The Naval Architecture of Ancient Fujian Style Sea Going Sailing Junks: A Manuscript

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Abstract

As the most important qualities of ancient Chinese sailing junks, the square bows and sterns with transverse watertight bulkhead and the lugsails with bamboo mat and strip remained the same over thousands of years. Of which, the traditional Fujian style sea going junks is one of the major vessel forms for the ocean and oversea route in ancient China. This paper make an interpretation of Fujian style sea going junks through ship form and structure, principle of design, models, choice of material, sequence of construction, painting and decoration, tools, ship-builders, and ship component remains. This study is combined with the interpretation of Chinese historical documents and drawings, foreign historical drawings, ethnographical field work on main traditional shipbuilding centers along the Fujian coast, reconstruction of traditional shipbuilding, land archaeology evidence, and especially gathers information from a newly discovered illustrated manuscript for shipbuilding. This manuscript at present is the most detailed manuscript found pertaining to the principle of design, modulus system, main unit data, measures and amounts materials used for each ship form. The purpose of this paper is to recover the historical archetypes of ancient Fujian Style Sea going sailing junks, then providing one set of helpful method to explain and identify relevant ship remains excavated in future shipwreck underwater archaeological projects.

Keywords: Fujian style Sea going junks, Traditional shipbuilding, Ship remains, Naval architecture, Manuscript

Introduction

The traditional Fujian style sea going junks is one of the major vessel forms in ancient China. But, what did that ancient junks look like? How were they made? How were they operated and maneuvered? China's navigation and naval architecture constitute a history of this production technology with its root in the common people. Extant historical data is rather limited and therefore regrettably slight when contrasted with the

art and expertise accumulated over time and the ancient and magnificent culture that it represents. The emergence of sea-faring wooden vessels, their development, transformation and eventual disappearance had a lot to do with the political and economic conditions as well as the available natural resources at any specific time. Without question, changes in available resources as well as in sea routes entailed modifications to form, size, function, names, and even the mode of operation of these vessels. Equally, the technological development and improvement in ship design had its effects on society and the subsequent trajectory of social history. Before, domesticated shipwreck archaeology was founded in the matching and displaying of wrecks, and never went further to carry out experiments on replica and reconstructions according to ancient navigation environment perspectives.

Even after researching into the history of naval architecture and ancient writings, searching through relics from different dynasties, focusing mainly on the general conditions of ship-building and the wide variety of methods of manufacturing through every historical period, we are still unable to reconstruct history in its entirety. What could be done was to set up a systematic way of collecting data; then to summarize, understand and subsequently experiment with them. With this data as the foundation, the project became to produce a series of replicas using methods of construction that had been passed down from generation to generation, so that people today can see and experience them; replicas that may allow later generations to reconstruct actual history. Only by doing so can we answer the three questions pertaining to ship-building and sea-faring history listed above, an only then can the value of research be made clear.

Ship Form and Structure of Fujian Style Junks

Facing Taiwan across the strait, Fujian has 3,324 km of coastline and 1,404 small islands off the coast. The way of life of the ancient Yue people, Fujian's early inhabitants, was sea orientated with sea travel as their main means of communication. Despite the hilly landscape and mountain ranges in Fujian's hinterland, these proved no barrier to its economic interaction with other provinces and places overseas (Fig. 1).

Fig. 1 A Color Images of Fujian Style War Junk. (W. Alexander)

The inland, inshore and offshore sea-faring networks linked Fujian with the outside world thereby ensuring that Fujian's shipping and fishing industries continuously developed. In addition, Fujian was rich in natural resources such as wood, iron, tong oil (Verniciafordii seeds oil), lihui (lime obtained by burning oyster shells), rattan, hemp and lacquer. With such handy materials that could be used to build ships, ship-building prospered across the province. Viewed from a different perspective, Fujian's coastline was full of creeks and inlets. Facing the Strait of Taiwan, it was situated where warm and cold air currents mingled. Not only was the wind strength very inconsistent, it was also where typhoons move inland from the sea during the summer and autumn. Due to this complicated natural environment, certain demands had to be met with regard to form, function and structure of ships, and to the choice of materials and skills employed in their manufacture. It is such circumstances that gave birth to vessels with V-shaped bottoms, raised flat bows, indented sterns, flaring bulwarks, framing, stern-hung, lifting rudders lowering deeply below the keel line, and wide cambered decks that eased the drainage of water. These unique environmental and cultural factors together made the Fujian style junks one of the major vessel forms in ancient China.

Building Fujian style junks required standard procedures in the choosing of ship form, design, materials and construction strategy, and involved manufacturing processes such as carpentry, metal work, sewing, painting and smelting. The Southern Song dynasty seagoing ship unearthed in Houzhu in Quanzhou in 1974, the mid-Yuan dynasty Fujian merchant ship discovered in Xin'an of Korea in 1982, and the many ships found in the sea-beds in Lianjiang, Pingtan, Putien and Dongshan in Fujian province are comprised solely of those parts of the ships that were below the waterline.

Therefore, they provide no information on the complete form and design of these vessels. These remains, however, do prove that during the Song and Yuan dynasties the necessary skills developed to build the three-sectioned keel, the water-tight cabins and stern-hung rudders that could be hoisted and lowered.

Historical Evidence

The earlier records from extant historical writings that contain information on different types of ship from the Fujian style junk series were written around the late 16th to the mid-17th century. A middle 17th century collection of the Berlin Ethnologic Museum was the earliest meticulous color image of Fujian style junks (Anonymous, mid-17th Century). A mass of Drawings of Chinese ship anchored around Matsuura and recorded by local Japanese painters since last decade of 17th century (Oba, 1972) were of great value for study. In 1796, William Alexander's colour images are the earliest and the best realistic portrayals of Fujian style junks available to us today (Fig. 2).

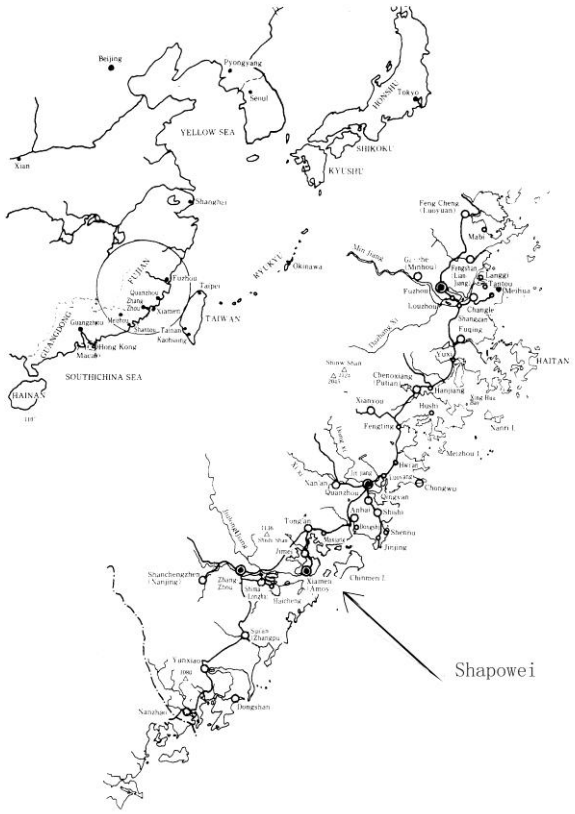


Fig. 2 The Coast of Fujian Province and the Location of Sha Po Wei. (Xu Lu)

Domestic sources were researched as well. *The Navy Abstract,* written in the year of the Emperor Kangxi (1654-1722) by the regional commander Chen Liang Shi contained an iconography for Fujian style warship (Chen Liang Shi, 2002). *The Taiwan Conversation by Writing*, written between the years of the emperor Kangxi to Yongzheng by Huang Shu Jing, recorded parts of materials, quantities and specifications needed to build the Ganzeng types of Fujian warship (Huang Shu Jing, 1957). *The Illustrated Manual of Instruction in Shipbuilding for the Navy of Fujian Province*, a manuscript between the years of the emperor Yong zheng to Qianlong by anonymous writer recorded by the order of the Admiralty (Anonymous,

Fig. 3 The Old Dockyard in Sha Po Wei inside Xiamen Gang. (Xu Lu)

Mid-18th Century), listed the kinds of warships in use during that time. Types like Ganzeng, Shuangpeng, Pingdi, Fazhuo, Bajiang were listed, and their peculiarities and used for different areas and condition. *The Regions Formula of Fujian Sea Going Warships*, a woodblock edition was written in 1768 by the order of the emperor Qianlong (Anonymous, 2002). Through putting together mostly-forgotten information that have been scattered all over the world, the appearance and design of junks traceable to the Song and Yuan dynasties are visualized. These sources show wahat ancient Fujian style sea-going junks probably looked like.

Ethnographical Field Investigation and Manuscripts

From 2004, we began to visit the main traditional shipbuilding centers along the Fujian coast and carried out the field investigation of wooden sailing junks. We found 7 manuscripts recorded and inherited by 4 shipwright families. The Sha Po Wei inside Xiamen Gang (Old Amoy Port) is a famous traditional shipbuilding center up to the first half of the 20th century. It was comprised of more than 15 private dockyards around 3 hectares of shoreline (Fig. 3). The Chen family in one of largest and oldest dockyards in the region, the family migrating from Huian country to Xiamen Gang at least five generations ago. An illustrated manuscript of naval architecture was archived by Mr. Chen Yan Ning of this family. It is 51 pages of paper, 22.5 cm in length and 11cm wide, 6 vertical red lines to a page, badly written in the end of 1910s.The manuscript was drawn by Chen Yan Ning's uncle, Chen Guo Zai (died in 1949), and then his son gave it to Chen Yan Ning. It contents size and cost of fourteen Fujian sea-going sailing junks,

all the numbers expressed in Suzhou numerals (Table 1). It is the most detailed record so far pertaining to the principle of design, modulus system, main unit data, measures and the amount of materials used for different ship forms. One of those is Da Pa, a junk that each side of hull is printed five gun ports (Fig. 4), it is the only civil junk with gun ports in the period of the Republic of China, alias Hei Bo or Feng Wei Chuan by recorded of G. R. G. Worcester (Worcester, 1948) (Fig. 5).

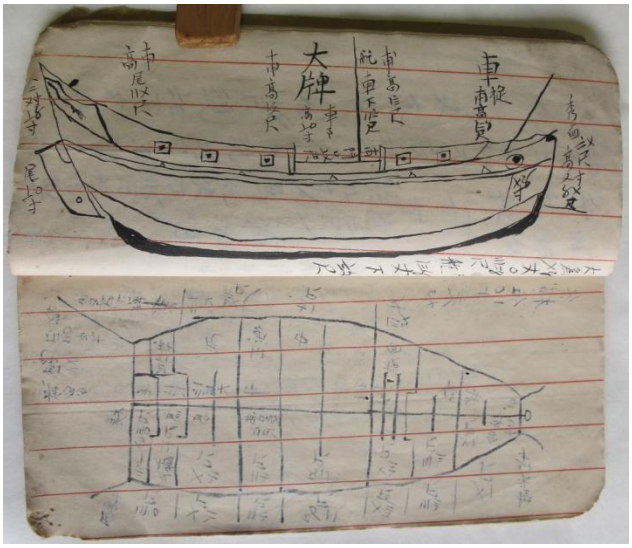


Fig. 4 The Manual of Da Pai in the Naval Architecture Manual of Chen's Family. (Chen Guo Zai)

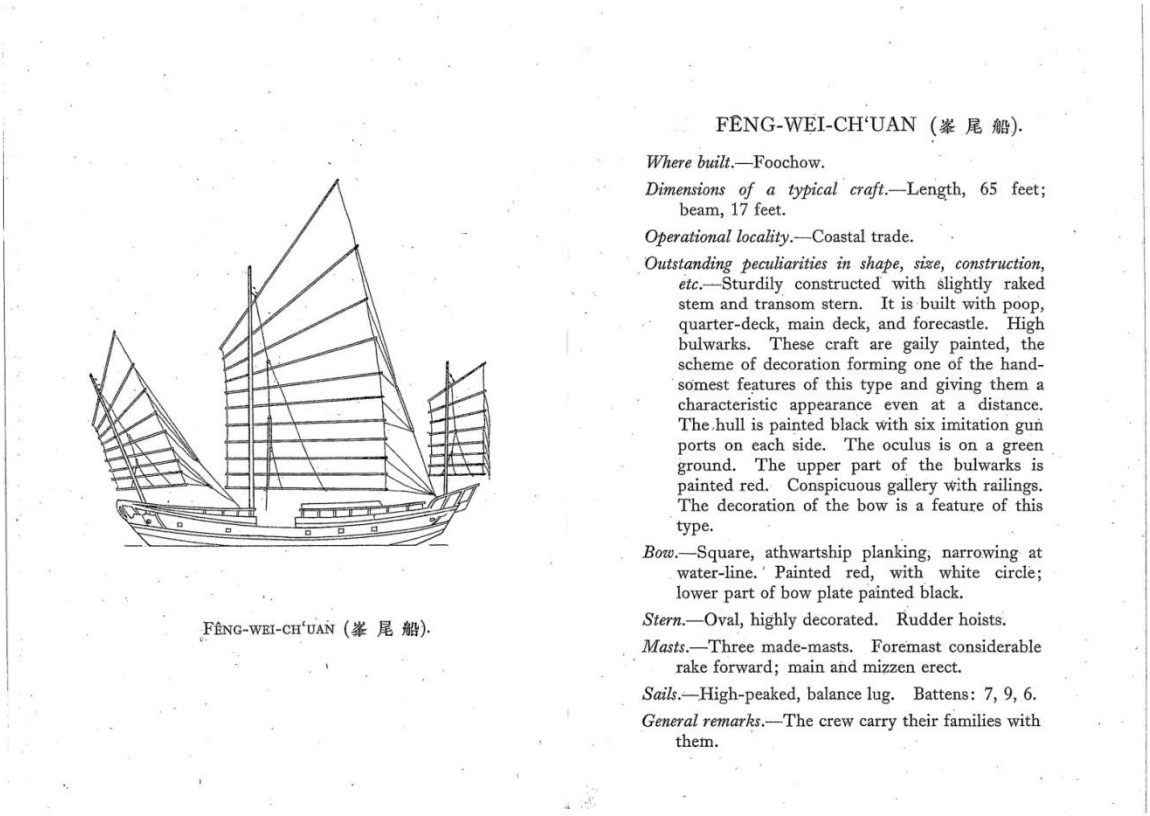
Design

In ancient times, master ship-builders relied on their individual experience and the knowledge passed down from previous generations. They would make patterns on the spot rather than prepare drawings with precise dimensions in advance. Traditional ship-building was a conservative, physically demanding profession. Apprentices were people from the lower end of society who could not afford an education. Being mostly illiterate, ship-builders' experience and knowledge was an oral tradition, passing it down to apprentices as they worked. In those days livelihoods very much depended on such skills, so what they learned they kept to themselves and seldom disclosed. For these reasons, illustrated construction manuals were rare. When designing a new ship, Fujian shipwright would decide on the measurements:

- The length of the keel (longgu) and the rise at both ends based on the intended use of the particular ship;
- The location of the four main transverses – those at the front and back, behind the mast and that which defines the main cabin;
- The width and depth of the ship in proportion to the length of the keel (longgu), for example, the measurement of the transverse behind the mast should be 4/10 the measurement of the keel.

- All other measurements such as the bottom-width of the transverse behind the mast, the top and bottom widths and locations of other transverses were then defined based on experience and according to the type, usage and other requirements of the vessel.
- The height of the mast depended on the top-measurement of the transverse immediately behind. So was the size of the major sail.
- Finally, measurements of width and the size and shape of the rudder post and tiller were determined.

The earliest historical document about design of Fujian style junk that has been discovered up to now is a document from the early Qing dynasty.



FÊNG-WEI-CH'UAN (峯 尾 船).

FÊNG-WEI-CH'UAN (峯 尾 船).

Where built.—Foochow.

Dimensions of a typical craft.—Length, 65 feet; beam, 17 feet.

Operational locality.—Coastal trade.

Outstanding peculiarities in shape, size, construction, etc.—Sturdily constructed with slightly raked stem and transom stern. It is built with poop, quarter-deck, main deck, and forecastle. High bulwarks. These craft are gaily painted, the scheme of decoration forming one of the handsomest features of this type and giving them a characteristic appearance even at a distance. The hull is painted black with six imitation gun ports on each side. The oculus is on a green ground. The upper part of the bulwarks is painted red. Conspicuous gallery with railings. The decoration of the bow is a feature of this type.

Bow.—Square, athwartship planking, narrowing at water-line. Painted red, with white circle; lower part of bow plate painted black.

Stern.—Oval, highly decorated. Rudder hoists.

Masts.—Three made-masts. Foremast considerable rake forward; main and mizzen erect.

Sails.—High-peaked, balance lug. Battens: 7, 9, 6.

General remarks.—The crew carry their families with them.

Fig. 5 Feng Wei Chuan. (G. R. G. Worcester)

Models

The building process started with making a model. Measurements would then be proportionately enlarged for making the ship. This was a method recorded in documents from the Song dynasty onward and continues to be used even in the present. Currently,

scholars take the making of models as the means by which to conserve and record the technology used to make a particular ship, but the ship-building industry knows well that components are difficult to reduce and reproduce to scale. Hence details that scaled down would be too small to show are often omitted. Furthermore, to build a ship requires totally different skills to those required for making a model. When detailed plans and descriptions are lacking, models can at times be misleading. Model offered the possibility of experimenting with various solutions before the replica in full scale was begun.

Selection of Material

As far as the choice of wood is concerned, a kind of natural fir tree Cunninghamia lanceolata (Lamb). Hook from Fujian a mountainous area was normally used for the parts of a ship's shell that have direct contact with the sea, such as the keel (longgu), bottom, shuishe (literally water snake), and zouma (literally running horse), the deck and transverses (gecangban, literally cabin-separating boards), and natural small-leaf camphor for other parts of the body such as cangliangzhuo (base of cabin beams) liangtou (beam-end) and gecangfuqiang (cabin-separating strengtheners). For the rudder and anchor which required harder material, kundian wood, which was grown in Guangdong and Southeast Asia was used. Wood for the mast was the most carefully selected, natural fir trees from Fujian aged 80 or more were generally used. Extant historical documents prove that tight rules governing the selection and quantity of materials to be used for ships built in imperial shipyards existed from the mid Ming. The allowances, however, seem overly lavish. With experienced folk ship-builders, measurements of all the parts would be clear in their minds as they searched for materials. Any piece of wood was to them an assembly of some parts. Ship-building uses a lot of wood, but the availability of wood is subject to specific growth cycles. A shortage of supply occurred in Fujian from the early Ming Dynasty, and with it, the cost of ships went up. Wood was then imported in large quantities from Southeast Asia (Chen Xi Yu, 1991). At the same time, some folk-shipyards moved out of Fujian. Some relocated abroad where a few expanded to substantial size. With them Fujian ship-building technology spread overseas.

	Launched	Type	Owner	Length of keel (chi/meter)	Cost (Silver Dollar)
1		Da Shuang Zhang (Jiang)	Qiu Xiong	28.4/8.72	500
2		Da Gu		22.7/6.81	
3		Da Gu		28/8.4	
4		Da Gu	Jin Mu Chuan	21/6.3	
5			Chong Wu Changshun hang	35/ 10.5	
6	1915	Da Pai	Chong Wu Cheng Chuan	31.5/9.45	500
7	1914	Da Pai	Chong Wu Chang Shun	21/6.3	
8		Da Pai	Xiu Chuan	30.5/9.15	
9		口 Cao (DiaoCao？)	Jiu Zhi	22/6.6	
10	1906		He Shang	30.5/9.15	
11			Tou Chuan	30.5/9.15	
12			De Bao	27/8.1	
13				31/9.3	
14		Shui Chuan		20/6	230

Table 1. The Contents of Fourteen Fujian Junks from the Naval Architecture Manual of Chen's Family. (Chen Guo Zai)

Sequence of Construction

Traditional production starts with establishing the keel (longgu), fixing transverses (longuyiban, literally dragon bone wing-boards), parts of bottom planking, gecangban, biban (bilge Keel), wen (stabilizer), lianggung (upper ribs), then the intermediate ribs between the transverses, and finally, the remaining bottom planking. After these, work on the weather deck begins. First the boards along the bulwarks, followed with shishe on the exterior of the bulwarks, shuixianmen (literally narcissus door) and then the bulwarks. The dragon-eye is usually installed on an auspicious day chosen by the boatman. When the making of the ship's hull is finished, the filling or Lihui (Caulking) and all sewing work too come to completion. Before the new ship is launched, the exterior of the shell is first covered with a mixture of rice soup and lihui to protect against shipworms. The owner selects a date and time for the launching after which the mast is set up and the sails bent on. This pattern of ship-building is traditional for many

areas along China's coastline and continues to be used even up to the present. Scholars named it chuankefa, literally the Chinese frame first system. The modern Chinese building techniques for large wooden ships begins with the keel, then erects the frames or ribs and the bottom planking before completing the side planking. This method of ship-building first appeared in *Shi Ryukyu Lu (Diplomatic Mission to Ryukyu)* written by the Ming dynasty diplomat Xia ZI yang in 1606 (Xia Ziyang, 1970).

Painting and Decoration

That part of hull below the water-line is usually covered with baikehui (lime from white s hells). The flares (tuolang ban, wave-lifting boards near the bow) are also first covered with lime before painting the figure that characterizes Fujian junks with a solution made of glue, tung oil and natural color pigments. Some Fujian junks even come with a carved head of a lion at the bow. Dragon eyes on the bulwarks near the bow are usually made of camphor. Particular rules govern the size and shape of these eyes: the ratio between the keel length and eye should be 110:4; eyes for fishing boats should look downwards t o signal the search for catches while eyes for merchant ships should look at the route a head. Mulong (wooden dragon), i.e., loach poles (qiuyuji) are painted on the bulwarks n ear the stern, a seabird (muyi) on the yingban (the oval-shaped sern facing), and at the bottom of the yingban is the board which carries the ship's registration number. Accordi ng to legend, qiuyuji, muyi bird and Matsu (Goddess of the Sea) are the three treasures that watch over the safety of ships. A statue of Matsu or a paper charm as its substitute may be placed in a sanctuary in the after part of the poop.

Tools

Confucius says, "Good tools are a prerequisite to the successful completion of a job". For the execution of specific tasks, special tools are required, such as axes, chisels, saws, files, tweezers, awls, knives, rulers and modou (ink markers) used by carpenters, and hammers, large tweezers, sickles, paint-brushes, truncheons for working with lime are used by other workers.

Axe: triangular in shape, the axe is the most important tool in ship-building. In traditional ship-building, the qualification of ship-building masters is measured by the number of years he has used an axe.

Adze: shaped like a hoe, it is also named guangfu (smooth-out, or faying axe) meaning

that it is used for smoothing out or faying in parts.

Saw: for cutting raw materials into boards.

Plane: for smoothening out wood surfaces.

Lu Ban ruler: also known as “wengong ruler”, which, according to legend, was a system of measurement invented by Lu Ban following Daoist truth and the laws of the Eight Diagrams. With birth, aging, sickness, death and suffering as the basis, the ruler is divided into 8 parts named cai, beng, yi, li, guan, li, hai and ben. When using the ruler, cai is the top and beng the end, and it is important also to avoid the inauspicious and adopt what is auspicious.

Modou: that part which serves as a container of ink is called mochi (ink-well) which holds cotton wool soaked in ink. There is a line reel at the end. Cotton thread comes through from the modou and is also soaked with ink. To use the modou, the cotton thread is first fastened to the piece of wood which requires marking at each end, and by gently pulling the thread outwards near the center and then letting it go, a clear and distinct ink line appears on a raw piece of wood or boards measuring several meters.

Caulking iron: made of wrought iron and steel for the teeth. An iron loop forms part of the wooden handle and is used for mixing hemp, rattan and lime and inserting the mixture into crevices.

Shipbuilders

Over the centuries, ship-builders coming from Fuzhou, Quanzhou and Zhangzhou slowly gathered in Fujian. Apprenticeship generally started at the age of 11 or 12. Those who joined the profession were mostly members of ship-builders’ families; their children, cousins or relatives. No less than 3 years of training were necessary. In the beginning, apprentices were not allowed to handle the axe and helped only in menial duties such as mending or minor repair work. Only after a number of years of training, when students had picked up sufficient knowledge and skills from their masters, were they allowed to work on important components such as keels, helms and masts before they became masters. There is a common saying, “Master of a particular shipyard builds ships exclusive to that shipyard”. Each shipyard had its unique ship form. Generation after generation of ship-builders inherited the skills, expertise and

experience passed to them by their predecessors, which over time established a given set of practices and forms.

Crossed the Pacific Voyages

In Donnelly's *Chinese Junks and Other Native Craft*, he listed three most important crossed the Pacific voyages have been taken by type of Fuzhou pole junk and another one was make by Xiamen fishing junk.

- "Keying": length of 48.7 m, Hong Kong to London, 1848.
- "Whangho": length of 30 m, Shanghai to San Pedro, 1906.
- "Ningbo": length of 42 m, Shanghai to San Pedro, 1912.
- "Amoy": length of 21.03 m, Xiamen to Victoria, 1922.

Captain Eric de Bisschop sailed a Xiamen built 12 ton gross junk Fou Po II in the southwestern Pacific Ocean and East Indian Ocean. In 1955, a Fuzhou style cargo junk with a length of 23 m, Free China, sailed from Taiwan to San Francisco. In 2008, our experimental replica of Fujian Style warship "Princess Tai Ping" sailed form Xiamen to San Francisco and Hawaii.

Conclusions

Unlike shipbuilding in other indigenous areas, the Chinese shipbuilding tradition changed a little through all the time, the structure of square bows and sterns with transverse watertight bulkhead and lugsails with bamboo mat and strip showed little change over thousands of years, and the last successors of traditional shipbuilding are alive. Western classifying studies of Chinese sailboats in the early of 20th century just based on the field investigations and the interviews with the successors of traditional naval architecture, such as the great achievements of François-Edmond Paris, Louis Audemard, Barbosa Carmona, Donnelly Ivon, G. R. G. Worcester and Etienne Sigaut, etc. It is last chance to be invested promptly on ethnographical field work investigation for Fujian coast traditional shipbuilding centers. The Naval Architecture Manual of Chen's Family provided most detailed database so far, yielding valuable information pertaining to principle of design, a modulus system, main unit data, and measures used for typical ship forms of traditional Fujian style sea going sailing junks. ~There are still 3 shipwrights alive in Sha Po Wei, a valuable ethnographic resource, soon to be lost.

Therefore, historical and archaeological projects need to be invested into promptly to recover the historical archetypes of ancient Fujian Style Sea going junks, which will provide helpful methods to explain and identify relevant ship remains excavated in future shipwreck underwater archaeological projects.

Acknowledgements

Thanks are due to all members of CSJES, the last craftsmen of traditional Fujian naval architecture and seamanship, who provided their invaluable experience and knowledge. I must also express my sincere thanks to Dr. Jia Hao and Miss Jia Xiaofan. Dr. jiahao helped me to search relevant historical materials and Miss Jia xiaofan revised the article format.

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Biography

Xu Lu *is the initiator and director of Chinese Sailing Junk Expedition Society (CSJES), an exclusive institute focus on protect and study ancient Chinese naval architecture and nautical navigation. He also is commissioner of China Maritime History Studies Association. As a maritime archaeologist special in the field of junks, he spent over a decade on field work to investigate and ethnographic study the last traditional sailing craft still be built and operating in China, wrote and released numerous academic papers. He led an experimental archaeological ship-reconstructions project in 2007, Princess Taiping, a junk replica sailed across the Pacific.*