

STRUCTURE AND DECORATION ART OF DOU-GONG BRACKET SETS AND ITS CULTURAL COMMUNICATION

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ABSTRACT

A system of brackets inserted between the top of a column and a crossbeam (hereinafter referred to as Dou-Gong Bracket Sets) is a unique and important structural component in traditional Chinese architecture. It is used to represent the connotations of traditional Chinese culture. To begin, this paper discussed the meanings of Dou-Gong Brackets Sets and their various features at each stage. At the same time, it thoroughly examined the system's structure and decoration, as well as its changes over time. Second, this paper expanded on its connotations of traditional Chinese culture. Then, a Dou-Gong Brackets Sets is chosen to design a 3D digital simulation game, and the game interface and interactive module are created based on the game design's participation and dissemination. The interface design with Chinese charm, visual function, and simplicity is created using design psychology and emotional design principles. This study evaluates and tests the user experience as well as the effect of cultural and educational communication of the Dou-Gong game, and it confirms that digital communication means play an irreplaceable role and significance in Dou-Gong communication.

Keywords: Dou-Gong bracket sets, architecture of China, dissemination, interactive games.

INTRODUCTION

Traditional Chinese architecture with its unique architectural form and flexible and balanced timber structure, has won the praise and learning of others among world architectures. Delicate and complicated structural forms that we see today are formed as a result of significant development of China's timber-structured architecture. The structural appearance of the Dou-Gong Brackets Sets contains a wealth of information, and its various shapes depict various ages, construction backgrounds, related historical stories, historical figures, architectural thoughts, and architectural styles at the time. Using digital technology, we can reproduce the characteristics and significance of the Dou-Gong Brackets Sets in various buildings. The first goal of this paper is to examine the artistic characteristics of Dou-Gong Brackets Sets from the perspectives of combination, quantity, decorative modelling, and educational significance; the second goal is to enable users to learn cultural knowledge and experience the cultural connotation of the Dou-Gong Brackets Sets fights anytime and anywhere through games, in order to better inherit the tradition.

RESEARCH BACKGROUND

The Art of Bracket Sets

The main form of presenting traditional architectural art is decoration, which is linked to the development of architectural structure. They are complementary to one another. Dou-Gong bracket sets (hereinafter referred to as DGBS) have played the roles of structure and grading decoration in the evolution of Chinese traditional architectural culture, and have witnessed the entire process of Chinese traditional architectural evolution. In Chinese architecture, DGBS is a system of brackets inserted between the top of a column and a crossbeam. It is used as a force transfer and decoration joint between the top of a column and a crossbeam. People usually discuss the status of DGBS when discussing traditional Chinese timber structures.

“DGBS” is divided into three parts: “bucket,” “arch,” and “Ang.” In ancient times, the term “bucket” was used to measure food. The bucket of architecture, on the other hand, refers to a square wood block excavated with a notch and located beneath DGBS. It is commonly referred to as a large bucket. Because buckets are located in different locations, different names are assigned later. The term “arch” refers to how ancient carpenters extended stub poles level by level from column to crossbeam to support eaves that were extended outside the building body.

Because of their different locations, they are given different names later on. (see Figure 1) “Ang” is a diagonal component that serves as a lever in DGBS. It is divided into upper and lower Ang, with the upper being used only indoors and the lower being used only outdoors. As a result, DGBS is made up of a square bucket, a rectangular arch, and a diagonal Ang. Joinery has been a major focus since ancient times, when the Chinese first

began to use wood for building, and craftsmen cut the wooden pieces to fit so perfectly that no glue or fasteners were required (Steinhardt, 2002).

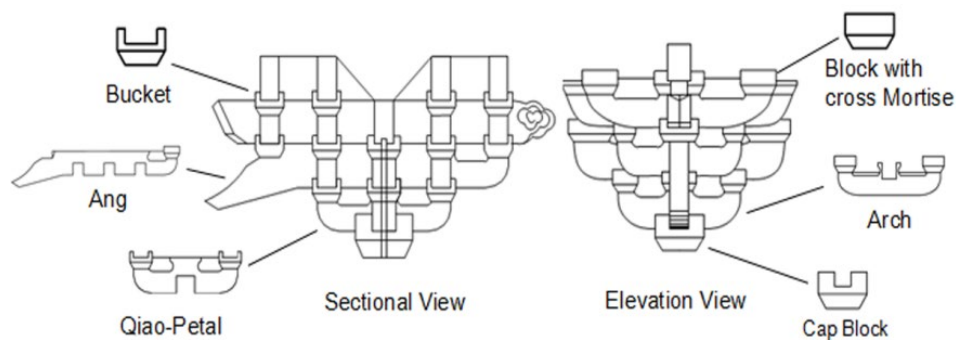


Figure 1 DGBS analysis graph

Source: Author

DGBS is a specific structural component in traditional Chinese timber structures that was invented to bear weight on architectural structures so that large area load of roof can be transferred to columns via functional transfer of DGBS. It is primarily used at each joint. When a roof truss bears weight, it can withstand natural disasters such as earthquakes and high winds. However, after a long period of development, people are dissatisfied with the functions of DGBS, resulting in its gradual evolution into a symbol of the strict hierarchy system of feudal society. Even at the end of feudalism, some DGBS were completely transformed into pure decorations on timber-structured architecture.

In research on the traditional art of DGBS, conceptual meaning is usually used to interpret the formation of structure and decoration forms of DGBS and the differences in their changes, but research on the formal meaning of making technology to traditional spirit and views is ignored. The making technology of traditional timber structure determines the forms of DGBS in each era, according to timber structure technology. That is, technology shapes form, and forms determine the level of decoration and structural variation. Exploring their technology is thus one of the best ways to study the structure and forms of DGBS in different eras.

The aesthetic of people in a specific period is directly reflected by DGBS as material culture and connotations of cultural spirit. We study it not just for its structure or visual beauty, but also for its creation technology. So, based on DGBS manufacturing technology and individual observations, the investigation into the significance of DGBS component technology to traditional architecture is helpful in understanding the composition and significance of traditional Chinese timber structure and architecture. As a result, we can reveal the spiritual connotations of Chinese traditional culture on a deeper level.

Origin and Evolution of DGBS

When compared to traditional Western architecture, Chinese traditional architecture has a distinct and beautiful style. In addition to its distinct appearance, the DGBS's special design is the focal point, as it not only demonstrates the technical meaning of mechanics in structure, but also demonstrates its distinct decorative role in spatial display. This is the technique's and formation's duality. What exactly is DGBS? "Eave extends from the rafter and is placed on the eaves purlin to extend the eaves further. As a result, the overlapped bent wood warp extended outside to support the eave purlin. Bent wood warp was added to reduce shearing force at the intersection of purlin and warp. A bucket-shaped wooden block was placed between upper and lower levels or warps at the two ends of the DGBS or at the intersection of the DGBS with the warp. To support the extended eave, bent wood was combined with a bucket-shaped wooden block. This is the DGBS (Liang Congjie,1999) DGBS can be simply understood as a combined component consisting of several square buckets and arched layers inserted between the top of a column and a crossbeam. Figures 2 and 3 at the special location, DGBS will produce patchwork light and shadow under the eaves, virtual and realistic space, and a dedicated model, resulting in a strong visual impact and maximum imagination of people. The evolution of DGBS is not only a sign of the evolution of China's traditional timber-structured architectural form, but it is also an important basis for determining the year of China's traditional timber-structured architecture.

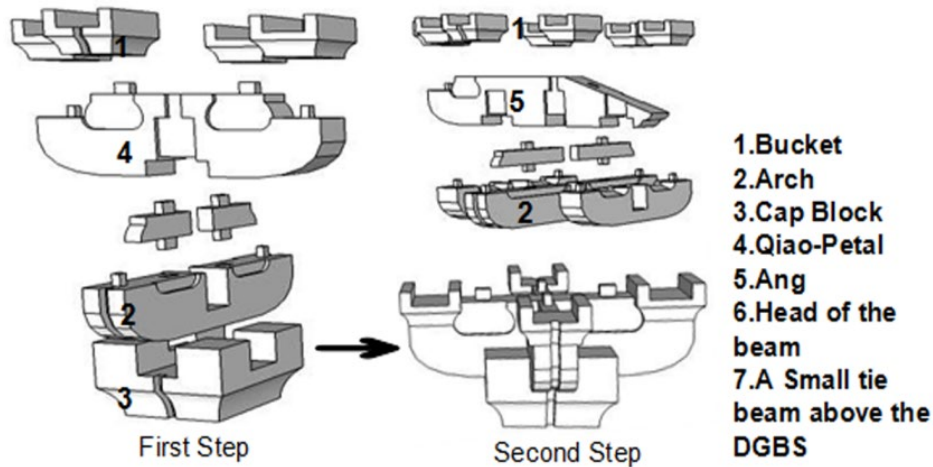


Figure 2 Structure professional description-DGBS

Source: Author

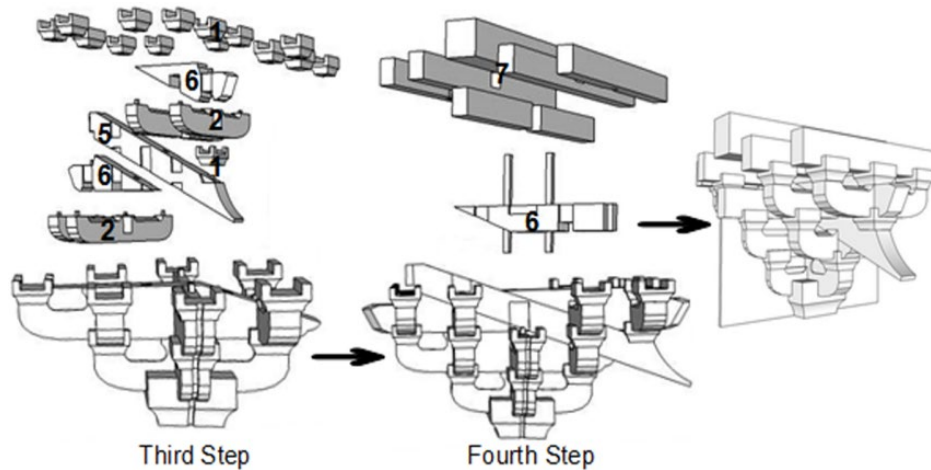


Figure 3 Structure professional description-DGBS
Source: Author

Developing overview of Bracket

The setting of a protective bucket on top of a column was mentioned in the book *Geomancy and Architecture*, and there was a beam head inside the protective bucket stretching out to bear the roof. Perhaps this was the DGBS prototype. For over 1,000 years, the form of one bucket and three rises has been developed. It is widely assumed in architectural history that DGBS develops in three stages: 1. During the transition period from the Western Zhou Dynasty to the Northern and Southern Dynasties, the initial shape of DGBS was formed and applied to copper ware. 2. The Tang and Song Dynasties. For the DGBS of the time, an institutionalization trend was developed, and mechanics and architecture were perfectly combined. 3. The Ming and Qing dynasties. With the downsizing of DGBS in architecture, its structural functions were also weakened, but its decorative role was strengthened, resulting in the essential degradation of DGBS.

The stage from the Western Zhou Dynasty to the Northern and Southern Dynasties

The prototype of DGBS was a beam head and a wooden strip, and its image can be found on Zhou Dynasty copper ware (Hongjian Zuo, 1996) (see Figure 4). The period from the Western Zhou Dynasty to the Warring States is a period of early prototype formation. We can find various forms of DGBS, but no fixed norms or systems, according to some things left over. Despite the fact that it is still being investigated, its basic features have been demonstrated.

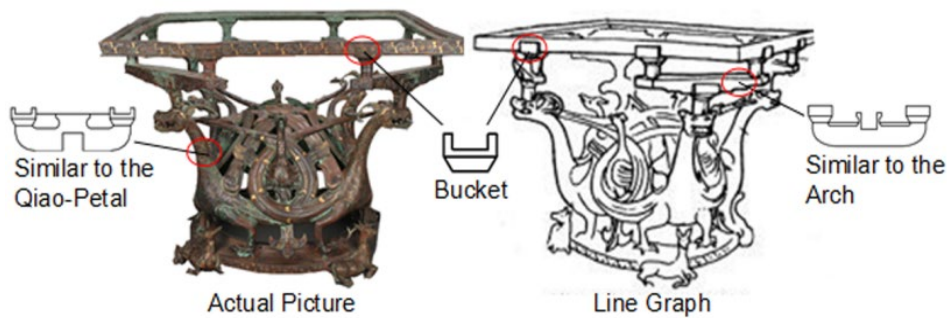


Figure 4 Square table with four Phoenix and four Dragon

Source: Author

The Han Dynasty DGBS is distinguished by its distinctive artistic style. The Northern and Southern Dynasties were responsible for shaping the DGBS norms. Ang was created for the period's DGBS as a decoration beneath the architecture's eaves. For example, DGBS in Shifou Pavilion of Maijishan Grottoes appears to be in DGBS state, but it cannot be considered DGBS.

The rise of Buddhism architecture during this time period had a significant impact on timber structure. The emphasis on DGBS decoration below the eaves and the active pursuit of DGBS effects influenced the research on the decorative role of DGBS as a structural component significantly. At the same time, it laid the groundwork for the glorious development of DGBS for Tang Dynasty architecture (see Figure 5).

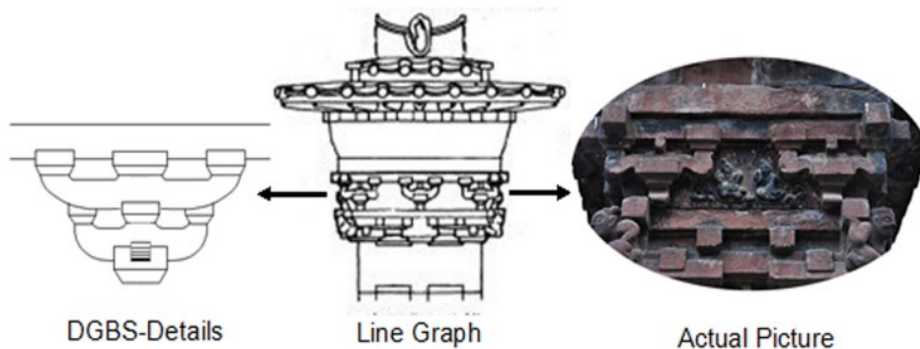
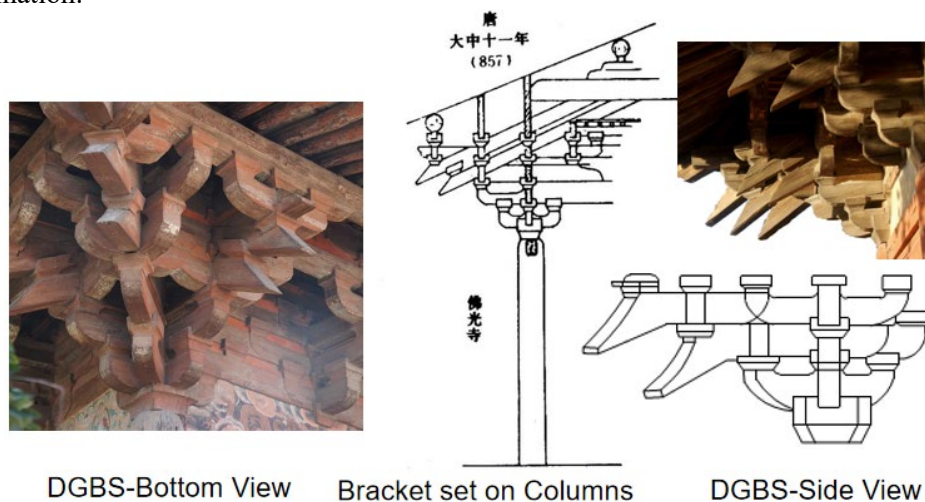


Figure 5 Stone statue of Han Dynasty

Source: Google (2020)

In Tang Dynasty and Song Dynasty

The period was a glorious period for Chinese ancient architecture. As a representative of ancient Chinese architecture, DGBS developed quickly in structure and decoration, which were highly unified. The period's DGBS began to have precise mechanical relations, clear logical relations, and a reasonable system to present its decorative and strict structure. The Tang Dynasty was a golden period for China's cultural prosperity, during which the DGBS reached full maturity. The Tang Dynasty's DGBS primarily assumed the role of directly bearing weight, and the double system was frequently used, and it was grand with a clear layout. The hue of the dynasty's DGBS was concise and clear in artistic style, and each DGBS was connected with architectural stress, giving people the impression of bigness and grandness (see Figure 6). The period's DGBS is the most appropriate material-spirit combination.



DGBS-Bottom View

Bracket set on Columns

DGBS-Side View

Figure 6 Foguang Temple, Wutaixian
Source: Baidu

With the prosperous economy of the Song Dynasty, DGBS advanced to a new level. People began to advocate for architectural structure simplification and the reduction of DGBS structural functions. As a result, the DGBS structure was both rich and strict. In terms of artistic style, it was transformed from grandiose in the Tang Dynasty to thin and graceful in the Ming Dynasty, created with intricate techniques. Since the Song Dynasty, DGBS has evolved from large to small, simple to complicated, and grand to thin. As a result, it can be considered a dedicated decoration structure. The DGBS of the time could be hidden beneath the eaves, and its size was appropriate. As a result, it improved the overall aesthetic of architecture (see Figure 7).

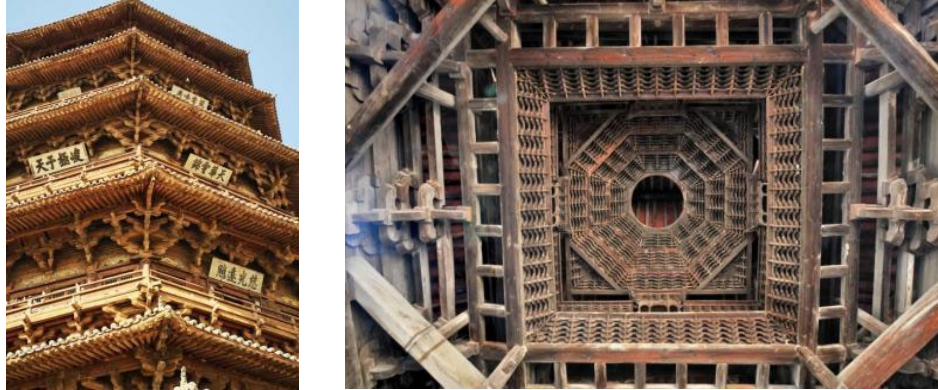


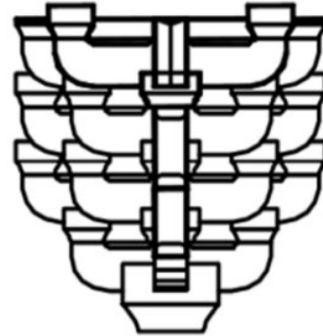
Figure 7 The Fo-kung Ssu Wooden Pagoda, DGBS Museum of ancient Chinese architecture

Source: Author

In Ming Dynasty and Qing Dynasty

The architecture of the Ming and Qing dynasties has the grandness of Tang architecture and the magnificence of Song architecture, as well as its own characteristics. In the Ming and Qing dynasties, the functional structure of DGBS changes, as a large nose on the outer side of the beam is developed to bear weight directly and Ang below the beam becomes a pure decoration structure, resulting in a smaller size of DGBS. Because of the widespread use of bricks and lime in stage architecture, beams are no longer used in DGBS. As a result, DGBS is reduced to a purely decorative component and is transformed from a profound structural image into a trivial and thick decoration belt below the eave (see Figure 8). Traditional timber structures have reached maturity in this stage, and architectural design has also become more standard.

DGBS is no longer a key structural unit or measuring unit, so it has lost its former status and significance. Li Sicheng wrote in *Investigation on the Front Gate of Kuanying Pavilion in Dule Temple of Li County*: “DGBS refers to a unique structural system of Chinese architecture and it functions as the transition and contact between crossbeams and columns, and its structural parts are decorative”; “During the Tang and Song dynasties, the structure of DGBS was grand and solid as the main body.” Following the Ming and Qing dynasties, DGBS gradually loses its former functions and shrinks and thins. It is usually rowed beneath the eaves and becomes purely decorative. As a result, it has plummeted to the bottom” (Liang Sicheng, 1932).



Line Graph

Figure 8 T'ai-ho Tien (Hall of Supreme Harmony)

Source: Author

Research on cultural connotations of DGBS

Liang Sicheng once emphasised the reflection of "national style" cultural value in Chinese architecture at the beginning of the 1950's. Architecture is a cultural form in and of itself, and DGBS is a structural component with national architecture decoration symbols. With special status, DGBS has been developed in China for 5000 years, and it is no longer just a decoration component of architecture, as it carries out the dedicated spirit of DGBS in Chinese culture.

DGBS was not permitted for private use during the Tang Dynasty, despite being the most decorative component of Chinese classic architecture. As a result, it can be regarded as an architectural culture signal indicating hierarchy and identity. Temples and other senior architectures can later be installed with DGBS, and the number of levels represents the ethnic taste of architecture. It gradually exits the stage of architecture in modern cities and becomes a cultural relic for people to appreciate as the era progresses, but its cultural connotations are especially significant. It not only demonstrates the uniqueness of mechanics (structure) and the wonder of aesthetics (decoration), but it also reflects a philosophical attraction. Furthermore, it not only bears the load of architecture, but also serves as a structure to beautify architecture and reflects the mutual dedication of traditional Chinese architecture as well as the concept of "doctrine of the mean" in Chinese culture. The study of the cultural connotations of DGBS did not begin recently, as it has piqued the interest of people since ancient times. Three stages are primarily distinguished here.

In ancient times

The Book of Diverse Crafts is the crystallisation of ancient skilful craftsman's wisdom and talents, and it records the earliest knowledge of technology on the structure of DGBS. The DGBS recorded in the book is concerned with production management and manufacturing technology, with structural technology being mentioned briefly at first. Until the composition of Mujing in the Northern Song Dynasty, a reasonable ratio of DGBS parts was first analysed. Following that, Li Jie wrote Ying-tsao fah-shih based on Mujing to clearly record modular system first with accurate DGBS technology. As a result, it becomes one of the characteristics of Chinese ancient architecture. In this stage, the cultural connotations of DGBS are as follows: a practical structural component that can reflect "national culture."

In modern times

Based on his research into ancient architecture, Liang Sicheng compiled the Qing Structural Regulations in 1934. The book has become a must-have resource for anyone interested in ancient architecture. In 1944, Liang Sicheng completed the History of Chinese Architecture, analysing and comparing architectural features of each stage using China's historical development as a baseline. Since the establishment of the People's Republic of China in 1949, the research and protection mechanisms for ancient architecture have been constantly improved. People's research on ancient Chinese architecture at this time is mostly concerned with housing construction and garden construction in general, with no specific research on small parts. Liu Zhiming and Chen Mingda published Types and Structure of Chinese Architecture and Research on Carpentry Work of Building Methods in 1957, respectively, to begin a comprehensive study of material production in the Song Dynasty and before. As a result, they serve as the foundation for research into the structural mechanisms of ancient architecture. The DGBS of this period became a part of ancient architecture study only, and it represented a small part of the composition of ancient architectures featured differently in different stages and reflected the architectural style of different stages.

In contemporary period

Ma Bingjian, a well-known Chinese expert on ancient architecture, regarded history, theory, aesthetics, philosophy, economy, and geomantic theory in Chinese ancient architecture as "soft science" of ancient architecture, making of architectural structure, structural features, technology, technical norms, operation procedures, material management, and other contents directly related to repair of an ancient structure (Lu, Xuan,2010).

Prior to the 1980's, people in China primarily studied "soft science," but after the 1980's, research on ancient architecture shifted from the purification of data to a comprehensive study of ancient architectural science. As a result, research on ancient Chinese architecture has flourished, with valuable research findings made.

DGBS as the Media of Cultural Communication

The term "communication" can be traced back to the beginning of human society, and people participate in the activities of spreading information in various forms and methods every day, but research on communication behaviour as a science only began in the 1990s. Lasswell, a politician, proposed the "5-W model," a classic theory of communication science centred on five factors to study five fields (control analysis, content analysis, media analysis, audience analysis, and effect analysis) (Harold Lasswell, 2012). In communication science, the term "media" refers to "instruments inserted in the communication process to expand and extend the transfer of information" (Wilbur Schramm, 1984). In the traditional sense, communication science instruments include newspapers, radio, television, and networks. However, changing architecture in various era backgrounds as a carrier of information communication can also be regarded as a medium for information communication between people.

As a disseminator of architecture, its dissemination instruments are obviously not newspapers, television, or radio, but to be architects and shapers of architecture. DGBS was initially developed as a bearing component to support the eave only, with no clear conception of model or so-called aesthetic function, as people were primarily concerned with the practical functions of DGBS. Following that, during the evolution process, DGBS was gradually given a symbolic meaning, causing people to place a high value on DGBS design. As a result, the most important responsibilities of each designer were to figure out how to make DGBS grand and reflect different meanings of each class. DGBS designers focused on the pursuit of excellence during the company's period of great prosperity. The various architectural models and ornamentation represent ruler identities. As a result, those who designed and built DGBS have taken on the role of mass disseminator. DGBS, on the other hand, was not designed or built at will, as it was constrained by social and ideological constraints. There was a strict set of systems to follow from the preliminary stage of construction to the final stage. As a result, information on specific DGBS events was limited, as more information was abstract. As a result, DGBS was endowed with a wealth of connotations and a humanistic spirit.

The former national character and uniqueness in connotations of architectural culture are strongly impacted in the modernization process, which will bring severe problems and challenges in protecting and inheriting DGBS culture. With the advancement of technology, seismic shifts in technical reform occur, affecting people's lifestyles. People are exposed to new physiological experiences and mental feelings as a result of new forms of information content and reception methods. The question of whether the received result of people on communication contents is directly influenced by reception methods is being researched. For many years, people have debated how to disseminate and protect the culture of ancient architecture. The most common and conservative method of renovating and re-building ancient architecture. However, these methods will cause damage to its dissemination and protection to varying degrees, and the essence of its connotations will also be lost. At the

moment, people are interested in protecting ancient architecture through the use of digital technology, but the current application is just a kind of single system to restore architectural structure or wander, but without placing a high value on dissemination of its cultural information. As a result, people must devise a new method to preserve the culture of ancient architecture.

Design Application Case

The author investigates and employs the aforementioned design framework in the design process of an architectural DGBS education game design exhibition, and elaborates on the case here. The exhibition's main goal is to demonstrate the various ages, construction backgrounds, related historical stories, historical figures, architectural ideas, and architectural style characteristics of DGBS at the time. This type of digital interaction allows the audience to experience the DGBS's patchwork structure and to discuss the DGBS interaction's details. Simultaneously, the author tests and analyses the user experience and communication of an architectural DGBS education game on a mobile platform, demonstrating the feasibility of realizing digital communication of traditional architectural culture connotation.

The primary goal of the DGBS education game is to facilitate cultural communication among traditional system components. As a result, when designing the contents of the simulation system, it is critical to keep the information subject – components of the DGBS authentic first and foremost. Second, to ensure the system's interest and ease of use, the difficulty demand of users on system operation should be taken into account. Furthermore, as a cultural education and promotion system, the simulation system's contents should incorporate objective, accurate, and sharing functions for DGBS culture information. Finally, usability and purpose are important properties of the digital simulation system of DGBS components.

(1) Downsize actual DGBS components at an equal rate as well as different types of components, and structure authentic DGBS components as much as possible. (2) Provide different types of DGBS components for users to choose independently, as well as humanistic and easy-to-play content, and provide necessary tips to assist users. (3) To achieve multi-sensory property in interactive entertainment, visual, tactile, and auditory senses should be coordinated when designing interactive functions. (4) Adopt a single awarding mechanism for users and distribute files that are easily shared.

Its design is primarily comprised of knowledge and structure: knowledge and structure. Introduce the DGBS components "bucket," "arch," and "ang" based on natural evolution sequence in the knowledge section. Introduce corresponding decoration of DGBS, insertions, dynamic, years, and application scope when designing the card. Users can drag to enlarge and view them in 360°. Users will have the impression that they are amassing a fine picture book (see Figure 9 and 10).

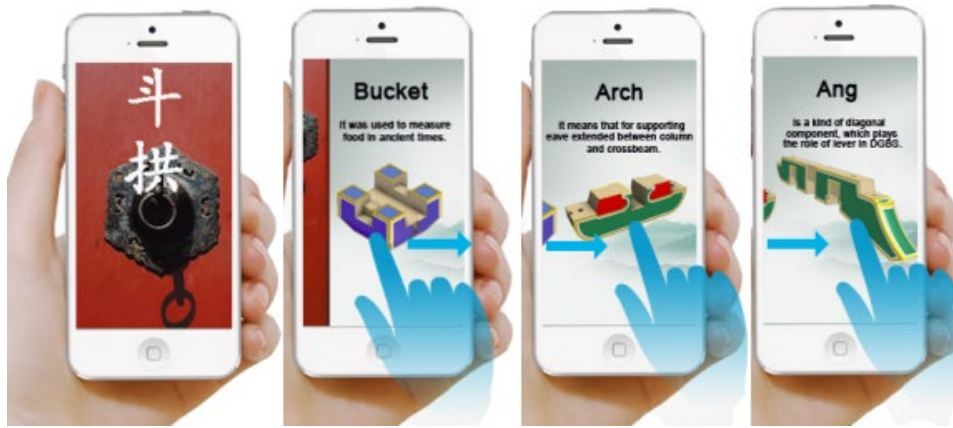


Figure 9 Content plate design



Figure 10 Interface design and interaction design

Select commonly seen DGBS structures in the structure section, such as bracket set on corner, gold-plating bracket, flat seat bracket, Y-shaped bracket, and rack bracket, among others. When first entering the system, users must complete the combination game of the simplest DGBS according to the tips and obtain the DGBS's primary card. Following that, users can play DGBS combination games with varying degrees of difficulty. Users can choose different games based on their abilities and earn awarding cards. On the other hand, it can increase the popularity of DGBS, broaden the scope of promotion, and make DGBS more conducive to cultural dissemination (Figures 11 and 12).

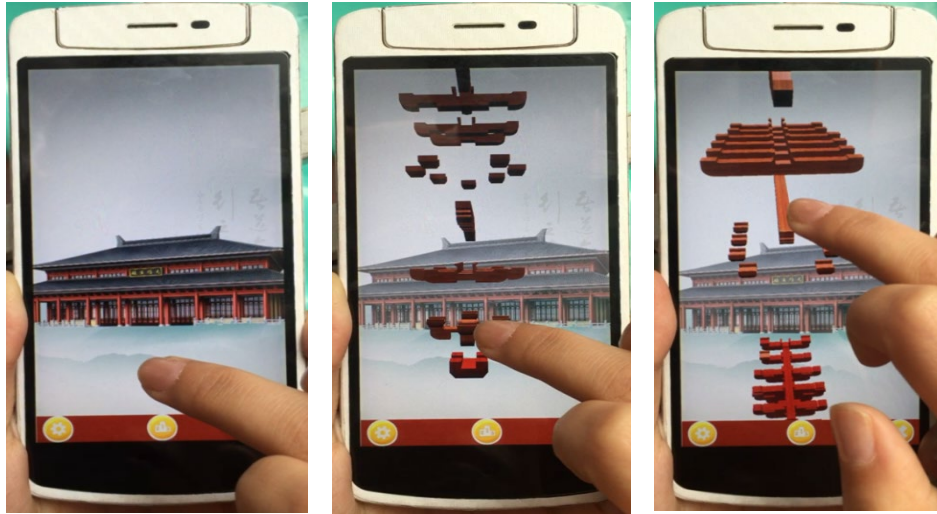


Figure 11 Actual operation of DGBS-APP by users

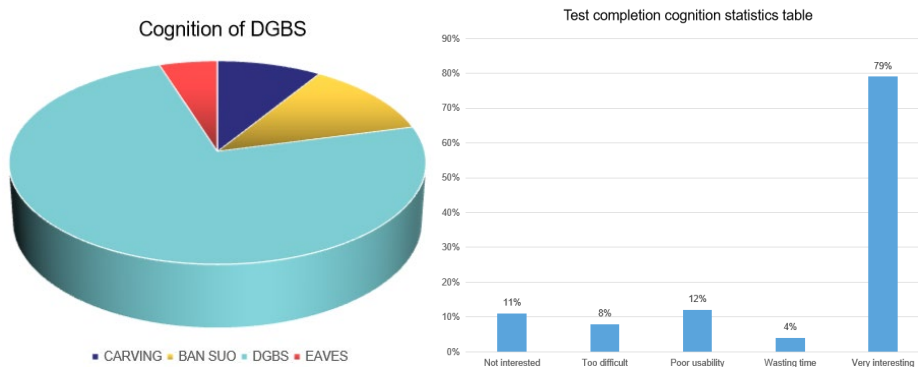


Figure 12 User test statistics

CONCLUSION

According to the preceding statement, DGBS can be interpreted as an architectural signal and mass communication medium with strong symbolic significance, as the design of its structure and decorations can make contemporary people sense the features of different times in its symbolic system. By studying communication science, we can learn that research on DGBS dissemination is carried out on the basis of specific dissemination media that are acceptable to national culture, the establishment of digitalized techniques, and the application of digitalized methods. As a result, it differs slightly from the traditional pure

dissemination model of architectural information. In general, this paper focused on the critical state of national architecture culture and investigated architectural symbols of the DGBS under the official awareness state. As it has the potential to disseminate culture throughout society, it is not only disseminated through architecture as a medium, but it is also attempting to apply forms of digital techniques to disseminate culture of national architecture. As a result, it has some practical significance and referential value in terms of national architecture. However, the dissemination effects of the method must be learned and researched further.

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