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Transformation of Prairie Cultural Symbols into Public Art under Parametric Technology

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Abstract: In the era of science and technology, due to the continuous development of digital technology and the continuous integration of traditional grassland culture, traditional grassland culture has been forced to start the road of digital transformation, and what method can be used to effectively and quickly improve grassland cultural symbols for public art The level of transformation has become one of the current research topics of great concern. In response to this problem, it is of great research significance for the field of public art transformation of grassland cultural symbols. With the in-depth research on digital transformation technology, the research on the transformation of parametric technology in public art is gradually carried out, and its performance advantages are of great significance to solving the problem of cultural symbol art transformation. This paper aims to study the public art transformation of grassland cultural symbols based on parametric technology. Through the analysis and research of grassland cultural symbols and parametric technology, it can be applied to the construction of the public art transformation model of cultural symbols of the Senate, so as to solve the problem of the current situation. The problems of low conversion and poor quality of public art of grassland cultural symbols. This paper analyzes grassland cultural symbols, public art transformation and parametric technology, conducts an experimental analysis on the transformation of grassland cultural symbols to public art based on parametric technology, and uses relevant theoretical formulas to explain. The results show that the comprehensive satisfaction index of the method based on parameterization technology is higher than that of the traditional method, and the difference between the two is 16.53%. It can be seen that this method can meet the needs of improving the level of public art transformation of grassland cultural symbols, and the efficiency and quality are greatly improved.

1. Introduction

In the current surging trend of public art, traditional cultural industries have joined the queue of

public art of cultural symbols, and ordinary cultural product design cannot meet the increasing requirements in terms of quality. The symbol of grassland culture is the symbol of traditional grassland culture, which can reflect the life of grassland people and is the most representative element of grassland cultural life. It has been widely integrated into the design of products in various fields. As for the continuous development of the current digital technology, a large number of grassland art and culture contents exist in the form of images and texts and are integrated into the design of various art products, but the quality is not high. Therefore, improving the level of public art transformation of grassland cultural symbols is important for preservation. And the development of grassland culture has far-reaching significance. Parametric technology has a good effect on the transformation of grassland cultural symbol art to be solved and has fewer restrictions, so its application range is very wide. In recent years, some scholars have applied parametric design to the problem of prairie cultural symbols—artistic, but the application quality of parametric technology in this area is not high. Therefore, it is of great significance to apply parametric technology to the research on improving the transformation level of grassland cultural symbols in public art.

At present, with the continuous advancement of the artistic transformation of cultural symbols in the era of art and technology, more and more scholars have explored the transformation of grassland cultural symbols into public art. Among them, Downey H, in order to study the neglected practical use in the transformation of grassland culture public art, some scholars analyzed the Londonderry Temple and explained this transformative dynamic [1]. In order to better understand and transform grassland cultural symbols, some scholars rely on the unique natural and humanistic characteristics of Central Asia to sort out the landscape elements such as architecture, sculpture, and plants from a cultural perspective [2]. In order to conduct a deeper research on the steppe culture, LIU conducted an analytical study on the cultural symbol of Akkorongtigi in the Makassar wedding tradition by using semiotic methods [3]. In order to better display the prairie cultural symbol artwork, Salam N studies a reconfigured lighting system to illuminate it [4]. In order to probe deeper into the problems that arise in the transformation of public art from the prairie cultural symbols, Kisin E's influence on the pursuit of changing art theory and contact with non-classical art in the mainstream art world traces the relationship between contemporary art and anthropology [5]. However, there is no specific method for the public art transformation of grassland cultural symbols.

The parametric technology can be used in the transformation of grassland cultural symbols public art, and has a good performance in the convenience and integration of data modification. Among them, for the study of parametricity in steppe cultures, Meyer CH exemplified the main challenges in this research field and mature reduction techniques, at that stage, ignoring parametric dependencies [6]. In order to study how to meet the personalized design needs of public art culture in parametric design, Holder K demonstrated the use of a graphic-based design language for automatic gear synthesis and automatic three-dimensional arrangement of gear set parts [7]. In order to explore the method of parametric technology for the transformation of grassland symbol public art, Kumar S analyzed a computer-aided system for parametric design of composite molds [8]. In order to explore the selection of parameter estimators in parametric techniques applied to the transformation of grassland cultural symbols in public art, Lacour C explained some general thoughts on the calibration problem of estimator selection methods [9]. These methods have affected the public art transformation of grassland cultural symbols to a certain extent, but their effect on improving the transformation level of grassland cultural symbols in public art is limited.

In order to solve the above-mentioned problem of the low level of public art transformation of grassland cultural symbols, this paper uses parametric technology to analyze the transformation of grassland cultural symbols public art, and through experiments on its effects, in order to achieve the purpose of improving the transformation level of grassland cultural symbols public art. The innovation of this paper is: using parametric technology to analyze how grassland cultural symbols,

public art and parameterization play a role in the research on the transformation of grassland cultural symbols to public art under parametric technology. The proposed method for the transformation of grassland cultural symbols to public art is expounded. Through experiments, it is found that this method has a good effect on the artistic transformation of grassland cultural symbols, is more practical, and greatly improves the quality level.

2. The Transformation Method of Grassland Cultural Symbols Public Art under Parametric Technology

2.1. The Research Content and Organization of this Paper

As the idea of cultural integration is deeply rooted in the hearts of the people, the defects and deficiencies of the traditional way of public art transformation of cultural symbols have become increasingly prominent, so it is very important to improve the level of public art transformation of cultural symbols [10-11]. Grassland cultural and artistic works are shown in Figure 1:

(a) Prairie cultural symbols

(b) Part of the artwork

Figure 1. Grassland cultural and artistic works

Through the investigation, it is found that the current research on the transformation of grassland cultural symbols public art under parametric technology is not complete enough, so this paper proposes a method and simulation of grassland cultural symbol public art transformation based on parametric technology [12-13]. This paper analyzes the parametric technology and methods of the transformation of grassland cultural symbols public art, applies parameter technology and other related methods to the transformation of grassland cultural symbols public art, and proposes a new method. Simulation and experiments show that the conversion method of grassland cultural symbols public art incorporating parametric technology is better than the ordinary method in terms of the quality of the output. The organization structure of the full text is shown in Figure 2:

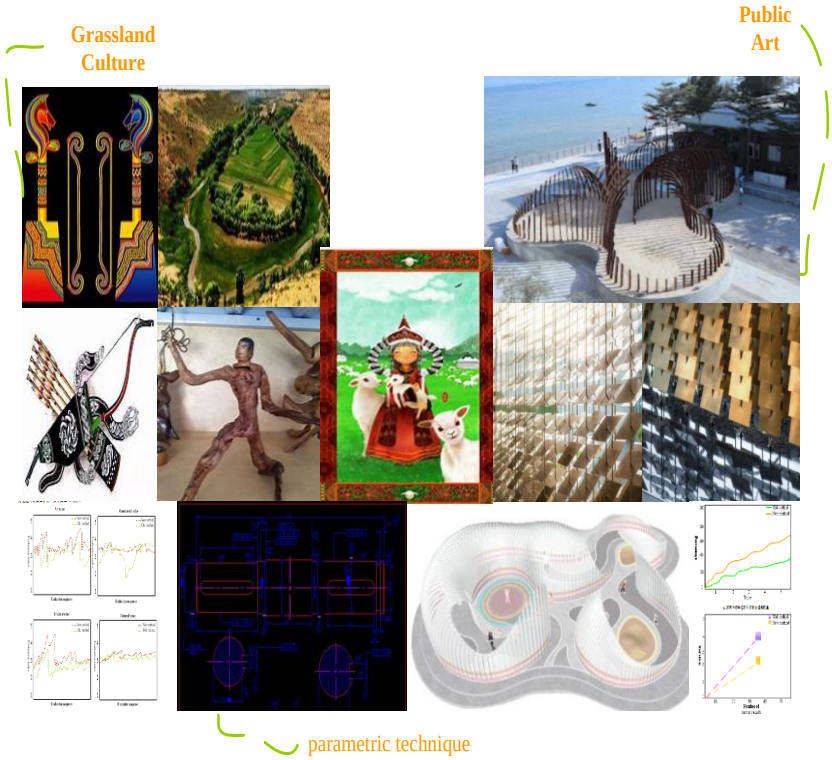


Figure 2. Full-text content organization structure

As shown in Figure 2: The full text of this study consists of five parts. The first part mainly introduces the research background of the transformation of grassland cultural symbols to public art under the parametric technology, and elicits the problems to be solved to illustrate the purpose and significance of this research. A general analysis is made on the research status of the field of artistic transformation materials and the application of parametric technology, and the content and innovations of this paper are explained. The related methods of public art transformation and parametric technology are analyzed, and the proposed new art transformation methods are described; the third part describes the data sources of the public art transformation research of grassland cultural symbols under parametric technology in detail. The fourth part is the conclusion after analyzing the result data; the fifth part is the conclusion.

2.2. Transformation of Prairie Cultural Symbol Public Art Integrating Parametric Technology

In this paper, parametric technology is applied to the transformation of grassland cultural symbols in public art to optimize the parameter problem of grassland cultural symbols in public art transformation, and to achieve the effect of improving the transformation level of grassland cultural

symbols in public art. The related methods are analyzed below.

Parametric design takes constraint modeling as the core and dimension-driven features [14]. The parametric design is shown in Figure 3:

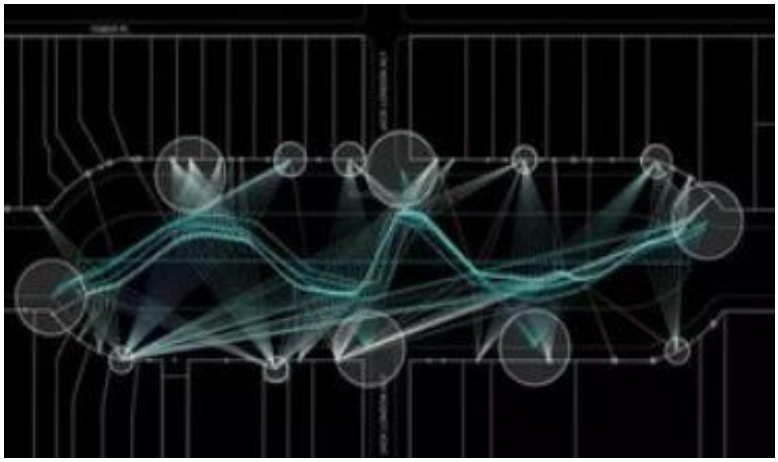


Figure 3. Parametric design interface

The word constraint has different meanings in different fields. In the field of parameterization, constraints can be interpreted as a set of relationships that must be satisfied between specific elements. There are two basic concepts closely related to constraints, one is the degree of freedom , one is the constraint degree [15].

Drive dimensions by changing dimensional constraints to enable parameterization by changing graphics. Therefore, dimensional constraints are variable, and in order to facilitate label-driven, dimensional constraints must be labeled [16]. Structural constraints and dimensional constraints can be expressed by formula (1):

$$Y = (U, I_1, I_2, O) \tag{1}$$

Among them, Y represents the parametric design constraints in the transformation of public art; U is the type of constraint; I_1 and I_2 are the objects of the constraint; O is the value of the constraint.

When converting a 3D CAD model into an STL file, the continuous surface is discretized into tens of millions of triangular patches, and then complex models are formed in various ways [17]. The artwork design CAD model is shown in Figure 4:

Figure 4. Artwork design CAD model

For example, to obtain the maximum side length of a continuous parametric surface, the calculation formula is shown in formula (2)(3)(4)(5):

$$B = 3\{ \frac{\delta}{2(Z_1 + 2Z_2 + Z_3)} \}^{1/2} \tag{2}$$

$$Z_1 = \sup_{(x,y)\in M} \left\| \frac{\alpha^2 q(x,y)}{\partial x^2} \right\| \tag{3}$$

$$Z_2 = \sup_{(x,y)\in M} \left\| \frac{\alpha^2 q(x,y)}{\partial x \partial y} \right\| \tag{4}$$

$$Z_3 = \sup_{(x,y)\in M} \left\| \frac{\alpha^2 q(x,y)}{\partial y^2} \right\| \tag{5}$$

Among them, δ is the chord difference; $q(x, y)$ is a continuous parametric surface; M is a triangular patch; B is the maximum side length.

Before the FDM molding process, the STL file converted in the previous step needs to be discretized in the Z-axis direction, which is referred to as layered slicing [18]. The layering direction error is mainly determined by two factors, the layer thickness and the forming direction size of the molded part. Its size error can be expressed by formula (6):

$$\Delta C = \begin{cases} C - c \times \text{int}(\frac{C}{c}) \\ C - c \times [\text{int}(\frac{C}{c}) + 1 \end{cases} \tag{6}$$

Among them, c is the layer thickness; ΔC is the dimension in the forming direction; C is the dimension error.

Forming and processing errors will occur during the processing of works transformed into public art of grassland cultural symbols. This error may be caused by the setting of artistic process parameters. We can perform wire width compensation for it [19]. Adjusting the sample error value through parameterization technology is shown in Figure 5

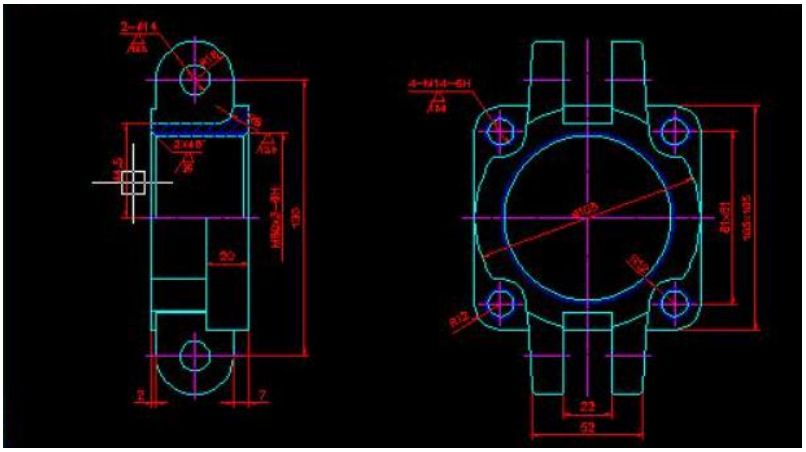


Figure 5. Adjustment of sample error values through parametric techniques

In general, the calculation formula of wire width is shown in formula (7)(8)(9).

$$Q = W \times E \tag{7}$$

$$\rho = \frac{m}{v} = \frac{m}{E*B*20*V_Q} \tag{8}$$

$$B = \frac{m}{\rho*E*20*V_Q} \tag{9}$$

Among them, Q is the cross-sectional area; ρ is the material density; B is the wire width; E is the layer thickness; m is the material quality within 20s; V_Q is the scanning speed.

When the extrusion speed increases, the formula for calculating the cross-sectional area becomes as shown in formula (10):

$$Q = j + k + l \tag{10}$$

Among them, j is a rectangle; k; l are arcs.

Continue to refine until the calculation formula (11) can be obtained:

$$Q = WE + 2*\frac{E}{4}(\sqrt{W^2 + E^2} - W) = \frac{E}{2}(\sqrt{W^2 + H^2} + B) \tag{11}$$

The density calculation formula changes as shown in formula (12):

$$20QV_j\rho = 10E(\sqrt{W^2 + E^2} + W)V, \rho = m \tag{12}$$

Let $\delta = \frac{m}{10EV_Q\rho}$, can be obtained as formulas (13) (14):

$$\delta = \sqrt{W^2 + E^2} + W \tag{13}$$

$$W = \frac{\delta^2 - E^2}{2\beta} \tag{14}$$

Then the calculation formula of wire width can be finally obtained as shown in formula (15):

$$B = b_{ac} = \sqrt{W^2 + E^2} = \sqrt{(\frac{\delta^2 - E^2}{2\delta}) + E^2}$$
$$= \sqrt{\left[(\frac{m}{10EV_Q\rho})^2 - E^2\right]^2 \frac{100E^2V_Q^2\rho}{m} + E^2} \tag{15}$$

Errors caused by shrinkage of materials are prone to occur when transforming grassland cultural symbols into public art. Thermal shrinkage and molecular orientation shrinkage are the two main causes of material shrinkage errors [20].

The amount of heat shrinkage can be expressed by formula (16):

$$\Delta B = \varepsilon * (B + \frac{\Delta}{2}) * \Delta * \tag{16}$$

Among them, ε is the linear expansion coefficient of the practical material; B is the size of the molded work; ΔF is the temperature difference.

The nozzle drives the wire to fill in the X-Y plane, the wire will be elongated, and will shrink during the subsequent cooling and forming process. Under the effect of orientation, the shrinkage rate of the filament in the X-Y direction (filling direction) is greater than that in the Z direction (stacking direction). The amount of shrinkage in different directions can be expressed by formulas (17) (18):

$$\Delta B_1 = \mu * \delta_1 * (B + \frac{\Delta}{2}) * \Delta * \tag{17}$$

$$\Delta B_2 = \mu * \delta_2 * (B + \frac{\Delta}{2}) * \Delta * \tag{18}$$

Among them, ΔB_1 is the amount of shrinkage in the X-Y direction; ΔB_2 is the amount of shrinkage in the Z direction; μ is the interactive influence factor of the size shrinkage of the grassland cultural symbol art transformation work; δ_1 and δ_2 are the shrinkage rates in different directions.

From the above, it can be seen that by integrating parameterization technology into the public art transformation method of grassland cultural symbols, the local data of works can be adjusted finely and accurately to make up for errors in production, which can effectively improve the public art of grassland cultural symbols. The quality of the transformation works has further achieved the effect of improving the transformation of grassland cultural symbols in public art. The public art transformation of grassland cultural symbols through parametric technology is shown in Figure 6:

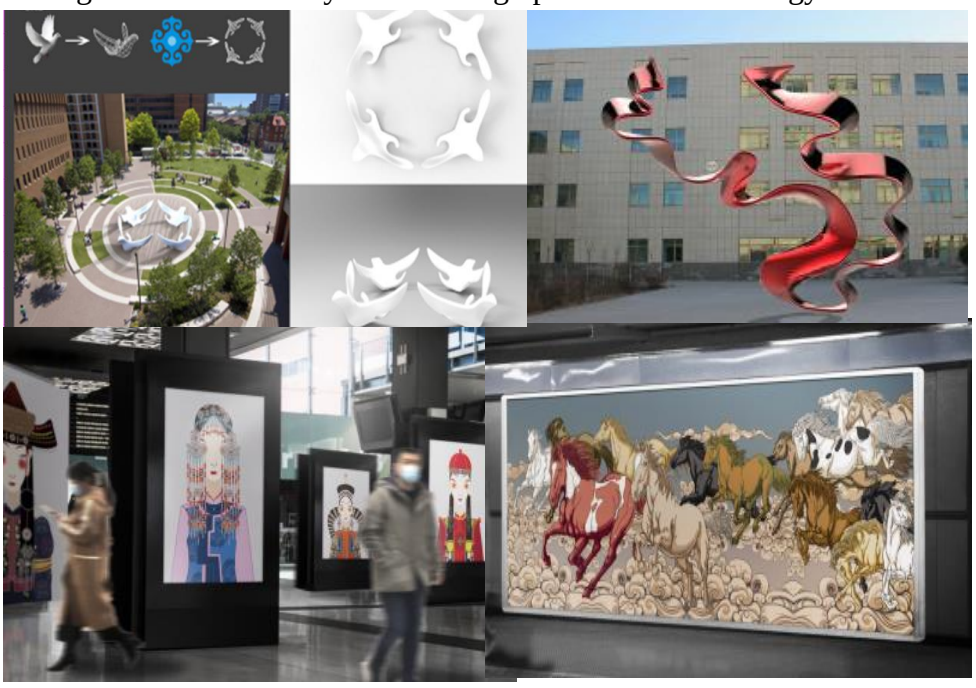


Figure 6. Public art transformation works of grassland cultural symbols using parametric technology

3. Experimental Data Sources for the Transformation of Grassland Cultural Symbols to Public Art under Parametric Technology

The data used in this paper is divided into three parts. The first is to obtain some sample data of public artworks of grassland cultural symbols through data mining. Some data contents are shown in Table 1:

Table 1. Examples of sample data content of some works of art

Project	Sample1	Sample2	Sample3
Source	Network	Provincial Museum	Personal collection
Creation time	2017	2008	2011
Artistic technique	Direct misappropriation	Break up refactoring	Exaggerated deformation
Style type	Pattern	Plate	Painting

Among them, this part of the data set consists of four attributes, namely the source of sample work data, creation time, artistic technique and style type. Then, by simulating the public art transformation method of grassland cultural symbols integrating parameterization technology, the working performance parameters are obtained, and some content data are selected, as shown in Table 2:

Table 2. Examples of some operational performance data content

Project	Test 1	Test 2	Test 3
Number of outputs	27	59	117
Operation hours	2.4	3.6	6.97
Conversion efficiency	0.089	0.061	0.059

Then, the result parameters output by the method were collected, and the specific content data of some samples were extracted as shown in Table 3:

Table 3: Example of parameter content of some output results

Project	Sample1	Sample2	Sample3
Accuracy	0.74	0.85	0.89
Similarity rate	0.63	0.56	0.67
Difference rate	0.37	0.44	0.33
Effective generation rate	0.64	0.57	0.68

The parameters extracted from this part of the content are the accuracy rate, similarity rate, difference rate and effective generation rate of symbol conversion.

At the same time, a comprehensive evaluation of the artistic transformation carried out by this method is also carried out by means of questionnaires, and the expert group scores its various indicators. Some of the data obtained are shown in Table 4 and Table 5:

Table 4. Some examples of questionnaire survey content

Project	Subject1	Subject2	Subject3
Gender	Male	Male	Female
Age	24	38	27
Like the work	Yes	No	Yes
Evaluation	5	3.6	4.3

Table 5. Examples of data content of expert rating items

Project	Sample1	Sample2	Sample3
Artistic value	8.34	7.34	7.93
Practical value	7.26	8.12	8.14
Cultural value	9.41	6.66	7.43
Commercial value	7.88	7.64	8.62
Overview	8.24	7.91	8.26

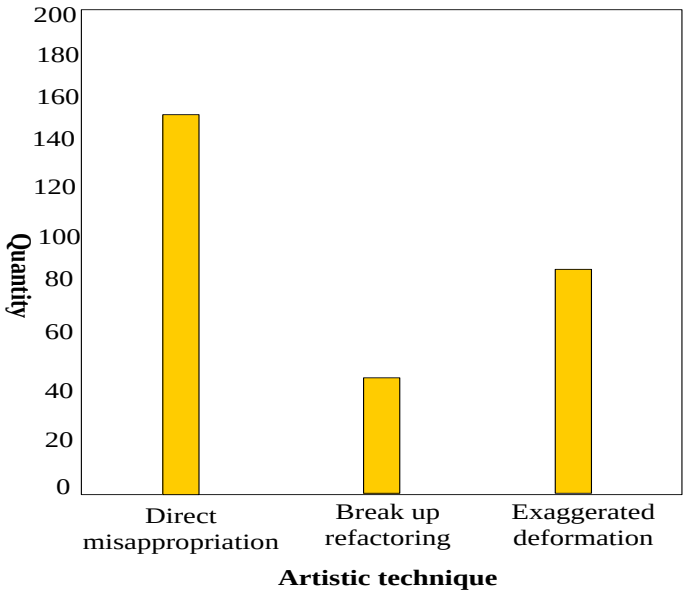
As shown in Table 4 and Table 5: Experts score the artistic value, commercial value, cultural value and practical value of the sample, and finally get a comprehensive evaluation of the work, which can reflect the effectiveness of the transformation method.

4. The Transformation of Grassland Cultural Symbols into Public Art under Parametric Technology

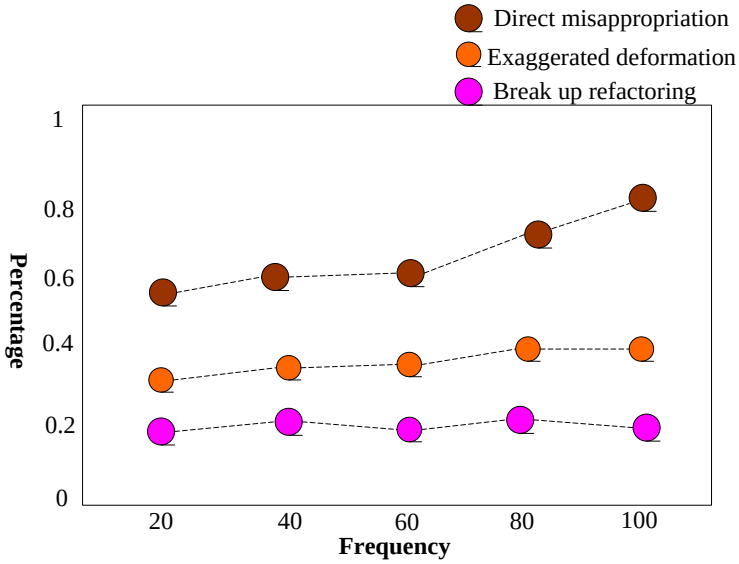
This paper will process and analyze the data collected from the simulation experiment and questionnaire survey of grassland cultural symbols public art transformation under the parametric technology, and discuss the results obtained.

4.1. Application of Prairie Cultural Symbols in Art Works

Through the research on the existing grassland cultural and artistic works, the application of common artistic transformation techniques is obtained after data collection on the application of the current grassland cultural symbolic art transformation. The specific content is shown in Figure 7:



(a) Frequency of artistic techniques used in prairie cultural symbols in art works



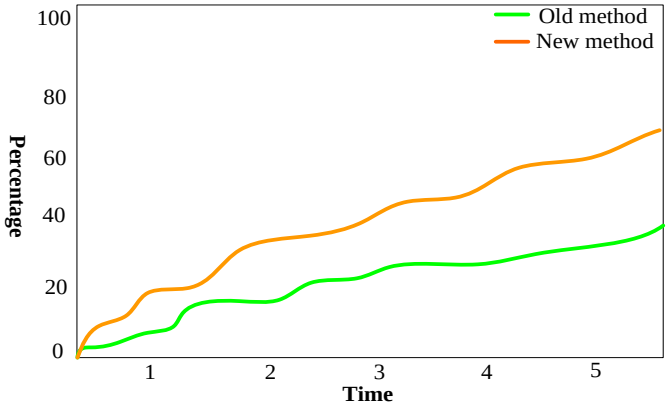
(b) The proportion of the use of grassland cultural symbols in art works

Figure 7. Application of grassland cultural symbols in artworks

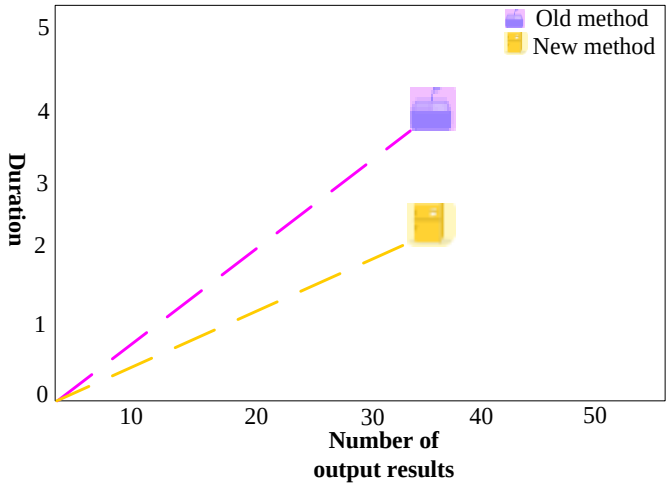
From Figure 7, we can see that the artistic transformation of grassland cultural symbols is mainly based on direct appropriation, and the number reaches 147 times. This is because the cost of directly appropriating cultural symbols is low, the technical difficulty is not high, and it saves time and effort. But this has also resulted in a low level of artistic transformation and poor quality.

4.2. Comparison of the Result output Efficiency of Different Methods

Compare the conversion method model of grassland cultural symbol public art proposed by the text with the traditional method and the output result per unit time. The specific data content is shown in Figure 8:



(a)The number of output results per unit time of different methods



(b)Comparison of the running speed of different methods

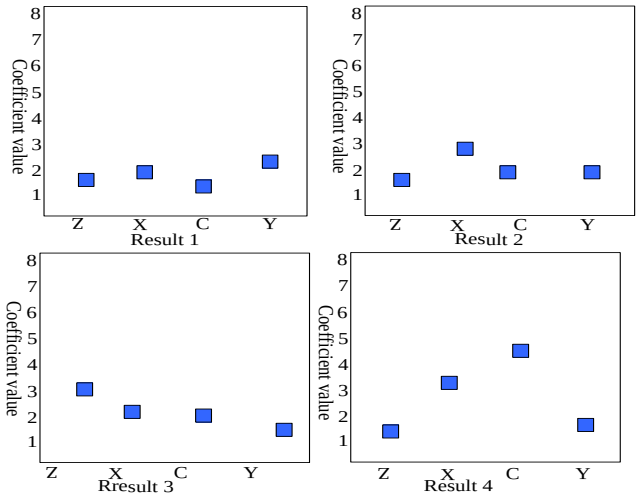
Figure 8. Output result efficiency of different methods

It can be seen from Figure 8 that, on the whole, the conversion method of grassland cultural symbols public art incorporating parameter technology is better than the traditional method in terms of the efficiency of result output. In terms of the number of output results per unit time, the number of initial outputs in a short time is similar to that of the traditional method, but with the increase of time, its advantages become apparent. After 5 minutes, the number of output results is 23 higher than that of the traditional method. Adjust the overall data through single data adjustment to quickly and efficiently form a new result output.

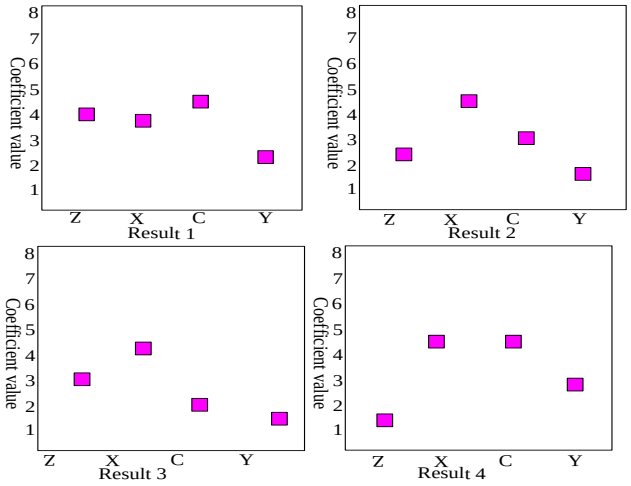
4.3. Comparative Analysis of the Quality of Artistic Transformation Results of Different Methods

Input the same grassland cultural symbol parameters into different public art transformation method models, and analyze and compare the accuracy, similarity, difference, and effective

generation rate of some randomly selected result samples. The specific content is shown in Figure 9.



(a)Traditional methods output sample results



(b)The method of this paper outputs the sample results

Figure 9. Different methods output sample results

From Figure 9, we can see that the overall quality of the output of the grassland cultural symbol public art conversion method based on parameter technology is better than that of the traditional method. The accuracy rate, similarity rate, difference rate, and effective generation rate of the art conversion results of the method proposed in this paper are all higher than those of the traditional method, and the accuracy rate coefficient reaches 6.24; the similarity rate coefficient reaches 6.45; the difference rate coefficient is 4.37, the effective generation rate coefficient reaches 8.34. It can be seen that this method has improved the quality of public art transformation of grassland cultural symbols.

4.4. Comprehensive Evaluation and Comparative Analysis of Different Methods

According to the evaluation data collected by the questionnaire survey and the scores of the expert group, a comprehensive evaluation is made on the transformation method of grassland cultural symbols public art in this paper, as shown in Figure 10:

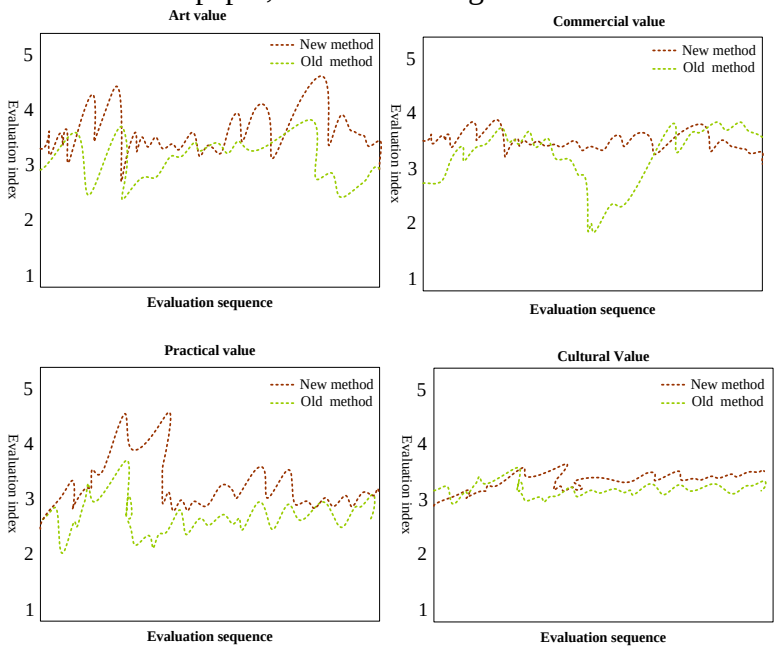


Figure 10. Comprehensive evaluation of various indicators for the transformation of grassland cultural symbols to public art

As can be seen from Figure 10: in the evaluation of different public art transformation methods of grassland cultural symbols, the evaluation index of the transformation results using the new method is higher than that in terms of artistic value, practical value, cultural value and commercial value. Among them, the average evaluation of the commercial value index reached 4.16, and the evaluation of the artistic value index reached 4.26. Compared with the traditional method, the evaluation index was stable and much higher. It can be seen that the transformation of grassland cultural symbols public art based on parameter technology has improved its transformation level.

Through comprehensive experimental tests, it can be seen that the transformation method of grassland cultural symbols public art based on parameter technology is superior to the traditional method in all indicators, not only has a high degree of artistry, but also has strong practicability. Compared with the comprehensive evaluation index The traditional method is 16.53% higher. This improved transformation method used for the transformation of grassland cultural symbols public art can meet the current demand for the transformation of grassland cultural symbols public art. Of course, the analysis results may be affected by some uncertain factors, such as the instability of the use environment, the difference of operators, and the test time and frequency, etc., so that the results of this experiment are not completely accurate and reliable, and there are certain differences .

5. Conclusion

The transformation of cultural symbols and art in the era of great integration is becoming more and more popular, and people have higher and higher requirements for art works. The development of the transformation of grassland cultural symbols and public art is inseparable from the contribution of parametric technology, which has precise parameters because of its precise

parameters. The conditioning advantage is widely used in many fields. This paper first makes a general analysis of grassland cultural symbols, public art transformation and parametric technology, explains their functions and principles, and then uses relevant principle formulas to analyze their functions, and finally finds that they all have great functions in terms of functions Advantage. In the experimental part, this paper compares the transformation method of public art of grassland cultural symbols with parametric technology and traditional methods, and draws the conclusion that the transformation quality of public art transformation methods of grassland cultural symbols integrated with parameterization technology is higher than that of traditional methods. Therefore, it is very necessary to study the transformation of grassland cultural symbols into public art under the parametric technology.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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