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Visual Related Analysis and Application of Saline Soil Culture Design Factors

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Abstract

Saline soil culture is one of the driving forces of human civilization development. Nevertheless its spiritual heritage has not been effectively passed on. Creative product design helps culture to be widely recognized with a sense of the times, the connotation value of the product is enhanced, through which attraction towards the certain culture is expected to increase. Accordingly, this paper proposes a creative design idea based on visual related analysis for the saline soil culture. Through research on the revolutions influenced by three salt ancestors, the artifacts involved are analyzed, then the extraction of characteristic factors is performed by action verbs and other modern design methods. Eye movement tests is mainly conducted to evaluate the extracted schemes,combining with an emotional engineering method. The selected design factors are applied to a new product development. This process is validated by applying a serial tea set design.

Keywords*: Saline soil culture, Design factors, Eye movement test, Kansei engineering, Design evaluation*

1. Introduction

In the course of human civilization, saline soil has had special merit in casting the temperament and character of salt-boiling people and has also promoted the progress and development of society. Represented by research on well-salt in Zigong, Sichuan Province, research on the salt culture has led to many important results. The China Sea-Salt Museum, which was established in 2008 in Yancheng, Jiangsu Province, has also provided abundant data for research on the saline soil culture. For years, experts and scholars have been dedicated to studying the salt culture and have published monographs, magazines, *etc*., as discussed in the literature [1]. Transitional development countermeasures of saline soil agriculture in the coastal area of Jiangsu have been put forward, and soft power has been increasing continuously.

The cultural characteristics of design factors comprise a symbolic visual language that is presented in a large number of cultural forms, is strongly recognized, and can lead to perceiving a target group easily. Current research on design factors concentrates more on brand recognition. For instance Apple, Toyota and other large enterprises are involved in in-depth studies of design language, so as to enhance brand recognition and enterprise competitiveness [2]. Taking Volvo cars and Nokia products as examples, Karjalainen [3] explored the conversion from brand language to product modeling elements. Jap P McCormack *et al.* [4] presented shape grammar as a method to encode the key elements of a brand into heritable design language, and demonstrated the feasibility through an example of Buick front-end vehicle design. Chen and Chang [5] employed a numerical

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definition-based systematic approach (NDSA) to extract the critical form features of a product, which are vital for determining consumers' perceptions of product image. Additionally, an effective method based on the genetic theory was applied to extract Banpo painted pottery cultural factors and design practices [6].

The combination of culture and design helps enhance the connotation and added value of a product. Cultural creative product design with the rich heritage of the Chinese nation's five thousand years of traditional culture would resonate with consumers better, while the design factor research methods used in cultural studies can also be of great benefit to cultural heritage and development. Accordingly, starting from the significant turning point in the saline soil culture development, the characteristics of related artifacts are extracted and analyzed in this study. The extracted schemes are evaluated and selected through methods such as an eye movement test, and the results are applied to a new tea set design. Exploring the innovative breakthrough of the salt culture in the field of product design would not only increase the cultural connotation of products but also promote the development and innovation of the saline culture.

The inheritance and expansion of the historic saline soil culture remains at the relatively simple level of bath salt development. In this study, we seek to extend our observations as well as to specifically test how to integrate the salt culture more closely with people's daily life by applying its cultural factors to product design practices.

2. Saline Soil Cultural Analysis and Design Idea Planning

With regard to the design study of the saline soil culture, the problem was refined and defined explicitly. Content related to the salt culture was collected extensively for this study through brainstorming. The problem was further refined using "Creative Cloud" mind mapping. Starting from the center words, related concepts were derived and the whole issue was explored [7]. A retractable in-depth research on the saline soil culture can promote further design integration. Figure 1 presents the mind map for this study.

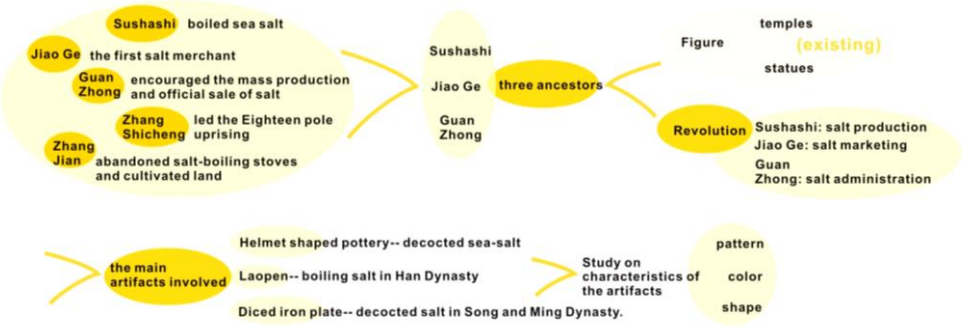

Figure 1. Saline Soil Cultural Analysis and Design Map

According to a pre-Qin documentary, Shi Ben recorded that Sushashi was the earliest tribe to boil sea salt and therefore became an ancestor of salt (salt production). The Jiaoge tribe were considered the first salt merchants (salt marketing) and are enshrined in the ancestral temple in Taizhou as the ancestors of salt merchants. Guan Zhong was a famous figure in the salt industry history who originated the Guan Shan Hai and proposed a way for mass producing salt and officially selling it (salt administration). Zhang Shicheng led the uprising against Yuan, which was called the Eighteen Pole Uprising. Zhang Jian was the pioneer of the modern Yancheng coastal economic revolution in the period when salt-boiling stoves were abandoned and land cultivation started being encouraged.

The main objects involved are helmet-shaped pottery, the laopen and the diced iron plate as shown in Figure2 to Figure4. Helmet-shaped devices are salt manufacturing

remains that have received the earliest attention and are the major salt tools currently identified. According to Song Dynasty records from The Origin of the World, the appliance for boiling salt in the Han Dynasty was called a laopen. Shi Ji•Ping Zhun Shu recorded that in the hopes of encouraging people to raise their own funds, the government supplied the laopen for boiling salt. The diced iron plate was used to decoct salt from the Song Dynasty until the later years of the Ming Dynasty.

Figure 2. Helmet-Shaped Pottery

Figure 3. Laopen

Figure 4. Diced Iron Plate

3. Method

3.1. Research Framework

Initially, a large number of resources were integrated and then the characteristic factors were extracted on the basis of these data. Meanwhile, a suitable product carrier was analyzed and available extracted design factors were redesigned. Furthermore, different schemes extracted through visual correlation analysis were compared, after which the optimal scheme was selected by means of an eye movement test combined with the Kansei engineering method. Finally, the characteristic factors were applied to the appropriate carrier. The research process is shown in Figure 5.

Figure 5. Research Flow Chart

3.2. Analyzing and Extracting the Characteristic Factors of the Saline Soil Culture

According to a literature study on the saline soil culture, three related artifacts from the significant revolutions were selected as ideas for the design activity. The artifacts are helmet-shaped pottery, the laopen and the diced iron plate. Through the analytic hierarchy process to confirm the available factors in the saline soil culture, the pattern, color and shape factors were identified as the most representative in culture creative product design. In this paper, four parallel studies were conducted on pattern, color, shape and spiritual connotation to uncover the integration between the characteristic factors and product design.

3.2.1. Pattern Factor Extraction

The process of collecting patterns from artifacts to refine the basic, core features generates the dominant gene patterns. The deduction of additional associated patterns represents the generation of recessive gene patterns, and the law of this deduction is an action verb. Different verbs are added to the dominant patterns, and each verb corresponds to a structural and visual distortion. Many variations can be made via this method. The newly generated recessive patterns are not only related to the original dominant patterns but also to the continuation and expansion of the original gene, while patterns are also made in accordance with the characteristics of the times.

"Stretch", "melt", "flatten", "ssemble", "restore"and "reduce" are a series of actions applied to the dominant patterns to generate transfigured patterns. The results are presented in Figure 6.

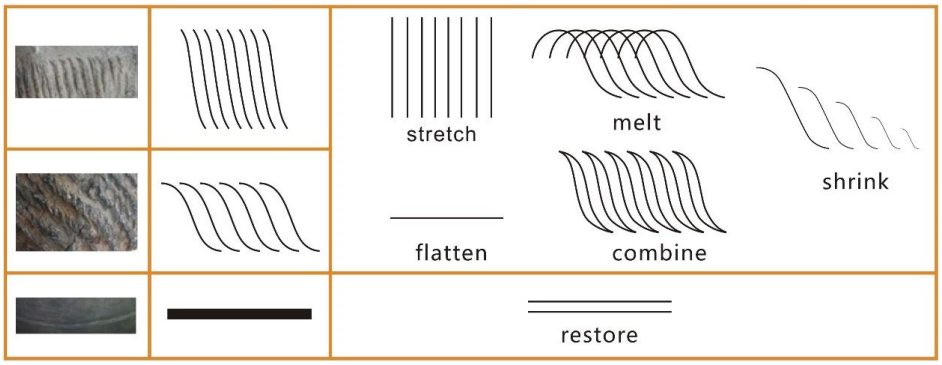

Figure 6. Pattern Evolution

3.2.2. Color Factor Extraction

Another cultural factor that cannot be ignored is color. Color transfers information, expresses feelings and carries certain meanings. The main colors of saline soil culture-related artifacts are gray and a special khaki, and this particular yellow is referred to as "saline yellow." Besides, different degrees of brown or blue can be combined in order to highlight these objects' characteristics. Each salt soil cultural artifact was assigned a number. Digital photos were made with a special synchronous shooting color card processing method for color space, *etc.*, and the photos were used to extract the color factors in the objects' images and to number these colors.

Figure 7. Color Extraction for Object 1

Figure 8. Color Extraction for Object 2

Figure 9. Color Extraction for Object 3

3.2.3. Shape Factor Extraction

Every saline soil cultural artifact displays a clear contour shape owing to the explicit function of each artifact. Crozier [8] explained that the the psychological responses to products are influenced by the product's appearance, as well as their meanings in cultural context, and the functions they fulfill. The core form of each object was extracted using the visual semiotic method, and it was subsequently evolved through a combination of modern popular elements. On the premise of unchanged key features, the variable characteristics were adjusted and edited (see Figure 10).

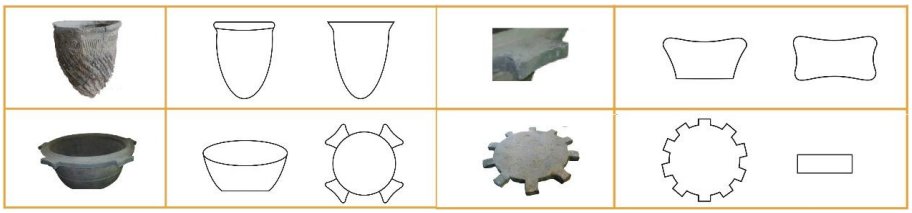

Figure 10. Shape Extraction for Saline Soil Cultural Artifacts

3.2.4. Spiritual Connotation Extraction

Saline soil has the temperament of magnanimity and delicacy, simplicity and profundity. From the perspective of the five senses, the design, color, texture and shape of the products were determined in terms of vision and touch. The roles that the three salt

ancestors had in the development of the saline soil culture are interpreted through the certain functions of a particular product carrier, which reflect the vitality of the cultural-spiritual heritage to make the product more vivid. This is not only beneficial to cultural heritage but is also useful for users to shape an attitude towards life and pursue a high-quality life.

3.3. Pattern Factor Evaluation Test

An eye tracker was employed to evaluate the patterns extracted above. The five patterns were paired with each other to form 10 testing samples. Motion information of the viewpoints was recorded and the subject evaluation process was observed to attain the screening of pattern factors.

To ensure the accuracy and pertinence of the experimental results, the test images were unified into 1240×1754 pixels in black and white processing. The tests were conducted in a quiet, undisturbed and comfortable environment. Twenty young and middle-aged test objects with visual acuity or corrected visual acuity of over 1.0 (22-50 years old) were invited to participate.

3.3.1. Experimental Process

a. The purpose and content of this experiment were introduced so that participants would remain focused.
b. Upon completing the eye tracker calibration and other operations, the imported PDF files began playing. On the first page, the words “please enjoy the following patterns” appeared on the screen as a transition phase before the test to minimize laboratory effects on the subjects.
c. No. 1-5 pairwise comparison images started from the second page. There were a total of 10 pictures and the playback time of each picture was set to 5 seconds.

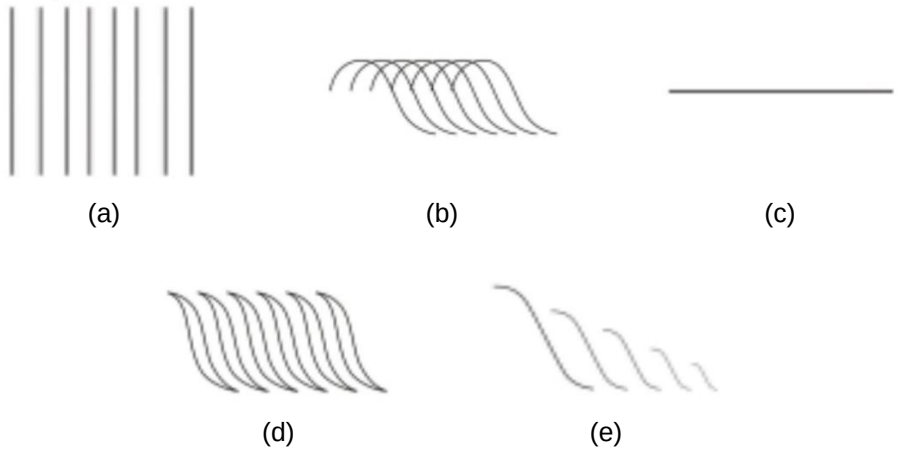

Figure 11. Sample of (a) Pattern 1, (b) Pattern 2, (c) Pattern 3, (d) Pattern 4, and (e) Pattern 5

4. Results and Discussion

4.1. Data Analysis and Results

The experimental data represents motion information of the viewpoints, Figure 12 is an example of gaze analysis, it exports the data about Page8 gaze map.

For dynamic presentation material, the scene was divided for analysis. Figure 12 indicates the record name of Page 8 scene, the name of the current subject, the duration of the scene as well as visual algorithm parameters. Due to different elements on the stimulating material image, count type was selected to represent that the calculation of heat map is cumulative numbers of all fixation points. Width of a single fixation point displayed by the radius, the appearance of display type is heat. X and Y coordinates and duration of fixation points were shown as well.

```
Scene Name: Page8
Scene Total Duration: 5.0076088s
Subjects: p1
Recordings: Recording1

Parameter:
Type:Count  Max Value: AutoRadius:5.0%   Style:Heat

Data:
num   X(%)  Y(%)   X(px)   Y(px)   Duration(s)
1     0.3572398816835 47   0.4655540033885 39   571.583810693675     418.998603049685     0.975
2     0.6055698383723 78   0.4560123443820 52   968.911741395805     410.411109943847     1.55
3     0.6506239443276 06   0.4643005711914 66   1040.99831092417     417.870514072319     0.3
4     0.6114073903954 66   0.4789705866429 43   978.251824632745     431.073527978648     0.375
5     0.6688551229941 61   0.5207150939293 97   1070.16819679066     468.643584536458     0.6
6     0.6467323609022 33   0.4999550357376 09   1034.77177744357     449.959532163848     0.475
```

Figure 12. Export Data about Page 8 Gaze Map

In order to show the test result more intuitively, the sample data is visualized and explained:

(1) Heat map analysis

A heat map shows the visual duration of subjects in a certain area. From items b, c, d and j in Figure 13 it was found that pattern 3 received less attention than patterns 1, 2, 4 and 5; thus, pattern 3 was eliminated first. Item g demonstrates that the attention area and duration for pattern 4 were significantly better than pattern 1 and were distributed more densely and evenly than pattern 5, as shown for item i; hence, pattern 4 was superior to patterns 1 and 5.

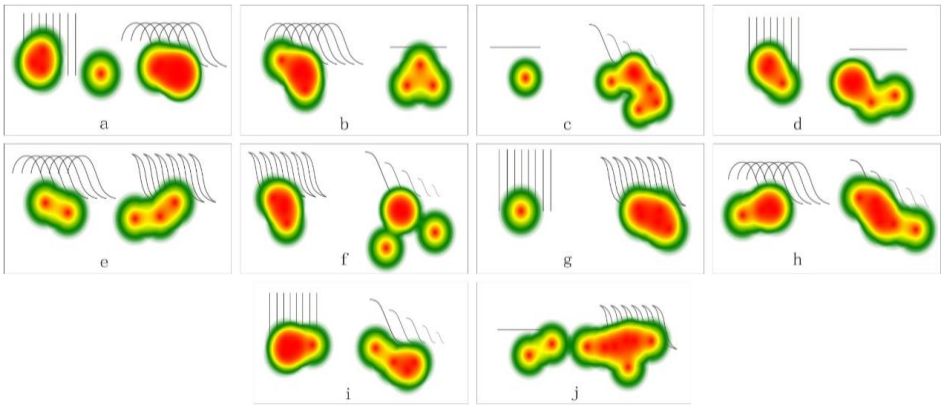

Figure 13. Heat Map

(2) Track Diagram Analysis

The fixation duration and scanning path are visually presented through a track diagram. Figure 14 indicates that pattern 3 neither attracted the eyes in the first entry nor received more attention than pattern 5 subsequently. Similarly, the comparison results for patterns 1 and 4 are obvious in Figure 15. Since the upper cross section of pattern 2 emerges a complex visual effect that cannot be recognized easily and the fixation length is abnormally long, the visual effect of pattern 4 is more comfortable compared to pattern 1, as shown in Figure 16.

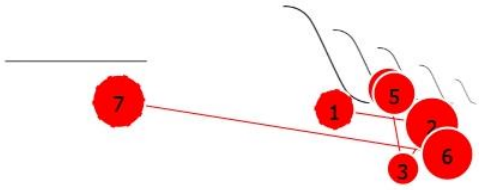

Figure 14. Track Diagram 1

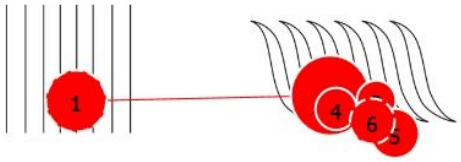

Figure 15. Track Diagram 2

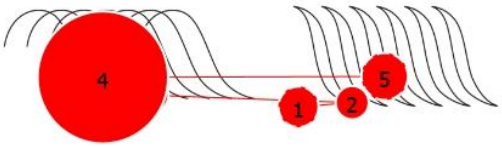

Figure 16. Track Diagram 3

(3) Clustering analysis

The clustering analysis diagram is a visual graphic presentation of the largest dense region of fixation data in the background. Each cluster containing gaze data automatically creates an interest area.

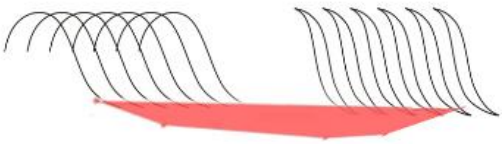

Figure 17. Clustering Analysis Chart 1

Figure 18. Clustering Analysis Chart 2

Figure 19. Clustering Analysis Chart 3

Through the above heat maps, track diagrams and clustering analysis diagrams, it is possible to intuitively see the fixation length, scan path and interest area of each sample. Pattern 4 was selected after a comprehensive comparison and a marginal optimization of its bottom was used to conduct the next design application phase.

4.2. Color Factor Evaluation Test

Color can affect the user's perception of a product. To quantify the impact of color on product image, some researchers have proposed the concept of “color mood” [9]. By using the Kansei engineering method, the color mood of saline soil culture creative products was defined as simple, quietly elegant and decent. These emotional terms were subsequently evaluated.

Kansei vocabularies that reflect the color mood of saline soil were collected extensively. “Simple,” “elegant” and “decent” best reflected the saline soil images as obtained through a questionnaire survey and cluster analysis. The Likert scale was utilized to evaluate the degree of compliance of each color sample on a scale of 1 to 5 (1=none, 2=a little, 3=much, 4=very much, 5=exact). The results were retrieved and the average values were calculated. Evidently, sample 6 attained the best results in the Kansei image evaluation (Table 1, Figure 20).

Table 1. Color Sensibility Evaluation

Artifact	1						2						3					
Color Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Red (R)	178	94	107	103	70	197	103	153	106	147	58	128	133	164	50	167	81	116
Green (G)	175	103	79	108	72	171	108	156	107	146	59	143	126	146	58	128	99	149
Blue (B)	168	108	75	102	67	120	102	155	93	63	54	114	116	110	37	99	103	166
Emotional Value	4.5	4.1	4.5	3.3	3.0	4.7	4.1	4.5	4.0	3.4	3.2	4.3	4.2	4.6	2.9	4.5	3.1	3.6

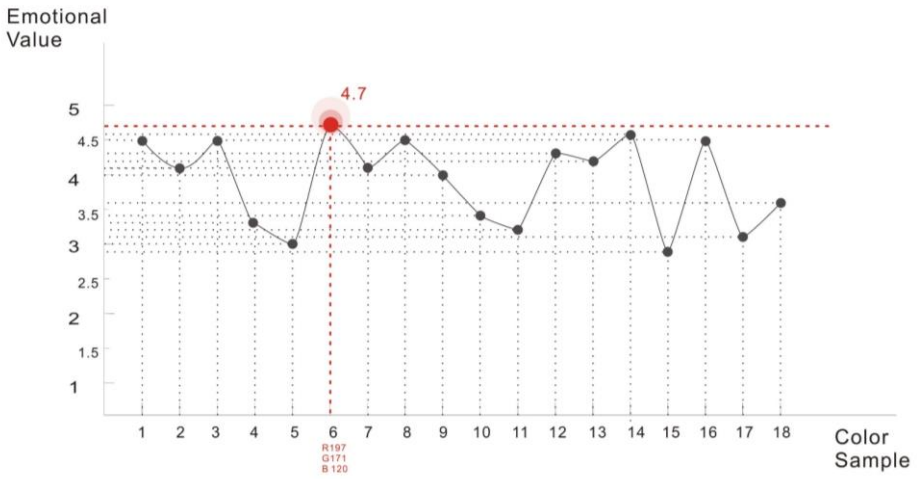

Figure 20. Color Factor Evaluation Results

4.3. Saline Soil Culture Creative Product Development

The factors that comprise a product are not isolated from each other but are interrelated, thus allowing the product to present its diversity precisely. The Yan tea set design was used as an example for the cultural factor extraction process in order to achieve a saline soil cultural creative product design.

SAPAD (Semiotic Approach to Product Architecture Design)[10], from the perspective of semiotics, served to connect the product's structure, function, materials, *etc.* with the signification that appears in users' interaction with the product. The association analysis of design factors is shown in Figure 21. A tea set, as a carrier, was chosen based on three dimensions, namely signification, object and behavior. The interactive user-product behavior when using the tea set was analyzed, and a mapping relationship was established with the object. The core signification arising from user behaviors was found to be that enjoying the taste and emotions will enhance the cultivation, refreshment and preservation of health. Finally, by analyzing the mapping between signification and object, the key object and signification were clustered to complete the construction of the third dimension in order to build an innovative product.

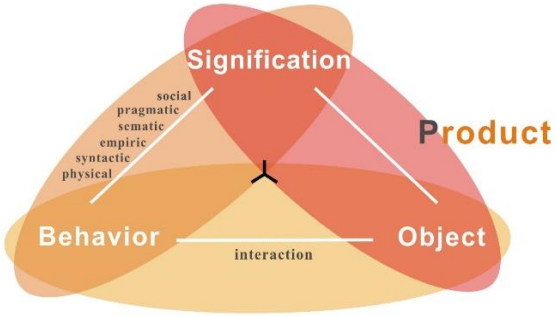

Figure 21. Association Analysis of Design Factors

The extracted product color from the color palette was saline yellow, and the evolved pattern and shape were applied to the entire tea set or some parts to guarantee an excellent functional experience. A tea set was selected as the product carrier because of the inherent meaning in each single piece contained in the product itself. Based on the prototype of helmet-shaped pottery, the tea strainer was designed in memory of Sushashi -- the ancestor of salt production. The laopen and diced iron plate were used in the salt administration process, based on which the teapot and teacup were designed to honor the ancestor Guan Zhong. Meanwhile, the salt trade is exactly the intermediate link, while the justice cup has an equality role with the function of diverting in the entire tea set; thus, a saline soil culture justice cup was designed to imply the importance of Jiao Ge, the ancestor of salt marketing. The texture of the tea set is grainy porcelain, so users can feel the touch of salt and experience the continuation of the saline soil culture while enjoying tea.

Figure 22. Final Product

5. Conclusion

The saline soil culture possesses rich spiritual connotations. Different degrees of research have been done to collect preliminary data on the saline soil culture. The saline soil culture has not yet been fully studied by researchers, as it is not an easy topic and it is hard to understand for most people. Besides, product categories that are closely related to people's lives are relatively simple. Therefore, it is essential to develop effective methods to make products penetrate people's daily lives, and the saline soil culture needs to be passed on to future generations in order for them to study and develop an interest in this topic.

In this study, an attempt was made to extract pattern, shape, color and spiritual connotation factors of important artifacts from the evolution of the saline soil culture. Modern aesthetic elements were integrated and applied along with eye movement experiments and other methods to the design evaluation and design practice, so that a communication would be achieved between traditional artifacts and modern appliances. This study is expected to provide a useful way to develop a practical tool for culture creative product design. Further research can be conducted from different perspectives, such as the exploration and innovation of different product carriers and feature extraction methods, to open up a broader space for our cultural creative design industry.

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