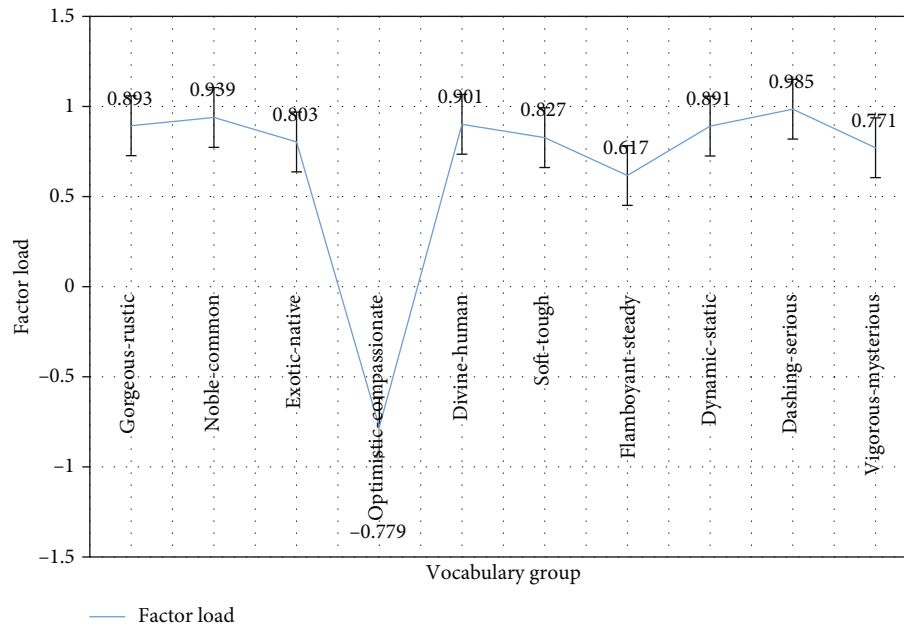


FIGURE 4: Principal component result analysis chart.

aesthetics and functions and trigger consumers' desire to buy through visual effects and practical functions.

*3.4.2. Educational Cultural and Creative Products.* Educational dissemination of cultural and creative products for young people and groups interested in history and culture, while experiencing the cultural and creative products deduced by dynamic graphics, understands the story behind the damage and triggers reflection.

*3.4.3. Interactive Cultural and Creative Products.* The Internet allows consumers to transform their identities between producers and users, breaking consumers' passive acceptance of the design results of creators. Users can create their own unique cultural and creative products to meet the individual needs of young consumers and bring more benefits. Immersive interactive engagement.

*3.4.4. Service-Oriented Cultural and Creative Products.* Expand cultural and creative services provide additional travel experience for tourists and consumers and provide consumers with convenient tour service products when traveling offline in scenic spots.

## 4. Experiment Analysis of Cultural and Creative Design of Dunhuang Frescoes

*4.1. User Evaluation.* In order to verify the effectiveness of the extension and reconstruction design, this paper evaluates the output graphic design scheme based on the user satisfaction in turn integrating traditional culture, conforming to modern aesthetics, and user expectations and satisfaction. Using the fifth-order semantic difference method, the scoring criteria are as follows: ① whether it incorporates

traditional cultural design factors, ② whether it conforms to the modern aesthetic situation, and ③ whether it meets the user's expectation of "elegant." The scoring system is 1-5 integer points, respectively, 1 very unsatisfactory, 2 unsatisfactory, 3 agreeable, 4 somewhat agreeable, and 5 very agreeable. 15 reviewers were selected for scoring, including 7 designers and 8 users. The evaluation results are shown in Table 1.

As can be seen from Figure 3, the score of integrating the traditional culture design factor is 4.80, conforming to the modern aesthetic situation is 4.63, conforming to the user's expectation of "elegant" is 4.73, and the comprehensive score is 4.72. According to the evaluation results, the extension reconstruction design process has certain innovation and effectiveness. It not only incorporates traditional cultural design factors and conforms to the modern aesthetic situation but also meets the user's expectation of "elegant."

*4.2. Principal Component Analysis of Consumer Perceptual Evaluation.* Through observation and analysis, the perceptual tendency of the tested group to different sample elements was obtained. For the multiple perceptual vocabularies, the principal component analysis method was further used for the sample data, and the dimensionality reduction analysis was carried out on the data. The specific results are shown in Table 2.

The value of KMO is 0.618, which can be used for factor analysis. Factors greater than 1 are extracted from the eigenvalues of factor analysis. It can also be seen from the gravel diagram that the second factor is relatively flat, two principal component factors were retained, and the cumulative explanatory variables were 80.766% as shown in Table 3.

Analyzing Figure 4, it can be seen that they are constructed by two perceptual lexical factor axes, respectively. Although the first set of perceptual factor axes corresponds to the words "beautiful-plain," "noble-popular," and "exotic-local," the factor loadings of optimistic-compassionate and divine-humanity are 0.893, 0.939, 0.803, -0.779, and 0.901, respectively, which have a relatively high correlation with factor 1, while "soft-hard," the factor loadings of "public-stable," "dynamic-static," "sleek-serious," and "booming-secret" were 0.827, 0.617, 0.891, 0.985, and 0.771, respectively. Factor 2 is highly correlated. According to the dimensionality reduction analysis, it can be seen that factor 2 is a relatively direct evaluation of perceptual intentions that can be obtained through intuitive observation, and factor 1 requires a certain cultural understanding and is a deeper and more implicit perceptual intention. Therefore, the first group of principal components can be defined as deep understanding factors, and the second group of principal components is intuitive perception factors.

## 5. Conclusions

The advent of the era of digital technology has released a vast imaginary space for the cultural and creative industry. Cultural and creative products are no longer limited to the extraction of static graphic elements. The popularization of new Internet media has not only changed the communication channels but also changed the traditional cultural and creative design. Strategies and performance methods. Tak-

ing the modern cultural and creative design of Dunhuang mural art as a practical case, this paper analyzes the shortcomings of the current cultural and creative market and the characteristics of high-quality cultural and creative design. Combined with the principles of cultural and creative design of cultural relics, based on deep learning algorithms, a generative adversarial network model is proposed. This paper introduces the modern cultural and creative design model and analyzes the process of the three-level cultural model of cultural and creative design. This paper innovatively combines its history and culture, artistic design, and modern business model, takes Dunhuang Feitian as the core theme, combines cultural analysis with Kansei engineering experiments, and analyzes the cultural core of Dunhuang traditional mural art with modern behavioral logic. Innovatively explore the balance and entry point of Dunhuang traditional art and modern market trends.

## Data Availability

The data underlying the results presented in the study are available within the manuscript.

## Conflicts of Interest

The author declares there is no potential conflict of interest.

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