Designing a Mini-Program for Culture Learning and Creative Product Customization: DIY RADP

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Abstract. Taking Chinese royal architecture decorative patterns as an example, this paper explores an overall socioeconomic framework of culture learning and culture creative product customization as well as the technological framework for developing a WeChat mini-program. It highlights the results so far and the challenges of it.

Keywords: Royal Architecture Decorative Patterns, Creative Product Customization, Mini-Program, Culture Learning

1   Introduction

As an important part of Chinese traditional architectural culture, the imperial palace complex in Beijing is of high historical and artistic value. It is also a miracle in the history of Chinese architecture and a treasure in the history of world culture and art. Royal architecture decorative patterns (RADP) with various styles and magnificent beauty are an important and essential part of the historical and cultural heritages of colored patterns with a long history and profound significance. As a prominent aesthetic feature of royal architectures, the RADP program not only shows the overall style and outline of traditional architecture but also highlights the details of the buildings. Since more and more traditional cultural heritages are suffering from modernization, it is necessary to use new digital media and technology to bring aesthetic, experience and cultural value of RADP to the masses.

Since RADP is not an independent cultural heritage and it is not well known to the public, we cannot follow traditional ways to support its culture learning. How to do it? According to the **socioeconomic theory**, culture is one of the most powerful resources and cultural heritage objectives must be treated as (consumable) goods to achieve its main value. At the same time, information and communications technology (ICT), along with other advanced technologies, can potentially dramatically increase our ability to exploit this cultural heritage. Considering the rise of culture creative industry and the technical feasibility, we decide to design a WeChat mini-program that can change

RADP culture into consumable goods to support culture learning and creative product customization. **WeChat mini-programs** are "sub-applications" within the WeChat ecosystem that can help users to build up businesses at much lower costs. With more than 1 million mini-programs on the market covering 200 categories and more than 200 million daily users, mini-programs have become the way to do almost everything in China. By the beginning of 2019, a survey made by Tencent based on data gathered from 8000 WeChat users shows that 72% had used WeChat mini-programs and 34% of them declared to be frequent users (Cool Goose User Research Institute, 2019).

This paper explores an overall socioeconomic framework of culture learning and culture creative product customization as well as the technological framework for developing the mini-program for RADP. It highlights the results so far and the challenges of it. We believe the economic promotion of cultural heritage objectives may be a promising way to exploit such cultural heritage, although we are still far from achieving this aim.

2   Exposition of the Investigation

2.1   Data Collection

At the beginning of the project, we went to the Palace Museum several times to collect data and explore the characteristics and decorative patterns of the palace buildings. First built some 600 years ago, the Palace complex with more than 9000 rooms inside is the largest and most complete existing ancient royal architectural complex in the world. RADP is an important part of the palace complex and has various types. Although the exact figure of it in the palace complex is hard to be accurately calculated, it is easy to identify the most typical one, the dragon patterns. Most royal buildings with large volumes have dragon patterns from the eaves, brackets, purlins to the ceilings, from outside to inside all. The "three big halls" of Supreme Harmony, Complete Harmony and Preserving Harmony have the most gorgeous and clear dragon patterns, representing the highest standard of color painting used in palace decoration in ancient dynasties. All these reflect the unique culture in China, that dragon patterns are only the royals could use and extol the paramount imperial power to the extreme.

About data collection, we took photos of the dragon patterns in "three big halls" with the DSLR camera, and then selected colored paintings with relatively clear lines. According to the scale, grade and use function of palace architecture, dragon patterns include but not limited to the following: Golden dragon Hexi, Golden phoenix Hexi, Dragon and phoenix Hexi, Dragon Grass Hexi, and Suhua Hexi(See table 1). Almost all the dragon patterns are painted with the most luxurious golden color, showing a solemn and sumptuous effect. The strong color contrast can highlight the expression of patterns and the sense of layers, as well as make dragon patterns show a very prominent decorative effect for the architectures (Wang, 2017).

Table 1. Dragons patterns' classification features and patterns

Pattern type	Feature	Implication	Element extraction
Golden dragon Hexi	Used for main shrine buildings on the center of the palace.	It means "the son of the true dragon" is supreme.(Wang, 1990)	Dragon
Golden phoenix Hexi	Used for buildings associated with royalty, such as Ditan Park and Yuetan Park.	Phoenix is a beautiful bird pattern, is the totem of the early tribes.	Phoenix
Dragon and phoenix Hexi	Used in the chambers buildings where the emperor and his wives lived.	The meaning of prosperity brought by dragon and phoenix.	Dragon, Phoenix, Fire, Cloud
Dragon Grass Hexi	Used in temple buildings in the axis constructed by emperors.	Absorb the characteristics of Buddhist art, adopt wavy bone method, pattern symmetry.	Dragon, grass
Suhua Hexi	Used in the royal garden, for painting characters and mountains on the buildings of royal tourist places, flowers, birds, fish, and insects garden style.	Paintings for landscapes and figures, flowers, birds, fish, and insects garden style.	Grass

2.2 Preprocessing and Element Extraction

Image Processing. We collected many pictures from field photographing that needed to be processed. First of all, pictures contain clear dragon patterns are selected, while the others with serious geometric deformation or gray value deviation are eliminated. However, the selected pictures are still less effective for various reasons, which means the definition and sharpness of the images should be enhanced before the next step. We use Adobe Photoshop to process the images. We directly copied the layer with CTRL+J and applied the "High Pass" in the filter to adjust the pixel value of the radius (R) so that it can present the image outline. Then we changed the layer blending mode, and operate overlay/soft/strong light depending on the situation. This can be repeated consistently to enhance the effect until we finally got the suitable images. Comparing with USM sharpening, this method can reduce the over-smoothed limitation and avoid losing excessive high-frequency information (Li, 2005).

Pattern Elements Extraction. To provide users with various pattern elements in the culture creative product customization section, it's necessary to extract architectural

pattern elements from selected and preprocessed dragon pattern pictures. We use cutout technology to remove useless background images and the region growth algorithm is finally adopted. Region Growth is a serial region segmentation method to assemble pixels with similar properties to form regions(Hou, Yang, 2010). We use the Numpy package and cv2 module in Python to invoking functions to implement the region growth algorithm. Firstly, images are scanned sequentially to find the first unassigned pixel and set it as (x0,y0). Taking it as the center, consider the 4-neighborhood pixel (x, y) of (x0,y0). If (x0,y0) satisfies the growth criteria, (x, y) is merged with (x0,y0), and (x, y) is pushed onto the stack. Secondly, we take a pixel from the stack and return it as (x0,y0) to step 2, or return to the original step when the stack is empty. Repeating the operation, finally, the extraction of typical pattern elements in each picture is completed (See Fig. 1). Note that since region growth involves seed selection, it is important to design a proper function to obtain image coordinates.

Fig. 1. Image element extraction

2.3   Mini-program Structure Framework

DIY RADP has two main functions of culture learning and culture creative product customization. We develop several storylines as the organic connection between two main functions and can be considered as the best highlight of the whole program. Main function modules are built in a linear arrangement.

- The first step is to enter the guided plot module, switching between various scenes with the three main halls of the Palace Museum as the background, through the text adventure game. Users accept the guidance of the story characters from the first-person perspective and learn from the text introduction of scenes and architectural patterns.
- Then, the program presents a certain number of related questions based on the text content of the previous module. Each question corresponds to the different pattern elements. Users need to memorize the pattern knowledge to answer the questions correctly. The obtained elements are according to the correct answers of the users.
- In the DIY process, users can only use the pattern elements. They can choose

to answer the questions again to get more. Users can DIY on their ideas or refer to the pattern templates. All the designs will be saved after completion.

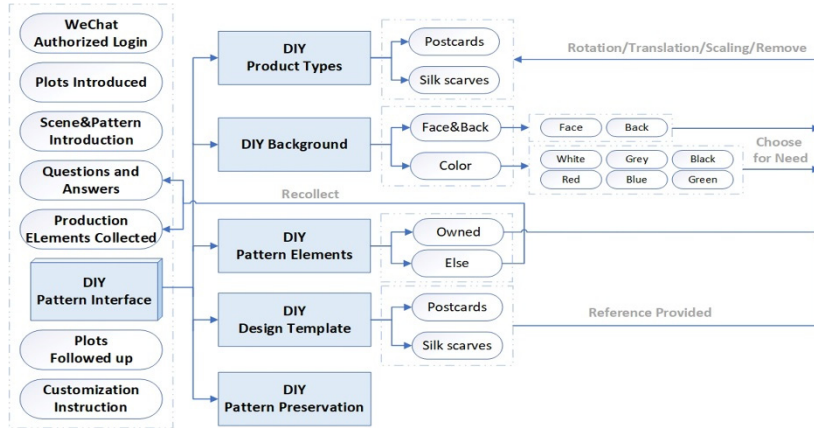· Finally, users can choose whether to customize physical products or not.

Fig. 2. Mini-program structure framework

2.4   Mini-program Implementation

We conducted a global configuration and built the overall environment in the background app.js, app.json, and app.wxss according to the overall structure and page setting. JSON mainly implements the common configuration of the program, which must be set in the root directory, but page configuration is not required. WXML syntax is also a must in page setting, which combines basic components and event system to build the structure of the page. It can set templates, perform conditional rendering and list rendering. WXSS language is used to describe the component styles of WXML. The styles in app.wxss are global styles that apply to each page, while the styles defined in the wxss file of pages only apply to the corresponding page and override the same selectors in app.wxss. However, since interface presentation is not enough in service, it also needs to interact with users by parsing JavaScript files.

Culture Learning Function Module. DIY RADP program has a culture-learning module carried out in the form of "mainline + fragments". The program takes the scene switch of the "three big halls" as the main plotline. Each part has the same theme structure, but different chapters are divided by scene switching. Each chapter contains some knowledge points about royal architecture and its pattern culture. Appropriate plots are arranged throughout the tour to make the knowledge points more natural. When the user entering the scene, a eunuch role will guide users to tour and teach users pattern culture knowledge with multimedia materials.

Elements Collecting Module. After touring one scene, the eunuch requests users to design a gift for empress dowager, leading users to the elements collecting module. The element-collecting module is conducted by the Q&A approach. The Q&A database is related to the rendering interface for obtained elements. It needs to import questions and answers according to previous script design and display the questions and options

in random order. When the wrong option is touched, the correct answer and explanation will pop up. The pattern elements bounding to the correct answers are deemed to have been successfully collected by the user (see Fig. 4). Users will jump to the elements collection interface after 12 questions are answered, and the interface displays the obtained elements. Users can select the button to decide whether to redo the questions or start DIY by using owned elements.

Fig. 3. Patterns knowledge text adventure interfaces

Fig. 4. Patten element collection interfaces

DIY Function Module. Users can choose the product type they would like to customize (a postcard or a silk scarf). Meanwhile, the background image and its colors can be switched according to the preference of users. After that, users can select and drag the lower pattern elements to the main page for panning, zooming, rotating and other operations to complete DIY design (see Fig. 5). We also design some pattern templates by referring to the composition forms of traditional Chinese patterns(Han, Bian, & Wei, 2019), and provides them for users. After the DIY process, the eunuch role will praise the users through the plot of the word game. Then the program will go back to the final interface with the plot backing to the modern times. Users can preserve their DIY culture creative products digitally and share with their friends on social

media. Meanwhile, they can also apply for physical products as gifts for themselves or others.
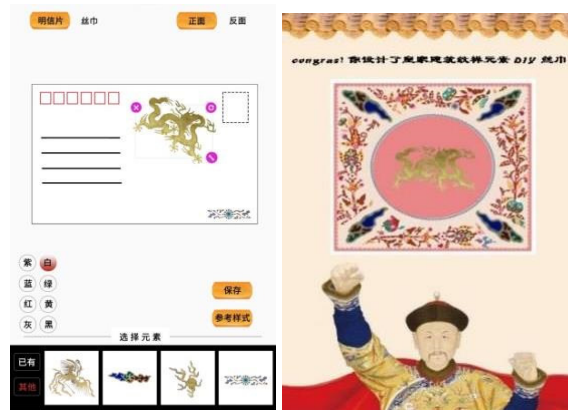

Fig. 5. Postcard DIY interface and Silk scarf design finished interface

3   Conclusion

We have already finished the preliminary development of the DIY RADP program and the function test has been conducted on a small scale to help to improve the program. About the future work, firstly, we will add more palace scenes in the pattern learning module to allow users to explore the royal architectural culture deeply. Secondly, we will expand the type and quantity of pattern elements, increase the DIY available background color tray, expand the backend database, and design more matching Q&As. Finally, we will develop an interactive platform entrance for users to participate in. Users can participate in the compilation of Q&A, which will be reviewed and stored in the database. They can also upload their architectural patterns, color pictures and other images for backend identification, extraction, and storage of elements. We believe this participative behavior can improve product performance and increase user stickiness. After that, we will conduct the usability assessment, including UI, functional integrity, cultural learning effect, and further optimize, to improve it.

This project makes an exploration of using a socioeconomic approach to carry forward RADP culture value through the whole process of learning and consuming. We believe this experience of bringing culture heritage into economic movement is a powerful indicator of our utilization of cultural heritage. It can provide reference ideas of preservation and inheritance with other cultural heritages, especially for those non-mainstream ones. In the future work, the program can expand the DIY customization categories of culture creative products and the industrial chain of cooperative suppliers (Yu, 2017), which will be both an opportunity and a big challenge. We hope that more companies will be willing to cooperate with us to produce culture customized physical products so that we can integrate more types of creative cultural production and broaden the business scope.

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