

RESEARCH ARTICLE

Sailing the Waters of East and Southeast Asia: Chinese Navigators and their Material and Mental Tools

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Abstract

In the early modern period, the waters of East and Southeast Asia saw a bustling maritime trade. To conduct this trade, ships needed competent sailors to safely travel between ports. Chinese sources name one person as particularly important: the *huozhang* 火長. The sources tell us that the *huozhang* were charged to use the compass and, employing sailing manuals, to guide ships in the correct direction. In this role, they had to work closely with other sailors, such as *duogong* 舵工 (steersmen). This article reconstructs the role and function of the navigating personnel on Chinese ships, as well as the tools they used to determine course in the period between the fifteenth and eighteenth century.

Keywords: Ming; navigation; maritime history; compass

Introduction

To sail a ship safely, a whole crew works together: someone needs to decide where to go, others need to operate the rudder, and yet others have to work the sails. Each of these people has a specialized skill set and each of them works with a specific set of tools. Early modern Chinese sources suggest that one of the most important roles aboard a ship was that of the *huozhang* 火長 (literally: “fire chief”; also written as *huozhang* 夥長, literally: “group chief”), whom we can identify as the navigator or pilot of a ship, but who also performed other duties.¹ *Huozhang* worked closely together with the people operating the rudder, the *duogong* 舵工 (steersmen), and their presence is attested for a range of different voyages. They accompanied Zheng He 鄭和 (1371–1433) in the early fifteenth century into the Indian Ocean, manned ships that carried Ming and Qing envoys from Fuzhou to the capital of the Ryukyu Kingdom, Naha, and took an active part in trading voyages in East and Southeast Asia. They were essential crew members, working together with other personnel on the ships.

¹Use of the characters 夥長 instead of 火長 is particularly widespread in the sources dealing with navigation between Fujian and Naha and the navigation to Japan.

Only few studies so far have considered the composition of Chinese ship crews.² Previous studies have acknowledged the importance of *huozhang*, but with few exceptions have not investigated the actual role of the *huozhang*.³ In the most detailed study so far, Liu Yijie summarizes sources showing that *huozhang* were essential personnel in charge of the compass.⁴ However, research is still lacking concerning the question of how *huozhang* fit into the general composition of the crew and how their sailing practices related to the tools they had available. One difficulty in studying Chinese sailing practices is that most Ming and early Qing sources were written by scholars with little reason to know much about maritime matters. Even sources that *huozhang* might have used were often preserved through the hands of scholars. We therefore have no document from early modern China that is directly linked to a *huozhang*. The consensus so far, based on these sources written by Ming and Qing scholars, is that sailing manuals, also known as rutters or *zhenjing* 針經 (literally: needle texts) in Chinese, enabled *huozhang* to safely find routes between harbors in connection with the compass. However, when reading the Chinese sources more closely and supplementing it with material evidence and considerations of practical navigation and of the composition of the crew, a more complicated picture emerges: the duties of *huozhang* went beyond simply navigating. Based on these considerations, this article therefore aims to examine the details of the role and technique of *huozhang* and the implications this has for our understanding of sailing practices by Chinese navigators in the period between the fifteenth and early eighteenth centuries.

Many People Sail a Ship

Multiple sources from the fifteenth to the eighteenth century list the types of personnel necessary to sail a ship. These include texts written in connection with the early fifteenth-century voyages of Zheng He to the Indian Ocean, records on Fujianese trade, records of missions between Fuzhou and Naha, and military records. Understanding these lists comes with problems. Terms might not be clear or easy to render into English, as many of the terms are part of a specialized nautical vocabulary. Nevertheless, the personnel lists do provide a glimpse into the composition of ship crews. To avoid associations with the terminology of European ship crews, in which duties were divided differently, I will use

²Paola Calanca briefly discusses the composition of early Qing period crews: Paola Calanca, *Piraterie et contrebande au Fujian: L'administration chinoise face aux problèmes d'illégalité maritime* (Paris: Les Indes savantes, 2011), 245–55. Nanny Kim has conducted such a study for boatmen on rivers in a period later than this article considers; see Nanny Kim, *Mountain Rivers, Mountain Roads: Transport in Southwest China, 1700–1850* (Leiden: Brill, 2020), 144–85. Zhang Xinyun and Wang Xiangsheng provide a short overview comparing the management of the ship crew on Qing and American vessels; Zhang Xinyun 张忻昀 and Wang Xiangsheng 汪祥胜, “Qingdai Zhongguo yuanyang shangchuan chuanyuan zhiwu tixi tanxi (1644–1840): Jian yu Meiguo yuanyang shangchuan chuanyuan zhiwu tixi bijiao” 清代中国远洋商船船员职务体系探析 (1644–1840)——兼与美国远洋商船船员职务体系比较, *Zhongguo shuiyun* 中国水运, no. 10 (2023): 44–47.

³E.g. Guo Yongfang 郭永芳, “Zhongguo gudai de diwen daohang” 中国古代的地文导航, in *Zhongguo hanghai keji shi* 中国航海科技史, ed. Zhang Xun 章巽 (Beijing: Haiyang chubanshe, 1991), 234–35. Takase Kyōko looked into the role of *huozhang* aboard ships sailing to Ryukyu: Takase Kyōko 高瀬恭子, “Rekidai hōan dai isshuu ni okeru kachō ni tsuite” 歴代宝案第一集における火長について, *Tōnan Ajia: Rekishi to bunka* 東南アジア: 歴史と文化, no. 12 (1983): 61–90.

⁴Liu Yijie 刘义杰, “‘Huozhang’ bianzheng” “火长”辨正, *Haijiaoshi yanjiu* 海交史研究, no. 1 (2013): 56–78.

either literal translations or the Chinese transcription of the job titles mentioned in the sources.

In particular, the records made in connection with Zheng He provide a wealth of information. One source includes a list of the type of crew members, and another a record of rewards for outstanding service after the voyages, giving job titles and the amount of compensation.⁵ Featuring prominently on both lists are military personnel, doctors, interpreters, and *huozhang*. There were even two types of *huozhang*, foreign (*fan huozhang*) and presumably “Chinese” *huozhang*, in line with the widespread practice in the Indian Ocean of hiring navigators from various locations. The foreign *huozhang* received compensation on the level of imperial doctors, much more than the other *huozhang*, who received the same as ordinary soldiers and interpreters. The source gives no indication as to why the foreign *huozhang* were singled out. The lists mix personnel needed for sailing (*huozhang*, sailors, steersmen), personnel vital for the mission (translators, military personnel), and personnel needed to keep the ship running (carpenters, doctors). The lines between these categories were certainly murky. Translators might also have been vital to keep the ship sailing: they could facilitate communication between *huozhang* and foreign *huozhang*, for example. Not all the personnel listed were directly necessary to sail the ship, but they were certainly essential for the success of the voyage.

Trading vessels sailing to East and Southeast Asia needed different compositions of personnel. The *Dongxiyang kao* 東西洋考 (Records of the eastern and western ocean, 1618), written by Zhang Xie 張燮 (1574–1640), a scholar who interviewed sailors in Zhangzhou 漳州, Fujian, provides information for Fujianese trading vessels. He starts with the trading side of personnel, explaining that a *bo zhu* 船主, a shipmaster, is in charge, and all the merchants obey him. The second person is called *caifu* 財副 (literally “money deputy,” possibly overlapping completely or partly with what is known as “supercargo” in the English-speaking maritime world) who oversees the financial accounts. A *zongguan* 總管 (general manager) organizes things aboard the ship and acts as spokesperson for the shipmaster. Next is the *zhiku* 直庫 (literally “[person] in charge of the depot”), who according to Zhang is in charge of weaponry. Turning to the crew needed to sail the ship, Zhang writes that they include people who climb up the masts (*aban* 阿班);⁶ and two people each to take care of the anchor (*touding* 頭碇, literally “head anchor,” and *erding* 二碇, “second anchor”), the rigging and sails (*daliao* 大繚, literally “big entanglement” and *erliao* 二繚, “second entanglement”),⁷ and the rudder (*duogong* 舵工, literally “rudder worker”). Lastly, Zhang mentions the

⁵Zhu Yunming 祝允明, *Qianwen ji* 前聞記, in *Jilu huibian* 紀錄彙編, [http://nrs.harvard.edu/urn-3: FHCL:24998867?n=4258](http://nrs.harvard.edu/urn-3:FHCL:24998867?n=4258) (1617), *juan* 202, 37a; *Taizong shilu* 太宗實錄, 1430 (Taipei: Zhongyang yanjiuyuan lishi yuyan yanjiusuo, 1967), *juan* 118, 3ab / 1499–1500. The section in the *Shilu* was translated in Liu Yingsheng, “An Open Knowledge System for Navigational Science: Zheng He’s Maritime Expeditions and Sino-Foreign Overseas Exchange,” *China and Asia* 1.1 (2019), 80.

⁶This is likely a loan word from Malay. Claudine Salmon, “Contact Languages on the South China Sea and Beyond (15th–18th Centuries),” *Asian Culture* 43 (2019), 25–26.

⁷Needham explains that these terms refer to “winches (‘winders’) for halyards of foremast and mainmast.” Joseph Needham, Wang Ling, and Lu Gwei-Djen, *Science and Civilisation in China*, Vol. 4, *Physics and Physical Technology*. Part 3: *Civil Engineering and Nautics* (Cambridge: Cambridge University Press, 1971), 405.

huozhang, who “takes care of the needle” and because “the routes across the sea are vast, all listen to his commands.” (其司針者名火長, 波路壯闊, 悉聽指揮).⁸ Compared to the list from Zheng He’s voyages, the *Dongxiyang kao* focuses more on the operation of the ship itself, but it also mentions the financial and trading side of sailing, and emphasizes that the administrative side of a ship operation was separate from navigational aspects.

Around a century later, the Japanese Nishikawa Joken 西川如見 (1648–1724) recorded the composition of the crew of Chinese trading ships, also based on records from Zhangzhou.⁹ *Huozhang*, *duogong*, and people in charge of the anchor and climbing the mast are listed first, before Nishikawa turns to the administrative side, listing the person in charge of finances and cargo (*caifu* 財附) and general manager (*zongguan*). The last four people on Nishikawa’s list are people in charge of a *sampan* (a small boat to easily go ashore, *shanpan gong* 杉板工);¹⁰ general sailors (*gongshe* 工社); the person responsible for rituals and offering incense (*xianggong* 香工); and finally the ship master (*chuan zhu* 船主), who is said to have no role on the ship itself but to take care of the cargo and make other management decisions. The general division into navigating, ship operating, and administrative / financial personnel overlaps in Zhang Xie’s and Nishikawa Joken’s texts. Both job titles and divisions of labor seem to have stayed the same in the case of seventeenth- and eighteenth-century Fujianese trading vessels.

Late-seventeenth to mid-eighteenth-century trade records made in Manila and Nagasaki provide some information about the make-up of crews and names of people, including *huozhang*, aboard ships. Several inspection records of Chinese ships arriving in Manila in 1744 were signed by Spanish inspectors, as well as three crew members from the Chinese side: the ship master, the *caifu* (treasurer / supercargo), and either a *huozhang* or a *duogong*.¹¹ Similarly, the Japanese government conducted interviews on Chinese ships arriving in Nagasaki to keep a tight control on trade. Records of these interviews, known as *Tōsen fusetsu gaki* 唐船浮説書 (Records of rumours from Chinese ships) or *Ka-i hentai* 華夷変態 (The change of the civilized and the barbarian), survive for the period between 1644 and 1728.¹² A few of these reports include information on the number of people on board ship and list at the end several or even all crew members by name and position.¹³ A report of a ship arriving in Nagasaki from Fuzhou in 1696, for example, lists the names of the ship master (*chuantou* 船頭), the person in charge of finances (*caifu*), the head of merchants (*ketou* 客頭), the *huozhang*,

⁸Zhang Xie, *Dongxiyang kao*, 1618, annotated edition by Xie Fang 謝方 (Beijing: Zhonghua shuju, 2000 [1981]), 170–71.

⁹Nishikawa Joken, *Zōho Ka-i tsūshōkō* 增補華夷通商考, 1708, www.wul.waseda.ac.jp/kotenseki/html/i13/i13_00581/index.html, kan 2, 26ab.

¹⁰On *shanpan*, see Huang Shujing 黃叔瓚, *Taihai shicha lu* 臺海使棧錄, 1722, in *Jifu congshu* 畿輔叢書 (1879), juan 1, 17b.

¹¹Archivo General de la Nación, México (AGN), Inquisición 903/15, 146r–157v. I thank Guillermo Ruiz-Stovel for bringing this document to my attention.

¹²For an introduction to the *Tōsen fusetsu gaki*, see Ishii Yoneo, ed., *The Junk Trade from Southeast Asia: Translations from the Tōsen Fusetsu-Gaki, 1674–1723* (Singapore: Institute of Southeast Asian Studies, 1998), 1–12.

¹³I found records of nine ships with this kind of information: *Ka-i hentai*, kan 21 下, www.digital.archives.go.jp/img/3999849, p. 25; kan 22 上, www.digital.archives.go.jp/img/3999850, p. 19, 22; kan 22中, www.digital.archives.go.jp/img/3999851, p. 6; kan 23 上, www.digital.archives.go.jp/img/3999853, p. 28; kan 25上, www.digital.archives.go.jp/img/4000800, pp. 41, 43; kan 29, www.digital.archives.go.jp/img/4000808, pp. 24–25, 28, 46–47, 49.

the *duogong*, and the general manager (*zongguan*).¹⁴ In two other cases, both of ships arriving in 1703, the records list the names of all crew members. In one case, the ship from Fuzhou carried twenty-eight people, but the records identify only the ship master and treasurer by their titles,¹⁵ while the records of the second ship, from Nanjing, with nineteen people onboard, identify the ship master, a merchant (*ke* 客), and the *duogong*.¹⁶ In both the Manila and Nagasaki records, the ship master appears every time; with the exception of the 1703 ship from Fuzhou, all records list at least one *huozhang* or *duogong*. For trading purposes, the ship master and *caifu* presented the most important personnel, and the authorities in both Manila and Nagasaki might have wished to include one person responsible for navigation in the signature.

Records related to voyages sponsored by the Ming and Qing states going to the Ryukyu Kingdom provide slightly different information again. In 1579, Xie Jie 謝杰 (1537–1604) had gone to Naha. Several years later, he recorded that eight *huozhang* were serving in pairs on the ship, and that they worked closely with sixteen *duogong* grouped into four groups of four.¹⁷ Based on a voyage taken 150 years later to the same destination, Xu Baoguang 徐葆光 lists twenty-two crew members on his ship, including one main and one deputy *huozhang* (*zheng huozhang* 正夥長, *fu huozhang* 副夥長).¹⁸ The other twenty people included two steersmen (*duogong*), and people in charge of the anchor and the rigging, just as Zhang Xie had stated in his *Dongxiyang kao*. Xu Baoguang, however, adds others, among them a person in charge of incense (*xianggong*) as in Nishikawa Joken's text, and two cooks (*zongbu* 總舖), but no administrative positions like the ship master or *caifu*.¹⁹ As this was an official voyage, the lack of personnel related to trading activity is not surprising.

Military vessels had different requirements. A mid-sixteenth-century military handbook mentions that military ships needed first a robber-catcher (*budao* 捕盜), probably reflecting the purpose of the mission: to go after pirates. The source continues to list personnel needed to sail the ship: people in charge of the rudder, the rigging, and the anchor, but *huozhang* appear nowhere.²⁰ This raises the question: Who was responsible for navigation on military vessels? Given that military ships mostly only patrolled a small section of the coast, navigating must have required a very different set of skills from navigating to Southeast Asia or even the Indian Ocean. Was a *huozhang* only someone who sailed far from the coast?

That *huozhang* were indeed needed only when sailing further away is mentioned in Huang Shujing's 黃叔璥 1722 *Taihai shicha lu* 臺海使槎錄 (Records of being an envoy in the Taiwan Strait). To trade within the Qing Empire, a ship needed a ship master and a *duogong*, in addition to people climbing up the masts and taking care of the rigging, anchors, and *shanpan*, as well as a cook and ordinary sailors. Ships going to trade abroad (*waiguo* 外國) additionally needed more personnel, among them a *caifu* (treasurer /

¹⁴*Ka-i hentai*, kan 23 上, www.digital.archives.go.jp/img/3999853, p. 28.

¹⁵*Ka-i hentai*, kan 29, www.digital.archives.go.jp/img/4000808, pp. 24–25, 28.

¹⁶*Ka-i hentai*, kan 29, www.digital.archives.go.jp/img/4000808, pp. 46–47, 49.

¹⁷Xie Jie, *Qiantai wozuan* 虔臺倭纂, 1595, http://read.nlc.cn/allSearch/searchDetail?searchType=1002&showType=1&indexName=data_892&fid=411999018468, *juan* 1, 25a–26b.

¹⁸Xu Baoguang, *Zhongshan chuanxin lu* 中山傳信錄, 1721, <http://resolver.staatsbibliothek-berlin.de/SBB0001603D00000000>, *juan* 1, 7b.

¹⁹Xu Baoguang, *Zhongshan chuanxin lu*, *juan* 1, 7b–8b.

²⁰Qi Jiguang 戚繼光, *Jixiao xinshu: Shiba juan ben* 紀效新書·十八卷本, ed. Cao Wenming 曹文明 and Lü Yinghui 呂穎慧 (Beijing: Zhonghua shuju, 2001), *juan* 18, 314.

supercargo), two *huozhang*, and an incense master (*xianggong*).²¹ Huang Shujing's text very explicitly reminds us how important it is to consider the type of voyage before we draw any conclusions.

Each of the sources speaks of a different type of voyage over a period of three hundred years. Unsurprisingly, therefore, the personnel lists differ, as each list describes a different kind of voyage.²² Food and medical care were surely necessary on all voyages, but not all compilers of ship crew lists mention personnel responsible for these aspects. The omission of doctors and cooks could mean one of two things: either the lists are incomplete, or sailors were supposed to cook and care for themselves. Looking at the personnel mentioned for any type of voyage, i.e., those needed to physically sail the ship, reveals a certain set of crew members mentioned consistently. Absolutely central to all the lists are the steersmen, termed *duogong* in all sources. However, not all sources list *huozhang*. Especially for shorter voyages, *huozhang* seem to not have been necessary. Could *duogong* fulfill part of the duty we assume *huozhang* to have had? In the following section, I will examine what the sources tell us about their duties and relationship.

Huozhang, Co-workers, and Authority

Several sixteenth- to eighteenth-century sources explicitly state that *huozhang* oversaw the compass. Xie Jie, who served as an envoy to Ryukyu in the sixteenth century, and Zhang Xie in his early seventeenth-century *Dongxiyang kao* both state that the *huozhang* “attended to the needle” (*si zhen* 司針).²³ Sources from several decades to a century later, Liu Xianting's 劉獻廷 (1648–1695) *Guangyang zaji* 廣陽雜記 (Miscellaneous notes of Guangyang), Nishikawa Joken's *Zōhō Ka-i tsūshōkō*, and Xu Baoguang's *Zhongshan chuanxin lu*, list more duties. Liu Xianting mentions that aside from “watching [the compass] day and night,” the *huozhang* “knew the depth of the water and the color and smell of sand” (夥長晝夜視之 ... 其水之淺深, 泥之顏色臭味, 皆知之。).²⁴ Nishikawa explains: “*Huozhang*: the person who takes lead in being at sea. His duties are knowing the way of the compass; measuring the sun, moon, and stars; thinking about the weather; and examining geographical features” (夥長: 海上ノ乗方ヲ主ドル者也。羅經ノ法ヲ能知テ, 日月星ヲ計リ, 天氣ヲ考ヘ地理ヲ察スル役ナリ).²⁵ Xu Baoguang explains the role of the *huozhang* as follows: “The main *huozhang* takes care of the needle compass. The deputy *huozhang* manages the needle room and takes care of the water hook and three long ropes to measure the depth of the water” (正夥長主針盤羅經事。副夥長經理針房兼主水鉤長纜三條候水淺深).²⁶ According to Liu, Nishikawa, and Xu, a *huozhang* was a very knowledgeable person who did much more than just minding the compass. He also performed a variety of tasks to decide where the ship should and could safely sail.

²¹Huang Shujing, *Taihai shicha lu*, *juan* 1, 18ab.

²²Comparing them with personnel on board boats sailing rivers yields even more discrepancies. See Kim, *Mountain Rivers, Mountain Roads*, 147.

²³Xie Jie, *Qiantai wozuan*, *juan* 1, 25a; Zhang Xie, *Dongxiyang kao*, 171.

²⁴Liu Xianting, *Liu Jizhuang xiansheng Guangyang zaji* 劉繼莊先生廣陽雜記, in *Xuxiu siku quanshu* 續修四庫全書 (Shanghai: Shanghai guji chubanshe, 2002), *juan* 5, 658.

²⁵Nishikawa, *Zōhō Ka-i tsūshōkō*, *juan* 2, 26a.

²⁶Xu Baoguang, *Zhongshan chuanxin lu*, *juan* 1, 7b. The term for water hook (*shuitao* 水鉤) appears as *shuigou* in the *Shinan kōgi*. See [note 37](#).

The role of the *huozhang* closely relates to that of the *duogong*. Based on his experience of being an official envoy on a ship from Fuzhou to Naha, Xie Jie explains that *huozhang* and *duogong* work closely together in teams of two *huozhang* and four *duogong* (who work in four shifts), pointing out that “wherever the needle points, the rudder follows” (針之所向則舵隨之).²⁷ while Xia Ziyang 夏子陽 and Wang Shizhen 王士楨, envoys to Naha in 1601, are more explicit about the hierarchy: “The *duogong* listens to the commands of the *huozhang*” (舵工聽命於夥長焉).²⁸ Nishikawa Joken, too, makes clear the close relationship between *huozhang* and *duogong*. He writes that the duty of the *duogong* involves “joining his heart with the *huozhang*” and that he “knows the wind and conquers the waves” (彭[sic]長ト心ヲ合セ、風ヲ辨ジ、濤ヲ凌グ).²⁹ A slightly different relationship between *huozhang* and *duogong* is described by Liu Xianting. He explains that “once an island / mountain is seen, things are [in the hands of] the *duogong* and the duty of the *huozhang* is over” (一見山、則事在舵工、夥長之任卸矣).³⁰ Liu’s remarks suggest that the role of the *huozhang* was necessary only in the open seas, and as soon as the ship was in sight of land, the *duogong* could take over. But out in the open seas, the *huozhang* was in charge and told the *duogong* where to go. The *duogong* then implemented practical navigation by steering the ship.

Many ships probably carried more than one *duogong* and *huozhang*. Most sources discussed above speak of two *duogong*, while the *Taihai shicha lu* makes a distinction between short voyages needing only one *duogong*, and voyages abroad needing two. According to the early seventeenth-century *Dongxiyang kao*, the two worked in shifts, while the early eighteenth-century *Zhongshan chuanxin lu* and *Taihai shicha lu* divided their roles into a “main” (*zheng* 正) and a “deputy” (*fu* 副) *duogong*, implying a hierarchy between the two.³¹ The number of *huozhang* is mentioned less often. The *Dongxiyang kao* can be interpreted as speaking of only one, while the *Zhongshan chuanxin lu* and *Taihai shicha lu* mention a “main” and “deputy” *huozhang* in parallel to the situation for the *duogong*. Sources written by envoys to Ryukyu in the late sixteenth and early seventeenth centuries, however, explain that ship crews consisted of twice as many *duogong* as *huozhang*. Xie Jie mentions sixteen *duogong* and eight *huozhang* who work in four shifts.³² Xia Ziyang and Wang Shizhen explain that twice the number of *duogong* is needed, as steering the ship is a physically demanding job, in contrast to watching the needle.³³ We therefore have no conclusive answer on the number of *huozhang* and *duogong*, but most sources point to there being more than one on board, dividing responsibilities. As mentioned above, Xu Baoguang suggests that the main and deputy *huozhang* fulfill different duties: only the main *huozhang* was directly concerned with the compass, while the deputy had responsibility for the compass room. In general, however, the division of labor among *huozhang* was achieved in one of two ways: by working in shifts or by assigning a main and a deputy *huozhang*.

²⁷Xie Jie, *Qiantai wozuan*, *juan* 1, 25a.

²⁸Xia Ziyang and Wang Shizhen, *Shi Liuqiu lu* 使琉球錄, 1607, in *Shi Liuqiu lu sanzong* 使琉球錄三種 (Taipei: Taiwan yinhang, 1970), *juan* xia, 274.

²⁹Nishikawa, *Zōho Ka-i tsūshōkō*, *juan* 2, 26a.

³⁰Liu Xianting, *Liu Jizhuang xiansheng Guangyang zaji*, *juan* 5, 658.

³¹Zhang Xie, *Dongxiyang kao*, 171; Qi Jiguang, *Jixiao xinshu*, *juan* 18, 314; Xu Baoguang, *Zhongshan chuanxin lu*, *juan* 1, 7b; Huang Shujing, *Taihai shicha lu*, *juan* 1, 18ab.

³²Xie Jie, *Qiantai wozuan*, *juan* 1, 25a.

³³Xia Ziyang and Wang Shizhen, *Shi Liuqiu lu*, *juan* xia 下, 274.

Hierarchy and organization guided colleagues fulfilling the same duty, but also assured that all crew members knew their place. To understand hierarchy, the type of ship and the purpose of voyage are particularly important. On military ships, which included those for Zheng He's voyages, military personnel were probably in charge; generals received the highest compensation after the Indian Ocean travel. Records of trading ships, on the other hand, hint at a distinction between the operation of trade and the operation of sailing. The *Dongxiyang kao* explains that someone called "ship master" (*bo zhu*) was in charge, while at the same time, stating that "all listen to [the *huozhang*'s] commands."³⁴ Nishikawa Joken confirms this sentiment: Not only does he claim that the *huozhang* "takes lead in being at sea," but he also describes the role of the ship master (*chuan zhu*) as follows: "He is the head of the ship. He has no duty on the ship. He orders [when] to go to Japan to trade, informs the government, and decides the number of people for each ship" (船主：船頭ナリ，船中ニテ役ナシ。日本ニテ商賣ノ下知ヲシ，公儀ヲ勸メ，一船ノ人数ヲ治ム).³⁵ Similar divisions of labor between shipmasters and pilots are recorded for navigational practices in other regions of the Indian Ocean, such as the Persian, Arab, and Malay regions.³⁶ In other words: the shipmaster decided who went where, but as soon as the ship had set sail, the *huozhang* made all the decisions to assure a safe journey.

Rutters, Maps, and Images to Guide the Way

Chinese sources speak of several tools *huozhang* had at their disposal to find their way safely: sailing manuals, tools to measure the depth of the water, and others to measure the position of stars, incense sticks or hourglasses to measure time, and of course the compass.³⁷ In the following sections, I will focus on the two most prominent tools: sailing manuals and the compass.

Sailing manuals or rutters are usually called *zhenjing* (lit. needle texts), referring to the compass needle. Several copies of *zhenjing* survive from the sixteenth and seventeenth centuries, connecting China with other places in East and Southeast Asia and the Indian Ocean region.³⁸ These texts describe how to reach major ports in the region using

³⁴Zhang Xie, *Dongxiyang kao*, 170–71.

³⁵Nishikawa, *Zōho Ka-i tsūshōkō*, kan 2, 26ab.

³⁶The sixteenth-century Persian text by Abu'l Fazl, 'A'in-i Akbari, for example explains that the owner of the ship (*nakhoda*) determines the course, while the pilot (*mu'allim*) had the nautical skills to guide the ship safely. G. R. Tibbetts, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese* (London: The Royal Asiatic Society of Great Britain, 1971), 58. On Southeast Asian shipboard organization and navigation, see Anthony Reid, *Southeast Asia in the Age of Commerce: 1450–1680*, Vol. 2, *Expansion and Crisis* (New Haven: Yale University Press, 1993), 43–53.

³⁷The *Shinan kōgi* explains that the tool for measuring the depth of the water is called a "water hook" (*shuigou* 水鈎). Tei Junsoku 程順則, *Shinan kōgi* 指南廣義, 1708, <https://shimuchi.lib.u-ryukyu.ac.jp/collection/nakahara/na02401/1>, p. 28 of the scan. On time measuring and tools for measuring the position of stars, see Joseph Needham, Wang Ling, and Lu Gwei-Djen, *Science and Civilisation in China*, Vol. 4, pt. 3, 570, 574–76.

³⁸For a list of Ming sources, see Elke Papelitzky, "Seafaring Knowledge of Ming Literati: The Scholarly Dissemination of Sailing Route Descriptions," in *Seafaring, Trade, and Knowledge Transfer: Maritime Politics and Commerce in Early Middle Period to Early Modern China*, edited by Mathieu Torck, Angela Schottenhammer, and Wim De Winter (Leiden: Brill, forthcoming). For a collection of sources until the Qing, see Chen Jiarong 陳佳榮 and Zhu Jianqiu 朱鑿秋, eds., *Zhongguo lidai hailu zhenjing* 中國歷代海路針經, 2 vols. (Guangzhou: Guangdong keji chubanshe and Quanguo youxiu chubanshe, 2016).

compass directions and a time unit (*geng* 更; usually translated as “watch”; 10 *geng* are 24 hours) to explain the journey, naming islands, mountains, and other landmarks as places to sail past. They mostly use very formulaic language: “From place A, sail in the direction of *x* for *y* *geng* until you reach place B” (A用*x*針*y*更取/平B). However, most of these extant sources are only preserved through the editorial intervention of Ming and Qing scholars. Even two manuscripts held by the Bodleian Library, commonly known as *Shunfeng xiangsong* 順風相送 (May favorable winds escort you, late sixteenth century) and *Zhinan zhengfa* 指南正法 (The correct way of using the compass, second half of seventeenth century), include prefaces that makes it clear that they are fair copies of rutters.³⁹ We therefore have texts preserved that record the contents of the rutters but we have no actual Ming or early Qing rutter that was aboard a ship.

None of the lists and descriptions of the duties of the *huozhang* discussed above mention rutters, but several Ming and Qing observers refer to *zhenjing* and their use by sailors more generally. Zhang Xie in his *Dongxiyang kao*, for example, states that “from old times on, mariners had rutters [*hanghai zhenjing*]. They are all written in jargon and not easy to analyze. I have translated them [into standard language] and written them down” (舶人舊有航海針經，皆俚俗未易辨說，余為稍譯而文之).⁴⁰ Another text presents a similar sentiment: “The people at sea familiar with the sea routes use the compass [*zhinan zhen*, also known as *luojing*] to guide the way. They have passed down rutters [*hanghai zhenjing*]” (海人習知海道者，率用指南針(即羅經)為其導向。相傳有航海針經).⁴¹ Tei Junsoku 程順則 in his *Shinan kōgi* 指南廣義 (General description of the compass), a Ryukyuan work completed in 1708 based on a Chinese navigational text, also explains that in 1683 he received a book titled *Hanghai zhenfa* 航海針法 (The way of the needle for going to sea) from a Fujianese *duogong* who had come to Naha. The comment documents a direct interaction between the compiler of a text and a sailor who had such a text in his possession.⁴² Early modern Chinese sailors relied on some form of text as a guide.

Analyzing the rutters more closely along with the remarks of some contemporary observers, however, paints a picture of the rutters as guidelines rather than actual sets of instructions. Comparing the actual environment with the description in the rutters reveals quickly that much vital information is missing. Warnings of shallows are less frequent than necessary and, in particular, the last step of reaching a harbor receives hardly any attention at all.⁴³ Rutters therefore cannot have been the only source of knowledge of *huozhang* and others who navigated. The introduction in one of the extant rutters even hints at navigators receiving help from people familiar with local conditions, stating: “If you have difficulties following the route, there are paths you can follow, and

³⁹Scans are available from the website of the Bodleian Library. *Shunfeng xiangsong* is Bodleian Library MS Laud Or. 145, <https://digital.bodleian.ox.ac.uk/objects/40aeb385-ef63-4f69-b11f-cccc2dc4f723/>. *Zhinan zhengfa* is Bodleian Library Arch.O.d.46, <https://digital.bodleian.ox.ac.uk/objects/f786131a-6334-4c0e-af69-ed507a90697a/> (from image 1189).

The two were edited together by Xiang Da 向達, as *Liangzhong haidao zhenjing* 兩種海道針經 (Beijing: Zhonghua shuju, 2000 [1960]).

⁴⁰Zhang Xie, *Dongxiyang kao*, fanli 20.

⁴¹Gu Yanwu 顧炎武, *Tianxia jinguo libing shu* 天下郡國利病書, mid-seventeenth century, in *Siku quanshu cunmu congshu* 四庫全書存目叢書 (Ji'nan: Qilu shushe, 1997), ce 26, 99a.

⁴²Tei Junsoku, *Shinan kōgi*, p. 19 of scan.

⁴³Elke Papelitzky, “Shallow Water at China’s Coast: Depicting Dangers on Early Modern Chinese Maps,” *Isis* 112.1 (2021), 111–21.

people you can ask” (行路難者有徑可尋, 有人可問).⁴⁴ Xie Jie’s description of his voyage to Naha provides an example of the ship not following the rutter. Instead of following the chain of islands of the Ryukyuan archipelago after having passed the northern tip of Taiwan, as rutters suggested, the ship sailed directly from Fuzhou to Kume 久米 Island, close to Okinawa Island. Xie explains that this way of sailing “is called to cross [the ocean] flying” (所云截流飛渡) and that nobody on the ship “looked at old texts” (不循舊章), most likely referring to rutters. For Xie, this was a scary experience, and he ends his description of the voyage with the comment: “Oh! It was so dangerous! While I am writing this down, I remember this past event, and I am low-spirited and feel dread” (嗚呼, 危矣哉! 我執筆至此, 追惟往事, 不覺黯然鬼魂銷).⁴⁵ According to Stephen Davies, Xie Jie describes a perfectly valid way to sail, which made sure the ship did not accidentally end up in the Pacific.⁴⁶ However, for the Ming envoy, not following the rutters turned the crossing into a scary voyage. Rutters provided only rough guidelines that needed to be adapted based on the navigator’s experience and added to by people knowledgeable about local conditions, a fact that Ming scholars did not necessarily understand.

Aside from rutters, navigators also had some form of maps or drawings at their disposal. One of the very few texts that directly connects *huozhang* to these rutters, a text related to the Zheng He voyages, explains that “from the sailors that were selected, those who had experience sailing into the ocean are called *huozhang*. They were employed as ship masters. The leaders were supplied with rutters and drawings (*zhenjing tushi*). When they used them, they were [fully] concentrated [on the *zhenjing tushi*]. It was very important and a big responsibility. Who would dare to be neglectful?” (選取駕船民梢中有經貫下海者稱為火長, 用作船師。乃以針經圖式付與領執, 專一料理, 事大責重, 豈容怠忽).⁴⁷ The exact form of these *zhenjing tushi* is unclear: Are they maps? Rutters with only a few drawings? Does the text refer to two things? *Zhenjing* and *tushi*? The Chinese term *tu* can refer to any kind of diagram, image, or painting but also to maps.⁴⁸ Given that navigation today, just like early modern European sailing, relies heavily on charts, and given that an extensive genre of coastal maps has existed in China from the mid-sixteenth century onwards, the first impulse might be to equate *tu* to maps, i.e., a representation of the coastlines as seen from above.⁴⁹ However, this is unlikely as no early modern Chinese map exists that would be suitable for sailing by, even among those that focus exclusively on coastal areas. Even in 1934, Lieutenant Forrest H. Wells of the US

⁴⁴Xiang Da, *Liangzhong haidao zhenjing*, 21. The whole passage is translated in Joseph Needham, Wang Ling, and Kenneth Girdwood Robinson, *Science and Civilisation in China*. Vol. 4, *Physics and Physical Technology*. Part 1: *Physics* (Cambridge: Cambridge University Press, 1962), 285–86.

⁴⁵Xie Jie, *Qiantai wozuan*, *juan 1*, 25b. For a translation of this passage, see Papelitzky, “Seafaring Knowledge of Ming Literati.”

⁴⁶Stephen Davies, “Getting from Fuzhou to Naha in 1579CE: Xie Jie (謝杰), *Shi Liuqiu lu* (使琉球錄) and Xiao Chongye (蕭崇業), *Liuqiu guohai tu* (琉球國海圖) Among Other Things,” online lecture held on July 18, 2023.

⁴⁷Gong Zhen 鞏珍, *Xiyang fanguo zhi* 西洋番國志, ed. Xiang Da 向達 (Beijing: Zhonghua shuju, 2000), *Xiyang fanguo zhi zixu* 6.

⁴⁸Francesca Bray, “Introduction,” in *Graphics and Text in the Production of Technical Knowledge in China: The Warp and the Weft*, ed. Francesca Bray, Vera Dorofeeva-Lichtmann, and Georges Métaillé (Leiden: Brill, 2007), 1–78.

⁴⁹Needham for example assumes that Chinese navigators used charts. Needham, Wang Ling, and Lu Gwei-Djen, *Science and Civilization*, vol. 4, pt. 3, 568.



Figure 1. Page 6v of the so-called Yale map, which was captured from a Chinese ship in 1841. Beinecke Rare Book and Manuscript Library.

Navy remarked that he had been on a large number of Chinese trading ships without having seen a single chart.⁵⁰

Instead, *zhenjing tushi* were probably coastal views, drawings showing the shape of islands and coastlines as seen from a ship. We know that such drawings were used in the mid-nineteenth century on Chinese ships (one of them was captured from a ship in the mid-nineteenth century, Figure 1), and Wells confirms their usage for the early twentieth century.⁵¹ Other sources point to sailors having used them centuries earlier.⁵² Zheng Ruozeng's 鄭若曾 1562 *Chouhai tubian* 籌海圖編, for example, combines a textual sailing instruction with an image of islands for the route between Taicang and Japan (Figure 2), a section titled "Explanation of the *zhenjing tu* to go to Japan" (Shi Wo zhenjing tu shuo 使倭針經圖說) in the table of contents.⁵³ This view is supported by the 1708 *Shinan kōgi*. This text explains that sailors had available needle books (*zhenben* 針

⁵⁰Forrest H. Wells, "Chinese Mariners' Compass, Charts, and Methods of Navigation," *Proceedings of the U.S. Naval Institute* 60.3 (1934), www.usni.org/magazines/proceedings/1934/march/chinese-mariners-compass-charts-and-methods-of-navigation.

⁵¹Wells, "Chinese Mariners' Compass, Charts, and Methods of Navigation."

⁵²Zhang Xun discusses a map that might have Ming origins, but is also a Qing copy: Zhang Xun 章巽, *Gu hanghai tu kaoshi* 古航海圖考譯 (Beijing: Haiyang chubanshe, 1980).

⁵³Zheng Ruozeng 鄭若曾, *Chouhai tubian* 籌海圖編 (1562), facsimile edition of 1562 print in Zhongguo bingshu jicheng 中國兵書集成15-16 (Beijing: Jiefang jun chubanshe and Liaoshen shushe, 1990), *juan* 2, 210-16.



Figure 2. A section of the *Chouhai tubian* showing a written description of the route between Taicang and Japan with images of islands in the upper register. *Chouhai tubian*, juan 2, 6b–7a. Harvard-Yenching Library.

本) and *huatu* 畫圖, and that the Chinese book that Tei Junsoku had received from the Fujianese sailor had included images of the flow of water and shape of mountains (*shuishi shanxing tu* 水勢山形圖), using terms that clearly indicate drawings and not maps. A manuscript copy of the work contains such images (Figure 3).⁵⁴ Although both these texts were edited sources, they provide a glimpse into what *zhenjing tu* might have looked like.

Chinese sources therefore point to both texts and drawings as tools for *huozhang*. Given the continuity in type of drawing in the *Chouhai tubian* and in the atlas captured from the ship in the mid-nineteenth century, as well as the explanation in the *Shinan kōgi*, it is likely that similar sources found their way aboard ships in early modern China. We have, however, no sources that tell us how and when *huozhang* consulted these sources. It is entirely possible that *huozhang* memorized the parts about the voyage they were embarking on and did not need to consult rutters or drawings on the way. In addition, neither the *zhenjing* nor the *zhenjing tu* provide a comprehensive and complete picture of navigational instructions necessary to safely sail from one port to another. Instead, they provided a guideline and a mental aid to find one’s way around East and Southeast Asia, requiring supplementation from experience.

⁵⁴Tei Junsoku, *Shinan kōgi*, zixu (p. 7 of the scan), *Chuanshou hanghai zhenfa ben mokao* (p. 19 of the scan). See also the discussion in Liu Yijie 刘义杰, “Shanxing shuishi tushuo” 山形水勢图说, *Guojia hanghai* 国家航海 10 (2015), 88–111.

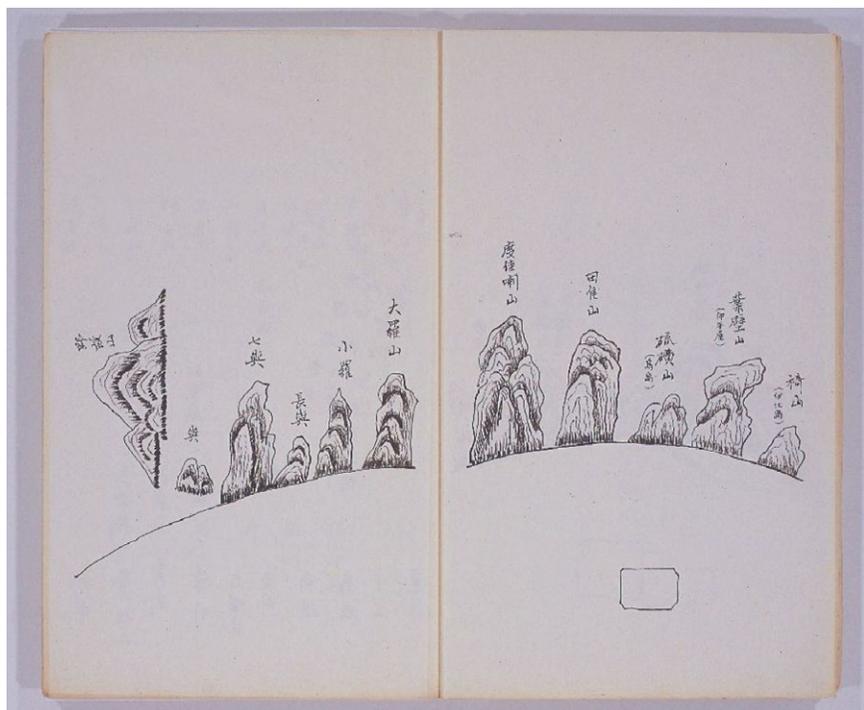


Figure 3. A page of the *Shinan kōgi* showing drawings of islands along the route between Fuzhou and Naha. University of the Ryukyus Library.

When and How to Use the Compass

Sources describing the duties of the *huozhang* make it clear that one of his most important tools was the compass, known by terms such as *zhinanzhen* 指南針, *luopan* 羅盤, *zhenpan* 針盤, and *luojing* 羅經.⁵⁵ Rutters heavily rely on giving compass directions to guide the seafarer. Ever since its first mention on a ship in the late eleventh century, the compass became an indispensable object aboard ship. Without it sailors would be lost at sea.⁵⁶ Or at least, that is the common narrative in much of the secondary literature.⁵⁷ Even though the compass is omnipresent in assumptions about sailing, there is very little research on the compass itself. Much of the literature simply mentions the compass as one of the “four great Chinese inventions,” describes the compass rose, and takes its use by sailors for granted, in part because scholars tend to focus on rutters that describe voyages by using compass points.⁵⁸ The most in-depth recent discussion of the

⁵⁵There are different nuances to these terms. *Zhen* refers to the physical needle, *luopan* to the bowl the needle is suspended in, and *luojing* probably to the compass rose.

⁵⁶Needham, Wang, and Robinson, *Science and Civilization*, vol. 4, pt.1, 279; Needham, Wang, and Lu, *Science and Civilization*, vol. 4, pt. 3, 562.

⁵⁷See for example Li Shu-Hua, “Origine de la boussole II. Aimant et boussole,” *Isis* 45.2 (1954), 191–92; Liu Yijie 刘义杰, *Shunfeng xiangsong yanjiu* 《顺风相送》研究 (Dalian: Dalian Haishi daxue chubanshe, 2017).

⁵⁸Wang Zhenduo 王振铎, “Zhongguo gudai cizhen de faming he hanghai luojing de chuangzao” 中国古代磁针的发明和航海罗经的创造, *Wenwu* 1978.3, 53–61; Liu Yijie, *Shunfeng xiangsong yanjiu*, 61–72.

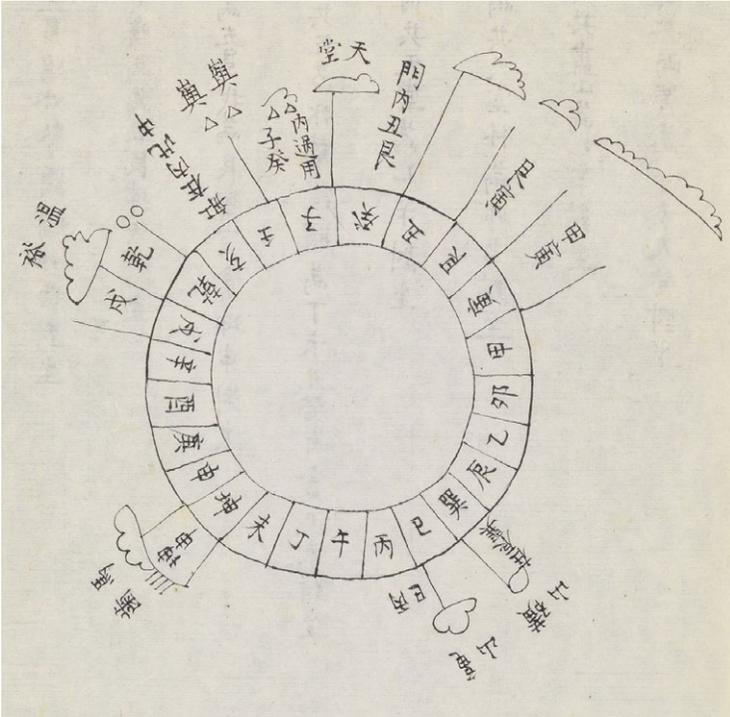


Figure 5. Compass rose from the manuscript rutter *Zhinan zhengfa* 指南正法. Second half of seventeenth century. Bodleian Library Oxford.

the *Shunfeng xiangsong*, which describes that one has to put the needle on water.⁶¹ To my knowledge, no such Chinese floating compass still exists.⁶² A late sixteenth-century source comments that Chinese sailors had used wet compasses (*shui luojing* 水羅經), but because of attacks during the mid-sixteenth century by Japanese pirates, who used dry compasses (*han luojing* 旱羅經), Chinese sailors started to adopt the latter.⁶³ From the late eighteenth to nineteenth century, a range of dry mariner's compasses exist

⁶¹Xiang Da, *Liangzhong haidao zhenjing*, 25.

⁶²Needham describes a floating compass that he mentioned as being in the "Collection of Mr A. A. Mick and Old Ashmolean Museum, Oxford," which is now the History of Science Museum. Needham, Wang, and Robinson, *Science and Civilization*, vol. 4, pt. 1, plate cxvii. Needham assumes this likely to have been a Japanese floating compass. The object belonged to the private collector Armand A. Mick who sent photos to the museum, which Needham studied. The object was never in the museum. Email Correspondence with Sarah Chard-Cooper of the History of Science Museum, August 10, 2023.

⁶³Li Yuheng 李豫亨, *Qingwu xuyan* 青烏緒言, in *Baibu congshu jicheng* 百部叢書集成 (Taipei: Yiwen yinshuguan, 1965), 1a; Li Yuheng 李豫亨, *Tuipeng wuyu* 推篷寤語, 1571, in *Siku quanshu cummu congshu* 四庫全書存目叢書, *juan* 7, 15a. For translations of the passages, see Needham, Wang, and Robinson, *Science and Civilization*, vol. 4, pt. 1, 289.



Figure 6. An illustration of a compass next to an image of an hourglass from the 1721 *Zhongshan chuanxin lu*. Staatsbibliothek zu Berlin.

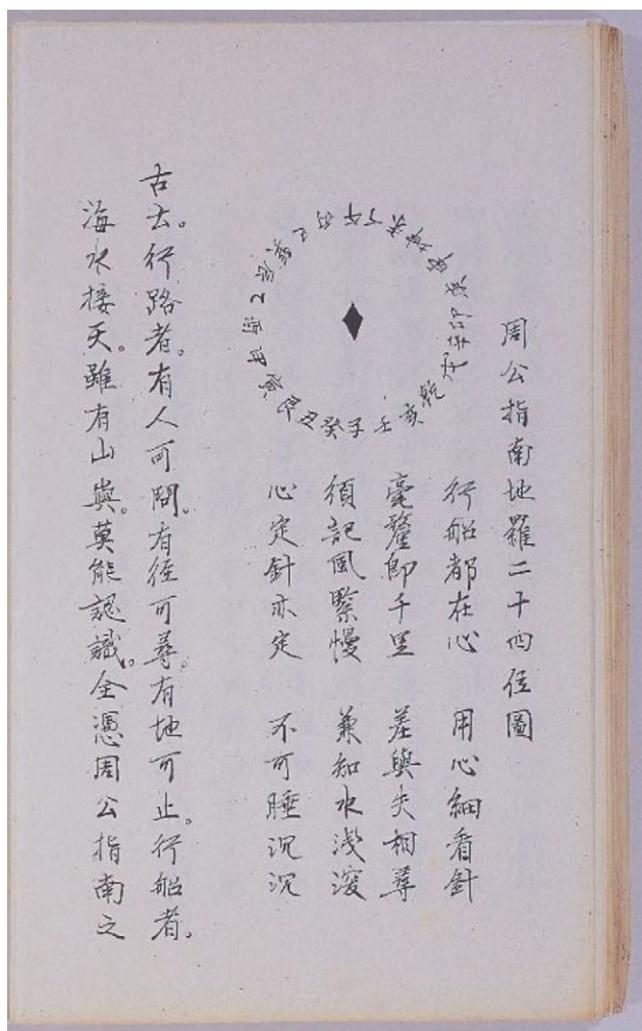


Figure 7. A page of the *Shinan kōgi* showing a compass rose. University of the Ryukyus Library.

(Figure 8).⁶⁴ These are small compasses that fit in one hand with a needle suspended in the middle and the usual compass rose on the outside, often with a lid. The dry compass required protection from the vibrations of the ship. To achieve this, Liu Xianting states in

⁶⁴There might also be Ming dry-compasses extant. Rong Liang 荣亮, “Fuzhen bian siwei. Hanghai luopan yinjin shi” 浮针辨四维——航海罗盘演进史, *Dazhong kaoqu* 大众考古 5 (2019). But as this is a magazine for popular archaeology and gives no information about where the objects are located, I was not able to confirm this statement. For examples of compasses, see <https://collection.sciencemuseumgroup.org.uk/objects/co8623885/wooden-case-for-chinese-mariners-compass-case-container>, <https://collection.sciencemuseumgroup.org.uk/objects/co55897/chinese-mariners-compass-4-1-2-diameter-wooden-bowl-compasses-direction-indicators>, www.rmg.co.uk/collections/objects/rmgc-object-42452, www.hsm.ox.ac.uk/collections-online/#/item/hsm-catalogue-6563.



Figure 8 Nineteenth-century dry compass. Science Museum, London.

the late seventeenth century, the dry compass was placed in a box, which was then put on top of sand to keep it level.⁶⁵ This practice of suspending the compass on sand (or rice) is still attested in the early twentieth century, and, according to Wells, “cushion[s] the instrument against shock and vibration.”⁶⁶ During the sixteenth century, the floating compass was slowly replaced by the dry compass, which then needed its own way of mounting. By the late seventeenth century at the latest, dry compasses were mounted on sand or rice.

Xie Jie’s record of his voyage from Fuzhou to Naha provides a description of the workplace where the *huozhang* used the compass. He writes that “the place of the people in charge of the needle is very secluded; they cannot see a single thing on the outside. There is only an opening in a small wall facing the rudder door. The hope is that this will [help them] concentrate. In the needle cabin, a light burns, and so night and day cannot be discerned” (司針之處甚幽密，外物一無所睹，惟開小牖，與舵門相向，欲其專也。針艙內燃長明燈，不分晝夜).⁶⁷ Xie Jie assumes that the compass played a crucial role in navigating, but he also describes it as something kept away from plain sight. Given that Xie Jie describes the compass room as completely dark and secluded, it is possible that he was never allowed in there. That there indeed was such a room on some ships, at least on ships sailing between Fuzhou and Naha, is confirmed in two further accounts of envoys between the two cities: Xia Ziyang and Wang Shizhen speak of a “secret room” (*mishi* 密室), where the compass is kept; and Xu Baoguang’s *Zhongshan chuanxin lu* includes an illustration of a ship with a room marked as “needle room” (*zhenfang* 針房), which does not seem to have any windows (Figure 9).⁶⁸ It is located below a shrine (*shentang* 神堂). In line with Xie Jie’s description, Xu Baoguang explains that next to the helm (*duolou* 舵樓) there is a small cabin (*xiaocang* 小艙), in which the compass is kept.⁶⁹ The compass and *huozhang* were thus close to the rudder and a shrine, again confirming that the *huozhang*

⁶⁵Liu Xianting, *Liu Jizhuang xiansheng Guangyang zaji*, juan 5, 658.

⁶⁶Wells, “Chinese Mariners’ Compass, Charts, and Methods of Navigation.” Needham furthermore discusses the suspension of the compass needle: Needham, Wang, and Robinson, *Science and Civilization*, vol. 4, pt. 1, 290–91.

⁶⁷Xie Jie, *Qiantai wozuan*, juan 1, 25a.

⁶⁸Xia Ziyang and Wang Shizhen, *Shi Liuqiu lu*, juan xia, 235; Xu Baoguang, *Zhongshan chuanxin lu*, juan 1, 2a.

⁶⁹Xu Baoguang, *Zhongshan chuanxin lu*, juan 1, 4a.

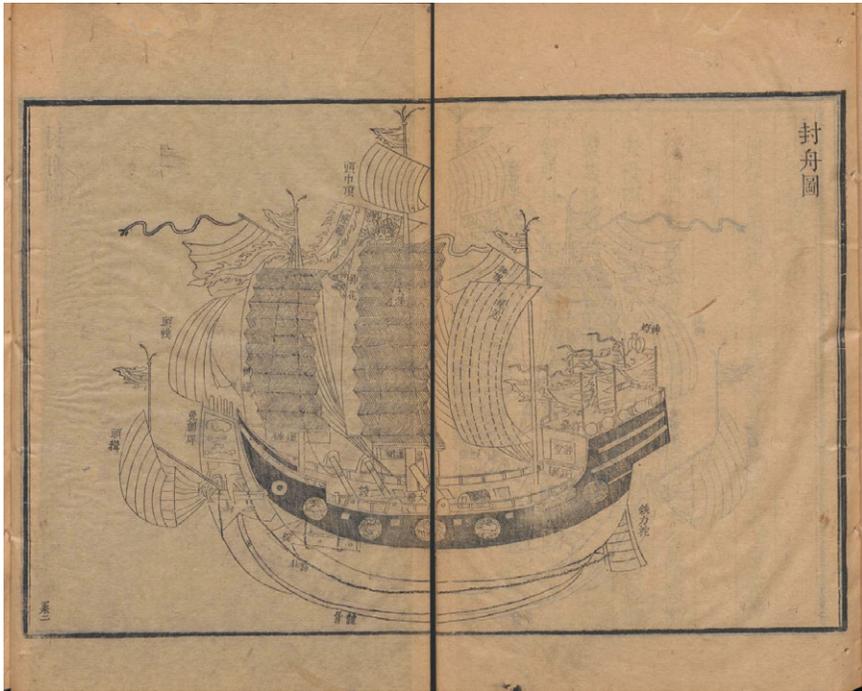


Figure 9. Tribute ship from the 1721 *Zhongshan chuanxin lu*. Staatsbibliothek zu Berlin.

and *duogong* had to work closely together, but also suggesting their close relationship with ritual practices, to be discussed further below.

The sources discussed above attest to the presence and importance of the compass aboard ship but do not say *when* the *huozhang* consulted it. Several of the very early records of compass use in the maritime context explain that the compass was used mainly when the weather was bad. For example, an early twelfth-century text states: “The shipmaster knows the geographical features (of the coast). At night he watches the stars; during the day he watches the sun. If it is a cloudy night, he watches the south-pointing needle” (舟師識地理。夜則觀星，晝則觀日。陰晦觀指南針)。⁷⁰ The compass seems to have gained importance for navigating in the centuries that followed, as can be seen in the *Dongxiyang kao*, which explains that experienced sailors “rely only on the compass for guidance” (獨特指南針為導引)。⁷¹ Sources from the late sixteenth and early eighteenth century speak of the compass being watched around the clock, with Xie Jie describing the needle room as permanently manned in shifts, and the *Shinan kōgi* explaining that “those who are in charge of the compass (*luojing*) have to observe [the compass] carefully, day and night” (故主掌羅經之人，務要晝夜留心細看)。⁷²

⁷⁰Zhu Yu 朱彧, *Pingzhou ketan* 萍洲可談, 1119, in *Jingyin Wenyuange Siku quanshu* 景印文淵閣四庫全書 (Taipei: Taiwan shangwu yinshuguan, 1983), *juan* 2, 3a. For other examples, see Needham, Wang, and Robinson, *Science and Civilization*, vol. 4, pt. 1, 280.

⁷¹Zhang Xie, *Dongxiyang kao*, 170.

⁷²Xie Jie, *Qiantai wozuan*, *juan* 1, 25a; Tei Junsoku, *Shinan kōgi*, 27 of scan.

However, Stephen Davies raises several issues regarding the actual use of the compass on early modern Chinese ships. The iron nails on the ship, as well as the movement of the ship, would have made the compass usable only for finding very rough directions.⁷³ Cardinal directions could be determined using the sun and stars, a practice Nishikawa Joken in the early eighteenth century mentions as the duty of the *huozhang*, who should be skilled in “measuring the sun, moon, and stars.”⁷⁴ Even in the twentieth century, some sailors seemed to have used the compass in this way. Davies cites a communication with Nicholas Burningham, who had been on a ship in Indonesia in 1979. The navigator (*nakoda*) took the compass out of storage only because the weather was so bad that there was no other way to tell which way was north.⁷⁵ Liu Xiangting’s seventeenth-century description of the duty of the *huozhang* being over as soon as land was in sight further supports the idea that the compass was not needed for navigation at all times, particularly not when sailing close to the coast. The compass was an important device, of course, but it was not the only means of navigating.

At first glance, the compass being used only in case of unfavorable weather seems to contradict all the rutters and sailing route descriptions that rely on providing compass directions. However, Davies argues that a navigator would not necessarily need the compass itself, but only a mental compass rose. One could figure out north from the stars and the sun, and then deduce the other directions.⁷⁶ Compass illustrations also make this distinction between the concept of a compass rose and the actual physical object (Figures 4–7). The earlier two seventeenth-century images illustrate only a compass *rose*, not a compass, while one of the two later depictions includes the needle, thus making it an image of a compass. The image in the *Shinan kōgi* includes a diamond shape resembling a needle, but the caption, “Image of Duke Zhou’s 24 positions of the compass” (Zhou gong zhinan diluo ershisi wei tu 周公指南地羅二十四位圖), suggests that this, too, was meant as a compass rose. Furthermore, images of the compass (or even compass roses) are surprisingly rare—basically non-existent—in Ming manuals that illustrate all kinds of other maritime objects. The *Chouhai tubian*, for example, includes maps of the coast, images of ships, anchors, and weapons, as well as sailing route instructions. Yet, no floating or dry compass is illustrated. In fact, I am not aware of any illustration of an actual compass dating before the early eighteenth century.

The compass rose as a mental tool was much more important for navigating than the physical compass. Certainly, the object was essential when the weather was bad, but even then, it was only necessary to figure out roughly where north or south was, and then one could rely on one’s mental image of the compass rose to execute the navigational steps. The compass was one of several methods for finding directions. In addition to wayfinding, the compass also was closely intertwined with ritual practices, which the next section explores.

⁷³Davies, “Routes, Rutters, Navigational Techniques.”

⁷⁴Nishikawa, *Zōho ka-i tsūshōkō*, *juan* 2, 26a.

⁷⁵Davies, “Routes, Rutters, Navigational Techniques,” 156–28.

⁷⁶Davies, “Routes, Rutters, Navigational Techniques,” 165–66. A similar argument has been made in the case of Micronesian navigation: Charles O Frake, “A Reinterpretation of the Micronesian ‘Star Compass,’” *The Journal of the Polynesian Society* 104.2 (1995), 149.

Ritual Practices: Not Just Navigating

Sailing was a dangerous matter, and therefore intertwined with ritual practices from shipbuilding, to praying before and during voyages, to performing rituals on board.⁷⁷ Several sources include sections on how to offer sacrifices or transcribe prayers.⁷⁸ There are also specific handbooks just for explaining ritual practices.⁷⁹ Furthermore, rutters mention that for several places the ship passes, one should conduct a ceremony. When entering the Luzon Strait (Wuyu yang 浯嶼洋), for example, the ship should offer sacrifices (*ji xian* 祭獻).⁸⁰ It is not always mentioned which deity receives the offering, but in at least one case reference is made to the goddess Mazu 媽祖, one of the most prominent seafaring deities, and another the spirit Dugong 都公.⁸¹ These offerings and rituals could take many forms, from releasing colorful boat models to burning incense.⁸² The early eighteenth-century lists by Xu Baoguang, Nishikawa Joken, and Huang Shujing discussed above suggest that ships carried a specialist on board to perform rituals, the incense master (*xianggong*). A century earlier, this role seems to have been less formalized, as no such role appears in the list of the *Dongxiyang kao*, although Zhang Xie describes a similar role in another part of his book on sacrifices, stating: “One person is particularly ordered to be responsible for incense (*sixiang* 司香); he has no other duties.”⁸³ Rituals were essential, and many ships even carried specialized personnel for performing rituals onboard.

Although the lists describing the role of the *huozhang* speak only of secular duties, several sixteenth- and seventeenth-century sources directly link *huozhang* to rituals and supernatural phenomena. In his 1536 *Haiyu* 海語 (Words of the sea), Huang Zhong 黃衷, who had interviewed sailors in his native Nanhai 南海 in Guangdong,⁸⁴ tells an anecdote that during a calm day on the ocean, the people aboard a ship saw a red flag suddenly appearing and racing over the water as quickly as lightning. The *huozhang* then burned incense and explained that this was an ocean deity on a journey and that meeting it was an auspicious omen.⁸⁵ In the next section, Huang Zhong explains that when one ship

⁷⁷For rituals during shipbuilding, see Li Yiwen, “Navigating Voyages in Real and Religious Life: The Big-Dipper Belief and Shipbuilding in Premodern China,” *Religions* 11.8 (2020), 398, <https://doi.org/10.3390/rel11080398>. For a discussion of ritual practices on the travel between Fuzhou and Naha, see Maria Schreibweis, “Der Seeweg China—Ryūkyū am Beispiel des Gesandtschaftsberichts *Shi Liuqiu lu* 使琉球錄 von Chen Kan 陳侃 (1489–1538),” in *Trade and Transfer Across the East Asian “Mediterranean,”* ed. Angela Schottenhammer (Wiesbaden: Harrassowitz, 2005), 26–44.

⁷⁸Zhang Xie, *Dongxiyang kao*, 185–86; Xiang Da, *Liangzhong haidao zhenjing*, 23–24, 47–48, 109; Tei Junsoku, *Shinan kōgi*, 26–27 of the scan.

⁷⁹Ilay Golan, “This Ship Prays: The Southern Chinese Religious Seascape through the Handbook of a Maritime Ritual Master,” *Religions* 15.9 (2024).

⁸⁰Xiang Da, *Liangzhong haidao zhenjing*, 89, 93, 166.

⁸¹For the example mentioning Mazu, see Xiang Da, *Liangzhong haidao zhenjing*, 180. For Dugong, see Roderich Ptak, “Near the Greater Bay Area: The Wuzhu Sea 烏豬洋 and Wuzhu Island 烏豬洲 (Pulau Babi) in Chinese and Portuguese Sources (c. 1400–1600),” *Revista de Cultura* 75 (2024), 112–14.

⁸²Golan, “This Ship Prays,” 5.

⁸³Zhang Xie, *Dongxiyang kao*, 186. The role of this incense master is explored in Golan, “This Ship Prays,” esp. 2–5.

⁸⁴Elke Papelitzky, “Editing, Circulating, and Reading Huang Zhong’s *Hai yu* 海語: A Case Study in the History of Reading and the Circulation of Knowledge in Ming and Qing China,” *Ming Qing Yanjiu* 23.1 (2019), 7.

⁸⁵Huang Zhong, *Haiyu*, 1536, in Baoyantang miji, <https://nrs.lib.harvard.edu/urn-3:fhcl:25628881> (after 1620), *juan xia*, 31b.

encounters another, the *huozhang* must light a fire. If the other ship looks damaged and does not respond by lighting a fire in return, then it is a ghost ship (*guibo* 鬼舶), and the shaman (*wu* 巫) needs to perform rituals to defeat it.⁸⁶ This story was picked up by Qu Dajun 屈大均 (1630–1696) in his *Guangdong xinyu* 廣東新語 (New stories from Guangdong). While he retold the story of an encounter with a racing deity similar to Huang Zhong, the story of the ghost ship features the *huozhang* more prominently. It is he, and not a shaman, who needs to conduct rituals to defeat the ghost ship. If he fails, the *huozhang* must ask the ocean deity for help.⁸⁷ Not just incense masters, but also *huozhang* were expected to perform rituals.

The compass was deeply linked to ritual practices. The magnetic compass in China originated in the context of geomancy, and this ritual connotation continued for the mariner's compass. The two rutters *Shunfeng xiangsong* and *Zhinan zhengfa* include model prayers about blessing the compass needle.⁸⁸ These prayers were supposed to be said aloud in a ceremony, and the model prayers include several places where the person reciting them could fill in relevant data such as the date and location of the ceremony. The *Shunfeng xiangsong* proceeds to explain in a cryptic passage that the compass needle should be placed on *yang* and not *yin* water and that “*yang* water means that when there is wind, you overcome the danger. *Yin* water means that when there is wind, you succumb to disaster” (蓋陽水者風上危也。陰水者風下厄).⁸⁹

It is probably no coincidence that the room in which the compass was kept was right next to the shrine onboard ship, creating a spatial proximity between the navigational tool and the place where sailors asked for protection from deities. All these sources show that *huozhang*, alongside other crew members, performed ritual duties in connection with navigating, and the rutters gave guidance on how to do so.

Conclusion

In 1478, a ship sailing from Melaka to China sank along the coast of Vietnam, resulting in the death of two Ming imperial envoys and nineteen other people. Blame for the disaster was easily assigned. Not only was the ship loaded with too much merchandise, but the ship's *huozhang* “was ignorant of the rutter route” (昧於經路) as a survivor of the wreck recalled.⁹⁰ If things went wrong, *huozhang* were responsible. When Xie Jie sailed to Naha, he became uneasy when the ship's route did not follow the rutter. Passengers on Ming ships did not question the ability of the *huozhang* to correctly use a compass, but rather their ability to follow the rutter.

Early modern Chinese sources stress the importance of both the compass and rutters as the main tools of *huozhang* for navigating. A closer look, however, reveals that these were not the only things *huozhang* used to find their way at sea. Not every rutter had to be followed precisely, not every directional decision had to be based on the compass. *Huozhang* could determine the cardinal directions from the sun and stars, and decide on the path to take by the depth of the water and the color of the sea. Information from rutters needed to be

⁸⁶Huang Zhong, *Haiyu*, *juan xia*, 31b–32a.

⁸⁷Qu Dajun, *Guangdong xinyu*, 1700, www.digital.archives.go.jp/img/1073034, *juan* 6, 5ab.

⁸⁸Xiang Da, *Liangzhong haidao zhenjing*, 23–24, 109. See also Golan, “This Ship Prays,” 7.

⁸⁹Xiang Da, *Liangzhong haidao zhenjing*, 25.

⁹⁰Elke Papelitzky, *Writing World History in Late Ming China and the Perception of Maritime Asia* (Wiesbaden: Harrassowitz, 2020), 137; Huang Zhong, *Haiyu*, *juan xia*, 17b–18a.

supplemented with personal experience and consultation with locals. Navigation required the secular skills of the *huozhang*, but they also had to perform ritual duties, such as offering sacrifices and making sure that the compass was set up according to the correct rituals. Help and protection from deities were a significant aspect of navigating. The compass and rutters certainly played a valuable role in the daily work life of the *huozhang*, but we should not understand them as the only tools, knowledge, and help *huozhang* had at their disposal.

Huozhang were essential and skilled personnel aboard ships sailing on routes that went beyond those following the Chinese coast. Not every ship needed a *huozhang*, and when land was in sight, a *duogong* could ensure safe passage of the ship, while a *xianggong* might take charge of ritual practices. When *huozhang* were aboard ship, they shared navigation duties. Most ships had at least two *huozhang*. This might explain Xie Jie's mysterious description of a secluded room with the compass. One *huozhang* could carefully check the compass, while another could perform other duties.

With these essential duties came authority and responsibility. Even though *huozhang* might not have had the authority to organize the voyage, once the ship had set sail, they oversaw navigation and commanded other crew members to make sure the ship arrived at its destination. That duty included ritual practices as well as secular ones. A *huozhang* was more than just the person with the ability of using a compass; he had authority over the crew during ocean-going voyages.

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