

Two Ming Dynasty shipyards in Nanjing and their infrastructure

Sally K. Church

Abstract

This paper draws a clear distinction between two shipyards in the northwestern corner of Nanjing: the Treasure Shipyard and the Longjiang Shipyard. The former was the site where the Treasure Ships used on Zheng He's maritime expeditions (1405–1433) were built. The latter was founded at the beginning of the Hongwu period (1368–1398) in the Ming dynasty (1368–1644) to provide ships of a military nature to protect the capital (Nanjing, until 1421) and also to defend some of China's waters and shores against pirates. These two shipyards were in slightly different locations, and had different purposes and different historical trajectories. Our knowledge about them also comes from two different types of sources, one archaeological and the other textual. The two types of evidence complement each other well, and here they are used to survey what is known about the two shipyards and to bring them together into a more comprehensive picture of early Ming shipyards than has been attempted in the past.

要旨

本論文は南京の北西端に位置する二つの造船所（寶船廠・龍江寶船廠）を明らかに異なるものとする。前者は鄭和西洋下り（1405–1433）に使用された寶船を建造した造船所であった。後者は明朝洪武帝在位年間（1368–1644）の初めに、首都（1421年まで南京）防衛のための、また中国海域・沿岸域の海賊を取り締まるための軍船を供給するために建てられた造船所であった。これら二つの造船所は僅かに異って位置し、目的や歴史的歩みにおいて異なっていた。これらについては考古学的な資料と文献資料の両者により知識を得ることができる。これら資料は互いに十分に補完し合うものであり、ここでは二つの造船所についての知見を調査するために、これまでより明初の造船所について包括的な理解にむけての整理のために使用される。

Introduction

From 1405 to 1433, the eunuch admiral Zheng He (鄭和) commanded a series of maritime expeditions to India, Africa and the Arabian Peninsula.

Approximately 120 years later, in the 1540s–1550s, China's coasts were being attacked by pirates. Each of these events gave rise to a sudden wave of shipbuilding by the Chinese government. The first led to the creation of the Treasure Shipyard in the early 15th century, and the second to the revitalisation of the Longjiang Shipyard in the mid 16th century. Both of these shipyards were

in Nanjing (南京), which lies on the bend of the Yangzi River about 259 km (161 miles) west of present-day Shanghai.

At the time of Zheng He, Nanjing was the capital of the Chinese empire. This status, combined with its strategic location on the Yangzi, made it a logical place from which to launch the maritime expeditions. By the 16th century, the capital had been transferred to Beijing (北京), but the need for ships was still great along China's southeast coast,



Figure 3.2 1944 map. (Courtesy of Nanjing Municipal Museum)

the river, as the bank area has been substantially filled in and fortified against flooding during modern times.⁶ At the time, there would have been gates joining the western end of the basins to the river via a channel, called *Jia jiang* (夾江), which skirts present-day Jiangxin island (*Jiangxin zhou* 江心洲, literally, “island at the heart of the Yangzi”) and leads to the main part of the Yangzi. These gates would have allowed the completed ships to pass out of the dockyard into the Yangzi River on their journey toward Shanghai and the sea. The gates no longer exist and the exit from the basins to the river is blocked by dikes along the riverbank to guard against flooding. A modern road (*Jiangdong men beilu* 江東門北路) also runs in a north-south direction between the basins and the river.

The three remaining basins, which have conventionally been numbered basins 4, 5, and 6, are all approximately the same size. The basin to be examined here is No.6, the one that is furthest south. It was excavated intensely from 2003 to 2004, when it was entirely drained of water. All the finds were collected and analysed at that time. Although there are a few pieces of textual evidence concerning the Treasure Shipyard,⁷ the archaeological finds from this excavation constitute by far the largest quantity of evidence about it. These have been published in the archaeological report mentioned above.

By contrast, the site of the Longjiang Shipyard cannot easily be located today. Instead of archaeological

evidence, we have only textual evidence, in the form of the *Longjiang Shipyard Treatise* (*Longjiang chuanchang zhi* 龍江船廠志), written in 1553 by the shipyard’s director, Li Zhaoxiang (李昭祥, fl. 1537–1553). This work contains a vast amount of information about the Longjiang Shipyard and its infrastructure. Based on the two site plans given in Chapter 4 of the *Treatise*, as well as the verbal descriptions it contains, one can see that it was bordered on the east by the city moat and city wall, and west by the Yangzi. It is south of Lulong outlook (*Lulong guan* 盧龍觀), or Lulong mountain (*Lulong shan* 盧龍山), and Yifeng gate (儀鳳門), and north of the Qinhuai river where it flows into the Yangzi.⁸

The two sites not only had different locations, but also different purposes and historical trajectories. The Longjiang Shipyard was founded at the beginning of the Ming period for the purpose of building relatively small ships for inland transport and military defence. It was in operation from approximately 1368 to well into the 16th century and beyond. The Treasure Shipyard, on the other hand, was built specifically for the construction of the “Treasure Ships” for Zheng He’s maritime expeditions, and functioned only between 1403 and 1433.

The historical context for the founding of the Longjiang Shipyard is crucial to understanding its importance. The Ming founder Zhu Yuanzhang (朱元璋) (Emperor Hongwu 洪武, r. 1368–1398) had

just wrested power from the Mongols, who had ruled China for the previous century during the dynasty they proclaimed as the Yuan (元), 1279–1368. His effort to restore the empire to Chinese rule had involved a struggle for supremacy among Chinese rivals, and some of these battles had taken place on water. The Emperor thus recognised the need for naval strength both to acquire power and to hold onto it. During the first few years of the dynasty, the area around Nanjing and the Yangzi River was relatively secure, but the situation of the empire as a whole was not stable. Large parts of the country were still in Mongol hands. The memory of foreign conquest was fresh, and the desire to insure against its recurrence was strong. In addition to establishing military guards (*weisuo* 衛所) in strategic locations throughout the empire, Hongwu also attempted to build up the Ming's naval forces and it was to this end that the Longjiang Shipyard was founded, to provide ships for military use, and to guard the waterways around the capital. A further motivation for shipbuilding at the time was to secure China's shores against pirates, because the southeast coast had become a target for pirate raids during the latter part of the Yuan period.⁹ As a result of this policy to build up naval defences, four hundred families from China's southeast coast were moved to the Longjiang Shipyard to begin work, and ships were turned out in large quantities.¹⁰

It was not until over 30 years later that orders were issued by the third emperor, Zhu Di (朱棣) (Emperor Yongle 永樂, r. 1403–1424), for a different type of ship to be built. This was the huge ocean-going ship to be constructed in large numbers to sail overseas on the maritime expeditions of Zheng He. The *Ming shi* (明史) says that 62 of these ships were built for the first voyage, and other numbers are given elsewhere.¹¹ It is thought that most of the Treasure Ships used on Zheng He's maritime expeditions were built in the Treasure Shipyard, although some may have been built in Fujian province at Changle (長樂).

After 1433, when no further expeditions were sent out, ships were no longer produced at the Treasure Shipyard and it was allowed to go to ruin. The Longjiang Shipyard, on the other hand, continued to produce ships well into the 16th century. Although it went through periods of decline and revitalisation, a major effort was made in the mid 1550s to bring the Longjiang Shipyard back into efficient and productive operation. The appointment of Li Zhaoxiang as its director was a step in this direction. In fact, one reason why he wrote this *Treatise* was to record the situation as he found it in order to identify the problems and eventually eliminate them. The composition of this *Treatise* was thus the first step in the overhaul of the shipyard's operations.

II. The Treasure Shipyard and the Archaeological Evidence

As noted above, the Treasure Shipyard was founded in 1403 to build the ships that would be used on Zheng He's maritime expeditions. Because these ships were said to be going overseas to "collect treasures" (*qu bao* 取寶), the ships were called "Treasure Ships" (*baochuan* 寶船), and the shipyard was called Treasure Shipyard (*baochuan chang* 寶船廠, literally, "the yard for constructing Treasure Ships"). Other types and sizes of ship were probably also built at the yard as well, for use on the expeditions. These ships sailed along the Yangzi River eastward to *Taicang* (太倉), a large, deep-water port near present-day Shanghai, where the fleet for the expeditions assembled before sailing out to sea.

The Excavation

Between August 2003 and September 2004, the Nanjing Municipal Museum carried out a thorough excavation of Basin 6. The basin is 421 m (1,381 ft) long and 41 m (134 ft) wide. Before the excavation, it was full of water and mud to a depth of 3.5 m (11.5 ft). During the excavation, it had to be completely drained of water and flushed out gently with clean water to remove most of the mud. Thirty-four built-in structures were discovered along the centre-line of the basin's floor; these had to be excavated and the finds analysed. The loose items found in the basin, totalling roughly 1500, were cleaned, catalogued, labelled and properly stored. Because the site had to be prepared for its Grand Opening in July 2005, which was one event in the celebrations for the 600th anniversary of Zheng He's expeditions, the Nanjing Municipal Museum was under considerable pressure to make the site presentable to the public quickly, as well as to build a museum on site for displaying the finds. All these tasks were accomplished within the year. The photo of Basin 6, taken from the archaeological report of the excavation that was published in 2006,¹² looks westward toward the Yangzi River, which is just visible in the background. It shows the basin completely drained of water, while basins 4 and 5, visible on the right (north) side of the photo, are still full (See Figure 3.3).

Structures on the Basin's Floor

The 34 discrete structures embedded in the floor of the basin are rectangular or oval in shape, and lie perpendicular to the basin's longitudinal axis. The structures are irregularly spaced along the length of the basin, and are all between 10 and 14 m (33–46 ft). They consist of a series of upright wooden posts driven into the bottom of the basin, with lengths of wood



Figure 3.3 Basin 6 after excavation. (Courtesy of Nanjing Municipal Museum)

lying on top of them. These lengths of wood are either arranged neatly as if part of the structure or scattered haphazardly nearby (See Figure 3.4).

The authors of the report seem to suggest that these structures were frames on which the ships rested while under construction. However, there is no proof that they were used in this way, and it would go counter to the way in which ships are usually built: first on dry land and then lowered into the water. Another theory is that the basins may have been pumped dry during the construction period and then flooded to allow the ships to exit the shipyard. This theory also has its difficulties, not least because pumping the basin dry was sufficiently difficult during the excavation, with modern equipment. One wonders whether it was even possible during the 15th century. Moreover, all the ships would have had to have been finished and ready to exit the shipyard at once, which would have required a massive amount of coordination.

This being said, the authors of the archaeological report seem to assume that these structures were indeed frames on which the ships were built. If so,

it becomes a question of how the ships would have been arranged in the basin, whether each of the 34 frames supported a single ship, or whether they were clustered together in larger units. If each of the frames were for a single ship, the ships would have been quite small. Although the total length of the basin is 421 m, the portion containing structures is only about 300 m long. If the structures had been evenly distributed among the 34 frames, which they were not, the ships could not have been longer than 8.57 m.

This size contrasts sharply with the size of the gigantic treasure ships described in some of the Chinese sources, which were supposedly 44 by 18 *zhang* (丈). These dimensions work out to approximately 137 m (450 ft) long and 56 m (183 ft) wide. If they had been this size, Basin 6 would certainly have been long enough. In fact, three ships of this size could have fit along the 421 m length. However, the basin would not have been wide enough to accommodate even one of these ships. The width of the basin was only 41 m (134.48 ft), while the beam of the ships was supposedly 56 m (183.68 ft). One might attempt

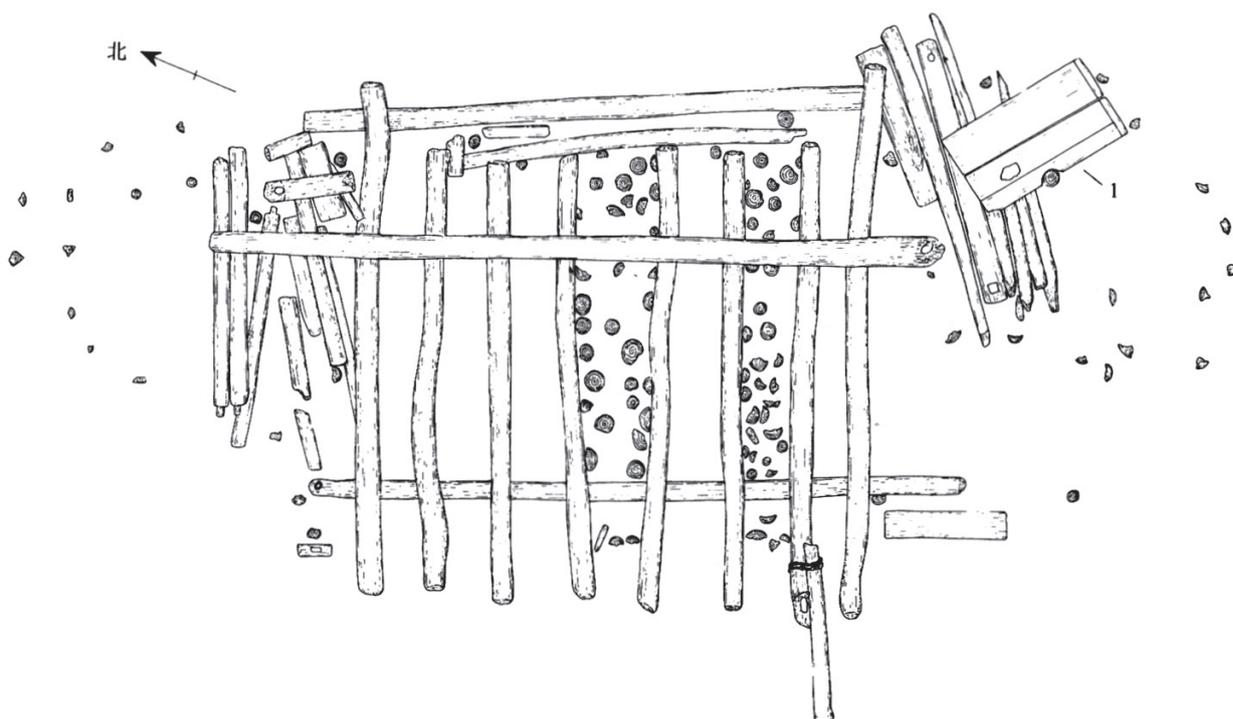


Figure 3.4 Drawing and photo of one of the structures. (Courtesy of Nanjing Municipal Museum)

to argue that the ships could have been wider than the frames supporting them, or than the basin itself, but one has to remember that the frames themselves within the basin were not 41 m wide. Instead they were 10 m wide. Moreover, it appears that the width of the basin rules out this size of Treasure Ship. An examination of ships under construction in shipyards suggest that the ships are not usually much wider than the frames that support them.¹³ The depth of the basin,

which is about 4 m (13.12 ft), could also not have accommodated a ship of sufficient depth for this size.

Some of the structures appear to be clustered together in groups, while others have larger gaps between them. It is possible that each of these clusters corresponds to the length of a ship.¹⁴ The westernmost cluster seems to include structures 1–10, which extend for 70 m (225 ft); the next cluster may include structures 11–17, which cover about 50 m (165 ft); the third

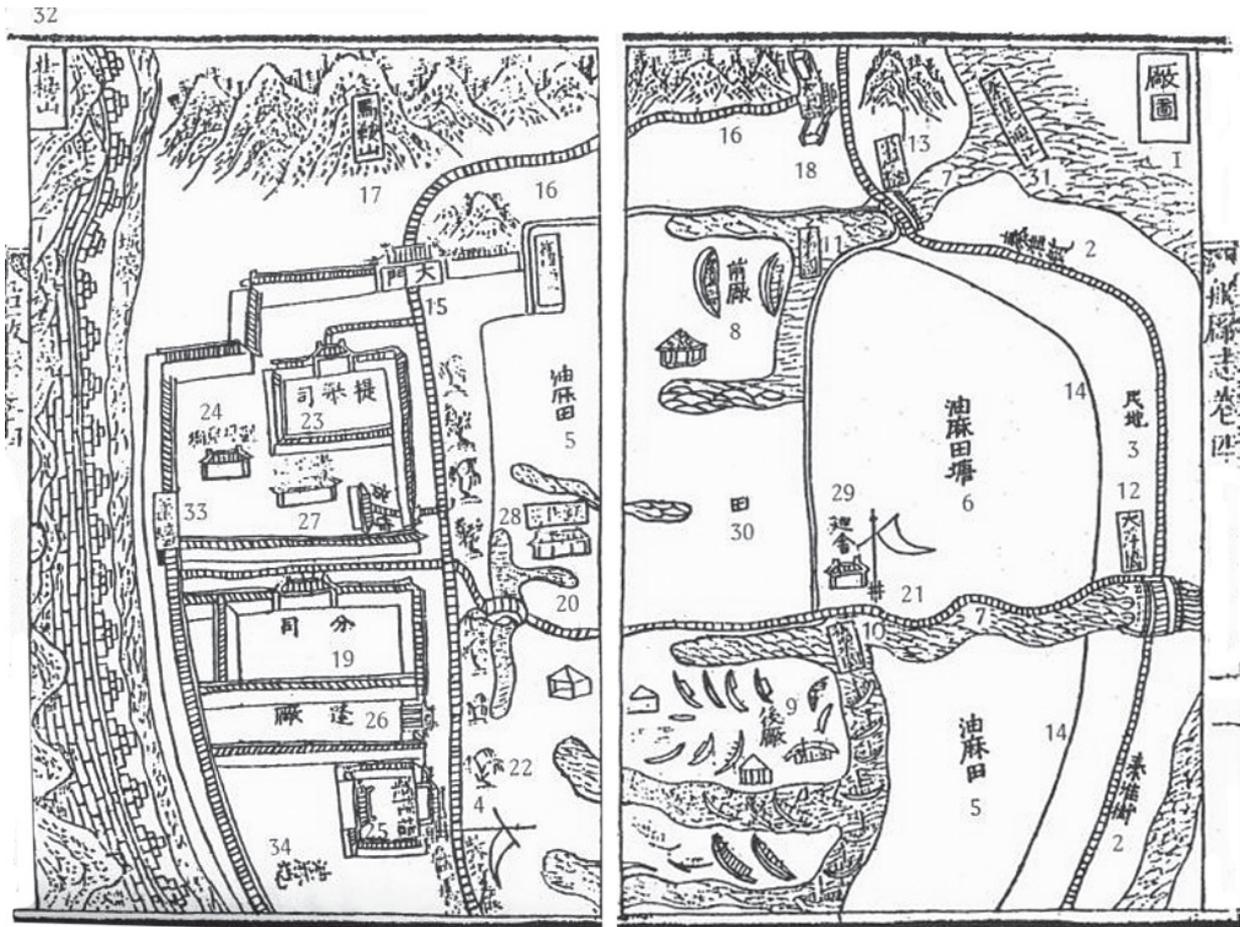


Figure 3.5 Site Map of Longjiang Shipyards. (Courtesy of Nanjing Municipal Museum)

cluster may include structures 18–24 or 18–25), which would measure 50 m (165 ft); and the final cluster may extend from structures 25 to 34 and cover 50 m (165 ft). Allowing for an overhang of the bow and stern, as well as some space between the ships, the basin might then have been divided into 3 or 4 separate sections each 50–68 m (165–225 ft) long. This way of looking at the site would tally with the view that the largest ships were probably less than 75 m (250 ft) long. They may of course have been even smaller. The site map in the *Longjiang Shipyards Treatise* shows ships lying neither lengthwise nor completely crosswise the waterway, but at an angle. The site map, however, is not a technical drawing, and although it is suggestive of what might have been going on in the Treasure Shipyards, one cannot be certain (See Figure 3.5).

The western end of the basin, nearest the river, has a higher concentration of finds and more complete structures than the eastern end, suggesting that more ships were built in the western end than the eastern end. The western end may have been the preferred end for shipbuilding because it was nearest the exit to the Yangzi River. It is probable that during the height of productivity the entire basin was used, whereas during more lax times ships were built or repaired primarily at the western end.

The Artefacts

As mentioned above, approximately 1,500 artefacts were discovered in Basin 6. These include only the loose items. In addition to these, a total of 1,615 pieces were embedded in the bottom of the basin. Of the loose artefacts, 1,000 were made of wood, 600 of iron, and 355 of pottery. These items seem to derive primarily from the infrastructure of the yard rather than from the ships themselves, although there were some ship parts among the finds. The discussion of the finds below follows roughly the same order as they are presented in the archaeological report, which groups them according to the material of which they are made, rather than the purpose of the objects. This is because the site was full of water when the excavation began, and had to be drained and hosed down to remove the mud. Thus many of the finds were disturbed or swept away with the water, and could not be restored to their original position. For this reason, and because no complete ships were found, it was sometimes difficult for the archaeologists to determine the function of the pieces. Therefore, the authors of the report did not try to group them by function. Instead, the authors

first classified the objects according to the material they were made of, and then into type, shape, and size. Only in cases where their use was clear were items of similar use grouped together.

Wood

In its discussion of the over 1,000 loose wooden objects found in the basin, the archaeological report divides them into three main categories. The first is tools and implements. These include hammers, T-shaped supports, wooden knives, earth pounders, wooden rulers, wooden paddles, and the like. The second consists of remains from what the report calls “shipbuilding infrastructure” (*zaochuan sheshi goujian* 造船設施構件), which is explained as: “items that are related to the engineering aspect of the shipyard” (*he zaochuan gongcheng youguan* 和造船工程有關).¹⁵ This is a narrower sense of the term “infrastructure” than is being used in this paper; in some senses all the items found at the shipyard can be seen as belonging to the infrastructure, except for the ship parts themselves. The report includes such items as wooden posts and piles (posts driven vertically into the ground), logs, a single water-wheel base (*shuiche longgu* 水車龍骨), and the like, in this category. The third category consists of ship parts, including rudderposts, parts of masts, railings, door frames, carved decorations, and so forth.

In the category called “implements” (*yongju* 用具), the first class of items to be discussed is the T-shaped supports, of which 12 were found.¹⁶ These were hardly the largest or most numerous finds, but they appear to be important because they had an unusual and unexpected shape. They are grouped with tools, probably because their T-shaped tops resemble some of the hammers, but they are much longer than hammers and they may have been supports on which the ships rested while being worked. The T-shaped tops may have protected the hulls of the ships from being punctured by the sharp ends of supporting posts. The other wooden implements found in the basin were: 16 hammers, 67 hammerheads and support-post heads, one earth pounder, one wooden pestle, nine knives, two wooden rulers, three paddles, two flat pieces of wood whose use is unknown, one footboard, two work-benches, 18 oars, and 85 handles for pottery and other vessels.¹⁷

Of particular interest are the two wooden foot-rulers, both 313 mm long, discovered in the basin.¹⁸ Although it is not absolutely certain when these rulers fell into the basin, if they date from the time of Zheng He, they may represent the size of the foot used for building the Treasure Ships. These rulers therefore constitute the most solid evidence we have so far concerning the size of the shipbuilding foot in Zheng He’s day.¹⁹



Figure 3.6 Water Wheel Base. (Courtesy of Nanjing Municipal Museum)

Under the category of “Shipbuilding Infrastructure”, the first type of wooden find to be discussed is wooden posts or piles. Those that were integral parts of the 34 structures embedded along the bottom of the basin were left in place during the excavation and were not analysed individually in the report. The posts examined in the report, which were removed from their original context, were the most numerous objects in the entire excavation, totalling 645 pieces. Of these, 96 are hardly worked at all by human hands. The largest number of posts, totalling 382, are rounded and pointed at the bottom. Finally, 167 were originally ship parts and only later reused as posts. Some have nail holes and traces of paint.²⁰

The second type of find in this category is the whole, round, virgin log (*yuanmu* 原木), i.e. a log that has not been cut or split longitudinally. The logs of this type are almost in their original state, only minimally adapted for use by having their bark stripped off and branches removed. Their trunks are left intact, and they are crude and unfinished. Marks of knives and axes are visible on some of them. Sixty-six of these types were found in the shipyard. According to the authors of the archaeological report, these are major components and tended to be used in relatively complex structures.²¹ Some have mortise or tenon elements on them, and some are inscribed with writing. Their use is unknown. They may have formed the long sections of the T-shaped supports, or they may have functioned as piles or parts of ships. The authors include the water-wheel base (See Figure 3.6) in this category.²²

Several different types of information are inscribed in writing on wooden and other objects. Sometimes it is a person’s name, as is the case of one of the rulers and some of the pottery. At other times the inscribed text consists solely of numbers. Wood was a valuable commodity that was difficult and costly to obtain. These could therefore have been inventory numbers, symptomatic of the careful control that was kept over wood supplies to prevent them from being wasted or pilfered. Some of these inscriptions include the size of the piece of wood, for example “three feet” (*san chi* 三尺).²³ In other cases the characters indicate where on the ship the object was to be fitted.²⁴ One wooden object is inscribed with



Figure 3.7 Windlass. (Courtesy of Nanjing Municipal Museum)

the word *guan* (official 官), indicating that it was “for official use only”.²⁵ It should be remembered that because the workers lived on or near the site, it would have been important to distinguish materials that were for official use from those that could be used privately. According to the *Longjiang Shipyard Treatise*, pilfering of supplies by the workers was an administrative problem in the shipyard.

The third category consists of ship parts. There are 55 items in this category. These are worked with considerable technical skill, and some are quite finely made. They are smooth, finished, and regularly-shaped, often having nail holes, wider holes, or grooves in them. Some have decorative motifs carved on them. In this category the authors have included two rudderposts and one portion of a rudderpost, 56 planks, eight round disks of various sizes with holes in the middle, three windlasses, and one door frame.

The rudderposts are perhaps the most striking of these items because of their size. The two complete rudderposts are both over 10 m (32 ft) long and made of teak. They supplement the one that was found in 1957 in the same shipyard, which measured 11.07 m (36.32 ft) in length. The fact that three complete rudderposts were found here, all of roughly the same size, strongly suggests that this was the type of rudderpost used on the Treasure Ships.

These rudderposts have been used in the debate about the size of the Treasure Ships. Zhou Shide (周世德) published an article in 1962 about the 11.07 m rudderpost, arguing that it proved that the Treasure Ships were 137 m (450 ft) long.²⁶ However, Zhou’s results are highly suspect. He used a formula for calculating the proportion of rudderblade area to ship size, but unfortunately, this formula was one designed for modern steel, propeller-driven ships, not for wooden ships. One cannot expect such a formula to work for modern wooden ships, let alone 15th century Chinese ships. Moreover, none of the rudderblades survive; we have only the three rudderposts. In order to obtain the rudderblade area, Zhou Shide measured the length of one side, which is possible because the distance between the two slots on the rudderpost for the insertion of the rudderblade can be measured, and then estimated the length of the other three sides.



Figure 3.8 Wooden disks. (Courtesy of Nanjing Municipal Museum)

If the rudderblade were rectangular, he would have been correct about the two vertical sides, providing they were parallel, but without the rudderblade itself one cannot know the correct shape or length of the horizontal side. Therefore the area cannot be known, and is of no use in any formula. Moreover, the shape of the rudder illustrated in his article is appropriate for a flat-bottomed *shachuan* (沙船), not for an oceangoing *fuchuan* (福船), which is the type to which most scholars now agree the Treasure Ships belonged.

Although the length of these rudderposts inspires awe, the stern mounted rudder, which is the most likely type to have been used,²⁷ requires a long rudderpost to extend upward from the water-level through the ship to the deck, where it is operated by means of a tiller. Thus a large proportion of the rudderpost is out of the water. One example of a modern junk with an 11 m long rudderpost, made in the traditional *Lümeimao* (Green Eyebrow 綠眉毛) style, is only 31 m long.²⁸

The 56 planks found in the basin are finely made, with nail holes at regular intervals. Some have red, blue, or black paint on them. Inscriptions are written on them to show where on the ship they fit. The archaeological report divides them into two types: single planks, of which there are 44, and planks joined together, of which there are 12. The longest single plank is 5.36 m long, and the longest joined one is 2.63 m long. Many of them contain traces of caulking material covering nail openings and in the seams, where more than one is joined.

One precious wooden find is the windlass pictured here, showing indentations from a rope that was wrapped around it. (See Figure 3.7) It is 594 mm long. The authors of the report speculate that one or more of the wooden disks that were found (See Figure 3.8) may have fitted on the ends of this windlass or one like it.²⁹ However, it seems doubtful that the pieces at the ends of a windlass would be circular; they would need the stability that such a round disk could not provide to perform their function. The largest of these disks is 581 mm in diameter and the smallest is 164 mm.

The finds at the shipyard show wooden pieces joined in mortise and tenon fashion, or with ends or slots that suggest this type of joinery. We can reasonably assume that this was the method of joinery used at the time of

the Treasure Ships, although we cannot say that other methods were not used. As will be shown below, a large number of iron staples were found which may also have helped to join pieces of wood together. The majority of these staples were quite small.

As part of their study, the authors of the archaeological report had 236 of the wooden pieces found in the shipyard analysed to determine their species. The breakdown of these species is shown in the following table. Most were found to be *Cunninghamia lanceolata*, with small numbers of pieces from a few other species.³⁰

Species	Pieces Found
<i>Cunninghamia lanceolata</i>	188
<i>Tectona grandis</i>	26
<i>Erythrophleum fordii</i>	13
<i>Castanopsis</i> sp.	4
<i>Pinis</i> sp.	2
<i>Diospyrus</i> sp.	1
<i>Shorea</i> sp.	1
<i>Cotylelobium</i> sp.	1
Total	236

Five pieces of wood found at the site have been carbon-dated, and the dates seem to range from 1320 to 1490. The results of this and all the tests done on the materials are presented in Appendix 2 of the report.

Iron

Iron objects were the second most common find at the Treasure Shipyard, after wood. Approximately 600 iron artefacts were found, most of which were tools and implements used in shipbuilding. Some agricultural implements and items for daily use were also found. The most numerous finds were iron staples, of which 292 were unearthed. The archaeological report divides these staples into categories according to size, with the largest 250 mm long. Only two fragments of this type were found. Most of the staples (258) were between 154 mm and 181 mm long; 29 were slightly larger and 3 slightly smaller. These staples may have been used to hold pieces of wood together during construction; it is unlikely that they would have been able to hold a ship together (See Figure 3.9).

The report says that 258 iron nails were found. It divides them into types according to the shape of the heads: straight, bent, flat, round, hammer-shaped, and looped. Some also had no heads at all, and these were called date-pit (*zao he* 棗核) shaped. The most numerous were the straight- and bent-head nails, numbering 135 and 101 respectively. Because of their length, one unique bundle of six nails should perhaps be called pins; they had never



Figure 3.9 Staples. (Courtesy of Nanjing Municipal Museum)

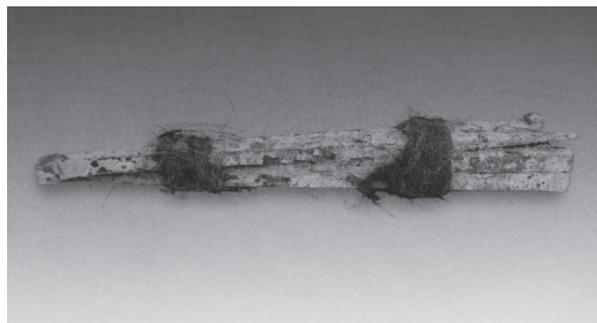


Figure 3.10 Nail Bundle. (Courtesy of Nanjing Municipal Museum)

been used and were still wrapped together with cord. These were between 552 mm and 587 mm long (See Figure 3.10).

The report divides the iron tools into those used for shipbuilding and those for agricultural work or daily life. Thirty-three items were classified as shipbuilding tools. These included three axe-heads, ten bores, seven knives, four awls, four chisels, one pick, one drill, and two saws. Tools like these would have been indispensable for shipbuilding. An additional find was a sharp iron tip that would have fitted on the end of a wooden pole. It is not clear what its use was, but appears to be a kind of spear. Five agricultural implements were found, including two sickles, two hoes, and a shovel. In addition, there were eight iron rings, four hooks, three reinforcement strips, two hoops, one butt end of a spear (*zun* 鎗), and one scoop.³¹ There were other miscellaneous objects whose use was not clear to the authors of the report, including a fork-shaped object, five U-shaped objects, one L-shaped object, and an object with a chain attached (See Figure 3.11). As with all the items found in the basin, some may have dropped into the basin at a later time, after the era of Treasure-ship construction. Therefore we cannot say conclusively that they all date from the time of the maritime expeditions.

Given the combination of objects used for shipbuilding and those used for agriculture and daily life that were found in the shipyard, the question arises whether the workers lived on or off site.

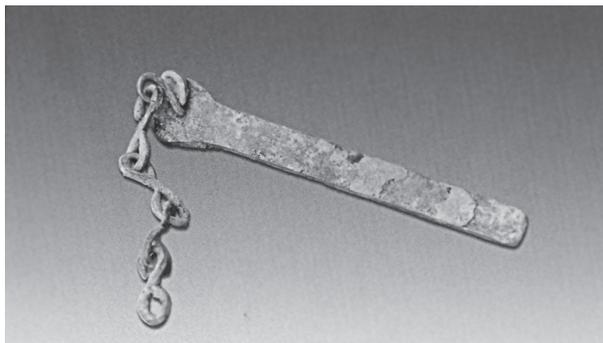


Figure 3.11 Object with chain. (Courtesy of Nanjing Municipal Museum)



Figure 3.12 Porcelain. (Courtesy of Nanjing Municipal Museum)

The agricultural implements may have been used by the workers for growing their own food, or for tending non-food crops, such as hemp plants and *tong* oil trees, which yielded products that could be used in shipbuilding (hemp and *tong* oil, or *tongyou* 桐油). In the case of the Longjiang Shipyard, according to the site maps, some of the land was for producing hemp and oil for shipbuilding. Other plots, called simply “people’s land” (*mindì* 民地), were probably used to grow fruits and vegetables.

Ceramics

A total of 355 ceramic items were found at the shipyard. Of these, 303 were porcelain, including small numbers with green, yellow, white, or brown glazes. The largest number (199) was of *qing* (青) porcelain, with 17 of *qinghua* (青花) and 9 of *qingbai* (青白). There were 68 *qing* bowls, four plates, one rice bowl, two glasses, two small plates, and one bowl on a tall pedestal (See Figure 3.12). One of the porcelain items was a weight used to sink a net (*wang zhui* 網墜).

In general, the ceramics found at the shipyard were rather crudely made. They were probably produced in kilns belonging to the common people and made for daily use. Some were inscribed on the bottom with names or numbers in black ink, but these seem to have been scribbled hastily, without great care. Some pieces were used for work purposes as well as for containing food: a small number of bowls contained left-over caulking material, which was probably mixed in the bowl and then applied to the ship from the hand-held bowl. This find is consistent with the archaeological report’s statement that most of the objects were for practical use, “having some relationship to the craftsmen’s work and life”.³²

Some of the pottery dates from a time after the maritime expeditions, i.e. from the mid- and late-Ming and even the Qing periods. Thus it is quite clear that, because the basins were open sites, these later pieces must have been dropped in after Zheng He’s expeditions were terminated in 1433.

Other Artefacts

A number of stone items were also unearthed at the site. The vast majority (70 out of 72) were stone balls (perhaps used as weapons) made from hard rock. They are grouped in the report by size. Most of the stone balls (55 out of 70) were between 84 mm and 108 mm in diameter. The largest was 148 mm in diameter, but this was the only one of its size. Six were between 113 mm and 132 mm in diameter, and another six were between 36 and 52 mm. There was an additional one of irregular shape. The other two stone items included one earth-pounding stone (*hangtou* 夯頭) and one stone with a hole and grooves in it of unknown function.³³

A total of fourteen bricks (*zhuan* 磚) were found at the site, including three showing signs of use for knife-sharpening.³⁴ In addition, there were three circular eave tiles (*wadang* 瓦當), one of which was decorated with an image of a lion with its mouth open, showing its teeth (See Figure 3.13).³⁵

Items made of coir (*zong* 棕) were more numerous, totalling 67. These included 64 pieces of rope, one rope mat, one shoe, and a palm-bristle brush with a wooden handle. Of the rope fragments, two were plaited and 62 were twisted using a method called “hemp-flower” (*mahua* 麻花). The longest rope found at the site was 12 m long. It was 78 mm in diameter and made with nine strands of palm. The thickest rope was 90 mm in diameter and made with twelve strands. It was 3.58 m long. The thinnest was 12 mm in diameter; it measured 1.24 m long and was made of three strands.

Four clumps of thoroughly hardened caulking material were also found. They were subjected to X-ray and infrared analysis to determine their composition, and the results are shown in Appendix 3 of the report.³⁶ They were found to contain calcium carbonate, montmorillonite powder, quartz, and feldspar. The largest was 296 mm x 208 mm x 172 mm, and the smallest was 212 mm x 180 mm x 144 mm.³⁷



Figure 3.13 Eave Tile. (Courtesy of Nanjing Municipal Museum)

Eight uniform squares of mother-of-pearl were among the most beautiful objects found at the site. It is not known what they were used for; perhaps they were decorations on a belt or some other item of clothing. They are all about 1 mm thick and range from 71 to 81 mm long and from 65 to 73 mm wide (See Figure 3.14).³⁸

Some Puzzling Omissions

Several items are puzzling for their absence from the shipyard finds. One is hemp, the material most commonly used for rope. Many fragments of coir were found but none of hemp. Perhaps, being a lighter material than coir, it simply did not survive. It is an essential material for making ropes, used extensively in sailing, and the *Shipyards Treatise* mentions it in all its discussion of materials. In fact, it is so important that it was one of two staple items grown on the shipyard site to save money because so much was needed. The other such staple item was *tong* oil. The quantities of these products required for each type of ship are given in Chapter 7 of the *Treatise*.

Another material conspicuous by its absence is *nanmu* (楠木). According to the *Longjiang Shipyards Treatise* this is the wood species used in greatest quantity for shipbuilding, with fir coming second. However, the archaeological report does not record a single piece of *nanmu* having been found in Basin 6. Most of the wood found there was *Cunninghamia lanceolata*.

No so-called “treasures” were found at the Treasure Shipyards, though this is not particularly surprising. Presumably if there had been any gifts from overseas left on the site — which is doubtful because they would have been delivered as presents or tribute to the emperor — they would have been kept in the treasury at the Treasure Shipyards. We know that there had been a treasury because of a passage in the *Longjiang Shipyards Treatise*, which says that by its time of writing in 1553, the “treasury for keeping valuables” (*bao ku* 寶庫) was completely



Figure 3.14 Mother of Pearl. (Courtesy of Nanjing Municipal Museum)

overgrown with weeds. The passage reveals that two men were regularly sent from the Longjiang Shipyards to guard the grounds of the Treasure Shipyards, which were so deserted that the men spent the time gambling, for lack of anything else to do.³⁹ This is an eerie image of a once glorious but now vacant site. Any remaining treasures in the treasury must have been looted from the site long ago.

There were also no military weapons included in the report of the excavation. The only finds that might be considered military in nature are the round stone balls and the single *zun*, or butt end of a spear. Since the voyages were partly of a military nature, and the ships were known to have been armed, it is slightly surprising to find no more than this. Perhaps there were more at some point and these were looted as well.

III. The Longjiang Shipyards and the Textual Evidence

Chapter 4 of the *Longjiang Shipyards Treatise* is the best source of information on the infrastructure of the shipyard because it concerns the physical plant of the site. Entitled “The Construction Site” (*jianzhi zhi* 建置志), it gives the history of the site, as well as some description, and the two site maps mentioned above. The maps are particularly informative. One is an overall map of the site and the other is a close-up plan of one of the building complexes, called the Branch Office of the Ministry of Works (*gongbu fensi* 工部分司, often referred to *fensi* 分司). This was one of the main administrative offices of the shipyard. The features of the shipyard site shown in these two plans fall into four main categories: facilities used for the construction of the ships themselves, administrative offices, features of the internal geography of the shipyard, and landmarks indicating the wider geographical context of the site. I shall discuss the various features within these categories below.

Ship Construction Facilities

The shipyard contained separate workshops for activities directly involved in shipbuilding, such as sail-making, metal-working, caulking, fine carpentry, rope- and cable-making and painting. Some are indicated on the overall map, others are shown on the close-up map and still others are mentioned in the text of Chapter 4 but not shown on either of the maps. On the overall map are what look like single buildings, named “sail-making workshop” (*peng chang* 蓬廠), “caulking workshop” (*nian zuofang* 艚作房), and “iron workshop” (*tie zuofang* 鐵作房). On the Branch Office map there are a “cabinet (fine-woodworking) workshop” (*xi mu zuofang* 細木作房), a “painting workshop” (*youqi zuofang* 油漆作房), and a “ceramics studio” (*jingtao zhai* 景陶齋).

The verbal descriptions of these workshops, which occur at the end of the chapter, indicate that in some cases these are not single buildings but multiple ones. Depending on how one interprets the word *jian* (間), however, these could be seen as multiple buildings or multiple rooms in single buildings. Their location and size are both mentioned in terms of numbers of *jian*. For instance, the sail-making workshop is said to have been in the northern part of the Branch Office complex, and to consist of ten buildings joined together (*fang shi lian* 房十連). An interlinear comment says that this is calculated to equal 60 rooms (*jian*). The use of the word “calculated” suggests that the word *jian* should be taken as a measure-word indicating room size; one *jian* was probably about 6 feet long.⁴⁰ This would mean that the sail factory was located in a building that was 360 feet long.

The passage also says that there were six carpentry workshops (or one, of six rooms) in the southwestern part of the Branch Office complex, four painting workshops (or one, of four rooms) in the northwestern part of the complex, three caulking workshops (or one, of three rooms) in the northern part, and four iron workshops (or one, of four rooms) beyond the road that goes northwest (*xibei lu* 西北路) of the Supervisorate Office (*tijusi* 提舉司). Also mentioned are *peng zuofang* (蓬作房), probably the same as the sail-making workshops mentioned above, “rope-making workshops” (*suo zuofang* 索作房), and “cable-making workshops” (*lan zuofang* 纜作房). The last three, according to Li Zhaoxiang, were all in ruins by 1553. In addition, there was a “material checking house” (*kan liao pu she* 看料鋪舍), perhaps for inventory or some other inspection activity, at the intersection of the roads in the rear half of the shipyard.⁴¹ This may be the same as the Material Observation Station or Patrol Office (*xunshe*) indicated on the overall plan and mentioned above.⁴²

Certain fields can also be considered part of the shipbuilding infrastructure because they were essential for growing such items used in shipbuilding as *tong* oil and hemp for caulking and rope-making. There were fields for these products (oil and hemp fields or *you ma tian* 油麻田), and ponds or pools for them (*you ma tian tang* 油麻田塘), as well as storage areas for these products (*youma di* 油麻地). Stands of bamboo had been planted within the shipyard, and may have fulfilled some of the ships’ requirements for bamboo, which were extensive.⁴³

Administrative Offices

Being an official himself, Li Zhaoxiang was preoccupied with the administrative operation of the shipyard. There were many sites within the shipyard that had an administrative function, particularly the buildings and office complexes. These captured his attention and were included on the site maps. They included the Branch Office of the Ministry of Works (*fensi*), the offices of the Supervisorate (*tijusi*) and Vice Supervisorate (*fu tijusi* 副), the Navy Coordination Command Station (*banggong zhilui ting* 幫工指揮廳),⁴⁴ the Material Observation Station (*xun she* 巡舍, also called the Patrol Office), the Main Administrative Office (*shuiheng bieshu* 水衡別署), the Control Office for Supervision of Craftsmen (*jiandu* 監督) and the Control Office for Supervision of Officials (*sheng shi* 省試). Li’s interest in administration is also shown in the inclusion of the separate close-up plan of the Branch Office, where Li must have had his office. Various other offices and halls are shown on the maps, as well as a library (*wenshu fang* 文書房).⁴⁵ The number and variety of different military and civilian offices show how many official institutions were involved in the operation of the shipyard and the complexity of its governance.

The Internal Geography of the Shipyard

Apart from the administrative buildings and complexes, and the buildings and other spaces used directly for shipbuilding, a number of other features are shown on the maps, which are part of the internal geography of the shipyard. These include roads, bridges, gates, walls, fences, canals and waterways, wells, additional fields, gardens, and a temple. The maps show an approach road (not labelled),⁴⁶ a Ring Road (*xungeng lu* 巡更路) around the shipyard, large and small pontoon bridges (*fujiao* 浮橋), the Main Gate (大門 *da men*), the Ceremonial Gate (*yi men* 儀門), the Approach Control Station (*Longjiang chang* 龍江廠),⁴⁷ a Side Gate on the Ring Road,⁴⁸ the outer wall surrounding the shipyard (*wei qiang* 圍牆),⁴⁹ the northern and southern branch canals (*shui ci* 水次), and the northern and southern water gates (*bei/nanmian*

shuiguan 北/南面水關). These canals and water gates may suggest what the gates in the Treasure Shipyard leading to the Yangzi River were like.

Other features marked on the maps include a well (*jing* 井) on the overall map, the pools or ponds for soldiers and civilians (*jun min tang di* 軍民塘地, abbreviated as *mind* 民地), and something called “old land” (*jiu di* 舊地), about which nothing is known.⁵⁰ There were also some fields (*tian* 田), which must have been for general farm use, in contrast to the dedicated oil and hemp fields mentioned above. The close-up map also shows the east garden (*dongpu* 東圃) and the west garden (*xiyuan* 西園), which were perhaps for fruits and vegetables. There are also some areas where willows and bamboo were planted. The willow trees may have been purely for coolness in summer and to prevent erosion; they may also have provided material for basket-weaving. Waterways were necessary for transporting materials as well as completed ships, and roads were also needed for conveying people and materials, as well as for communication with the rest of the city. Finally, the close-up map also shows a Temple to the Soil God (*tudi ci* 土地祠). Mentioned in the text but not shown on the map are a fence (*mu zha* 木柵) and a pond in front of the Branch Office. The front and rear halves of the shipyard are also indicated on the overall plan. Each of these areas had its own waterway leading to the river, and its own water gate.⁵¹

Landmarks Indicating the Wider Geographical Context

Several features on the map are included for the purpose of orienting the viewer and setting the shipyard in the wider context of the city. These features have been used to locate the shipyard. They include the city wall (not labelled on the map, but shown clearly on the left-hand side of the overall map), the city moat (*chenghao* 城濠) between the edge of the shipyard and the city wall on the northeast side, Qinhuai street (*Qinhuai jie* 秦淮街), labelled “the road leading to Yifeng gate and Lulong mountain (盧龍山)”, and two outlying hills, Ma’an shan (馬鞍山) and Guabang shan (掛榜山).

It is important to note that, as mentioned above, the map as pictured in the *Treatise* is oriented to face south or southeast. Therefore the city wall, which is actually on the northeastern side of the shipyard, is shown on the left-hand side of the map. The place where the Qinhuai River meets the Yangzi (*Qinhuai tong jiang* 秦淮通江) is also marked on the overall plan. The position of this conjunction on the map strongly suggests that the shipyard was north of the Qinhuai, near the point where it joins the Yangzi River.

Omissions from the Treatise

Several items are conspicuous for their absence from the *Treatise*. No specific location for processing or storing wood is shown on the map. This appears to be a serious anomaly, as cutting and working with large pieces of wood were essential to the operations of the shipyard. (The cabinet-maker’s workshop was woodworking on a different scale.) In the other chapters of the *Treatise*, there are copious references to wood and woodworking (*mu zuo* 木作); in fact wood seems to have been the most important material in the shipyard, heading the list of items required for shipbuilding in Chapter 5 as well as the more detailed quantities of materials used for the ships in Chapter 7. Woodworking is also listed as the first set of tasks in the calculations of work units required for shipbuilding in Chapter 7. Perhaps it was left off the map because it was so obvious and ubiquitous, or perhaps woodworking was done out-of-doors and not confined to any particular building. There is only one oblique reference to the storage of wood in an unused sail-making workshop (*peng zuofang*):

The sail-making workshop was located north of the Branch Office. In past years it was where the sails (feng peng 風蓬) were made for the ocean-going ships.⁵² It consisted of ten buildings joined together. It was used to store shipbuilding materials (liao 料). Today it is all in ruins. Only the walls still exist. Old planks from broken-up ships are piled up in the centre, and since there is no roof over it, the planks have become rotten over time. This building was probably constructed to house the work of the shipyard that could not be completed.⁵³

One therefore suspects that this long, narrow building may have been a place to store wood for shipbuilding.

There is also a striking absence of any reference to large engineering equipment — tools, dereks or cranes, ladders, and so forth. Perhaps as a scholar-official, and not an engineer himself, the author simply did not pay attention to such equipment. However, as he writes in such detail about other somewhat technical matters, this omission is still surprising. It is possible that there was no such heavy equipment, and that there was only scaffolding on which the workers climbed to reach higher areas of the ships.

The fact that there were at one time storage facilities for treasures brought back from overseas supports the view that the Treasure Shipyard was located on a different site from the Longjiang Shipyard, as does the passage quoted above about the soldiers sent to guard the Treasure Shipyard.

Timeline of Events in the Development of the Longjiang Shipyard

The timeline given below, is compiled from the information given in Chapter 4 concerning the history of the site, as well as information from Chapter 3, “Officials and Other Employees” (*guan si zhi* 官司志), on the personnel who were employed there.

- ca. 1368 The Longjiang Shipyard was built in the northwestern part of the capital city of Nanjing. This was an area with many rivers, therefore ships were very important. This is why the Supervisorate was established. There were two officials plus a clerk in charge. Later, the shipyard became subordinate to the Water Ministry (*shuibu* 水部).
- pre 1465 The burning of documents.⁵⁴
- ca. 1465 The Branch office of the Ministry of Works was first built; it was located in the east and faced west, and there was a pool or pond in front of it.
- 1491 Wang Huan (王環) built a fence encircling the two halves of the shipyard to make the perimeter secure. Water gates were built to allow easy access in and out, and make it convenient for the guards.
- 1519 Bureau Secretary Wang Wei (王煒) had three rear halls built, with left and right wings, as dormitories for workers; Head of the Supervisorate Guo Yanshi (郭彥實) had the building complex refurbished.
- 1528 Bureau Secretary Fang Peng (方鵬) built a Ceremonial Gate and three *paifang* (memorial gateways 牌坊), labelled “Branch Office” for the middle one, “Supervision of Grounds” (*jianmu* 監牧) for another, and “Supervision of Construction” (*duzao* 督造) for a third.
- 1536 Wang Li (王利) built the Branch Office for the Ministry of Works at the intersection of the roads in the northwest. A new road, paved with bricks, was 360 *zhang* long.
- 1537 Head of the Supervisorate Liu Zizhen (劉子貞) rebuilt the Ceremonial Gate and dormitories at the rear of the Hall.
- 1538 Zhang Han (張瀚), Bureau Secretary, built the drum towers (*genglou* 更樓) at the left and right corners of the gate.
- 1543 Head of the Supervisorate Zou Heng (鄒亨) set up a stele praising his predecessor.

- 1547 Qiu Yan (裘衍), Bureau Secretary, built Xikan Hall (*Xikan tang* 希侃堂) north of the Ceremonial Gate, and the Grain Hall (*Guting* 穀亭) on the left side of that hall. The Xikan Hall was built as a summerhouse. Head of the Supervisorate Zou Qiong (鄒瓊) built a house with three small rooms on the site of the old Officers’ Drawing Room (幕廳). Behind the office was a site for storing oil and hemp. There were eight storehouses on each side, left and right, but the storehouses were in ruins by 1553.
- 1549 All the buildings were burned down except for the Xikan Hall. The latter’s name was changed to Jingtao studio (*Jingtao zhai* 景陶齋).
- 1551 When Li Zhaoxiang took over in 1551, the Branch Office was overgrown with weeds because there had been a fire and it had burned down.
- 1552 Li Zhaoxiang rebuilt the Branch Office, modifying it to face south; Head of the Supervisorate Gong Ji (龔佶) rebuilt the eight storehouses. Behind the storage site were the rooms of the Head and Assistant Head. In Li’s day they were all abandoned, and only their outer structure remained.
- 1552 There was a fire in the old buildings where the painting workshops had been, as well as in the Branch Office. These were rebuilt in the same year.

IV. Conclusion

The two types of evidence relating to the shipyards, textual and archaeological, seem to complement each other to a large extent. Some of the textual evidence relating to the Longjiang Shipyard fills in the gaps created by the lack of documentary evidence for the Treasure Shipyard. The land between the waterways shown in the site maps of the *Treatise* seems to have been divided into fields for growing food and other products, as well as workshops, administrative buildings, gates, a well, roads, and so forth. These various facilities suggest the type of infrastructure that may also have been present in the Treasure Shipyard. The land between the basins in the Treasure Shipyard may have been used as work-space for shipbuilding, or as agricultural land for the cultivation of plant products for use in the shipyard, such as *tong* oil and hemp, or for growing fruits and vegetables for the workers and officials to eat. There may have been small ponds for stocking fish. There were probably also offices for the supervisors and inspectors who conducted the administrative operation of the shipyard, as well as workshops for the various activities involved in shipbuilding.

The land could also have been used for residences for the workers and/or officials. The *Treatise* mentions dormitories being built for the workers, though it also mentions that at least one group of workers lived off-site in a residential area nearby. Perhaps there was a combination of the two — some living on site and some off site.

Although the water gates leading from the Treasure Shipyard to the Yangzi River do not survive, those pictured on the plans of the Longjiang Shipyard suggest what they might have been like. The images of the ships lying in the waterways in the *Treatise* are also suggestive; if the Treasure Ships were much smaller they could have been arranged that way, some lengthwise along the basin and some crosswise. If the Treasure Ships were of the gigantic size mentioned above, or even half that size, they would have been too large to fit any way but lengthwise. It is hoped that further excavation at the Treasure Shipyard may yield more evidence of its infrastructure.

Some of the archaeological evidence also helps to flesh out the textual description and maps of the Longjiang Shipyard. The iron workshops may have produced pieces of iron like those found in the Treasure Shipyard, and the ceramic workshops may also have turned out items similar to those found at the site. The clumps of caulking material found there give tangible reality to the caulking workshop referred to in the *Treatise*, as does the porcelain bowl found still to contain caulking material in it. The latter shows the use of ceramic bowls for work purposes. The ceramic objects may have been produced in a workshop like the Jingtao studio in the *Treatise*. The joinery methods, the writing on wood and ceramics, and decorations are all highly suggestive of what may have been used in the Longjiang Shipyard. In fact, the evidence of each shipyard is evocative of the other.

Neither archaeological nor written sources are totally reliable or complete. Both provide only partial evidence. However, they both suggest certain minimum characteristics of the infrastructure of shipyards in the early Ming period can thus be perceived. Shipyards required proximity to a river bank or large body of water so the completed ships can be removed; they require a means to move the ships from the dockyard into the nearby waterways; water in which to build and manoeuvre ships, irrigate fields, provide drinking water and perhaps fishing stocks, and which provides a means of communication within the shipyard and with the outside world, for delivery of supplies, and for other uses during shipbuilding work; roads for the delivery of supplies; land on which to work, for the various tasks necessary for shipbuilding; land on which to store items for future use; land for administration buildings that supervise the workers,

supplies, and products; and land for growing crops for food. With both types of sources present for the two shipyards of this geographical area and time period, a significant amount of information about their infrastructure is now available.

Notes

This research was undertaken with the assistance of funding from the Golden Web Foundation. I would like to thank Richard Barker for his advice on numerous points, and Shunyi Tan for his help with the Chinese text of the *Longjiang Shipyard Treatise*. Any errors that remain are my own. Shunyi Tan and I are currently preparing a critical edition of the *Treatise* in English.

- 1 Nanjing Municipal Museum. (2006). *Baochuan chang yizhi: Nanjing Ming Baochuan chang liu zuotang kaogu baogao (Ming Dynasty Baochuanchang Shipyard in Nanjing 寶船廠遺址: 南京明寶船廠六作塘考古報告)*. Wenwu, Beijing. I have published reviews of the shipyard excavation report in *Archipel* 74. (2007): 261-265, and in the *International Journal of Nautical Archaeology*, Vol. 37, No.1. (March 2008): 198-200. I am grateful to the Museum for letting me publish the illustrations for this report.
- 2 Li Zhaoxiang. (1553). *Longjiang Shipyard Treatise*, Chapter 4: 97. References to this work are from the modern edition edited by Wang Lianggong 王亮功. (1999). *Treatise of the Longjiang Shipyard (Longjiang chuanchang zhi 龍江船廠志)*. Nanjing, Jiangsu guji chubanshe. See also the facsimile edition, *Xuanlantang congshu xuji 玄覽堂叢書續集*, vol. 117.
- 3 Nanjing Municipal Museum 2006: Colour Photo 1.
- 4 Nanjing Municipal Museum 2006: 1-3.
- 5 Hans Lothar Scheuring. (1987). *Die Drachenfluß-Werft von Nanking: Das Lung-chiang ch'uan-ch'ang chih, eine Ming-zeitliche Quelle zur Geschichte des chinesischen Schiffbaus*, Heidelberger Schriften zur Ostasienkunde, Band 9. Frankfurt/Main, Haag und Herchen: 114-115. When Scheuring was there in the 1980s, the extant basins were numbered from north to south as follows: 7, 3, 2, 1, 4, 5, and 6: 114, and map: 116. He refers to an article by Hong Changzhuo 洪長倬 entitled “Baochuan chang yizhi ji baochuan chidu wenti” 寶船廠遺址及寶船尺度問題, in *Jinian weida hanghaijia Zheng He Xia Xiyang 580 zhounian choubei weiyuanhui 紀念偉大航海家鄭和下西洋五百八十周年籌備委員會, Zheng He Xia Xiyang lunwenji 鄭和下西洋論文集*. (1985). Vol. 2. Nanjing, Nanjing University: 37-49.
- 6 Nanjing Municipal Museum 2006: 1-3.
- 7 The textual evidence consists of a few scattered sentences here and there and one image on a map.

- These include Gu Qiyuan's 顧起元 *Kezuo zhuiyu* 客座贅語 (1618), and the "Mao Kun Map", folio 1. The name of this map was coined by J. V. G. Mills because the map was found in the *Wubei zhi* 武備志, published by Mao Yuanyi 茅元儀 (1594–1641), who was Mao Kun's 茅坤 (1511–1601) grandson. The map dates from 1621, but it is thought probably to have been derived from a map from around the time of the voyages. See J. V. G. Mills. (ed. & trans.). (1970). *Ying-yai sheng-lan. The Overall Survey of the Ocean's Shores [1433]*, Hakluyt Society Extra Series 42. Cambridge, England, Cambridge University Press.
- ⁸ Scheuring, 1987. *Die Drachenfluß-Werft*: 104–124. Scheuring summarises the controversy surrounding the shipyard's location, concluding that it was north of the Qinhuai river, near its conjunction with the Yangzi. He pointed out that the plans have to be turned 200 degrees for north to be at the top, although 180 degrees seems to be sufficient.
- ⁹ Kwan-Wai So. (1975). *Japanese Piracy in Ming China during the 16th Century*. Lansing, Michigan, Michigan State University Press: 2–3.
- ¹⁰ Li Zhaoxiang 1553. Chapter 3: 92. For a discussion of the policy of the period, see Lo Jung-pang. (1958). "The Decline of the Early Ming Navy." *Oriens Extremus* 5.2.
- ¹¹ For references to these numbers, see Sally K. Church (2005). "Zheng He: An Investigation into the Plausibility of 450-ft Treasure Ships." *Monumenta Serica*, Vol. LIII: 1–42.
- ¹² The complete reference for the report is given in the first footnote to this paper.
- ¹³ For example, see Peter H. Spectre, and D. Larkin (1991). *Wooden Ship: The Art, History and Revival of Wooden Boatbuilding*. Boston: Houghton Mifflin; Ole Crumlin-Pedersen. (1997). *Viking-Age Ships and Shipbuilding in Hedeby/Haithabu and Schleswig*. Schleswig & Roskilde: The National Museum of Denmark & the Viking Ship Museum.
- ¹⁴ Sally K. Church (2008). "The Ming Treasure Shipyard Archaeological Report" in S. Langley & V. Mastone (eds.). *ACUA Underwater Proceedings 2008*, Advisory Council on Underwater Archaeology. Columbus, Ohio: PAST Foundation: 30–38.
- ¹⁵ Nanjing Municipal Museum 2006: 78.
- ¹⁶ Nanjing Municipal Museum 2006: 54–57.
- ¹⁷ Nanjing Municipal Museum 2006: 57–78. This makes a total of 219 items. In examining the report, I often find that the totals of the individual items often do not exactly match the totals given of the larger categories, although the discrepancy is not usually large. The difficulty of counting small fragments of materials can explain this discrepancy.
- ¹⁸ Nanjing Municipal Museum 2006: 66–67.
- ¹⁹ Sally K. Church (forthcoming). "How Long is a Foot: The Size of the Ships used on China's 15th-century Maritime Expeditions." Proceedings of the Asia-Europe Workshop on Medieval Wooden Ships in Portugal, April 2008.
- ²⁰ Nanjing Municipal Museum 2006: 78–95.
- ²¹ Nanjing Municipal Museum 2006: 95.
- ²² Nanjing Municipal Museum 2006: 111, Fig. 58; Black & White photos 19-1, 19-2.
- ²³ Nanjing Municipal Museum 2006: 63, Fig. 38, BZ6: 30.
- ²⁴ Nanjing Municipal Museum 2006: 121, Rubbing 6, BZ6: 250, 207.
- ²⁵ Nanjing Municipal Museum 2006 Colour Plate 21 [XII], BZ6: 30.
- ²⁶ Zhou Shide 周世德. (1962). "Cong Baochuanchang duogan de jiangding tuilun Zheng He baochuan" 從寶船廠舵杆的鑑定推論鄭和寶船. *Wenwu* 文物 No.3: 35–40.
- ²⁷ It seems correct to assume that a stern mounted rudder was used, partly because of tradition, and partly because the illustrations associated with the voyages indicate this type of rudder system. See those that accompany *Taishang shuo Tianfei jiuku lingying jing* 太上說天妃救苦靈應經, a religious text dating from 1420, the "ocean-going ship" (*haichuan* 海船) pictured in Chapter 2 of the *Longjiang Shipyard Treatise*, and the four "stellar diagrams" that occur at the end of the "Mao Kun map". While these are not technical drawings, they give an indication that the ships used this type of rudder. See Jin Qiupeng 金秋鵬. (2000). "Qijin faxian zuizao de Zheng He xia Xiyang chuandui tuxiang ziliao — Tianfeijing juanshou chatu" (The Earliest Hitherto Discovered Illustration of Zheng He Going to the South Seas in the Sutra on the Celestial Spouse 迄今發現最早的鄭和下西洋船隊圖像資料 — 《天妃經》卷首插圖). *Zhongguo keji shiliao* 中國科技史料 21(1): 61–64. See also Mao Yuanyi 茅元儀. (1989). *Wubei zhi* 武備志, 51 vols. (facsimile of the 1621 edition), j. 240, in *Zhongguo bingshu jicheng* 中國兵書集成. Beijing: Jiefangjun chubanshe. Vols: 27–36. The map is in vol. 36: 10388–10431 of this collection. It is also found independently in Xiang Da 向達. (1961). *Zheng He hanghai tu* 鄭和航海圖. Beijing: Zhonghua shuju.
- ²⁸ Thomas Hoppe. (2008) "Mainland China: Revival of the Junk." <http://thomashoppe.net/work/junks/luemeimao.php>, accessed 27 November 2010.

- ²⁹ Nanjing Municipal Museum 2006: 129-130.
- ³⁰ Nanjing Municipal Museum 2006: 239-251.
- ³¹ Nanjing Municipal Museum 2006: 169-174.
- ³² Nanjing Municipal Museum 2006: 190.
- ³³ Nanjing Municipal Museum 2006: 205-208.
- ³⁴ Nanjing Municipal Museum 2006: 208-209.
- ³⁵ Nanjing Municipal Museum 2006: 210.
- ³⁶ Nanjing Municipal Museum 2006: 256-257.
- ³⁷ Nanjing Municipal Museum 2006: 217.
- ³⁸ Nanjing Municipal Museum 2006: 216, Fig., 109.
- ³⁹ Li Zhaoxiang 1553: Chapter 3: 93.
- ⁴⁰ This is a tentative estimate of the length based on one definition of *jian* found in Morohashi's dictionary, where it says that one *jian* in Japan was 6 feet long. Morohashi Tetsuji 諸橋轍次. (1960). *Dai Kanwa jiten* 大漢和辭典. Tokyo: Taishukan.
- ⁴¹ The shipyard had previously been divided into front and rear halves (*qian/hou chang* 前/後廠).
- ⁴² Scheuring 1987. *Die Drachenfluß-Werft*. Karte II, No.29: 92.
- ⁴³ Chapter 7 provides lists of all the materials required for shipbuilding and their amounts for each type of ship. Bamboo is one of these, in several varieties.
- ⁴⁴ This is said to have been in the northeastern corner of the yard. It faced west, and the front and rear each had 3 rooms, with wings on the left and right. If one follows Mark Elvin, it would be called the "Command Office of the Military Tithing Soldiers". See Mark Elvin. (1969). *The Ming Tribute Grain System*. Hoshi Ayao 星斌夫 (trans). *Chugoku shakai keizai shi goi* 中國社會經濟史語彙. Michigan Abstracts of Chinese and Japanese Works on Chinese History, No.1, Center for Chinese Studies, University of Michigan. Michigan, Ann Arbor.
- ⁴⁵ For instance, there are the Main Hall (*zheng ting* 正廳), the River Hall (*chuan tang* 川堂), and the Rear Hall (*hou tang* 後堂), as well as the Liyin tang 吏隱堂 in the close-up map of the Branch Office.
- ⁴⁶ This is listed in Scheuring's work as No.16 on the overall map. See Scheuring 1987. *Die Drachenfluß-Werft*. Karte II: 92.
- ⁴⁷ This name is very difficult to read in all the editions I have examined. I am following Scheuring here, but unfortunately he does not give the Chinese characters. It is No.18 on Scheuring's overall map, Scheuring 1987. *Die Drachenfluß-Werft*. Karte II: 92.
- ⁴⁸ I am following Scheuring here in calling it the Side Gate, because I'm unable to decipher the Chinese on the map in any of the editions I have examined. It is at No.16 on the close-up map. Scheuring 1987. *Die Drachenfluß-Werft*. Karte III: 93.
- ⁴⁹ This outer wall is marked only on one side of the overall map, Karte II, No.33, on the side nearest the moat and the city wall. Scheuring 1987. *Die Drachenfluß-Werft*: 92.
- ⁵⁰ This site on the map is not listed by Scheuring.
- ⁵¹ One can tell that each had its own waterway and water gate from the map.
- ⁵² It is not entirely clear whether the text is referring to Zheng He's ships or to ocean-going grain transports, as the latter were also discontinued after the Grand Canal opened in 1411, when grain ceased to be transported by sea and was transported solely inland, via canal. Lo Jung-pang, "Decline of the Ming Navy": 160.
- ⁵³ Li Zhaoxiang 1553: Chapter 4: 106.
- ⁵⁴ It is an interesting question whether this burning of documents, dated before 1465, was the same destruction of documents attributed to Liu Daxia 劉大夏, which supposedly took place in the Chenghua period (1465-1487). It seems to be a different occasion. J. J. L. Duyvendak translates the account of the documents' demise that appears in Yan Congjian's 嚴從簡 *Shuyu zhousi lu* 殊域周恣錄 of 1574, rpt. *Zhongwai jiaotong shiji congkan* series. (1993). Vol. 13 (Beijing: Zhonghua shuju): 307-308. See Duyvendak. (1938). "The True Dates of the Chinese Maritime Expeditions in the Early Fifteenth Century", *T'oung Pao* 34: 341-412, esp. 395-396. The historian Gu Yingtai 谷應泰 (1620-1690) in *Mingshi jishi benmo* 明史紀事本末 (1658; rpt. Beijing Zhonghua shuju, 1977): 362, gives the date of the destruction of documents that related to the Annam campaign as 1480, and it is often claimed that Liu Daxia burned those relating to Zheng He's maritime expeditions at the same time. However, we have no hard evidence for this destruction other than Yan Congjian's discussion. Some scholars think that the only documents destroyed were those relating to the Annam campaigns. See Lo Jung-pang, "Policy Formulation and Decision-Making on Issues Respecting Peace and War", in Charles O. Hucker. (1969). *Chinese Government in Ming Times: Seven Studies*. New York: 41-72, esp. 62-63, n. 79. Tang Zhiba 唐志拔 suggests that the fire in the archives may have been the same one recorded in the *Ming Shilu* 明史錄 of 14 Jan 1482, which took place in the Nanjing Ministry of Works. See Tang Zhiba 唐志拔, "Zheng He baochuan chidu zhi wo jian" 鄭和寶船尺度之我見, in *Zheng He yanjiu* 鄭和研究 47 (2001) 2: 26-32, esp. 27-28, reprinted in *Chuanshi yanjiu* 17 (2002): 21-27.