OPEN ACCESS Freely available online

IDC Innovation on Design and Culture

ISSN XXXX-XXXX
Volume 1, Issue 2
https://www.iikii.com.sg/journal/IDC
Innovation on Design and Culture

Article

Natural Urushi and Its Performance Design

Sen-Yang Chang [1] and Hsin-Hung Lin [2,*]

[1] Department of Digital Media Design, Asia University, Taiwan; tyou114@gmail.com
[2] Department of Creative Product Design, Asia University, Taichung, 41354, Taiwan;
* Correspondence: hhlin@asia.edu.tw

Received: May 15, 2022; **Accepted:** Jun 15, 2022; **Published:** Jun 30, 2022

Abstract: Application design is used in Urushi art performances for Urushi art design by rebuilding its performance to show a unique Urushi beauty and modeling space. To understand the use of points and elements, design is needed to learn and seize a specific design object according to a subject. Color is critical in Urushi design. Therefore, this research was carried out to first understand the current status of Urushi art through the collection and observation of existing information and evaluate Urushi performance designs. For the research, the actual creation of three designs was conducted, and the design scheme was evaluated and analyzed by an AHP method. As a result, the expression and the creation of the three Urushi were created with unique Urushi beauty. The result allows craftsmen to provide a specific goal in design and a reference basis.

Keywords: Urushi ware, Color, Craft, Design

1. Introduction

In the early Ming and Qing dynasties, most living habits followed the tradition of Central Plains culture in Taiwan. Therefore, the general folk had Urushi wares including idols, temples, red sleep beds, wardrobes, Taishi seats, tables, dressing tables, Xie Basket, Tea Too, sacrifice fruit plate, and others. At that time, the main color was black and chocolate (red Urushi colors). Zhu Se (red) represented the blessing and joy of the Chinese people (Fig. 1). Due to the conversion of social types, business activities were gradually refined. The latest information from the design was rarely used in color characteristics. Although on the surface, the co-energy design was extremely rich, it did not require difficult technology. The real problem was to enrich its shapes so that the perfect beauty of processing could be done. Many artists highlighted the characteristics of their products which attracted consumers' attention and enhanced the competitiveness of the products by proposing the most important topic at the moment. The research quoted the design principles of the Urushiware (Sen, Block & Chandran, 2002; Saaty, 1980; Yu, 2002) which were consolidated as the architecture basis including seven evaluation items that were defined through an expert interview. The purpose of this research was to evaluate the project and provide the reference basis for Urushiware. The evaluation included the following three items such as seeking sorting of functional design evaluation, understanding the needs of Urushiware, and a combination of sales and art life.

Fig. 1. Source from National Taiwan Craft Research and Development Center.

2. Case Studies

We explored how to establish a product design evaluation model with an AHP method, aiming at the performance design of three existing Urushi arts. The advantage of the evaluation criteria includes the comparison of the pros and cons of the evaluation items to obtain the best evaluation value. First, the complex multi-objective decision-making problem was described in a tree-like hierarchical structure (Hierarchy) and decomposed into individual evaluation criteria. The entire decision-making process was judged by criteria, sub-criteria, and the hierarchy constructed by different design proposals. The evaluation items reflected the characteristics of design and modeling principles in the research, including decisiveness, avoidance of duplication, and independence. Through research and discussion and by compiling expert opinions from relevant document industries, the suitability of each evaluation item was discussed from the designer's point of view. The Urushi art performance design was divided into two parts for evaluation. One part refers to the design principles which are divided into proportion, balance, rhythm, harmony and unity, and emphasis. In the other part, the basic elements of the Urushi art design - material, color, and outline are used as the basis for the structure with the "material" project of the basic elements of design. Since the materials in the three Urushi arts are commonly used in surface blending methods in the research, they were not included in the evaluation items of the research (Yeh & Huang, 2014; Lin, 2019; Keramati & Salehi, 2013). Therefore, we divided the Urushi art design evaluation framework into three layers as shown in Fig. 2 (the Urushi dimension works are shown in Table 1).

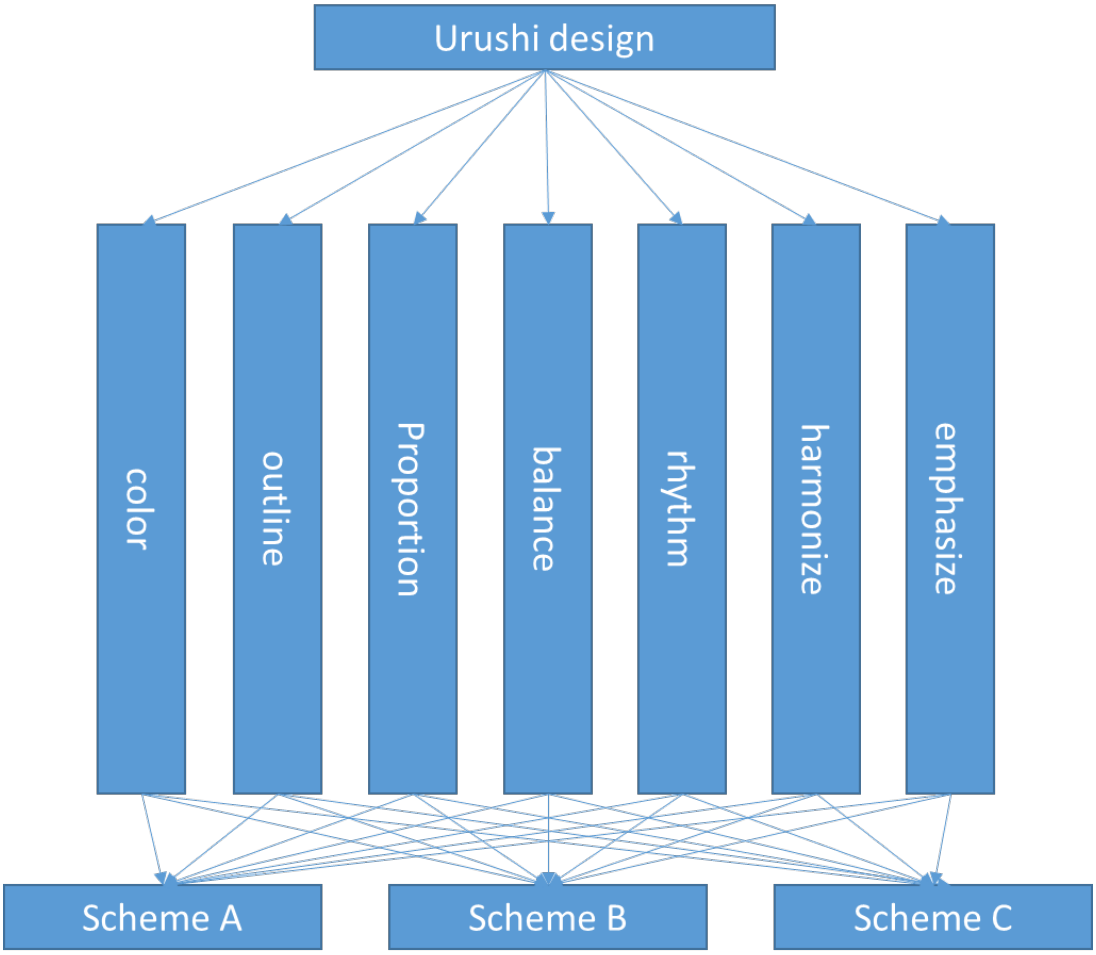

Fig. 2. Urushi Design Evaluation Framework.

Table 1. Urushi dimension works.

1	**Urushi dimension <11> 2021 39 x 24 x 27 cm**		Natural Urushi Ben Jiandi gold foil silver foil	In 2022, the 29th Japan "Beauty of Urushi" exhibition <Works on display>
2	**Urushi dimension <10> 2021 70 x 50 x 45 cm**		Natural Urushi Ben Jiandi Dry paint powder	In 2021, the 2nd Japan Tree Capital Craft Exhibition <JAL Award>
3	**Urushi dimension <12> 2022 31 x 18 x 31 cm**		Natural Urushi Ben Jiandi Dry paint powder	2022 Nihonbashi & Yokohama Takashimaya <Rotating Time> Contemporary Urushi Art Exhibition <Works Exhibition>

3. Results and Discussion

We adopted the Analytical Hierarchical Process (AHP) as the research method for the evaluation model of the Urushi performance design. The AHP method is a multi-objective or standard decision-making method. The purpose is to divide complex and unstructured problems into several components, arrange them into a hierarchical order, and then gather the opinions of experts and scholars in decision-making at all levels. A simplified complex system is used in a concise feature hierarchy, and the nominal scale is used to compare features in order. Then, after establishing the pairwise comparison matrix, the eigenvector of the matrix is obtained accordingly which is used as the priority vector of each level. Then, the priority among the elements is represented, and then the eigenvalue is calculated for evaluating the consistency of the Pairwise Comparison Matrix, an indicator for decision-making or re-evaluation (Moon, Kim, Lee, Kim, 2013; Lin, 2019; Lin, 2013).

3.1. Pairwise Comparison Matrix

For the elements of a certain level, an element of the above level is regarded as the evaluation benchmark. The pairwise comparison of the importance of the elements is then carried out by comparing the relative importance of two elements among *n* elements. The nominal scale is adopted to set the ratio of its relative importance (ratio) (Lee, Hung, Kang & Pearn, 2012) with the values of 1/9, 1/8, ..., 1/2, 1, 2, 3, ..., 8, 9. Then, the measured value of the pairwise comparison of the *n* elements is placed in the upper triangular part of the pairwise matrix. The main diagonal is the comparison of the features, and the value becomes 1. The lower triangle part is the reciprocal of the relative position of the upper triangle part, which is the contrast matrix A (Eq. (1)).

$$A=[a_{ij}]=\begin{bmatrix}1 & a_{12} & \mathsf{L} & a_{1m}\\ a_{21} & 1 & \mathsf{L} & a_{2m}\\ \mathsf{M} & \mathsf{M} & \mathsf{O} & \mathsf{M}\\ a_{m1} & a_{m2} & \mathsf{L} & 1\end{bmatrix}=\begin{bmatrix}1 & a_{12} & \mathsf{L} & a_{1m}\\ 1/a_{12} & 1 & \mathsf{L} & a_{2m}\\ \mathsf{M} & \mathsf{M} & \mathsf{O} & \mathsf{M}\\ 1/a_{1m} & 1/a_{2m} & \mathsf{L} & 1\end{bmatrix} \quad (1)$$

where a_{ij} represented the cross-comparison value obtained by the decision makers after comparing the decision factors i and j pairwise, which indicated the degree of importance that the decision makers placed on the decision factors.

After the pairwise comparison matrix is obtained, the weight of each level element is obtained, too. The eigenvalue solution method is commonly used in numerical analysis to find the eigenvector or priority vector and the largest eigenvalue of the pairwise comparison matrix. Since the pairwise comparison matrix is a positive reciprocal matrix, not a symmetric matrix, the available eigenvalue solutions are obtained with the exponentiation method and the Householder method. In this research, the eigenvector (or priority vector) was obtained directly by AHP analysis tool software as Expert Choice. By using them, the maximum eigenvalue and eigenvector were calculated with the following equatoin.

(1) Eigenvector W_i

$$W_i=\left(\prod_{j=1}^{m}a_{ij}\right)^{1/m}\Bigg/\sum_{i=1}^{m}\left(\prod_{j=1}^{m}a_{ij}\right)^{1/m};\quad i,j=1,2,3,...,m \quad (2)$$

where m was the number of decision-making factors.

(2) Maximum eigenvalue $\lambda_{\max}$

First, the pairwise comparison matrix A is multiplied by the obtained eigenvector W_i to obtain a new vector $W_i^{'}$, and then the average multiple between the two, $\lambda_{\max}$ is calculated.

$$\begin{bmatrix}1 & a_{12} & \mathsf{L} & a_{1m}\\ a_{21} & 1 & \mathsf{L} & a_{2m}\\ \mathsf{M} & \mathsf{M} & \mathsf{O} & \mathsf{M}\\ a_{m1} & a_{m2} & \mathsf{L} & 1\end{bmatrix}\begin{bmatrix}W_1\\ W_2\\ \mathsf{M}\\ W_m\end{bmatrix}=\begin{bmatrix}W_1^{'}\\ W_2^{'}\\ \mathsf{M}\\ W_m^{'}\end{bmatrix} \quad (3)$$

$$\lambda_{\max}=\frac{1}{m}\left(\frac{W_1'}{W_1}+\frac{W_2'}{W_2}+\mathsf{L}+\frac{W_m'}{W_m}\right) \quad (4)$$

(3) Consistency test

As the pairwise comparison matrix is a positive reciprocal matrix, it is difficult to require decision-makers to achieve consistency before and after pairwise comparison. Therefore, it is necessary to carry out a consistency check and determine whether it is a consistency matrix. The introduction of the consistency index is used to know how reasonable and consistent the judgment is in the evaluation process. The index is used as a reference for corrections to avoid bad decisions. The test of consistency, in addition to evaluating the judgment of decision-makers, is also used for the overall hierarchy. Since the importance of each level is different, it is necessary to test whether the overall hierarchy is consistent with consistency indicator values in a measure of decision-maker judgment or a test of the entire hierarchy. Saaty (1980) suggested that the value must be around 0.1, and the results of the assessment need to pass the consistency test for judging the questionnaire's consistency.

The consistency of each pairwise comparison matrix and the entire hierarchy needs to be checked. When the consistency of the entire hierarchy does not meet the requirement, there is a problem with the relationship between the requirements of the hierarchy, and the analysis of elements and their associations must be performed again. For the consistency test, the largest eigenvalue ($\lambda_{\max}$) and the eigenvector (W) are checked to see whether the pairwise comparison matrices are consistent. According to the suggestion of Saaty (1980), the consistency of the pairwise comparison matrix is tested by the consistency index (C.I.) and the consistency ratio (C.R.).

3.1.1. Consistency Index (*C.I.*)

$$C.I. = \frac{\lambda_{\max} - n}{n-1} \tag{5}$$

When $C.I. = 0$, the judgment is completely consistent. If $C.I. = 1$, the judgment is inconsistent, and $C.I. \le 1$, there is an allowable error.

3.1.2. Random Index (*R.I.*) (Saaty, 1980)

The consistency index (C.I.) is affected by the order of matrix A and the number of evaluation scales. When the order and evaluation scale of matrix A are known, the C.I. value is called a Radom index (R.I.).

3.1.3. Consistency Ratio (*C.R.*)

$$C.R. = \frac{C.I.}{R.I.} \tag{6}$$

$C.R. \le 0.1$ indicates that the consistency of the matrix is satisfactory.

3.1.4. Consistency Ratio of the Hierarchy (*C.R.H.*)

$$C.I.H. = \sum \begin{bmatrix} (\text{Each level priority vector}) \\ \times (\text{C.I value for each level}) \end{bmatrix}$$

$$R.I.H. = \sum \begin{bmatrix} (\text{Each level priority vector}) \\ \times (\text{R.I value for each level}) \end{bmatrix}$$

$$C.R.H. = \frac{C.I.H.}{R.I.H.} \tag{7}$$

When $C.R.H. < 0.1$, the consistency of the overall level was acceptable.

3.2. Questionnaire Design and Sample Analysis

After establishing a completely hierarchical structure, a questionnaire survey of the AHP method was carried out. Seven parts were included in the questionnaire: research description letter, questionnaire answering instructions and examples, importance intensity standard, index hierarchy structure, interpretation and item items, and comparing the importance of the two factors in each system. The evaluation scale was divided into five levels: equally important, slightly important, quite important, extremely important, and absolutely important, and scores of 1, 3, 5, 7, and 9 were assigned to them, respectively. There were four grades between the five basic evaluation scales, which were assigned the measurement value of 2, 4, 6, and 8. The scale to the left indicated that the factors in the left column were more important than those in the right column. Conversely, the scale on the right indicated that the factors in the right column were more important than those in the left column, and experts were asked to select the appropriate evaluation items. As many factors needed to be considered in influencing the design of Urushi art, it was assumed that the evaluation was based on the three factors of "color", "outline", and "proportion". The questionnaire design was shown in Table 2.

Table 2. Urushi art performance design questionnaire design.

Evaluation Metrics	Absolutel	Median	Extremel	Median	Quite	Median	Slightly	Median	Equally	Median	Slightly	Median	Quite	Median	Extremel	Median	Absolutel	Evaluation Metrics
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Color	□	□	□	□	☒	□	□	□	□	□	□	□	□	□	□	□	□	Outline
Color	□	□	□	□	□	□	□	□	□	□	□	□	□	☒	□	□	□	Proportion
N	N																	N

In the acquisition of respondents in the questionnaire survey, experts provided answers to the questions. The interviewed experts included design educators (mainly 10 lecturers and professors teaching "design" and "Urushi art design" related courses) and related industry professionals (product designers, a total of 22). The total number of questionnaires distributed in this study was 32. The number of recovered questionnaires was 32, and the recovery rate was 100%.

4. Results and Discussion

This research was for establishing Urushi art design criteria and indicators of a professional design model and setting the weight value of each index for the evaluation of Urushi art design. The results were presented in Table 3. Experts, scholars, and industry experts believed that "color" was the most important among all evaluation items, accounting for 21.2%. "Color" was one of the most frequently discussed and valued issues in life. A good color mixture affects the visual enjoyment of beauty. The golden ratio of 1:1.618 in ancient Greece was the most representative reference value, so "proportion" of colors is important in the weight value.

Table 3. Evaluation index and index weight value of Urushi art performance design.

Evaluation Items	Relative Weight (%)	High and Low Order	*I.R.*
Color	21.2%	1	
Outline	19.7%	2	
Proportion	11.4%	6	
Balance	12.2%	4	0.01
Rhythm	14.2%	3	
Blend and unify	9.2%	7	
Emphasize	12.1%	5	

Table 4. Weight of Urushi art works.

	1	2	3
illustrate	**Urushi dimension 2021 年 39x24x27**	**Urushi dimension <10>2021 年 70x50x45**	**Urushi dimension <12>2022 年 31x18x31**
Picture			
Weights	33.8%	30.3%	35.9%

5. Conclusions

Urushi art is favored by consumers, so it is important to arouse interest and resonate with customers and to understand how to express the characteristics of the Urushi art design. By using an AHP method, we proposed a set of design decision-making methods for Urushi art performance. In design considerations, the proportion of colors was the priority to express Urushi art design. The results help professionals of Urushi art design have a reference when designing it. The Urushi art performance and processing can be completed with the display of the target product's colors which provides a chance of product transaction.

Author Contributions: The author contributed to the paper. S.-Y.C. Collects and organizes data and acts, H.-H.L. as the corresponding author. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sen, S., Block, L. G., & Chandran, S. (2002). Window Displays and Consumer Shopping Decisions. *Journal of Retailing and Consumer Services*, *9*, 277–290.
2. Saaty, T. L. (1980). *The Analytic Hierarchy Process*; New York: McGraw-Hill.
3. Yu, C.S. (2002). A GP-AHP method for solving group decision-making fuzzy AHP problems. *Comput Oper Res*, *29*, 14.
4. Yeh, T. M., & Huang, Y. L. (2014). Factors in determining wind farm location: Integrating GQM, fuzzy DEMATEL, and ANP. *Renewable Energy*, *66*, 159–169.
5. Lin, H. H. (2019). Application of Fuzzy Decision Model to the Design of a Pillbox for Medical Treatment of Chronic Diseases. *Applied Sciences*, *9*(22), 4909. https://doi.org/10.3390/app9224909
6. Keramati, A., & Salehi, M. (2013). Website success comparison in the context of e-recruitment: An analytic network process (ANP) approach. *Applied Soft Computing*, *13*, 173–180.
7. Moon, C. B., Kim, H. S., Lee, D. W., & Kim, B. M. (2013). Mood Lighting System Reflecting Music Mood. *Color Res Appl*, *40*(2), 201–212. https://doi.org/10.1002/col.21864
8. Lin, H. H. (2019). A systematic approach of predicting color preference on the basis of grey relational grade. *Color Research and Application*, *44*(2), 194–204. https://doi.org/10.1002/col.22342
9. Lin, R. J. (2013). Using fuzzy DEMATEL to evaluate the green supply chain management practices. *Journal of Cleaner Production*, *40*, 32–39.
10. Lee, H. I., Hung, M. C., Kang, H. Y., & Pearn, W. L. (2012). A wind turbine evaluation model under a multi-criteria decision making environment. *Energy Conversion and Management*, *64*, 289–300.