

# Creative Product Design with 3D Printing Based on Jingchu Architecture—Taking Yellow Crane Tower as an Example

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**How to cite this paper:** Hou, S. M., He, M., Li, R. J., Jiang, S. Y. X., & Liu, Y. J. (2022). Creative Product Design with 3D Printing Based on Jingchu Architecture—Taking Yellow Crane Tower as an Example. *Art and Design Review*, 10, 231-242. <https://doi.org/10.4236/adr.2022.102017>

**Received:** April 20, 2022

**Accepted:** May 24, 2022

**Published:** May 27, 2022

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## Abstract

This study analyzed the artistic characteristics and investigated the current situation of Yellow Crane Tower and its cultural and creative products. In addition, using the advantages of 3D printing technology, the authors explore the design and manufacturing methods to solve the issues of product homogeneity, simplification, lack of innovation, and low price-performance. We hope that this method can inherit and carry forward traditional culture, promote the combination of art and technology, provide a variety of cultural and creative products to meet the needs of consumers, as well as promote the development of local tourism and local economy.

## Keywords

Cultural and Creative Products, Jingchu Architecture, Yellow Crane Tower, 3D Printing

## 1. Introduction

Cultural and creative products have the characteristics of cultural, regional, and memorable. With the rapid development of society, culture and economy, it provides potential opportunities and a huge market for cultural and creative products. More and more regions have developed a series cultural and creative product with regional cultural characteristics, such as creative lights of Dunhuang Silk Road, refrigerator magnet creative products of Sanxingdui bronze mask, etc. In 2022, Hubei Province following the requirements of the 14<sup>th</sup> Five-Year Plan (2021-25), and the Provincial Department of Culture and Tourism has issued a series document about the inherit and develop traditional culture, protection

and inheritance of intangible cultural heritage. It requires using the distinguishing feature of the Yangtze River culture and Jingchu culture to cultivate a cultural-tourism brand with “Wuhan city” and “romantic Jingchu style” while promoting it to the world. Yellow Crane Tower is “the first tower in the world” and one of the 5A-level tourist attractions and a local tourism’s centerpiece of Wuhan, it has perched atop Snake Mountain for millennia and centuries, with white clouds wafting around and the Yangtze River surging below. Since ancient times, it has been “a great wonder of the world” and has exceptionally regional characteristics of Jingchu culture. However, under the situation of the fever of tourism and the Intellectual property (IP) of cultural and creative products, there are some issues with creative products of Yellow Crane Tower, such as product homogeneity, simplification, lack of innovation, low price-performance, and cannot to meet the needs of consumers. To improve the competitiveness and enhance the economic value of creative products, designers need to change their design concepts and methods to explore the application of traditional elements, enrich products forms, and meet consumer demands (Jun, 2021).

Hence, by understanding the cultural background and artistic features of Yellow Crane Tower. We used the 3D printing technology, which has advantages of rapid manufacturing, precision manufacturing, cost-saving, and on-demand production, to explore the method to design and manufacture creation products of Yellow Crane Tower. Meanwhile, we have also created a series of jewelry works that include a hair crown, a comb, and a hairpin, which was designed from the “five-story cornices” architectural style of Yellow Crane Tower. We hope it can provide a reference for other designers to develop the creative products of Yellow Crane Tower. Furthermore, we also wish the creative products can be a bridge to show the beautiful feature of Wuhan and inherit traditional culture and promote the development of local culture, tourism, and economy.

## **2. The Artistic Characteristics and Current Situation of Yellow Crane Tower and Its Cultural and Creative Products**

### **2.1. The Cultural Background and Artistic Characteristics of Yellow Crane Tower**

Emerson said: “cities exist by memory”, and architecture represents the memory of a city. Yellow Crane Tower was built during the Three Kingdoms period and is now stands atop Snake Mountain and aside the Yangtze River in the “Chicago of China”—Wuchang District, Wuhan City. It blends classicism and modernism, poetics and aesthetics, which agrees with the custom, awareness, and philosophy of climbing mountains, getting close to nature, and revering to the universe of Chinese people. According to the data from the Culture and Tourism Bureau of Wuhan, the number of tourists to Yellow Crane Tower can reach more than 5700 times a day in 2019.

The restored Yellow Crane Tower was built in 1985 based on the scale of the Ming and Qing dynasties; it has undergone many contour designs and then adopts

a mix of the octagon (Ba) and square (Fang), which means “getting access to all eight directions”. Yellow Crane Tower consisted of staggered and over-lapped layers. The corners that curve upward is like the tower have wings to fly in the sky, which vividly reflects the historical and cultural connotations.

The new era gives Yellow Crane Tower new significance. It presented a long civilization and brilliant history. It is a treasure of the thousand-year-old Jiangcheng town, a heartbeat of the Yangtze River, a landmark building in Wuhan. Nowadays, Yellow Crane Tower is becoming a new well-known scenic spot at home and abroad. Therefore, we need to display the beauty of Yellow Crane Tower and the charm of Jingchu culture through various creative products to travelers.

## 2.2. The Situation of Cultural and Creative Products in China

Under the “tourism boom” situation, the Chinese government has issued a series of relevant policies to raise the cultural and creative industry to the national development strategy. The keyword burst map that “cultural and creative products” have become the current research hotspots in the research of product design evaluation theory, and will be the focus of scholars’ attention for some time in the future (Liu, 2021). According to the results of search trends related to cultural and creative products by the Baidu Index (Figure 1), the term “cultural and creative products” has been retrieved and followed since 2018. It has begun to show an upward trend in 2022. Since the Ministry of Culture and Tourism of The People’s Republic of China issued the “Notice Several Opinions on Promoting the Development of Cultural and Creative Products in Cultural Heritage Units” in 2016, people have begun to pay attention to cultural and creative products. In 2022, the government has continued to issue the 14<sup>th</sup> Five-Year Plan (2021-25), which proposed using culture to establish tourism, using tourism to disseminate culture, and using innovation as the driving force to develop cultural and creative products.

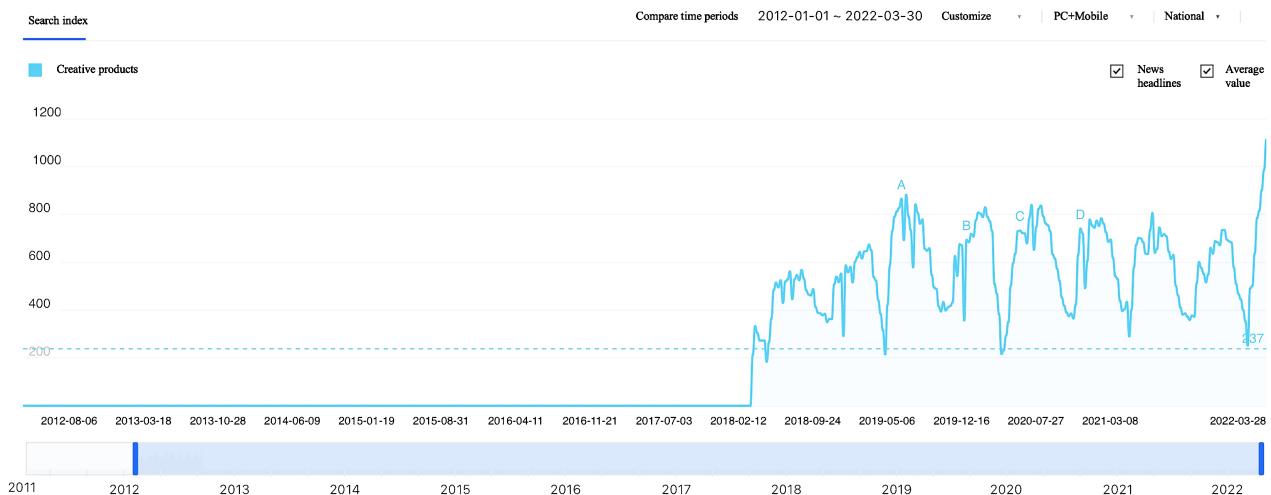










Figure 1. Search index about “cultural and creative products” (2012-2022) (<https://index.baidu.com/v2/main/index.html#/trend/>).

This paper investigated and analyzed the current situation and characteristics of cultural and creative products in the National Museum of China, the Palace Museum, Sanxingdui Museum, and Dunhuang Research Institute through literature research and website research. As shown in **Figure 2**, the creative products in National Museum of China combines new materials with new technologies and created a series of sub-cultural brands to display different scenes, such as used laser cutting technology to fabricate the Daguanyuan Paper Carved Lantern (**Figure 2(e)**), which presenting the aesthetics and humanistic characteristics of Chinese landscapes. The Palace Museum highlights the characteristics of IP brands, such as the Forbidden City Cat, Emperor Qianlong, and other IP elements. It used various forms like animation, games, and APP to enrich the fun and interactivity of products, as well as combined digital media and virtual reality (VR) technology to realize online museum exhibitions and spreading culture. In addition, the Palace Museum also tends use traditional elements and traditional crafts to recreate creative products, for instance, the earrings (**Figure 2(f)**) used traditional filigree and enamel crafts, and the design combines the elements of auspicious and the Forbidden City, which implies peace and longevity.

Sanxingdui Museum reproduced cultural relics into three-dimensional (3D) models using 3D printing technology, such as the “Resin Refrigerator Magnet”, a replica of one of the museum’s most precious collections of bronze masks manufactured by using resin materials and 3D printing technology (**Figure 2(g)**). These creative products not only can as “little cultural relics” gifts to tourists to take home but also can disseminate the ancient and mysterious culture of Sanxingdui.

	National Museum of China	The Palace Museum	Sanxingdui Museum	Dunhuang Research Academy
<b>Museum Introduction</b>	The National Museum of China (NMC) is China's supreme establishment that collects, researches, displays and interprets China's fine traditional culture, revolutionary culture and advanced socialist culture. NMC is the top palace of history and art and a cultural parlor for China.	The unique collection of the Palace Museum is the largest and best-preserved wooden palace complex in the world. It is a living archive of the history of the Ming and Qing courts.	Sanxingdui Museum exhibits both popular science and art, which effectively reveals the profound connotation of the Sanxingdui civilization. It reflects the splendor of Sanxingdui as the source of the Yangtze River civilization and the root of Tianfu culture.	Dunhuang Research Academy is a unit that protects, studies, and popularizes Dunhuang Grottoes culture. Because of its remote geographical environment and fragile Dunhuang Grottoes fresco culture, it focuses on the development of IP digital research.
<b>Museum Collections</b>	 (a) “Guo Ji Zi Bai” bronze pan & jade bird from western Zhou	 (b) Yongzheng court dress	 (c) Vertical-eyed Bronze Mask	 (d) Treasure mural of desert
<b>Museum Creative Products</b>	 (e) Star-shifting night lights & Daguanyuan paper carved lantern	 (f) Filigree enamel earrings & ornaments of the Forbidden City cats	 (g) Resin refrigerator magnets of bronze masks of Sanxingdui	 (h) Silk Road night lights & flying night lights
<b>Characteristics</b>	Application of new technology and new materials	Re-application on traditional culture and crafts, highlights interactive experience and digital technology, and development of the IP brands	Development of the IP brands, application of new technology and new materials	Digital technology, Regional culture

**Figure 2.** Research and analysis of characteristics of cultural and creative products in four museums.

Dunhuang Research Academy utilized its characteristics of regional culture. It developed the IP brand of “Silk Road”, for example, the “Silk Road Night Lights” was derived from the figures in the murals of the Mogao Grottoes in Dunhuang, which show the traditional and elegant charm of the “Dunhuang Flying Murals”.

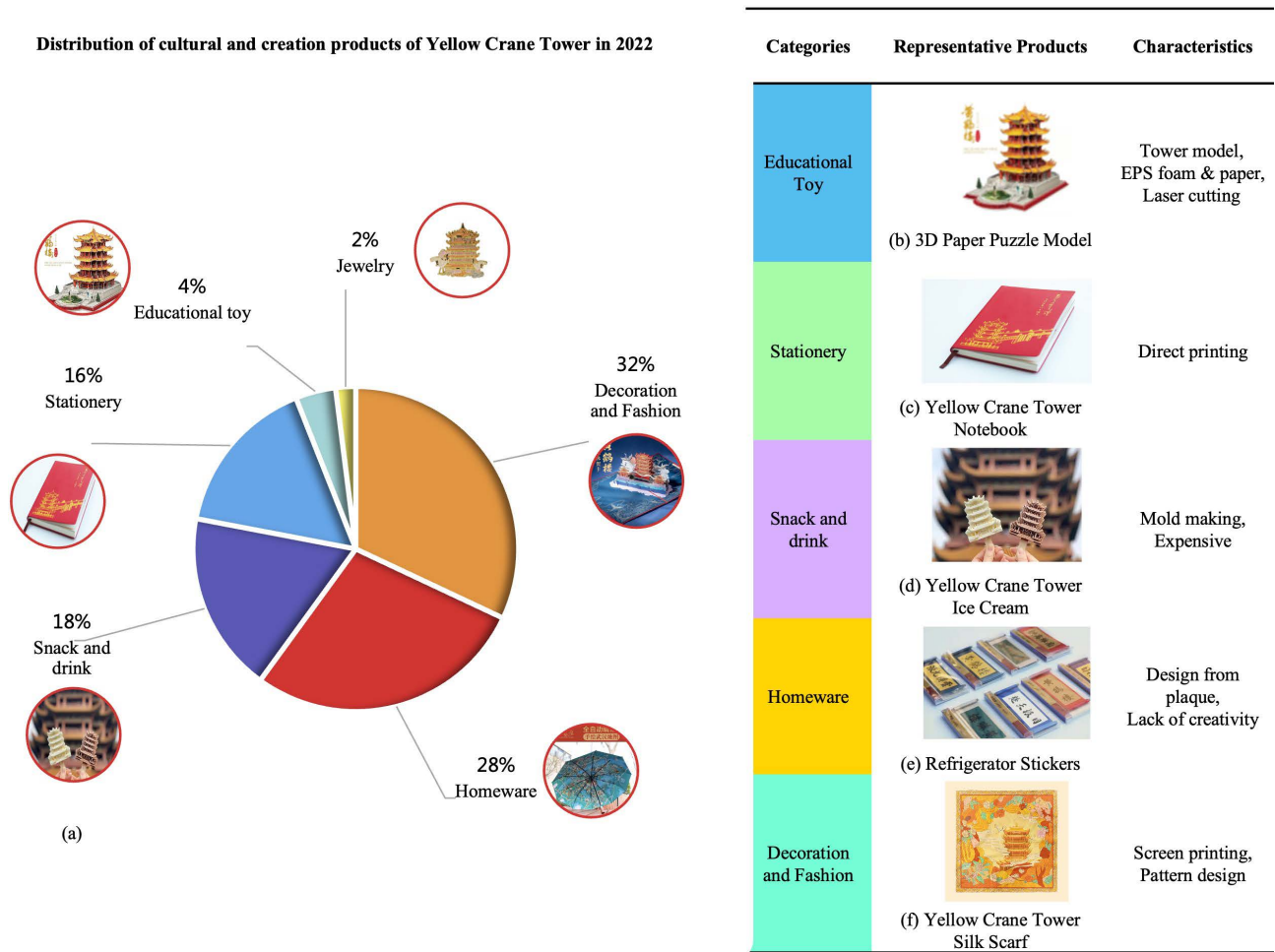
To sum up, the development of cultural and creative products in China tends to:

- Use digital technology to enhance the fun and interaction of creative products.
- Use advanced manufacturing technology and new materials to enrich the forms of creative products.
- Combine the aesthetics and the living needs of modern life people to innovative products.

### 2.3. The Situation of Cultural and Creative Products of Yellow Crane Tower

This paper compared the cultural characteristics, product categories, and design forms of cultural and creative products of the Yellow Crane Tower with the above four museums through online research. We also concluded the current issues about creative products of the Yellow Crane Tower as follows:

- Homogeneity and lack of features. As shown in **Figure 3(a)**, we have collected and classified 50 products by online research, such as the official website and Taobao store. The distribution of cultural and creative products of Yellow Crane Tower in 2022 shows that the decoration and fashion products account for the largest proportion with 32%, followed by homeware with 28%, snacks and drinks with 18%, stationery with 16%, educational toys with 4% and jewelry with 2%. Most of these products were made by directly extracting architectural elements of the Yellow Crane Tower’s architectural elements but without recreating the elements. Without digging deep into the cultural connotation and regional characteristics behind it, refining its artistic characteristics, and recreating elements, it lacks characteristics, is easy to copy and replace, and cannot fully use its cultural promotion and application value. As a result, the products lack features and application values to display the cultural connotation and are easily copied and replaced by other products.
- Simplification and lack of innovation. Compared with the National Museum of China and the Palace Museum which application of new technology and new materials to development cultural and creation products. The products of Yellow Crane Tower lack exploring the innovation of product processing methods and product functionality of fun and interactive. For example, the Yellow Crane Tower 3D paper puzzle (**Figure 3(b)**) is traditional for children. It only used the paper card to displays the architecture of the tower but has not emphasized the way of layer-by-layer splicing like Lego DIY to stimulate the creativity and hands-on ability of children.



**Figure 3.** Online research of cultural and creative products of the Yellow Crane Tower.

- Low price-performance and unable to meet consumer demands. The price of cultural and creative products is generally high while the processing methods are traditional, and the quality of products is not delicate enough. In addition, it lacks combining the cultural features with exploring Yellow Crane Tower IP brands. It lacks extracting the personalized, customized services, which leads tourists not to desire to buy. According to the requirements map for cultural and creative products displayed by the Baidu index and the age of consumer groups (Figure 4), nowadays, people have paid more and more attention to digital technology, creative development, cultural heritage, and interactive experience cultural and creative products. Figure 4 also shows that the leading consumer group is the age of 19 to 29-year-olds. Therefore, the innovative products' design of Yellow Crane Tower should keep up with the development of society and people's demands and utilize the advantages of digital technology for innovative personalized, interactive, and cost-effective products.

In summary, to solve the issues of homogeneity, simplification, lack of features, and low price-performance of cultural and creative products in Yellow

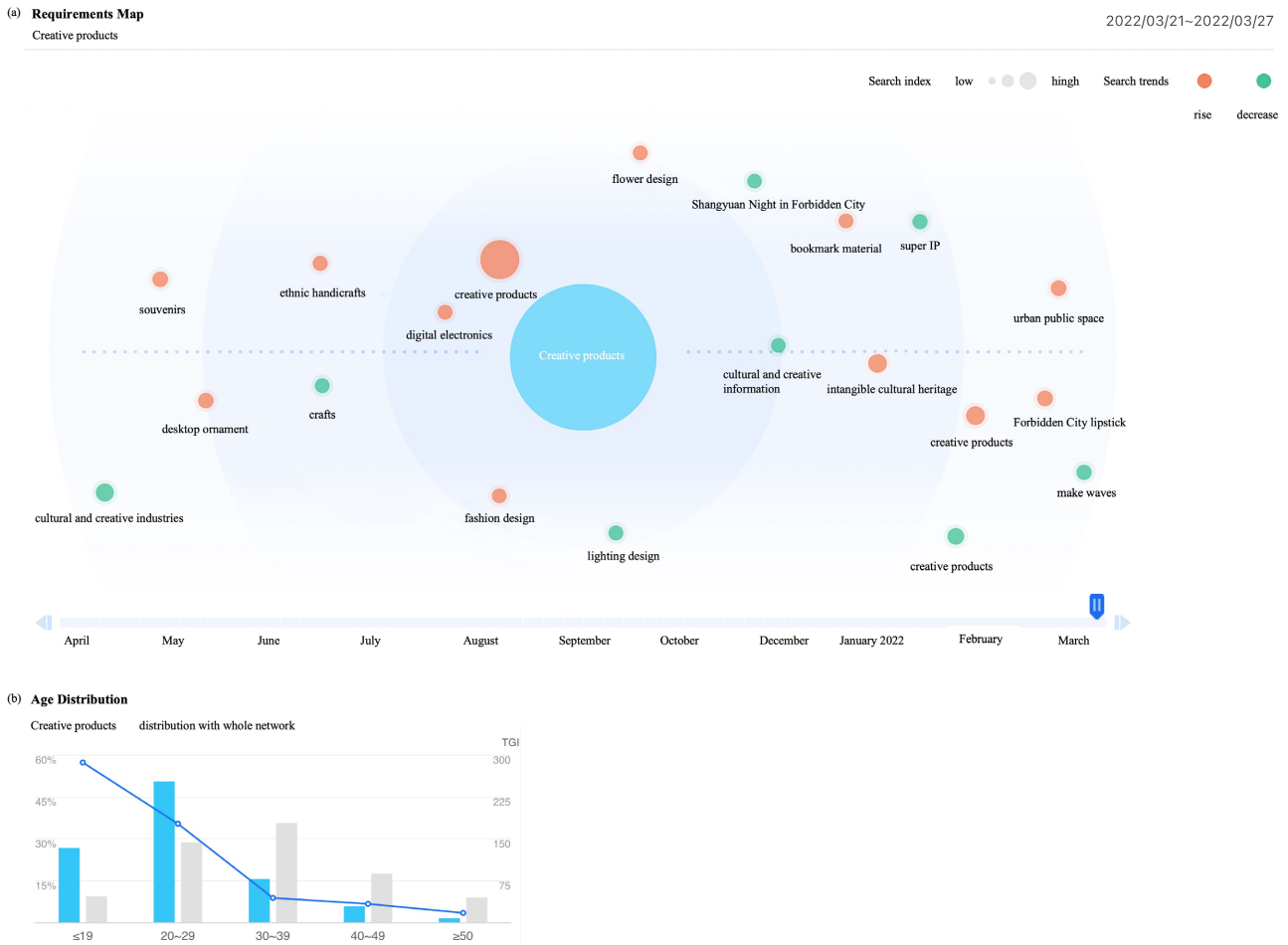


Figure 4. (a) requirements map and (b) age distribution of “cultural and creative products”.

Crane Tower. We need to extract the elements of the cultural characteristics, architectural characteristics, and pattern style of the Yellow Crane Tower. Moreover, use digital technology (digital software, App, AR, VR), advanced manufacturing technology (3D printing, laser cutting), and to explore the new materials, new design and manufacturing methods and new experience methods to innovate the forms and to enhance the fun and interaction of cultural and creative products.

### 3. Development and Design of Cultural and Creative Products of Yellow Crane Tower Based on 3D Printing Technology

#### 3.1. Advantages of 3D Printing Technology for Development of Cultural and Creative Products

3D printing technology manufactures objects layer-by-layer. It has the advantages of rapid manufacturing, precision manufacturing, cost-saving, and on-demand production, and is widely used in the products development of industrial products, jewelry, accessories, and toys (Zhang et al., 2016). The significant applications of 3D printing technology currently used on the market are Fused Deposi-

tion Rapid Prototyping (FDM), Photocurable Stereolithography (SLA), Selective Laser Sintering (SLS), and Selective Laser Melting (SLM) (Shahrubudin, 2019). Among the cultural and creative products, it has appeared to use 3D printing and 3D scanning technology for product development and customized design. The main advantages can be summarized as follows:

- Improve production efficiency and save production costs. On the one hand, the designed 3D models are easy to modify according to customers' demands. They can manufacture and customize according to the required quantity and material through 3D printing technology. On the other hand, compared to the long and complicated steps of traditional technology, the layer-by-layer processing method of 3D printing technology can avoid a large amount of waste of materials and simplify the processing and save costs and time.
- Innovative design methods and enriched product forms. 3D printing technology can complete complex structures that are difficult to process with traditional technologies, which can get rid of the limits of traditional crafts and improve the freedom of design. Designers can be creative more interesting cultural and creative products through digital software, 3D scanning and 3D printing technology. It can be inherited and carry the connotation of traditional culture to meet people's life and aesthetic needs in the digital era.
- Personalized customization to increase the interactivity of products. 3D printing technology can provide customized services for personalized products and manufacturing unique products such as chocolates, ice creams, dolls, clothes, jewelry, etc. At the same time, consumers can participate in the design and experience customized services through digital software and Apps, which are more simplified, conveniently, and quickly for people to design and modify. This service can spread the concept of "mass design" and enhance the understanding of the meaning of traditional culture and spirit, improve the interest and interactivity of products, and promote the development of tourism and the economy.

### 3.2. Design Methods of Cultural and Creative Products of Yellow Crane Tower Based on 3D Printing Technology

According to the characteristics of 3D printing, the design and process methods of Yellow Crane Tower jewelry products are summarized in **Figure 5**. First, research the thematic and background, then select and extract elements to design; second, based on different types and conditions of 3D printer, modify the design sketches, and use computer software to build 3D models. In addition, export the suitable files into the 3D printer, select relative materials to test the processing and printing of the whole work; finally, improve the work through post-processing such as polishing, coloring, assembling and install until the creative products are finally completed.



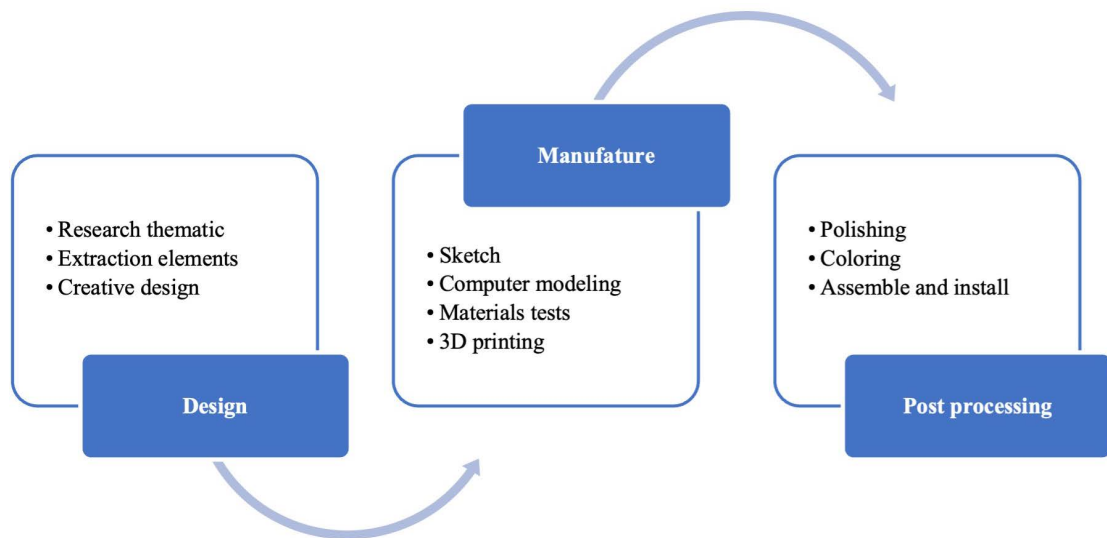
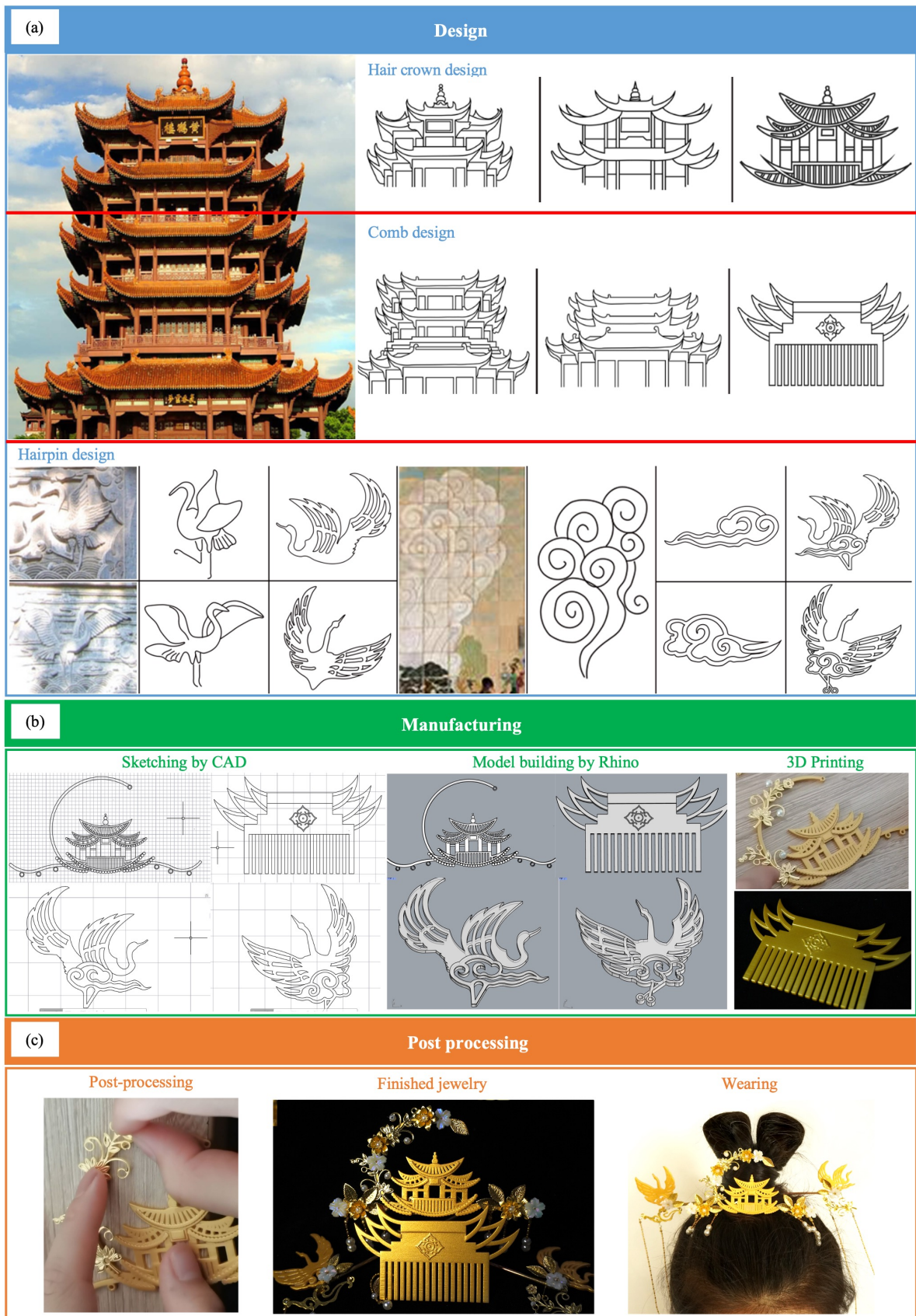


Figure 5. Design and process methods.

### 3.3. The Creative Jewelry Design of Yellow Crane Tower Based on 3D Printing Technology—“Yellow Crane Travel”

- According to research on the cultural background and artistic characteristics of Yellow Crane Tower and extract the main characteristics of the architectural style of “five-story cornices” to creation a set of jewelry that consisting of hair crown, comb, and hairpin. As shown in **Figure 6(a)**, the shape of the top hair crown inspiration from the fourth and fifth floor of the Yellow Crane Tower and make it more beautiful and vitality through simplified and curved the outline line. Simultaneously, the eaves part is hollowed out and exaggerated to express the delicately and vividly tiles. The comb is designed by constructing and reorganizing the three of bottom floors of the Yellow Crane Tower, and the hairpin is designed by deformation of auspicious pattern elements such as cranes and clouds. It shows the mystery, beauty, and unique historical charm and contains the meaning of peace and good fortune.
- **Figure 6(b)** shows the production flow of the jewelry artwork of Yellow Crane Tower. Firstly, sketch and build the 3D model using CAD and Rhino software. Secondly, modify the size, and thickness according to the requirements of 3D printing and jewelry wearing conditions. Finally, export the designed file and import it into the SLA 3D printer, choose the resin materials to fabricate the whole work.
- After processing, we need to polish, varnish, and connect with accessories such as mother-of-pearl and other metal decorations to make it can be wearable (**Figure 6(c)**). The set of jewelry can be individually worn or worn in sets, and it can also be an ornament placed at home. It presents the unique architectural beauty of Yellow Crane Tower and reflects the charm of traditional Chinese culture. Importantly, this artwork combined modern technology with jewelry, which can make people experience digital technology and cultural-artistic.



**Figure 6.** The production process of Yellow Crane Tower jewelry design (photo by the author, 2022).

Through research, we found that digital software can be more convenient for converting design elements and realizing a variety of design drafts. It can also be easy to modify and create a series of product designs. At the same time, the 3D printing technology can quickly fabricate the digital models, which saves manufacturing times and improve production efficiency. Notably, 3D printing can achieve tiny structures and delicate surfaces that are difficult to handmade. More interesting, we can also paint the parts accomplished by 3D printing with different colours and connecting different accessories. It also can provide a DIY experience for consumers to decorate their unique artworks.

#### 4. Summarize

Yellow Crane Tower is a landmark of Jingchu culture and scenic spots in Wuhan, and it has profound history and culture and abundant tourism resources. However, the cultural and creative products of Yellow Crane Tower have many issues and cannot meet consumers' demands. Hence, we need to utilize the advantages of the cultural value and tourism resources to create innovative variant products that include functional, attractive, beautiful, and technological to meet the needs of modern people's life. Digital software and 3D printing technology can innovate the production form and enrich products styles and provide personalized, customized services to people and enhance the fun and interactivity of products. This paper investigates and summarizes the design and production methods of cultural and creative products of Yellow Crane Tower based on 3D printing technology and completed a set of Yellow Crane Tower jewelry products through these methods. We hope to provide a reference for the further creative product design to use the new technologies to inherit and promote the traditional culture. We also hope it can provide a better product experience and simulate the tourism of Yellow Crane Tower and promote Wuhan's economic development.

#### Acknowledgements

This work is supported by the Innovation and Entrepreneurship Training Program for College Students of Hubei University of Technology (X202010500116X).

#### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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