

Design activates the villages Micro-intervention construction practices in rural area

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Abstract

The annual UIA-CBC International Colleges and Universities Construction Competition dated from 2016 provides an architectural practice platform that enables students to walk out of their classroom, face the real environment and issues, and implement the full practice from urban to rural, from design to construction, from drawings to buildings. As an important part of China's rural revitalization plan, a different village is selected as the construction site every year, defining the theme of competition in view of the local environment and characteristics. It let students learn more about the spirit of the place in the actual building, perceive the building space, and the relationship between the building and the site. This article takes two construction works of our university as examples, to study the advanced design, local materials, suitable technologies, and rapid construction for small public buildings in rural area. Based on the principle of micro-intervention, we hope to keep the authenticity of the village and its environment to the greatest extent, and to explore a form of small rural public building, which adapted to the rural public life, local climate and natural environment. We hope to explore the fun of rural public life from the perspective of culture, design and art, especially through the interactive experience, as an entry point to enhance rural vitality, which can inject the power of design into the basic mode of rural production, driving the change and improvement of rural lifestyle and

providing a paradigm for rural construction.

Introduction

The annual International Colleges and Universities Construction Competition dated from 2016 provides an architectural practice platform that enables students to walk out of their classrooms, face the real environment and issues, and implement the full practice from urban to rural, from design to construction, from drawings to buildings¹. In the contemporary context of rural revitalization, a different village is selected as the construction site every year, defining the theme of competition in view of the local environment and characteristics. It let students learn more about the spirit of the site in the actual building, perceive the building space, and the relationship between the building and the environment. We hope to explore a form of rural public space adapted to the natural environment through our design, explore the joy of rural public life, that will be used as an entry point to enhance rural vitality, and inject the power of design into the basic mode of rural life, to promote changes and improvements in rural lifestyles and provide examples for rural construction. Integrate the advantages of design into rural construction, combine advanced design concepts with low-tech construction practices, and stimulate public participation through interactive experience design, and promote rural public space environment with a small investment, and then stimulate the value and vitality of rural public space.

Design activates the village

This article takes the 2018 and 2019 two construction works of Tongji university as



Figure 1. Digital Bamboo Structure Outdoor Theater. By Ruixiang Wu

examples to study the design strategies, materials, technologies, and construction of small public buildings in rural area. We take "architectural acupuncture" as the design logic and take "Micro-Intervention" as the design concept guide. Through cutting-edge architectural design methods, suitable building technologies, environmentally friendly building materials, and convenient and fast construction methods, we respond to changes in climate and building functions. The method of micro-intervention keeps the authenticity of the village and its environment to the greatest extent and provides support for the promotion of rural public services and the development of characteristic industries. In the context of vigorously developing rural construction in China, from the perspectives of culture, design, and art, we explore rural public building forms that are suitable for the natural countryside. We hope that rural public spaces can be activated by design, thereby stimulating the vitality of the entire rural area.

For specific rural construction conditions, the basic design principles we formulated are as follows:

- 1) Design as the leading
- 2) Micro-intervention
- 3) Local materials
- 4) Suitable technologies
- 5) Rapid construction
- 6) Low technical requirements for workers
- 7) Multifunctional
- 8) Recyclable
- 9) Adapt to local climate and environment
- 10) Emphasize the interactive relationship between people, buildings, and the environment

Construction Practices

Digital generation of nonlinear spatial morphology

"Digital Bamboo Structure Outdoor Theater" was a design work of our team participating in the "Third International University Construction Competition in 2018" (Figure 1). In the context of the rural revitalization of the national strategy, the competition was held in Xia Mutang Village, Wan'an County, Jiangxi Province. With the theme of "Q-Village", it was intended to think about how to "make the

country more interesting”, using acupuncture techniques, and the whole village was inspired by design². The design started from the planning concept of the open-air small theater. The public space was located on the side of a vast farmland, which had been idled due to lack of public facilities. The classic architectural space prototype of the theater was used as the "interesting point" to trigger the rural public life. It explored the spatial patterns of the theater and the various possible types of rural public behavior effects to stimulate the potential of rural public life and communication. With the acousto-optic design, the theater's unique spatial mode can plan or spontaneously form a variety of functions, resulting in multi-functional composite spaces such as performances, games, parties, screenings, exhibitions and so on.

There was a bamboo forest near the base, so the local bamboo was used as the main construction material. Non-linear is a mathematical relationship between variables, not a straight line but a curve, a surface, or an attribute of an uncertain state, called non-linear³. Non-linearity is one of the typical properties of complex forms in nature, and because of its excellent bending toughness, bamboo slices are very suitable for the construction of nonlinear curved forms.

The logic for generating the primary and secondary structures of this project follows two basic principles: 1. Elastic line, 2. Geodesic line.

Using the bending resistance of the natural bamboo piece, the main structure elastically arches the bamboo piece according to the Euler elastic line principle, that was, the large deformation of the elastic straight bar (when the axial pressure exceeds the bending form of the Euler critical load), and the two ends were fixed by movable hinge. Geodesic lines on free-form surfaces and their physical implementation Geodesic line is a shortest path between two point on a surface⁴. The secondary structure was woven by Geodesic line, the shortest distance connecting the two points of the surface, and the change of the weaving density implies the density of the inner and outer space connections, and the overall shape was completed.

The elastic curves could from spaces. Different spatial scales could correspond to different body display methods. When one of the height, horizontal span and the length of bamboo strip was fixed, the other two elements had a one-to-



Figure 2. Bamboo structure compiled according to elastic line and geodesic line. By Feng Deng.

one correspondence. Different elastic lines had different angles at both ends. Adjusting each angle was an extremely complicated matter. So, living hinges were used, the feature of which could be rotated in both directions to solve this problem. (Figure 2)

According to the main directions of the pedestrian in the current situation, three openings were formed by the displacement of the structural point to guide the flow of people. In the high area, adults pursued the sound and enter the infield. In the low area, children could walk and play freely. Combined with an acousto-optic control system, it provided an interactive experience. A total of 130 LED strips were installed on the bamboo slices. After debugging, the light changes could be controlled according to the rhythm of the music. The light show itself could become one of the theater programs and provide an interactive experience. The center of the theater was covered with bamboo slices, and 8 solar-powered lights were inserted. It could be used as the base lighting for the stage without additional power supply. Fluorite was placed inside the circular concrete floor. When the night felled and the lights were



Figure 3. A pear pavilion blooming in Pear Orchard. By Dehan Li.



Figure 4. a flexible cable tension/traction opening and closing space steel-wood composite bionic structure. By An Guo.

turned off, many stars would be appearing on the ground. At the same time, it was equipped with a solar-powered floor lamp and a spray cooling device to improve the micro-climate of the site and created a fantastic stage atmosphere. It was constructed by 9 teachers and students in 13 days.

The entire design and construction combined traditional bamboo and traditional construction processing with parametric design to provide a more modern convenient and easier solution for the country theatre. In the context of digital design and digital construction that continue to influence architecture, we explore the combination of digital design and traditional bamboo processing techniques, reviving the new design potential of traditional materials.

Flexible cable tension/traction open space steel-wood composite bionic structure

2019 UIA-CBC International Colleges and Universities Competitive Construction Workshop was held in Guoyuan Village, Aiyuan Town, Siyang County, Jiangsu Province, China. Taking the century-old pear orchard as the site, this Competitive Construction Workshop set a theme of creating “Pear Orchard Cabins” that could improve quality of living in the orchard, in order to discuss how to “activate villages through design”, and to contribute to the revitalization of the “Century-old Pear Orchard”, and also to explore a path for changing villages by the power of design, driving the change and improvement of rural lifestyle⁵.

Because the project was built in the pear garden, take the meaning of "pear flower". It was designed a roof that was freely stretched like a petal, responding to the original natural state with the attitude of the building, adjusting the opening angle according to the change of climate and shade, meeting the needs of different functions such as rest and sale, giving the building a new vitality (Figure 3). The five-petal pear blossom roof interpreted the perfect natural geometric logic. Through modular unit design, with ecological and environmentally friendly materials, convenient transportation, simple construction, short construction period, Low technical requirements for workers, it was easy to be copied and built, which was conducive to promoting industrialization. Because it was a construction competition, the

construction period was truly short, and the prefabricated digital wood structure technology could precisely and accurately build without sacrificing quality⁶. In the end, it was constructed by 15 teachers and students in two weeks.

The micro-intervention method reduced the damage to the land and the environment. Unlike conventional concrete foundations, the main structural foundation consisted of 10 ground screws. In the future, if the pavilion would be demolished or relocated, only the ground screws need to be pulled out, and the land would not be damaged at all. The main materials were composed of Douglas fir, steel members and DuPont paper, which were environmentally friendly. The opening and closing of the roof could be adjusted according to the climate, it was protected from the sun, wind and rain, and was equipped with a solar lighting system, fully respecting the environment and nature, reflecting the adaptability and dynamic life characteristics.

The main structure adopted a flexible cable tension/traction opening and closing space steel-wood composite bionic structure, which was mainly composed of ground screw foundation, bottom platform, triangular support system, lightweight movable roof truss, steel-wood joints and suspension cables. The openable and lightweight roof was composed of DuPont paper and wooden frame. The opening and closing of the roof were controlled by a motor that pulled the cable, which was connected to the main members of the roof. The whole structure was simple and distinct. (Figure 4)

The functions were mainly based on viewing, rest, games, and fruit sales, which varied with the pear season and the picking season. The space covered by the pear flower was a place where people gather and communicate. It considered climatic conditions and building performance. The opening and closing of the roof were just like the process of pear blossoms. The sunny days could be opened for sunshade, and the rainy days could be closed to avoid rain. Combined with the solar lighting system, the sky was getting darker and the lights were turned on automatically, which fully reflected the respect for the nature, environment, and culture of the pear garden.



Figure 5. Pear blossom Pavilion after the rain. By Feng Deng.

Adopting the advanced building technologies and local materials, adopting the modes of assembly, modularization, and Micro-intervention environment. It tried to intervene in the village in the lightest way, to maximize the authenticity of the village and bring the new modern architectural experience to the village.

Conclusion

In the context of China's rural rejuvenation, micro-intervention is the main design logic of our rural construction practices. The purpose is to maximize the preservation of the authenticity of the village and minimize the damage to the environment and structure of the village itself. The method is characterized by understanding the rural structure as meridians, and the construction operation activates rural public space and revitalizes related industries through the implantation of space and functions.

In summary, the design and construction methods applicable to the village are as follows:

- 1) Respect for tradition, environment and local culture, respect for the lifestyle of local residents, at the same time, it should also stimulate and guide local public life, drive industrial innovation, and then stimulate the vitality of the entire village.
- 2) Take "architectural acupuncture" as the design logic and take "Micro-Intervention" as the design concept guide.
- 3) Adopt more innovative methods to use local materials, integrate into the local primitive state in the humblest way, and make buildings that are truly emotional and full of artistic beauty and revive the new design potential of traditional local materials.
- 4) Pay attention to the interactive relationship between people, buildings, and the environment. All projects should establish a connection between architecture and people, nature, culture, and history to optimize the use experience, and use interactive experiences to bring vitality to public spaces.
- 5) Reasonable use of energy and resources, through variability and adaptive design, adapt to changes in various climates and functions, and improve building efficiency.

- 6) In rural projects, the challenge is how to achieve high-quality spaces with limited construction conditions. The solution is to try to achieve industrialization, standardization and productization, so that quality control can be implemented in the early stages of construction. In this way, the technical requirements of the workers are not high, and the construction can be completed in a truly short time. At the same time, building products can also be promoted and replicated in vast cities and villages.

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Endnotes

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