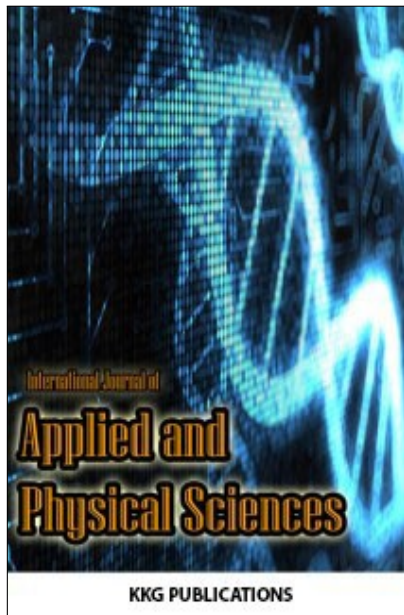


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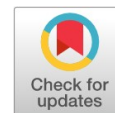


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Tooling Applications in the Collaboration Construction of Traditional Settlements in East Asia



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TOOLING APPLICATIONS IN THE COLLABORATION CONSTRUCTION OF TRADITIONAL SETTLEMENTS IN EAST ASIA

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Abstract. Open Source Architecture (OSArc) has gradually gained prevalence in the construction industry in recent years. However, OSArc support is largely exhibited in design while lacking in construction. The earliest form of OSA has been observed in vernacular architecture. A literature review was conducted in the present study to investigate tooling applications, such as techniques, collaboration methods, organization frameworks, in the collaboration construction of the traditional settlements of East Asia. The results can serve as a reference for the future construction of OSArcs. In summary, (1) tools and building materials observed in different regions seem limited by the environment. In reality, they were combined with life recipes to create multipurpose tools; for instance, building materials and ingredients complemented one another to maintain continuity. (2) Two collaboration methods were generally used. The first is applying unified training, family teaching, or mentorship systems to actuate collaboration construction. The second is the application of sharing, exchanging, and transacting to satisfy basic needs. (3) In terms of the organization framework, professionals were typically seniors, fathers, artisans, and semi-professionals were younger protgs. Professionals and semi-professionals assumed technical tasks, while non-professionals were responsible for manual labor; this formed a collaboration system.

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INTRODUCTION

The concept of modern open source architecture was first formed in the vernacular architecture of traditional human settlements [1]. In order to provide more references of modern open source architecture, this study has compiled the instrumental application of traditional settlement in East Asia civilization, including the technical characteristics, cooperation method and structure of the construction. Based on the characteristics of traditional settlements, this study clarifies how people cooperate and construct vernacular architecture using physical tools and

intangible cooperation mechanisms.

The fact that traditional settlements are scattered in East Asia makes it difficult to conduct fieldwork, and therefore this study will explore cases through collected literature in the fields of archaeology, vernacular architecture, Chinese architectural history, anthropology, ethnography, geography, history and other fields. In addition, nine traditional settlements which have been studied extensively were chosen. Their locations are shown on the map below (Figure 1).

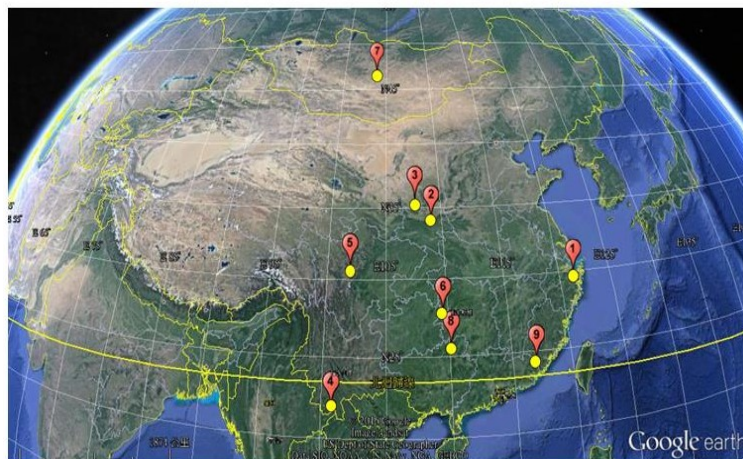


Fig. 1 . Nine traditional settlements in the Asian continent

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In the distribution of the time axis, correspond the earliest recorded literature to the table of Chinese dynasties to enable the study to refer each settlement to a corresponding dynasty and its referential literature coordinates (Figure 2). The nine settlements chosen are Hemudu Village and Banpo Village (Stone Age villages, which are currently in ruins); Dai Bamboo Houses, Han Cave-houses, Tibetan Blockhouses, Tujia and Miao Stilt Houses, Mongolian Yurts, Zhuang Houses and South Fujian and Hakka Tulou (which have both been preserved); and South Fujian and Hakka Tulou which include several UNESCO World Heritage Sites.

Houses, Tujia and Miao Stilt Houses, Mongolian Yurts and Zhuang Houses which have left us with only technologies due to their used perishable materials; Han Cave-houses and Tibetan Blockhouses whose technologies and architectures have both been preserved; and South Fujian and Hakka Tulou which include several UNESCO World Heritage Sites.

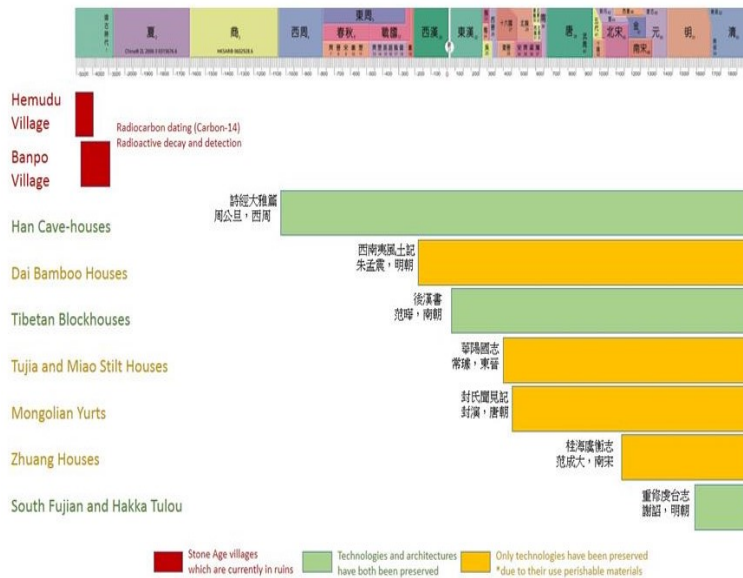


Fig. 2 . Nine traditional settlements in the Chinese time axis

CASE DESCRIPTION

This section describes each settlement’s environmental background, the cooperative method of construction, tools, materials, lifestyle, et cetera. Because of the abundant historical materials and the continuous evolution of traditional settlement construction [2], it is not easy to record the deduction of each period so this study can only aim at the commonly recorded part in different periods and confirm through the study of different areas.

Hemudu Village Ruins

This settlement was originally located in Hangzhou Bay, China. The climate was humid in ancient times. Matrilineal clans led people to work cooperatively for building construction. They collected raw materials together and processed them into tools (e.g., axes) or building materials (e.g., wooden tenons and wooden piles). The materials used included wood, bamboo, bark and reeds. The main tools for the construction were lumbering tools, hammering tools and tenon-and-mortise tools. The villagers shared food and lived on the cultivation of rice, livestock farming, fishing, hunting and collecting nuts [3].

Banpo Village Ruins

This settlement was originally located in Shaanxi Province, China. People excavated the loess to make livable caves. Cave walls were heated with fire which was a moisture-proofing measure taken in the cold climate. The matrilineal clan coordinated and allocated jobs to allow the villagers to work in cooperation with each other. The materials used included wood, bark, earth, rattan, reeds and stone. The main tools for the construction were lumbering tools, excavating tools (e.g., stone shovels, stone chisels, bone shovels) and fire (for pottery) [4]. To make a living, women were engaged in pottery making and agriculture while men were responsible for hunting and production. People worked in collaboration and shared food together.

Han Cave-Houses

This settlement is located in the hilly areas in the Southern Loess Plateau in China. Families and potters usually collaborate for house construction and the technology is passed down from masters to apprentices. The materials used are mainly soil, straw, stone and bricks. These materials can be built into earth kilns, stone kilns, brick kilns, and combination

kilns. The main tools used for construction are excavating tools. Due to the amount of labor required, all the manpower from the village is used. Therefore, almost all traditional settlements need to exchange labor for the purpose of house construction [5].

Dai Bamboo Houses

This settlement is located in the southwest of China at the border with Myanmar. The local climate is hot and humid. It has abundant rainfall throughout the year. Families and carpenters usually collaborate to construct houses. The materials used in construction are bamboo, wood and tiles. These materials are then processed into bamboo tenons, bamboo fences, bamboo windows and bamboo walls. Its rich forest resources provide a large volume of natural building materials for its residents. The main tools used for construction are carpentry and bamboo-cutting tools. Labor is usually exchanged for house construction [6].

Tibetan Blockhouses

The settlement is located in the Tibetan Plateau. Farmers all master basic construction technology and families pass on the technology from generation to generation. The materials used for construction are stone, soil, wood, cattle and sheep bones, ghee and cattle feces. The main tools used are measuring tools, carpentry tools, masonry tools, compacted earth, rhythm control tools, et cetera. Families and neighborhoods exchange labor to collaborate for house building [7]. Men usually perform physical works like building walls, logging and transporting stones, while women usually assist with transporting water and mixing concrete.

Tujia and Miao Stilt Houses

This settlement is located adjacent to Hunan Province and the Yunnan Guizhou Plateau. Carpenters, families and neighbors usually collaborate to construct homes. The construction work can be divided into carpentry, joinery, tiling, masonry, earthwork and painting. Carpentry is the dominant part of the construction works. The materials used are wood, stone, bamboo, bark, thatch, tile and tung oil. The main tools for the construction are ink fountains, bamboo rulers, wooden tools, et cetera. Neighborhoods usually exchange labor with each other [8].

Mongolian Yurt

This settlement is located in Mongolia where winters are long and extremely cold. A rapid construction method was developed to enable generally two to three people to build a dwelling within half an hour. The important part of keeping

a yurt is its daily maintenance, and this is usually completed by the occupying family. The materials used are Mongolian willow, felted wool, camel hair rope, ponytail hair rope, sheep feces, camel skin, nails and wood. The main tools used for construction are timber-making tools and animal-drawn carriers [9]. The usual way to make a living is family-based grazing and sharing.

Zhuang Houses

This settlement is located in the mountainous area in northern Guangxi, China. Due to the steep terrain, buildings are elevated to avoid wasting arable land. Carpenters and families usually work together to construct dwellings. The materials used are wood, earth, bamboo, brick, tile, and bark. The main tools for the construction are wooden tools and measurement tools. People aggregate based on their blood relationships. Communities are independent due to the limitations imposed by the terrain. In their daily lives, people do not form a huge living community, but there is a culture of labor exchange [6].

South Fujian and Hakka Tulou

The settlement is located in Fujian Province, China, which is a mountainous area. To make a living, craftsmanship is passed down from generation to generation. In terms of construction cooperation, a familial building manager is responsible for communication with the craftsman. The materials used are wood, soil, stone, bamboo, sand, ash, tile, et cetera [10]. The main tools used for the construction are compacted earth, stone and wooden tools. Workers are hired for the construction.

RESEARCH ON THE TOOLING USED IN COOPERATIVE CONSTRUCTION IN TRADITIONAL SETTLEMENTS

Tools and Materials

Tools are usually collected and processed in collective cooperation. Hemudu Village and Banpo Village settlements obtained animal teeth or bones through collective hunting. People gather in certain areas to light fires to heat the earth to stir fry bamboo nails for Tulou construction or produce tiles for bamboo houses. They collect materials together to manufacture standard measurement rulers for Zhuang houses and Han cave houses construction. Mongolians domesticate animals and train them to carry building materials. Tibetans use their own body parts (e.g., limbs) as measurement tools. People sing and dance together to control their strength while lifting up pillars for stilt houses. All the materials can be categorized into three types of collective production materials which are animal materials, natural materials and firing materials [2].

TABLE 1
CATEGORY OF TOOLS

Processing Tools	a. Process collectively hunted animal teeth and bones into tools. b. Use fire to process materials into tools. c. Process natural materials into tools.
Animal Force Tools	Use domesticated animals as carriers.
Physical Tools	Use body parts as measurement tools.
Controlling Tools	Use musical rhythm as a tool to control the pace of collective construction.

TABLE 2
CATEGORY OF MATERIALS

Animal Materials	Bone, skin, teeth, fur, secretions (oil, blood, feces), etc.
Natural Materials	Earth, mud, sand, rock, stone, wood, bamboo, thatch, grass, etc.
Firing Materials	Brick, tile, etc.

The Formation of Community

In traditional settlements in East Asia, community leaders or tribal leaders often promote daily face to face activities and collective cooperation practices among people by applying the overall building configuration of the traditional settlement [11]. For example, families who give birth in the village must build their own houses. There are other activities such as family rites of passage, groundbreaking ceremonies, collecting pillars from the hills in groups, et cetera. In the actual construction, uniting and forming a cooperative construction effort can be achieved through the following four means:

- **Construction:** Form cooperation among families and neighborhoods through the configuration of traditional settlements.
- **Religion:** Promote cooperative construction and practices through settlement ceremonies and beliefs. For example, groundbreaking ceremony, selection of an auspicious date, selection of location by throwing divining blocks, etc.
- **Culture:** Apply clan commune, family inheritance and mentoring and apprenticeship to establish professional teaching mechanisms, share knowledge and finally develop different kinds of craftsmen.

- **Demand:** Encourage non-professionals to exchange services for services to solve the problem of labor.

Cooperation Method

Vernacular Architecture is based on collective cooperation. For example, through hunting, farming and collecting, overcome the environmental limitations and basic survival needs of individuals and develop a stable method of cooperative construction [12]. Therefore, this study will divide cases into two categories: life and construction.

In life, according to the two economic definitions of effort and reward ratio which are gift economy [13] and barter economy [14], this study summarized three cooperation methods that developed along with cultural differences: sharing food, exchange labor and employment (Table 3).

In construction, this study mercerized three common cooperation systems: clan commune training, family inheritance and mentoring and apprenticeship (Table 4). Through these three methods, technologies are passed from the professionals to the paraprofessionals and meanwhile family or neighborhood members form a non-professional team to undertake non-professional and physical works in the construction process.

TABLE 3
IN LIFE, COOPERATION METHODS

Gift Economy	Sharing Food	Result in collective labor through the common daily life.
Barter Economy	Exchange Labor	Exchange labor with others for different periods of time.
Monetary System	Employment	Price the labor cost, directly trade with money.

TABLE 4
IN CONSTRUCTION, COOPERATION METHODS

Cooperation Method	Clan Commune Training	Family Inheritance	Mentoring and Apprenticeship
Professional Level	The Elders	Experts in the family	Craftsmen
	Train paraprofessionals; pass on technology, experience and knowledge. Focus on overcoming technical issues in the construction.		
Paraprofessional	Youth in the Settlement	Children in the Family	Apprentices
	Learn professional technology. Focus on learning to overcome issues that arise during construction.		
Non-Professional	Family Members	Neighborhood Members	
	Assist the professionals and paraprofessionals, provide labor and assistance. Focus on overcoming labor shortages.		

THE APPLICATION OF TOOLING IN TRADITIONAL SETTLEMENTS

The two operation modes can be regarded as software and hardware (Figure 3). Software consists of manpower, cooperative construction and cooperative living. Hardware, on the other hand, comprises of tools and materials. According to the cultural background of the traditional settlement, the person aiming to construct a building seeks professionals and paraprofessionals and then, through the geographical relationship,

forms a non-professional group. The cooperative construction will be performed through clan commune training, family inheritance of skills and mentoring and apprenticeship. Based on the local condition of use, professionals use the tools to process the materials and combine with cooperative living methods such as sharing of food, exchange of labor and employment to address the survival needs to finally serve the purpose of cooperative construction.



Fig. 3 . The application model of tooling in traditional settlements

SUMMARY

The traditional settlements in East Asia allow construction participants to use the concept of exchanging time rather than trading in money, which makes construction a living behavior rather than a consuming behavior. Also, they have a very clear culture of paraprofessional training. The paraprofessionals not only assist the professionals, but also become the coordinating intermediaries between the professionals and the non-professionals. In addition, in the process of cooperative

construction, members of traditional communities are good at using the following instrumental characteristics to drive cooperation among people:

Generality

- Multitasking: hunting tools can also be used for timber making.
- Food ingredients and building materials are essential to life, so construction is undertaken close to reserves of these resources.

- Use the smallest possible amount of locally-sourced materials to complete construction.

Integrate into Life

- Use technology that suits the season. Collect building materials in the dry season and cultivate and store food ingredients in the wet season.
- Combine technology with music to make the construction process more enjoyable.

Use of Recycling Resources

- Make complete and reasonable use of surrounding animals and plants as building materials.
- Effectively use waste such as rice husks or animal waste to achieve zero construction cost.

Reference of Sharing Economy Model of Modern Architecture

This study attempts to provide modern construction participants with another possible way to engage the general public in construction in addition to the current construction system by sharing construction equipment, exchanging building materials and recruiting participants through the network platform.

Research Contributions and Follow-Up Studies

This study provides a reference for modern open source architecture in its actual practices of cooperative construction based on the principle of not overly depending on industrial processes and achieving environmentally sustainable construction. Follow-up research will focus on the sharing economy model of cooperative construction and combining with computer support for collaborative work to practically establish a cooperative construction platform.

REFERENCES

- [1] C. Ratti and M. Claudel, *Open Source Architecture*. New York, NY: Thames & Hudson, 2015.
- [2] P. Oliver, *Encyclopedia of Vernacular Architecture of the World*. Cambridge, UK: Cambridge University Press, 1997.
- [3] L. Qin, D. Q. Fuller and E. Harvey, "Subsistence of Hemudu Site, and reconsideration of issues in the study of early rice from Lower Yangzte," *Oriental Archaeology*, vol. 3, pp. 307-350, 2006.
- [4] F. D. Ching, M. M. Jarzombek and V. Prakash, *A Global History of Architecture*. New Jersey, NJ: John Wiley & Sons, 2010.
- [5] G. Golany, *Chinese Earth-Sheltered Dwellings: Indigenous Lessons for Modern Urban Design*. Hawaii, HI: University of Hawaii Press, 1992.
- [6] N. Xiang-liang, "Comparison between the 'Gan Lan' Local-style Dwelling Houses of Zhuang Nationality in Guangxi and of Tai Nationality in Yunnan [J]," *Journal of Guangxi University for Nationalities (Philosophy and Social Science Edition)*, vol. 2, 2005.
- [7] L. I. U. Bo, "The genre and culture value of Stone Tower in Tibet and Qiang nationality [JJ]" *Guizhou Ethnic Studies*, vol. 27, no. 6, pp. 173-182, 2007.
- [8] X. H. LIU and L. QIN, "The characteristic and sustainable development of Tujia people's 'Diaojaolou' The survey to the traditional houses of Tujia people in the Southeast of Chongqing [J]," *Journal of Wuhan University of Technology (Social Science Edition)*, vol. 2, 2005.
- [9] X. X. Gao, H. K. Zheng and G. Jin, "Green design property of Mongolian yurts," *Journal of Inner Mongolia Agricultural University*, vol. 30, no. 1, pp. 109-113, 2009.
- [10] S. Wang and R. Guan, "Comparison between earth building and cave dwelling [J]," *Journal of Huaqiao University (Natural Science)*, vol. 24, no. 1, pp. 70-75, 2003.
- [11] P. Oliver, *Dwellings: The Vernacular House Worldwide*. London, UK: Phaidon Press, 2007.
- [12] L. Asquith and M. Vellinga, *Vernacular Architecture in the Twenty-First Century*. Oxon, UK: Routledge, 2005.
- [13] D. J. Cheal, *The Gift Economy*. New, York, NY: Routledge, 1988.
- [14] S. O'Sullivan, *Economics: Principles in Action*. Upper Saddle River, New Jersey, NJ: Pearson Prentice Hall, 2003.

— This article does not have any appendix. —