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The Introduction of European Fortification in the Late Ming Period[1]

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Abstract: In the late Ming period, Xu Guangqi and other Catholic literati were actively involved with military affairs because of the invasion of the Manchu forces and the threat of uprisings. The story of how they imported European cannons and gunners from Macao is now quite famous. However, the introduction of European fortifications, mainly the *trace Italienne*, in the same period is still relatively unknown. Xu Guangqi and his student Sun Yuanhua exerted considerable efforts in advocating European-style bastions. Xu not only received help from Jesuits, but also support from some Fujianese who were familiar with *Intramuros*, the Spanish walled city of Manila. In addition to Xu and Sun, Han Lin and Han Yun (also Xu's students) prepared a Chinese treatise on European fortification architecture based on Italian sources and tried to put the knowledge into practice. Another relevant figure is Ma Weicheng, who allegedly directed the building of 32 angled bastions in three cities around 1640. Although a few recorded writings and practices of constructing European-style fortification appeared in the first half of the seventeenth century, soon afterwards the art of *trace Italienne* met its end prematurely in China. To a great extent, the swift collapse of the Ming dynasty eliminated the possibility of spreading the new defense technology. Throughout the eighteenth century, the Qing dynasty enjoyed long-term peace, and the warfare at the frontiers brought few threats to the city walls. There was thus little urgency to develop innovative defensive works and European fortification sunk into oblivion until the mid-nineteenth century.

Keywords: fortification, firearms, technology transfer, Jesuit, Ming history, military history

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In the first half of the seventeenth century, the Ming dynasty suffered from both domestic strife and foreign threats. Some Catholic literati, for example Xu Guangqi 徐光啟 (1562–1633) and Li Zhizao 李之藻 (1565–1630), made great efforts to study and adopt European military technology. Apart from importing cannons from Macao several times, the Ming government also recruited Portuguese gunners to train artillery corps. Meanwhile, Renaissance fortifications not only appeared in Macao, Penghu and Taiwan (built by the European maritime powers), but were also introduced in different ways to the inland provinces of China.

The study of European firearms during the period from the late Ming to the early Qing dynasties has long been a heated area of research and has produced significant findings.[3] Following Montecuccoli's aphorism, *l'attacco insegna la difesa* (the attack instructs the defense), there is a close relation between firearms and fortifications. Researchers have noticed the efforts of Xu Guangqi (Wang 1986; Wang 1998, 242–244) and Sun Yuanhua 孫元化 (Lin and Guo 1987; Huang 2001), who promoted the construction of *chongtai* 銃臺 (lit. artillery platform, i.e., bastion) with *xiyang fa* 西洋法 (European methods). However, much of the historical evidence concerning how the art of European fortification was introduced to China during the Ming-Qing transition remains to be analyzed. *Shouyu quanshu* 守圉全書 (A comprehensive compendium of defense) (1636) is the main source of extant literature introducing European fortification methods and thus deserves careful study. The Renaissance fortification built at the end of Chongzhen's reign (1628–1644) in Chinese mainland also remains to be studied. First, this paper explains how Xu Guangqi advocated the building of European-style fortifications. It also demonstrates the influence of his projects and explores the sources of his knowledge, which came from the Jesuits and from the people of Southern Fujian who were familiar with the Spanish fortress in Manila. Second, the paper surveys Sun Yuanhua's plans and practice of building artillery fortresses. Third, focusing on *Shouyu quanshu*, it discusses the book's compilation, its European sources, and the efforts of its authors, Han Lin 韓霖 and his brother Han Yun 韓雲, to promote the building of European-style fortifications. Fourth, it presents the whole story of Ma Weicheng 馬維城 who built a number of angled bastions[4] around 1640. Further, it discusses the spread of knowledge of European fortifications before the late Qing period. Finally, it provides a brief discussion about why the art of *trace Italienne* failed to be widely

[3] Especially the groundbreaking articles (1996–2012) by Huang Yi-Long 黃一農, some of which are listed in the references section of this paper.

[4] The angled bastion was called *ruijiao tai* 锐角台 in early-seventeenth century China. The modern Chinese term *lengbao* 棱堡 appeared in the early twentieth century and is probably a loanword from Japanese 稜堡.

adopted in the late Ming and Qing period. Drawing on historical materials, this paper aims to provide a broader foundation for further exploration of the historical significance of introducing European fortification to China.[5]

1 Xu Guangqi's defense project

1.1 New bastions for Beijing

In Renaissance Europe, fortifications underwent significant reform. In the mid-fifteenth century, heavy artillery posed a serious challenge to traditional defensive systems. Consequently, new fortifications were introduced to resist cannon fire. The bastioned system of fortification, or *trace Italienne*, slowly evolved and reached maturity around the 1530s, making for a much stronger defense. In the late sixteenth century, this system was widely adopted by western European countries so that the attackers and the defenders involved in a siege were equal in terms of technological means (Hall 1997, 158–163; Arnold 2001, 35–47). The bastioned system of defense was highly developed in the seventeenth and eighteenth centuries and then gradually became obsolete, although it remained a part of military engineering up until the late nineteenth century.

In September 1584, Matteo Ricci (1552–1610) made the following comment on Chinese fortifications:

> It is true that they have many fortresses and all cities have walls to defend against the bandits. The walls are not built with geometrical proportions and do not have traverses or moats.[6]

This was written only two years after Matteo Ricci arrived in China. Since he had not travelled outside of Guangdong Province, and had only visited Guangzhou 廣州 and Zhaoqing 肇慶, his comments were inevitably biased. However, he was keenly aware of the difference between the design of fortifications in Europe and China, that Chinese city walls were not built with geometrical proportions as the European ones. In other words, the cities were not prepared for defense against bombardment.

In April 1619, a large expeditionary force of the Ming dynasty suffered a crushing defeat against the Nurhaci in the Battle of Sa'erhu 薩爾滸. The Manchu army subsequently turned to offensive operations. On August 7 of the same year, Xu

[5] The short biographies of Xu Guangqi, Li Zhizao, Fan Jingwen 范景文, Sun Yuanhua, Kong Youde 孔有德, Han Lin and some other characters (except Ma Weicheng) can be found in English in Hummel 1943–1944.

[6] "verdad es que tienen muchas fortalezas, y las ciudades todas tienen sus cercas, con que se defienden del ímpetu de los ladrones: no son las murallas de proporción geométrica ni tienen traveses ni fosos." (Venturi 1913, 48), translated into English with the help of Dr. Rui Magone and Dr. Mónica Colominas Aparicio.

Guangqi, Vice Supervisor of the Household 少詹事, submitted a petition to the throne titled "Liaozuo dianwei yi shen shu" 遼左阽危已甚疏 (Liaodong is in considerable danger). Xu reported that the capital city was in urgent need of impregnable bastions to ensure its long-term security. He suggested building twelve large-scale bastions in the four directions of the capital. The bastions were to be built as high as the city walls and divided into three stories. The largest guns should be set on the first floor. On the second and third floors, the guns could be smaller. The diameter of the bastion should be several *zhang* 丈[7] (more than 10 m). In each bastion, there would be about 500 well-trained soldiers. Meanwhile, the old bastions (rectangular platforms projected from the walls) could be transformed into hollow three-story triangular bastions to house cannons (Xu 1984, 106–116). The triangular shape is characteristic of angled bastions.

In May 1621, the Ming army were repeatedly defeated in the Liaodong peninsula, losing Shenyang 沈陽 and Liaoyang 遼陽 successively. On June 8, Li Zhizao, Vice Minister of the Court of Imperial Entertainments 光祿寺少卿, submitted a petition titled "Zhisheng wuxu xichong shu" 制勝務須西銃疏 (Western cannons are indispensable to victories). In this petition, he suggested adopting European cannons, recruiting gunners from Macao, and asking the Jesuits, Manuel Dias the Younger (1574–1659) and Francesco Sambiasi (1582–1649), to come to the capital to teach the art of artillery technology (Xu 1984, 179–181). On June 15, Xu Guangqi submitted another petition titled "Jin shen yide yi bao wanquan shu" 謹申一得以保萬全疏 (Modest advice on devising the safest plan). He ascribed the defeats to the fact that the soldiers were stationed outside of the moats, and wrote that, out of fear, they disbanded upon seeing the enemy. Even more worrying was that all the firearms were abandoned to the enemy, thus leading to an inversion of power. Xu urged for a rearrangement of the cannons and for a defense of the city from within the shelter of its walls. He worked out three schemes, namely, to import European cannons from Macao, to bring craftsmen together to cast European-style cannons and to build bastions in the European style. He emphasized that the bastions attached to the city walls should be built to protect the cannons, so that the cannons could protect the city, and that in turn the city could protect its residents:

> A strong [European-style] bastion can be equal to tens of thousands of soldiers. Such a design is beyond my intelligence and is different from the bastions in the military region of Ji 薊鎮 (northeastern frontier of Beijing). This is what the European countries call the artillery fortress (*chongcheng* 銃城). (Xu 1984, 173–177)[8]

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[7] In the seventeenth century, 1 *zhang* was equivalent to about 3.2 meters.

[8] "一臺之強，可當雄兵數萬，此非臣私智所及，亦與薊鎮諸臺不同。蓋其法即西洋諸國所謂銃城也。"

The typical bastion in the military region of Ji is called a *kongxin ditai* 空心敵臺 (hollow bastion). It is a small two- or three-story square-shaped bastion and was designed by the famous general Qi Jiguang 戚繼光 (1528–1588). More than a thousand hollow bastions were built independently or attached to the Great Wall in the 1570s (Wang 1998, 237–238).

On June 20, 1621, following the petitions submitted by Li and Xu, Cui Jingrong 崔景榮, the Minister of War 兵部尚書, submitted a further petition to the throne to support Xu Guangqi's suggestion to build bastions in the European style. He suggested that "it is proper for the Ministry of Works to discuss it in detail and put it into practice." A decree was issued, declaring that "the Ministry of Works is required to discuss the bastions as soon as possible and provide feedback" (Xu 1984, 181–183). On June 28, Xu submitted another petition titled "Tai chong shiyi shu" 臺銃事宜疏 (Matters concerning bastions and artilleries), appealing for the immediate construction of bastions and casting of cannons, which are top priorities in the defense of a city. He argued that the person in charge of the construction must have mathematical expertise, and highly recommended Li Zhizao to take charge of this. Xu stated explicitly that the method could be learned from Europeans like Matteo Ricci, but that he had mastered only one or two per cent of the knowledge. Since Francesco Sambiasi and Manuel Dias were still in China, and had books with them containing relevant illustrations and descriptions, Xu Guangqi suggested inviting them as soon as possible in order to learn from their expertise. He further proposed that the defense of the capital required building six of the largest bastions, whose cost would be very high, but "since the task is significant and its influence will last, it is unwise to be economical." In particular, he asked for financial support from the emperor's private treasury (Xu 1984, 187–189). On July 13, Wang Zuo 王佐 (1553–?), Minister of Works 工部尚書, accompanied by Xu Guangqi, Li Zhizao and other officials, inspected the tower of the Xibianmen 西便門 (Western informal gate)[9] and discussed the defense plan using a wooden model of a bastion made by Xu Guangqi. They reached the conclusion that the tower on the wall of the outer city was too low and small to properly defend such a large area. It was thus necessary to first build two bastions in this place to provide support for each other. Later on, after consulting Li Zhizao, Xu Guangqi made a new wooden model of the bastion. Meanwhile, they devised a plan of how to build the bastions, attached to which was an inventory of the necessary construction materials, and submitted the plan to the Ministry of Works. Wang Zuo was very pleased with Xu Guangqi's project and said that the construction could start as soon as the expenditure was in place. On August 12, the project was slightly revised by the Bureau of Construction under the Ministry of Works 工部營繕司, before Li Zhizao, who had just been commissioned as Supervisor of Military Supplies 監督軍需, approved the

[9] The gate is at the northwestern corner of the outer city wall.

budget. To build one large bastion, the total cost of construction materials, freight and labor amounted to 45,000 silver taels (Xu 1984, 193–206).

According to Xu Guangqi's plan, the bastions would be built with brick and stone and be round in shape, so that they could fire the canons in three directions, and would be attached to the corner of the city wall in the fourth direction. The bastion wall would be four *zhang* high (10 m), one *zhang* thick (2.5 m) and the external diameter would be 15 *zhang* (37.5 m).[10] The bastions would be hollow and two stories high. On the first floor, 16 embrasures would be dispersed on three sides of the wall. On the top of the bastion would be a breast wall with 21 embrasures. At the center of the top platform, a three-story octagonal watchtower would be built, five *zhang* (12.5 m) high and four *zhang* (10 m) in diameter. There would be four embrasures on the two upper floors of the tower, respectively (Xu 1984, 193–202). The structure of Xu's circular bastion is somewhat similar to the artillery tower that was popular in mid-fifteenth-century France and Flanders (DeVries 2005).

In late August or early September, Xu Guangqi wrote another petition titled "Lüe chen taichong shiyi bing shen yujian shu" 略陳臺銃事宜並申愚見疏 (A humble suggestion on the bastions and the cannons) in which he analyzed the changing situation of offensive and defensive strategies for future wars. Considering the fact that the Manchu troops already employed light firearms (which had been seized from the Ming army) on the battlefields and were adept at the corresponding tactics, Xu predicted that when attacking cities, the enemy would first use cannons to destroy the parapets, making it difficult for soldiers on the city walls to either stand or defend. The enemy would then climb the walls. Therefore, the defense of a city required bastions as well as firearms, both large and small. Since the construction of bastions in the capital was crucial for the dynasty to sustain its rule, Xu again implored the emperor's private treasury to be allocated funding (Xu 1984, 206–209). In the same month, an official from the Remonstrance Bureau impeached Xu. In consequence, although this petition was finished, it was never presented to the emperor. Soon afterwards, Xu resigned on the pretext of illness. The project to construct new bastions in Beijing, which Xu Guangqi had painstakingly built up, came to a halt (Liang 1981, 142).

The Jesuits Manuel Dias and Niccolò Longobardi (1559–1654) also arrived in Beijing in 1621. Previously in 1617, Jesuits in Beijing and Nanjing had been sent back to Macao after the Nanjing Church Incident (1616). Capitalizing on the opportunity to import European cannons to China, Xu Guangqi and others helped the missionaries to regain permission to travel freely in China. From 1622 to 1623, Manuel Dias took part in several discussions at the Ministry of War. On August 26, 1622, Manuel Dias sent a letter from Beijing to Mutio Vitelleschi (1563–1645), Superior General of the Society of

[10] Xu Guangqi noted that for these bastions he used the local measurement system of Zhejiang. At that time, one zhang was about 2.5 meters (Academy of Military Sciences 1998, 873).

Jesus. The letter contains information on the technical help he was providing at court and remarks on the opportunities that this opened up to the Christian mission. Among other things, Dias also mentioned that it would be beneficial to send to the court some of the books on military engineering that were kept by the Jesuits in China (Leitão 2008). The books most likely dealt with artillery and fortifications. From 1623 to 1635, Manuel Dias was in charge of the missionary work as Head of the Vice-Province of China. During the period from the reign of Tianqi to that of Chongzhen (1621–1644), military aid in various forms turned out to be an important justification for the Jesuits being allowed to stay in China. João Rodrigues (1561–1633) accompanied the Portuguese gunners and their cannons from Macao to the north frontier. Alfonso Vagnoni (1568/1569–1640) and Johann Adam Schall von Bell (1591–1666) introduced European treatises on fortification and artillery to China. Schall von Bell even advised Chinese craftsmen in Beijing on how to cast cannons.[11]

Xu Guangqi never forgot his plan to build bastions. In December 1629, the Manchu troops approached Beijing for the first time. Xu Guangqi sketched out some defense strategies and proposed that the safest way to protect the capital would be to rely on large and small guns. As for the best location for the large bastions, one angled bastion should be constructed at each side of every gate tower on the city walls. Two more angled bastions were needed in the northwest of the inner city and one in the southwest of the outer city, where the walls were irregular (Xu 1984, 277–278).[12] In 1630, not long after the crisis, Xu (who was then Vice Minister of Rites 禮部侍郎) submitted a petition titled "Choulu zan dong choumou yi ji jin shu chuyan yibei zhanshou shu" 醜虜暫東綢繆宜亟謹述初言以備戰守疏 (The barbarians have temporarily withdrawn to the east, and precautions need to start immediately. A sincere expression of my former opinions on how to prepare for defense), in which the first suggestion was "to build bastions." He suggested the construction of two bastions in the shape of canine teeth at each of the thirteen gates of the inner and the outer city walls, and to attach hollow, triangular, three-story bastions to the outside of each of the 40 old bastions, which were usually one or two *li* 里 apart.[13] The key to this project was the immediate improvement of existing fortifications, which would not cost too much and could be done quickly, "only hoping that artillery fire can cover everywhere" (Xu 1984, 284–288). Obviously, by making use of European-style bastions, Xu wanted to eliminate "dead angles" to make full use of the firearms. This project, however, was not conclusive. Beijing failed to build a single European-style bastion before the end of Ming dynasty. Xu had submitted over 20

[11] For the Jesuits' involvements in military activities, especially fortification building in early modern Europe, see de Lucca 2012.

[12] The old map of Beijing shows that the southeast corner of the outer city is irregular, not the southwest one. The text might be a slip of the pen.

[13] One *li* equaled about 576 meters in the seventeenth century.

petitions to the emperor to advocate building fortifications and casting cannons. As Xu's student Han Lin commented:

> This is just like how the most spectacular skill can find no outlet for practice, or the most splendid music can be lost. Now the achievements of European cannons are known to all, but no one knows who has contributed to the achievements. The proposals of the bastions construction turned out to be of no avail in the end. (Han [1636] 2005, chap. 1, 28a)[14]

Xu Guangqi's project to construct bastions may not have been without influence. In 1630, Fan Jingwen 范景文 (1587–1644) was appointed Governor of Tongzhou 通州. He then submitted a petition to the throne titled "Yi jian ditai shu" 議建敵臺疏 (A proposal for bastion construction), in which he argued that since Tongzhou was a place of strategic importance near the capital, it was urgent to strengthen its defenses. He wanted to construct bastions at his own expense. Fan briefly explained that:

> The bastions will be attached to the outside of the city wall and will be hollow inside to house firearms, so that they can fire in three directions and work wonders. Our soldiers need not worry, for the enemies will not dare to approach the wall or they will be attacked immediately. This is the best way to protect the city. It is therefore [worth] saying that the city wall would be useless if there were no bastions, and the bastions would be useless if the design did not follow the standard. That is how the city walls will protect the residents and the bastions will protect the city walls. (Fan 1673, chap. 3, 16a–17b)[15]

In the same year, two bastions were built in Tongzhou. According to the gazetteer of Tongzhou of Kangxi's reign (1697), when Governor Fan Jingwen, Prefect Zhang Chun 張春 and Commander Yang Guodong 楊國棟 inspected Tongzhou together, they considered both the northeast of the old city and the southwest of the new city to be vulnerable to attack, so one bastion was constructed at each of these locations. The shape of the bastions was like a fan. The bastions were 12 *zhang* (approx. 38.4 m) wide, and 3.7 *zhang* (approx. 13 m) high. Each bastion had three stories and there were embrasures for firearms on each floor (Wu 1697, chap. 2, 4a–b). Meanwhile, cannons and *folangji* (breech-loading swivel guns) were installed to defend the city (Wu 1697, chap. 6, 16a). According to the gazetteer of Tongzhou in Qianlong's reign (1783), the bastion at the southwest of the new city had collapsed while the other one at the northeast of the old city was still as stable as ever (Gao and Jin [1783] 2005, chap. 2, 4b–5a). In the gazetteer of Tongzhou in Guangxu's reign, in the map of the city (Figure

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14 "乃屠龍之技無用，廣陵之散不傳。惟西洋大砲，功已見於天下，而不知誰之功。銃臺之議，終作道旁之築。"

15 "敵臺者，緊附城外，虛中以安神器，三面橫擊，出奇無窮。在我上下無畏，而敵不敢逼，一逼立遭糜爛。護城之法，莫妙於此。故曰有城無臺，猶如無城，臺非其制，猶如無臺。是城所以衛人，而臺又所以衛城也。"

1), the bastion attached to the northeast of the old city was triangular while the one attached to the southwest of the new city was fan-shaped.[16] Both were absent on maps in former gazetteers (Gao and Wang [1879] 1968, maps, 3a–4b).

The fan-shaped bastions in Tongzhou no longer exist. According to local gazetteers, the size and structure of the fan-shaped bastion were similar to those of the circular bastions in Xu Guangqi's project. Fan Jingwen paid special attention to the new methods of fortification. His book, *Zhanshou quanshu* 戰守全書 (Complete guide to attack and defense) (1638), included Xu Guangqi's petitions to the emperor about the construction of bastions, the design of circular bastions and the documentaries recording construction materials and budget, which might have been taken from *Xushi pao yan* 徐氏庖言 (Xu's military writings, ca. 1628) (Fan [1638] 1997, chap. 10, 25a–46b). This book also includes *Chongtai shuo* 銃臺説 (On artillery fortresses) by He Liangtao 何良燾, which illustrates in detail the design and construction method of European fortresses (Zheng 2012). The hollow, fan-shaped bastions built by Fan Jingwen in Tongzhou seem to partly realize Xu's project of bastion construction.

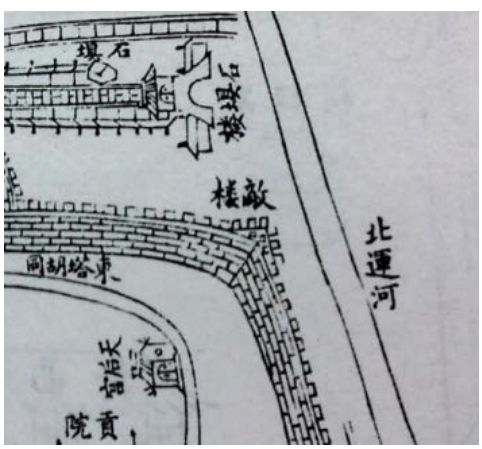

Figure 1a: The bastion in the northeast of the old city of Tongzhou.

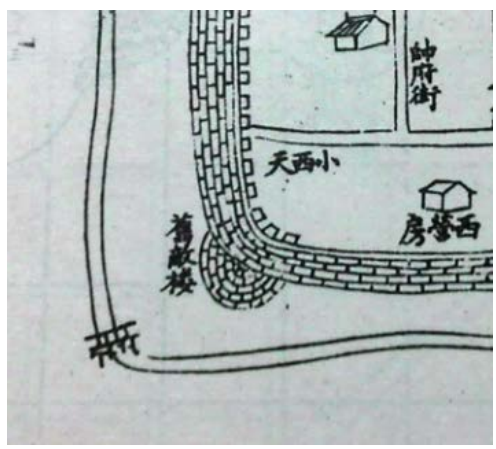

Figure 1b: The bastion in the southwest of the new city of Tongzhou.

1.2 Message from Manila

There are two main sources from which Xu Guangqi obtained his knowledge of European fortifications: one is the Jesuits discussed above, while the other, which has usually gone unnoticed, is the merchants of Fujian and Guangdong, who commuted between Manila and their home.

In 1567, the Ming government legalized overseas commerce in Yuegang 月港 (Port

[16] It should be noted that the shape and location of the bastions on the map of the 1879 edition are different from the corresponding text of the 1783 edition.

of Yue) in Zhangzhou Prefecture 漳州府. Consequently, it became much more popular for people in south Fujian and east Guangdong to travel abroad. During the last thirty years of the sixteenth century, it is estimated that nearly 200,000 journeys were made from the Port of Yue to Manila with about 630 junks. During the reign of Wanli (1573–1620), the Chinese population in Manila (mainly Fujianese) remained between several thousand to twenty or thirty thousand, the majority of whom came from Zhangzhou and Quanzhou 泉州, two prefectures in southern Fujian (Huang 2008a).

According to the record made by Shen Hongzhi 沈弘之[17] (ca. 1635), who was from Jiading 嘉定, in the period from 1604 to 1605 a merchant, Wu Jicai 伍繼彩, heard that the "*chongcheng* (artillery fortress)" at the eastern gate of Manila was very powerful and that it had caused the death of tens of thousands of Chinese in 1603.[18] He subsquently began an investigation and reported that the fortress had three stories: huge cannons were set on the first floor and the cannons above became smaller as the structure grew higher. Wu then secretly shipped back to China a craftsman and his son, whose surnames were Li. The father and son came from Fujian and were skilled at casting cannons. It is highly probable that they used to work for the Spanish in the Manila foundry. Wu brought them to Beijing and contacted the Ministry of War, hoping to perform an outstanding service by offering their services, but was refused. Holding office in Beijing at the time, Xu Guangqi happened to become acquainted with Wu Jicai and learned the specifications of European artillery and fortresses. Shen recounted:

> At that time, Xu Xuanhu (the style name of Xu Guangqi) had just received his *Jinshi* title (Metropolitan Graduate) and held a position in Hanlinyuan (the Imperial Academy). He was impressed by Wu Jicai and made his acquaintance. Subsequently, Xu learned the knowledge [of fortifications] from Matteo Ricci. In the 46th year of Wanli's reign (1618), the Nurhaci rebelled in Jianzhou and conquered the strongholds in the Liaoyang region. Our army marched to fight with them and suffered disastrous defeat. In the 47th year, when Xu, who was then Vice Supervisor of the Household and Investigating Censor of Henan responsible for training soldiers, invited Wu Jicai to discuss casting heavy cannons and asked him to visit the Lis. Wu Jicai left and a year later had not returned. Xu sent a letter to the provincial governor of Fujian to inquire about Wu, only to learn that the father and the son had gone [died?]. Wu Jicai therefore employed another six skilled craftsmen and returned, but Xu had resigned his military post by the time Wu arrived.

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[17] Shen Hongzhi was a countryman of Sun Yuanhua, and used to be a staff officer of Yuan Chonghuan 袁崇煥 in the 1620s. Fan Jingwen's work *Zhanshou quanshu* drew a lot of materials from Shen's work *Wushi quanshu* 武事全書 (On the military) including Shen's review of the introduction of European cannons and fortifications by Xu Guangqi and his contemporaries (Fan [1638] 1997, chap. 10, 46a–50a; chap. 12, 28a–29b). For Shen's life, see Cheng and Yang 1882, chap. 19, 14b.

[18] For the massacre of 1603, see Borao 1998.

(Fan [1638] 1997, chap. 10, 46a–50a)[19]

In 1619, Xu Guangqi received permission to train soldiers in Tongzhou. In a report concerning a number of urgent affairs, Xu recommended Wu Jicai, a native of Fujian, to recruit craftsmen. Wu knew of others from Fujian who were able to cast European cannons, as well as an instructor surnamed Lin 林. Xu believed it was necessary to send Wu off immediately to find these craftsmen (Xu 1984, 126). His words were in accord with Shen's account. "An instructor surnamed Lin" seems to refer to the same ones as "the Lis." Lin and Li are similar in pronunciation, so a mistake was made.

In 1621, Xu Guangqi also mentioned that it was not only the foreign courtiers (i.e. the Jesuits) who knew how to construct European artillery fortresses; merchants from Fujian and Guangdong also knew how to do this. He wrote that Huang Kezuan 黃克纘 (1550–1634), Minister of Justice, and Chen Liangcai 陳亮采, Surveillance Commissioner of Zhejiang, were especially familiar with it. Chen left a letter for Huang, and also through many hands sent a letter to Cui Jingrong, Minister of War, sparing no effort to advocate the construction of fortifications, and claimed that it should be planned immediately (Xu 1984, 173–177).

The merchants, Wu Jicai, and the father and son surnamed Li (or Lin), were already familiar with fortifications, having seen the one that was built in Intramuros (lit. within the walls), the colonial city of Manila (Reed 1992, chap. 5). Both Huang Kezuan and Chen Liangcai were from Jinjiang County 晉江縣, Quanzhou Prefecture, where there were many merchants and craftsmen who traveled to Southeast Asia to make a living. Chen Liangcai once wrote a preface to *The Seven Things to Overcome* 七克 for the Jesuit Diego de Pantoja (1571–1618), where he mentioned that when he was young, "some people from my hometown went abroad and stayed with people from the Far West. When they came back, they told me about Christianity" (Chen [1614] 1978, 701). In 1619, Huang Kezuan was commissioned to assist with military affairs in Beijing. He ordered his nephew to recruit from Tong'an County to Beijing 14 people who were good at casting Luzon bronze cannons. In the following year, they cast 28 cannons, 7 of which were sent to the frontiers of Liaodong. Some of these craftsmen would have learned the technology of casting cannons at the Spanish foundry in Manila (Huang 2008a). Both Chen and Huang were somewhat knowledgeable about European countries as they had lived in a center for overseas trade and supported Xu Guangqi's suggestion to construct bastions. In 1621, Su Yan 蘇琰, who also came from Jinjiang County and served as Investigating Censor 監察御史, submitted a petition to the court "to state that

[19] "時玄扈徐公方成進士，居翰林，奇其人而識之。已而徐公又從西洋利瑪竇得其説，益講明之。迨萬曆四十六年建州夷奴兒哈赤亂，寇陷遼陽邊堡，我師征之，大爲所敗。四十七年，徐公以詹事府少詹事兼河南道御史練兵，招繼彩至，議欲鑄大銃，令訪李姓者。繼彩往一年不返。徐公貽書閩撫促之，則李姓父子已(先)[死？]，繼彩購他工之能者六人至。則徐公已謝兵事矣。"

the method to build the artillery fortress in Luzon can defend against an army of a hundred thousand soldiers" (Wen et al. 1962, 969–970). He received no response.

The Chinese expression for fortification or bastion, "*chongcheng,*" could derive from the name of the fortifications in Intramuros. These were known as "the fortresses of Luzon (*lüsong chongcheng* 吕宋銃城)" in Southern Fujian. Later on, the expression was used to refer to artillery fortresses or bastions in general. Xu Guangqi's projects to build large three-story bastions and circular bastions attached to the city walls seem to have had some connection with the fortress in Manila.

During the 1620s, to defend against Chinese pirates and the Dutch East Indian Company, who had powerful ships and guns, the local governments of Southern Fujian and Eastern Guangdong built a number of fortresses along the coast, most of which were called "*chongcheng*" or "*chongtai*" (Pang 2011). For example, in 1623, Lieyu Chongcheng 獵嶼銃城 was constructed in Nan'ao County 南澳縣, Chaozhou Prefecture 潮州府. In 1627 and 1629, Zhegukou Chongtai 鷓鴣口銃臺 and Liushi Chongtai 溜石銃臺 were constructed respectively in Tong'an County, Quanzhou Prefecture. Around 1630, Dani Chongcheng 大泥銃城 and Xiwei Chongcheng 溪尾銃城 were constructed in Haicheng County 海澄縣 (where the Port of Yue was located), Zhangzhou Prefecture. In other areas, similar fortifications were usually called *bao* 堡, *ditai* 敵臺, or *paotai* 砲臺. To determine whether the artillery fortresses built in the late Ming period in Southern Fujian were modeled on European fortifications (such as those in Macao, Manila and the Dutch forts in Penghu and Taiwan), it is also necessary to conduct field surveys to find archeological evidence. The relative research is still in the preliminary stage.

2 Sun Yuanhua's proposal for and practice of building fortifications

Sun Yuanhua (1583–1632), from Jiading County, entered the county school of Shanghai aged 19 and became a student of Xu Guangqi. He had converted to Catholicism before passing the Provincial Examination in 1612 (Zhang [1638] 1997, chap. 12, 14a–26b). Sun joined the government in 1622 when he was already well known for his knowledge of mathematics and firearms. He held several positions as a staff officer and middle ranking official in the Ministry of War. In 1630, having been promoted to Grand Coordinator of Denglai 登萊巡撫 (in charge of the Dengzhou and Laizhou areas in eastern Shandong Province, close to Liaodong frontier), he recruited Portuguese gunners to train the artillery corps. Two other Catholics, Wang Zheng 王徵 (1571–1644, inspector of the Liaodong region 遼海監軍道僉事) and Zhang Tao 張燾 (?–1632, vice-commander of Dongjiang 東江前協副總兵), helped him. Dengzhou 登州 thus became "the stronghold of Western knowledge in the East" (Fang 2008, 543–544). Unfortunately, in 1632, after the Wuqiao Mutiny 吳橋兵變, a rebellious army of

well-trained artillerymen led by Kong Youde 孔有德 and Geng Zhongming 耿仲明 invaded Dengzhou. Sun was captured and subsequently released by the rebels (his former subordinates). Four months later, Sun Yuanhua and Zhang Tao were executed in downtown Beijing for neglect of duty, while Wang Zheng was exiled. From that time, influential pro-Catholic figures disappeared from the Ming army.[20] Consulting the literature and investigating extant relics, this section will concentrate on Sun Yuanhua's promotion of the construction of European fortifications.

At the beginning of 1622, Beijing was in a state of shock at the loss of Guangning 廣寧 to the Manchus, which was a crucial stronghold in Liaodong. Sun Yuanhua had just embarked on a journey to Beijing to take part in the Metropolitan Examination 會試 when he heard the bad news. He travelled quickly to the capital and wrote two open letters on March 16 and 18, titled "Fangshou jingcheng jie 防守京城揭 (To defend the capital)" and "Bingfang bianguan jie 並防邊關揭 (To defend the frontiers)," respectively. The letters briefly explained that the main purpose of constructing fortifications was to make full use of weapons. Since cannons set on a bastion can kill enemies from long distance, and no other weapon could reach as far, he elaborated on the methods of how to construct fortresses and cast cannons (Gui 2006).

In the first letter, Sun wrote that:

> Cannons are used to increase the power of the soldiers while bastions are used to increase the power of the cannons. However, the bastions have a certain shape and size. Special standards should be applied to determine whether the outline of a bastion should stretch or zigzag. Meanwhile, there are rules to follow in deciding where the inside of the bastion should be hollow and where it should be solid, where the troops should be stationed and where houses should be located. If the bastion cannot be constructed properly, it will not be suitable to house cannons.[21]

Besides,

> When enemies approach the bastion, our soldiers will be above while the enemies will be below. We could take advantage of crossfire and use other ways [to defeat them]. These methods will be effective because cannons work well with bastions.[22]

In the second letter, he further stated, "nowadays, soldiers cannot fight without cannons and cannons are useless without bastions" (Han [1636] 2005, chap. 1, 36a–41a). Sun demanded a military post and wanted to oversee the construction of the bastions. He suggested surveying the topography of the capital, and of each pass to the east of

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[20] One scholar has made excellent research on Sun's life and his influence (Huang 2001).

[21] "故銃以強兵，臺以強銃。然臺有一定之形勢面角，有一定之周徑廣狹，其直其折其平，有繩矩；其虛其實，其屯營其更舍，有方位。稍不合法，不可用銃也。"

[22] "即敵已至臺，而我高彼下，有互擊法，有聯擊法，又皆銃臺相乘以爲功者。"

Xuanfu 宣府 (northwest frontier of Beijing), using what was at hand, modifiying what required changing and constructing new bastions if necessary. Soldiers and officers would thus be taught how to make use of bastions and cannons.

Sun Yuanhua failed that year's examination. On March 10, Hou Zhenyang 侯震暘, who was Supervising Secretary of the Office of Scrutiny for Personnel 吏科給事中 and also from Jiading, submitted a petition to recommend Sun:

> China is superior in firearms. However, in field operations firearms must be carried on carts; when they are used to defend a city, they must be installed on bastions. . . . As to the methods to construct bastions, the *Juren* 舉人 (provincial graduate), Sun Yuanhua, can explain it in detail. It is urgent to recruit him to construct bastions according to the standards. (Wen et al. 1962, 991)[23]

Soon afterwards, with the help of Sun Chengzong 孫承宗 (1563–1638), the Grand Secretariat of the East Hall 東閣大學士, Sun Yuanhua was appointed Logistics Staff Officer 軍需贊畫. He went immediately to the Shanhai Pass 山海關 and investigated the topography of its environs. He then wrote to Wang Zaijing 王在晉 (1567–1643), the newly appointed Military Commissioner of Liaodong. His suggestions, among others, included how to construct bastions at the Sandao Pass and how to defend Yipianshi Pass. However, "none of his suggestions were accepted by the authorities" (Zhang [1638] 1997, chap. 12, 16a).

On May 31, 1622, Sun Yuanhua wrote in his report "Yi Sandaoguan wai zhu chongtai cheng" 議三道關外築銃臺呈 (On the construction of bastions around the Sandao Pass):

> The boundary of the Sandao Pass is ten *li* to the west of Yipianshi, and fifteen *li* to the east of the Shanhai Pass. There are steep mountains to the north while the sea is at the south. We can see the enemies from there but they cannot besiege us. Furthermore, with a river on the left and fields on the right, a garrison can encamp, cultivate the land and carry out ambushes there. The army can get their water supply from the river. In the transition of summer and autumn, the river that overflows can also defend against the enemies. No terrain can be more advantageous than that of this place.[24]

On June 14, Sun submitted another report to his superior, Wang zaijin, titled "Shang Wang Jingtai qi ding Sandaoguan shanzhai chongtai jie" 上王經臺乞定三道關山寨銃臺揭 (On the construction of fortresses at the stronghold of the Sandao Pass). In the

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23 "中國長技在火器，然火器用以臨敵，必藉車，用以守城，必藉臺。……其銃臺之法，宜講精之者，現有舉人孫元化，急宜留用，照法建制。"

24 "獨一片石之西十里，山海關之東十五里，適當三道關之口外，北倚峻嶺，南望滄溟，我得見敵，敵不得困我。而左水右田，可盤營，可屯地，可設伏。就河而深之，可濟渴。夏秋之交，盈渠汪洋，可遏渡。地利山形，無過於是。"

report, he invited Wang Zaijin to the Sandao Pass in person, "if you look from the top of the mountain, you will find that in the vicinity, no other place has such advantages than this one." He earnestly claimed that:

> I dare not construct any fortress where the terrain is not suitable, and I dare not cast cannons before the fortress is constructed. It is neither because I am reluctant to build fortresses nor because I want to hide the [knowledge of] cannons. I am just afraid that a fortress built at an unsuitable place will be constructed for the enemies, and that without the protection of a fortress the cannons will become the enemies' weapons. (Han [1636] 2005, chap. 2, sec. 1, 65b–70a)[25]

Three months later, in autumn 1622, Wang Zaijin was deposed. The new Military Commissioner Sun Chengzong went to the Shanhai Pass to take over affairs, and Sun Yuanhua was asked to survey the topography, station troops between the mountains and the sea, construct fortresses at places of strategic importance and manage the weapons and gunpowder (Wen et al. 1962, 1316, 1444).

Sun Yuanhua offered a series of suggestions, including building fortifications for Yipianshi, which were all accepted by the Grand Secretariat (Sun Chengzong). He then began to construct fortresses and cast cannons. The defense works were finished one after the other. In 1623, he further suggested that "soldiers could only defend against enemies by relying on natural barriers at the Sandao Pass in the mountain and the Zhima Bay at sea. The strongholds can be built at these places" (Gui 2006, 153–162). In the same year, after disagreeing with his superior, Sun Chengzong, Sun Yuanhua resigned. At that time, the Ministry of War also wanted to import European cannons, so Sun Yuanhua was called back to Beijing and formally appointed as General Servant of the Ministry of War 兵部司務. In 1624, he was promoted to secretary at the Bureau of Operations of the Ministry of War 兵部職方司主事. This ended the first period of Sun Yuanhua's role as an officer at the frontier.

In "Chongtai tushuo" 銃臺圖説 (Illustrated guide to the artillery fortresses, September 15, 1622), Sun Yuanhua presented a concise explanation of how to operate European cannons and also designs for European-style bastions. Because the enemies who remained close to the foot of the walls could not be shot from the traditional bastions on the city walls, Sun argued that bastions should protrude from the walls with an angled front, exposing the enemies to fire. This would eliminate the dead angle for the defenders and the enemies would no longer be able to approach the walls. He also said:

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25 "地不善必不敢築臺，臺不成必不敢造銃，非吝臺而私銃也，政恐以不得地之臺，爲敵設壘，以不得臺之銃，爲敵助器也。"

> At present, the bastions should be constructed with small angles, as illustration 1. The four corners of the city wall should have large angled bastions, as illustration 2. To build fortresses, we can either construct large angled bastions at the four corners, as illustration 3, or just construct small angled bastions along the wall in the four directions, as illustration 4. The city walls could be thin while the angled bastions should be solid and thick. For a fortress, both the wall and the bastions should be solid and thick. In order to defend the city, heavy guns are installed [at bastions] in the corners of the city walls, while matchlocks and bows are used on the walls to aid the cannons. Heavy guns are set inside the fortress while matchlocks and bows are used [on bastions] at the corners. Baskets of earth should be set beside the heavy guns, both protecting the guns and acting as the parapet. . . . Building angled bastions is a European practice. (Han [1636] 2005, chap. 2, sec. 1, 33a–35b)[26]

Judging from Sun's description and the illustrations (Figure 2), the large angled bastion is a kind of solid bastion, while the small ones should be a variant of the old bastions. The basket of earth should be a gabion, which was conventional equipment for artillerymen at that time in Europe.

On Febuary 24, 1626, Sun Yuanhua presented a petition to appeal for the construction of European-style bastions in the capital. He briefly stated:

> The shooting range of Chinese cannons is short, while the range of European guns is long. That is why European artillery must be adopted. Nonetheless, if European artillery is used on the ground, it will serve the enemies if we cannot hold our position, so it is necessary to construct bastions. However, the vanguard of the enemies will approach city walls with scaling ladders and shields while the follow-up troops will approach with strong bows and arrows. Even if we had long-range cannons, how could they shoot [the enemies near the wall]? In this situation, both the city wall with squared bastions at the corners and the hollow bastions are too weak. So European-style bastions must be adopted. (Wen et al. 1962, 3203)[27]

At the same time, the Battle of Ningyuan 寧遠 broke out. In this siege war, Yuan Chonghuan 袁崇煥 (1584–1630), commander of Ningyuan, deployed 11 European cannons on the city walls (one from Macao and ten from the wreck of a European vessel at the Guangdong coast), and the Ming garrison narrowly won over the Nurhaci-led Manchu army (Huang 2004a). This led to the popularization of European

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[26] "今築城則馬面臺宜爲小銳角，如第一圖；城之四隅，宜爲大銳角，如第二圖；若止築臺，則或於四隅爲大銳角，如第三圖；或於四面各出小銳角，如第四圖。城虛而銳角皆實，故城薄而銳角皆厚。臺則體與角皆實皆厚矣。城用大銃於角，而鳥銃、弓矢助之於牆。臺用大銃於中，而弓矢鳥銃助之於角。用大銃之處，旁設土筐，一以防銃，二以代堵……角之銳也，外洋法也。"

[27] "中國之銃，惟恐不近，西洋之銃，惟恐不遠，故必用西洋銃法。若用之平地，萬一不守，反藉寇兵，自當設臺。然前隊挾梯擁牌以薄城，而後隊強弓勁矢繼之，雖有遠銃，誰爲照放。此非方角之城、空心之臺所可禦，故必用西洋臺法。"

muzzle-loading cannons. However, the weak points of the traditional city defense, which restricted the power of cannons, were exposed (see section 6). Just after the victory, Sun Yuanhua submitted a petition proposing a retrofit of the fortifications outside the Shanhai Pass:

> Alterations should be made to the old bastions (rectangular platforms projected from the city walls), as well as the square platforms in the four corners, according to the European method. The claw-shaped bastions could protect each other. (Wen et al. 1962, 3269)[28]

He also requested to go to the frontiers to help with construction.

The emperor issued a decree that ordered Sun Yuanhua to rush to Ningyuan to discuss casting cannons and constructing bastions with Yuan Chonghuan. Sun Yuanhua then once again traveled around the environs of the Shanhai Pass to discuss with Yuan Chonghuan how to reinforce the north frontier and was put in charge of casting cannons. Three months later, he returned to Beijing. In the spring of 1627, an official accused Sun Yuanhua of having used illegal methods to secure the position of staff officer and Sun was punished by "preserving his official identity but being deprived of his post." In autumn, Yuan Chonghuan was also deposed on the charge of failing to rescue Jinzhou 錦州 (Huang 2001). The existing city walls of Ningyuan (now named Xingcheng 興城) were rebuilt during the Qing dynasty. The four corners of the city walls remained in the traditional style with square bastions (Liu 1989, 96). There is no evidence that angled bastions had been built in Ningyuan in the late Ming period.

Around the Shanhai Pass, Sun Yuanhua may have taken part in the construction of fortifications in three places. From south to north, they are located at the Jiao Mountain 角山, the Sandao Pass and the Water Pass of Jiumenkou 九門口, also named Yipianshi 一片石.

Sun Yuanhua's old colleague, another staff officer, Mao Yuanyi (1594–1640), reported:

> North of the Beishui Pass is a hill that overlooks the town. The staff officer Sun Yuanhua built the eleventh fortress there and equipped it with large cannons. The fortress would then control the foot of the hill. The Sandao Pass in the mountains can house tens of thousands of soldiers. On the pass, one can see for dozens of *li*, while from the outside of the pass, not one of our soldiers can be spotted. The construction was initiated by Sun Yuanhua in the hope of creating a place where troops can be dispatched spontaneously, and was finished by military officer Gao Guozhen and Liu Yuanjin, who built the gate of the pass, the watchtowers and arranged troops to strengthen the defense. (Mao [1638]

[28] "馬面臺、四角臺皆照西洋法改之，形如長爪，以自相救。"

1997, chap. 48, 3a)[29]

This is taken from the petition to the throne which Mao Yuanyi wrote on behalf of his superior Sun Chengzong in the 1620s. Shen Hongzhi, who, like Sun Yuanhua, came from Gaoqiao town in Jiading County, provided an account that differs somewhat from Mao's:

> Sun Chuyang (the courtesy name of Sun Yuanhua), like Xu Guangqi, also learned about cannons and bastions from the Europeans. When Sun went to Beijing to take the Metropolitan Examination, he met Wu Jicai, who arrived after Xu Guangqi had resigned. In the first month of the second year of Tianqi's reign (1622), Guangning was lost. The whole court was so shocked and frightened that no one knew what to do. Since he had failed the exam, when the enemy approached it was recommended that Sun assist with the military affairs of the Shanhai Pass and be put in charge of casting cannons, because he had claimed that he could cast cannons and construct fortresses. However, Wu refused to work for him, so Sun had Li Fan from Baoding cast the cannons. Sun himself also designed the fortress outside the Sandao Pass, which was built perfunctorily. Nevertheless, the enemy did not pass [through this route], and the fortress and the cannons were wasted. Therefore, what Sun had done was not as useful as Xu had planned. I detailed all this because it is what I saw. (Fan [1638] 1997, chap. 10, 49b–50a)[30]

Considering the two quotations above, it can be concluded that the construction of the fortress at the Sandao Pass was first proposed by Sun Yuanhua and completed later by Gao Guozhen and Liu Yuanjin. The fortress at the Sandao Pass is now destroyed and the walls have almost disappeared (Shen 2002, 33). A field survey is planned to determine whether such an angled-bastion-style fortress existed. It also remains to be confirmed whether "the eleventh artillery fortress (十一號臺)" is "the eleventh fortress east of the Jiao Mountain (角山東十一號臺)" recorded in the gazetteer of Yongping Prefecture during Kangxi's reign (Song and Zhang 1711, chap. 9, 9b). The latter is located 12 *li* (approx. 6 km) north of the Shanhai Pass. It is a typical hollow bastion in Qi Jiguang style and seems to have none of the characteristics of a Renaissance fortress (Shen 2002, 82–84).

Sun Yuanhua proposed to Wang Zaijin and Sun Chengzong that the fortifications at Yipianshi should be reinforced. Yipianshi lies thirty *li* (approx. 15 km) from the north of the Shanhai Pass where relics of the Ming Great Wall can be found. Researcher has

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[29] "北水關之北，外有嶺，下瞰城，以贊畫孫元化重築十一號臺，安天字號砲于上，遂可下瞰外嶺。三道關夾眾山，可容萬兵，上俯覽數十里，而外不能窺一騎。初以贊畫孫元化開門爲出奇之地，再以路將高國禎、劉元藎築關門，爲樓櫓，置城守，以嚴其防。"

[30] "至若孫初陽之造銃臺也，則亦得於西洋人，與徐公當。徐公罷，而繼彩至。初陽以會試至京遇之。天啟二年正月，廣寧失，舉朝震恐，莫知所措。初陽下第，因自言能鑄銃築臺，洎虜入，遂薦用之山海關贊畫，徑鑄銃。而繼彩不肯爲用，初陽乃得保定人李範鑄之，而自以己意築臺於門外三道關，苟且塞責而止。然虜亦不至，臺與銃俱廢。又不及徐公説矣。此皆予見而知之者，故悉之。"

noticed that the repaired fort-bridge 城橋 at Jiumenkou in Yipianshi is similar to the small-angled bastion depicted in the fourth illustration of "Chongtai tushuo" in *Xifa shenji* 西法神機 (Western masterpieces of firearms) by Sun Yuanhua (Dahaoheshan 2010). The only extant edition of *Xifa shenji* was published as late as 1902. In this edition, the four illustrations (different types of bastions) of "Chongtai tushuo" seem to have been complemented by the editor who did not have Sun's own drawings. The first and third illustrations are obviously unreliable while the other two illustrations are out of proportion (Figure 3) (Sun [1902] 1994, 1249–1250). According to what is cited from Sun Yuanhua's "Chongtai tushuo" in *Shouyu quanshu* (1636), the design of "small-angled bastions" 小銳角 (Figure 2) (Han [1636] 2005, chap. 2, sec. 1, 35b) is identical to the existing bastions on the walls of the Water Pass at Jiumenkou (Figure 4).[31]

Figure 2: "Chongtai tushuo" in *Shouyu quanshu* (1636).

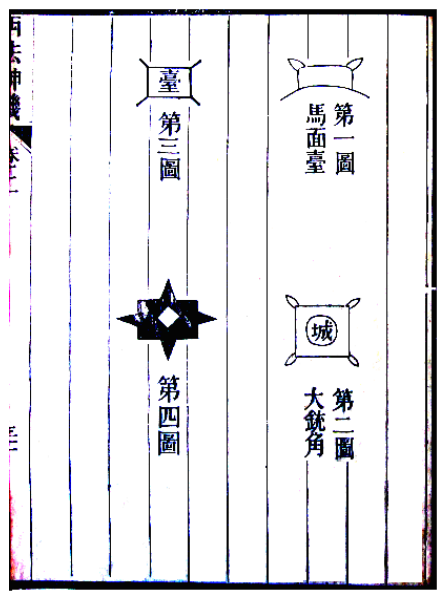

Figure 3: "Chongtai tushuo" in *Xifa shenji* (1902).

In the late 1980s, the site of the Water Pass at Jiumenkou was restored. According to the excavation report, there are eight fusiform piers built equidistantly on the river bed of the 103-meter wide Jiujiang River 九江河. The piers and platforms on both shores of the river form nine bridge openings. Each of the piers is 23.1 meters long and 6.46 meters wide, while each of the bridge openings is 5.74 meters wide (Feng and Xue 1991, 193–194; Shen 2002, 95). A stele from 1615 was discovered at the same place. The inscription on the stele states that in the spring of that year, over 700 soldiers constructed

[31] The author would like to thank Dr. Ren Congcong 任丛丛 for drawing this plan based on the satellite photo of 2017 from Google Map.

this bridge from the south bank to the third opening counted from the north. The height of the wall is three *zhang* and two *chi* (crenels included). The bottom width is four *zhang*, while the width at the top is three *zhang* and six *chi*. The breakwater is one *zhang* and two *chi* high (Feng 1996, 76; Shen 2002, 376–377). This being so, the breakwaters built in 1615 were only one third of the height of the bridge. The excavation report does not record the original height of the breakwaters before they were restored. After restoration, the breakwaters are as high as the bridge itself (10 meters or so, crenels included), forming fifteen equilateral-triangle platforms on both sides of the bridge. The triangular platforms are the only instances of their kind in existing defense works of the Ming dynasty.

Figure 4: The plan of the water pass at Jiumenkou.

Generally speaking, the breakwaters are only built on the side of the wall facing the upper reaches of the river to protect the piers. Some bridges have breakwaters on both sides as a precaution against the countercurrent coming from the lower reaches. As an ephemeral river, the Jiujiang has no countercurrent, so designing piers at Jiumenkou as fusiform (sharp at both ends) is more likely to have been for military defense purposes. If the shape and structure of the fort-bridge at the end of the Ming period had been the same as it is today after restoration, it is highly probable that the breakwaters underwent massive reconstruction after 1615, and the small-angled bastions proposed by Sun Yuanhua were adopted during the 1620s.

3 The Han brothers and European fortifications

Among Chinese Christians of the late Ming period, the brothers Han Yun and Han Lin from Jiangzhou 絳州 are two key figures who symbolize the prosperity of Catholicism in Shanxi Province. Han Yun was a *Juren* in 1612, and later served as Subprefectural Magistrate of Xuzhou 徐州知州, the senior official of the Court of the Judicial Review in Hanzhong 漢中司理. Han Lin (ca. 1598–ca. 1649) received his *Juren* title in 1621. The brothers' father Han Jie 韓傑 (1557–1608) accumulated a vast fortune in the textile industry by running dye houses in Songjiang 松江 and Suzhou 蘇州 (Li [1611] 1997, chap. 85, 3a–9a). When they were young, the brothers lived with their father in Songjiang Prefecture and enrolled in the county school of Qingpu 青浦 (next to Shanghai). Han Lin recalled that when they were young, the brothers learned military

strategies from Xu Guangqi. "We learned that firearms are the most powerful among all the facilities for offence and defense" (Han [1636] 2005, chap. 5, sec. 4, 51a–b). So the brothers must have known Xu Guangqi at an early age in Songjiang. Han Yun converted to Christianity earlier and must have been baptized before 1620. At the end of 1620, Han Yun invited a Jesuit, Giulio Aleni (1582–1649), to Jiangzhou to baptize his family members, and this should also have been the time when Han Lin converted. Both Han brothers were devout believers. Their substantial wealth, broad social network and huge efforts to support the Church contributed to the rapid expansion of Catholicism in Shanxi Province. Jiangzhou grew to be one of the most prosperous parishes of interior China during the Ming-Qing transition (Huang 2008b, 229–253).

Although Han Lin's political career did not progress after he passed the Provincial Examination, he developed impressive social connections and enjoyed huge fame. Moreover, he intended to take on important posts and put statecraft into practice. His biography reports that he "learned military strategies from Xu Guangqi, and learned artillery from Gao Zesheng" (Liu and Tao 1670, chap. 2, 56–57). Here "Zesheng" 則聖 is the courtesy name of the Italian Jesuit, Gao Yizhi 高一志 (Alfonso Vagnone). Vagnone arrived in China in 1604, took the name of Wang Fengsu 王豐肅 and lived in Nanjing. In 1616, he was arrested during the Nanjing Church Incident and sent to Macao in 1617. He returned to the mainland in March 1624 and changed his name to Gao Yizhi. In December, Vagnone arrived in Shanxi and stayed there for 15 years to propagate Christian beliefs. During this time, he also published more than 10 works (Pfister 1932, 85–95; Dehergne 1973, 278). The Han brothers regarded him as a teacher and assisted him in editing books and expanding his missionary work.

3.1 A Chinese treatise on European fortifications

Han Lin was a prolific author. His military works alone include *Shouyu quanshu*, *Shenqi tongpu* 神器統譜 (On extraordinary firearms) and *Paotai tushuo* 砲臺圖說 (Illustrations and descriptions of the artillery fortress) (Liu and Tao 1670, chap. 2, 56–57), but *Shouyu quanshu* (published in 1636) is the only work to have been handed down. In its preface, Han Lin pointed out that the country was in great danger, cities had been lost and the frontier defense weakened; the existing military books, however, were too brief on defense, and while they offered extensive information on how to attack, this was not relevant. Han Lin therefore made a selection from various sources, kept their essence and deleted what was unnecessary. His work, which was divided into eight chapters, was said to emphasize defense and was concise on how to attack. Han believed that if all that had been discussed could be adopted, even a mediocre official could easily carry out his duties (Han [1636] 2005, preface by Han Lin, 2b–3a). According to the list of "Caizheng shumu" 采證書目 (Reference works) at the beginning of the book, a total of 101 sources were used, of which 82 were compiled during the Ming period. Many

works that are cited are rare documents, and the ones concerning Western learning are especially impressive (Tang 2004).

Shouyu quanshu focuses mainly on the important tasks of defending a walled city. Han Lin believed he had an "insightful observation" of firearms, but "the powerful weapons should not be exposed to the public" (Han [1636] 2005, General notices). In Chapter 3 "Zhiqi pian" 制器篇 (On weapons), when it comes to European artillery, the book only includes the petitions to the throne written by different authors and is sparse on details. From the perspective of military technology, Chapter 2, "Shexian pian" 設險篇 (On fortifications) stands out for its introduction of European fortifications. The "Fanli" 凡例 (General notices) of *Shouyu quanshu* states:

> Constructing city walls and digging moats are the first priorities in defending a city. I have paid attention to research into relative materials and learned some very unusual methods. The way of warfare has changed dramatically since artillery became so powerful. Constructing bastions is the most urgent task in constructing fortifications. Jingbo (style name of Han Yun), my elder brother, has recently learned the method of fortress construction from a European courtier; it is among the many Western sciences translated under imperial orders and a secret that has never been disclosed. As it has not yet been presented to the emperor, I dare not send the whole thing to be published; instead, I select only a small part of it to be included in the book. Later on, the treatise [on European fortifications] will be revised and learned by all.[32]

The event of having "many Western sciences translated under imperial orders" derives from Xu Guangqi's petition to the throne "Tiaoyi lifa xiuzheng suicha shu" 條議曆法修正歲差疏 (Issues concerning the calendar reform), which was submitted in the autumn of 1629. At that time, Xu had just set about reforming the calendar by systematically introducing European astronomy and presenting an overall plan. He also hoped to introduce all aspects of practical knowledge of Europe. At the end of his petition, Xu enumerated ten subjects to which mathematical knowledge can be applied, including astrology and meteorology, surveying and hydraulic engineering, theory of harmony and musical instruments, weapons and fortifications, calculation and accounting, bridge construction, machine building, mapping, astrological medicine, sundial and astrolabe making. The fourth item on Xu's list claims that mathematical knowledge is indispensable to weapon-making and the construction of fortifications, the expertise of which would be beneficial for defending the frontier (Xu 1984, 332–339). But since the military situation became more aggravated and the tasks of calendar reform were demanding, the extensive plan of translation was not realized in Xu's lifetime.

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32 "築城鑿池，守圍第一要務。不佞留心講求，頗異常法。大砲既精，兵法至今一變。敵臺之制，尤設險所最急也。余兄景伯，從西洋陪臣新授造城法，乃奉旨所譯旁通西學之一，爲亘古未發之秘。因未呈御覽，不敢付梓，略采數端。當共參訂成書，傳佈海內。"

Xu passed away in 1633. He was succeeded at the Bureau of Calendar Reform 曆局 by Li Tianjing 李天經 (1579–1659). Having almost finished the new calendrical calculation system in 1635, the bureau restarted its plan to extensively translate Western knowledge (Xu et al. 2000, 140–143). One result was *Kunyu gezhi* 坤輿格致, an abridged Chinese edition of Georgius Agricola's *De re metallica* (1550), translated by Johann Adam Shall von Bell (Pan 1983; Han 2015)[33]. None of Li's extant petitions concerning the translation plan makes any mention of a participator living outside the capital, nor do they suggest that the method of European fortifications had been presented to the emperor. It seems that the Han brothers were using the words "translat[ing] under imperial orders" to gain their readers' attention.

"The European courtier" in Han Lin's account likely refers to Alfonso Vagnone. Brought up in an aristocratic family in Turin, Vagnone was an excellent student and taught philosophy in Milan. Between 1550 and 1600, at least 22 monographs on fortifications were published in Italy, the birthplace of the Renaissance fortifications, which were followed by 15 more in the subsequent 50 years (de la Croix 1963). In the early modern period, fortification construction, which is closely related to mathematics as well as art, was an interesting topic to the intellectual circle in general, rather than something only studied by military engineers. Vagnone could have been familiar with this kind of technology.

The book that Vagnone and Han Yun co-translated features on the "Reference works" list of *Shouyu quanshu*, titled *Xiyang chengbao zhi* 西洋城堡制 (On the European method of city and fort defense). In the chapter of "Shexian pian," entries including "Ditai" 敵臺 (The bastion), "Cheng zhi huang" 城之隍 (The city moat), "Shanqi jiucheng" 繕葺舊城 (The renovation of the old city wall) and "Daoyu chongtai" 島嶼重臺 (The multi-story fortress on water) are all annotated as "a newly translated European method (新譯西洋法)." At various places in the main texts and the attached comments, Han Lin also introduced the European method of fortifications, such as in entries of "Cheng zhi huan" 城之患 (The weakness of the city), "Cheng zhi suo" 城之所 (The city's location), "Cheng zhi ji" 城之基 (The foundation of the city wall), "Chengqiang" 城牆 (The city wall), "Humen" 護門 (The gate), "Chongsuo" 銃所 (The emplacement of cannons), "Chongchuang" 銃窗 (The embrasure), "Tiaotai" 眺台 (The observation tower) (in Chapter Two, Section One) and "Xiaocheng lun" 小城論 (The fortress) (in Chapter Two, Section Two). In addition, there are 20 corresponding illustrations in this chapter. Related descriptions are also scattered in the entries of "Wangyuanjing" 望遠鏡 (The telescope) in "Zhiqi pian" (Chapter Three, Section One), "Bei huopao" 備火砲 (Defense against bombardment[34]) in "Yingbian pian" 應變篇

[33] The only known manuscript copy of the book was recently rediscovered. See Han 2015.
[34] The entry is about how to use gabions.

(Chapter Seven: Dealing with emergencies) and "Fang ditai" 方敵臺 (Square-shaped bastions) in "Jiumiu pian" 糾繆篇 (Chapter Eight: Corrections of common errors). All of the entries above, adding up to around 5000 characters in total, can be regarded as a whole.

3.2 The textual sources

What are the textual sources of *Xiyang chengbao zhi*? Most of the possible references used by Alfonso Vagnone were Italian. There are two illustrations of "Daoyu chongtai" in "Shexian pian" of *Shouyu quanshu*, which are very similar to two illustrations in *Della fortificatione delle città* (Figure 5 and Figure 6).

Written by the Italian military engineer Jacopo Fusto Castriotto (1510–1563), *Della fortificatione delle città* (On the fortification of cities) was published posthumously in 1564 in Venice after Girolamo Maggi, a scholar and Castriotto's friend, edited and supplemented it. After participating in the defense project at Borgo in Rome, Castriotto was later appointed as director of the defense work, serving King Henry II of France. In this book, Castriotto treated the practical and technical problems of fortification with professional skills, while Maggi supplemented extensive commentaries with frequent references to classical authors and historical examples (de la Croix 1963).

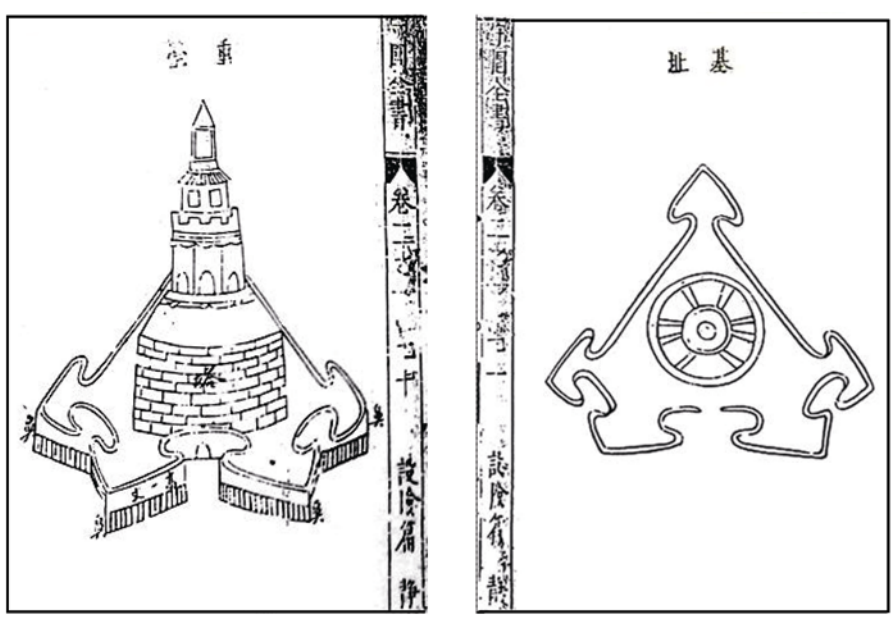

Figure 5: *Daoyu chongtai* in *Shouyu quanshu* (1638), chap. 2, sec. 1, 70b–71a.

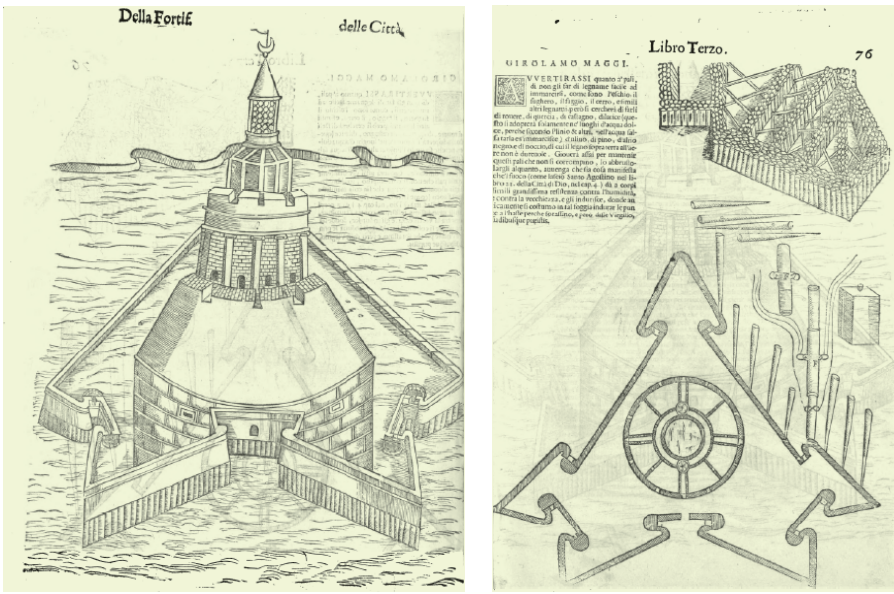

Figure 6: The fortress on water. *Della fortificatione delle città*, 1584, Libro Terzo, 76a–b[35].

The two illustrations from volume 3, chapter 2 of *Della Fortificatione delle Città* are used to specifically explain how to lay the groundwork and how to build the parapet (75b)[36]. "Daoyu chongtai," on the other hand, is more general and is not a word-for-word translation. It can be fully cited as follows:

> The multi-story fortress on water: A newly-translated European method
> If enemies suddenly land on an island on the lake or sea, we can construct a large fortress on the most strategic part of the water. Huge piles should be driven into the earth under the fortress and great rocks should be placed on top of them. Brick walls, which are one *zhang* (3.2 m) in height should be constructed on this foundation with parapets. On all sides, platforms for installing cannons should project from the wall, as if they were the bastions of a city's wall. At the centre of the fortress is a tower which has embrasures all around. All kinds of weapons and the soldiers could be housed in the tower. On top of the tower, beacon fires will be built and sentries will keep a lookout during the night. The defending troops should use short cannons and stone shots, as they are more helpful in attacking a vessel. High earth walls will not be built, because the cannons of the invaders

[35] The sample pages are from a copy owned by Ghent University Library, which is available on Google Books. The contents of the 1564 and the 1584 edition are the same, according to Breman 2002, 231–238. The author would like to thank Dr. Sun Chengsheng 孙承晟 for providing Breman's work.

[36] The chapter title is "Pianta & alzato d'una fortezza da farsi in acqua, e delle pallisicate per fondarla, col disegno d'un nuouo instrumento da ficcarei pali ne'luoghi doue l'acqua è molto profonda. C. II." The author would like to thank Dr. Zheng Fanglei 郑方磊 and Mattia Petrolo for translating this chapter.

> would fire from the vessel and their shots would not be so powerful. (Han [1636] 2005, chap. 2, sec. 1, 70a)[37]

In the original Italian work, the scene of "huge piles be[ing] driven into the earth under the fortress and great rocks placed on top of them" is presented in a specific illustration (in the upper-right corner of Figure 6).

It is still uncertain whether *Della fortificatione delle città* is the direct source of the illustrations in "Daoyu chongtai." As Castritto's work is not found in the *Catalogue of the Pei-t'ang Library* (Collection of the Jesuits' libraries in China from the late sixteenth to the early nineteenth century), it remains unknown whether the book had been brought to China by missionaries. Among all the books from Pei-t'ang that are stored in the National Library of China, there are altogether four monographs published before 1630 concerning fortifications (two in Italian, one in Latin, one in German) (Verhaeren 1949, no. 2191, 3291, 3514, 3913), but no similar illustration like those in *Shouyu quanshu* can be found in these books.

In the entries concerning European fortifications in "Shexian pian," many illustrations that depict the city's structure are obviously Sinicized (Figure 8). The authors are learning the basic ideas of the European books rather than simply copying them. However, all the key subjects of "Shexian pian," such as angled bastions, walls and moats, are discussed in detail in *Della fortificatione delle città*. It is reasonable to presume that the knowledge concerning European fortifications in "Shexian pian" comes from Italian works of the late sixteenth century. Vagnone might have consulted *Della fortificatione delle città* as well as some other European books.

3.3 Constructing fortifications with European methods

China has a long history of constructing fortifications and has much practical experience of defending against sieges, yet as Han Lin said, "the way of warfare has changed dramatically since the artilleries became so powerful" (Han [1636] 2005, General notices). The conventional city defense works of the late Ming period could neither defend against European heavy muzzle-loading cannons nor help them to take a full role in defense. As Han Lin said, "one side would use the cannons to attack and the other side would use the cannons to defend, thus the construction of bastions is comparatively more urgent than any other issues" (Han [1636] 2005, chap. 2, sec. 1, 2b). This became even more urgent after Kong Youde, Geng Zhongming and their

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37 "島嶼重臺 新譯西洋法

湖海島嶼，恐寇猝臨，可于扼要水口，創一重臺以守。將臺址下釘築巨樁，壘以大石，上圍磚垣，其高一丈，亦有護牆。四方設銃之所，突兀向外，仿佛城之敵臺。居中建一浮屠，周開銃窗，內藏各項守器，屯以戍卒。塔頂(然)[燃]烽，夜可遠瞭。守用短銃石彈，更利擊舟。不作高大土垣者，緣攻銃用於舟上，力衰故也。"

artillerymen surrendered to the Manchu regime in 1633.

The angled bastion is the essence of new defense works introduced by "Shexian pian." Han Lin stated that:

> Cities nowadays only have square-shaped bastions. Even if the two neighboring bastions can reinforce each other, the front of the bastion is left open to the enemy, so it would be more agreeable if the bastion were built as a triangle. (Han [1636] 2005, chap. 8, 2b)[38]

Accordingly, *zheng ditai* 正敵臺 should be built at the corners of the city wall, *bian ditai* 匾敵臺 should be built at the middle of each side of the wall, and in addition, *du ditai* 獨敵臺 can be built outside the city (Figure 7). *Zheng ditai* and *bian ditai* are angled bastions while *du ditai* are ravelins. A standard European-style angled bastion

> has throat, cheek, nose, eyebrows and eyes. In the eyes are eyeballs that can roll in different directions. Cannonballs can definitely hit a target that is miles away. The bastions can only be constructed by those who have expertise in mathematics. (Han [1636] 2005, chap. 2, sec. 1, 42a)[39]

In technological terms describing the early modern fortifications, the "throat," "cheek," "nose," "eyebrow" and "eye" are gorge, face, pointed tip, orillon and curved flank, respectively. Eyeballs, of course, are the cannons inside the bastions. In addition, the special *shuang ditai* 雙敵臺 and *shuangbi di tai* 雙鼻敵臺 in "Shexian pian" should be the double bastion and indented bastions.[40]

The angled bastions can support firing from the sides, increase flanking fire, eliminate dead angles and make the city walls inapproachable. The artillery can be set on bastions or in the cannon rooms (inside the "eye"), so as to be well protected.

In order to defend against artillery, the city walls should be systematically rebuilt. For example, according to the European method in Han's book, the city wall should be built with two stories and each story should be three *zhang* in height. The lower story should be built with bricks and hidden deep in the ground, while the upper story should be built with earth and its exterior built as a slope. Such a structure would be advantageous both in attack and defense. The parapet could be as thick as two *zhang* and five *chi*, with the thinnest part being five *chi*; a crenel would not be necessary. With this structure, even the most powerful cannon would not be able to damage the wall, as the power of the enemies' artillery would be reduced by the protective thick earthen slopes. Another entry concerns the design of a moat:

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38 "今之郡邑，敵臺皆作方形，縱兩面相救，前一面受敵矣，故須作三角形爲妙。"

39 "其制有吭，有頤，有鼻，有眉，有眼。眼有珠，珠能左右盼。數里之外，發必命中。精於度數之學，乃能造之。"

40 For the terminology, see Huber and Rieth 1990.

The width of the moat should allow the matchlock-shot fired from the city wall to reach the opposite side of the moat; that is approximately 15 *zhang* (48 m). . . . [When rebuilding the earthwork] the inside of the moat should be deepened to twice its original depth and widened to twice its original width. [On one side of the moat], the earth that has been dug out of the moat can be used to thicken the city wall, [while on the other side] the bank of the moat should also be heightened. (Han [1636] 2005, chap. 2, sec. 1, 52b, 58a)[41]

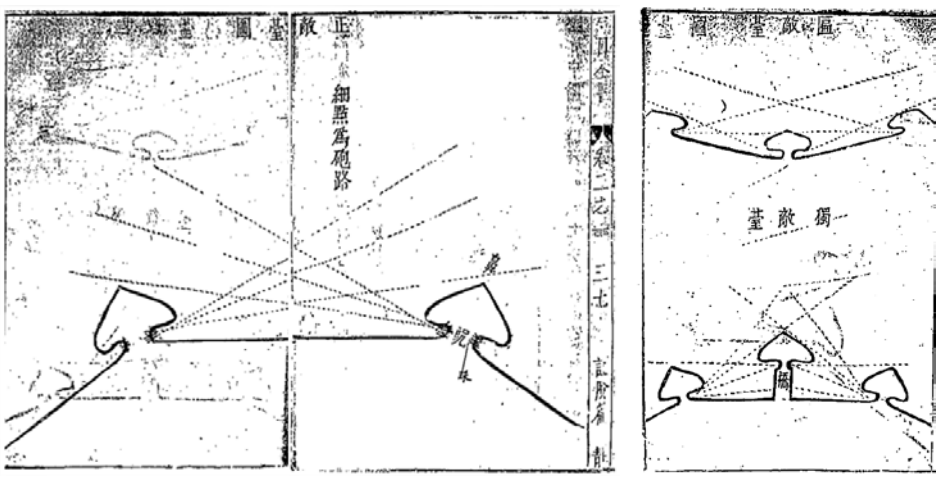

Figure 7: Angled bastions and ravelins in *Shouyu quanshu*, chap. 2, sec. 1, 37b–38b.

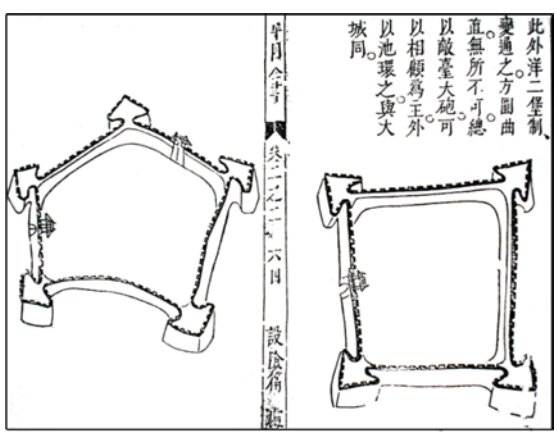

Figure 8: Foreign artillery fortresses. *Shouyu quanshu*, chap. 2, sec. 2, 64a–b.

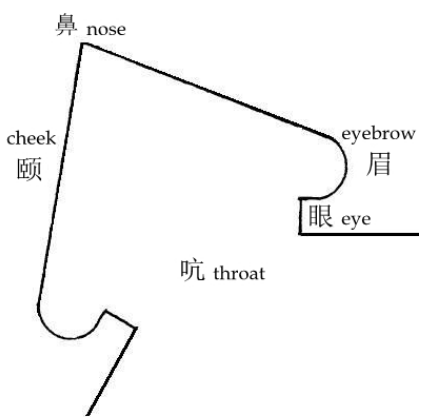

Figure 9: *Zheng ditai* (angled bastion), adapted from *Shouyu quanshu*.

After the outer bank of the moat is heightened, the glacis would be able to defend against horizontal fire. There are many other supporting projects:

[41] “作隍之寬，以城上鳥銃之彈，得到外岸爲率，大抵十五丈……隍中開鑿，倍深倍廣，即用其（圭）[土]，幫厚牆垣，將城對磡外，培令稍高。”

> The only ones that we have adopted are those that are suitable for China and can be practiced. The translation of the whole book on European methods will be submitted to the throne when it is finished, so as to contribute to the capital's defense work for eternity (Han [1636] 2005, chap. 2, sec. 1, 9a).[42]

Having learned about European fortifications, the Han brothers were eager to use them to safeguard their hometown, Jiangzhou. The gazetteer of Jiangzhou of Kangxi's reign records that:

> During the reign of Chongzhen (1628–1644), rebels from Shaanxi Province marched westwards over the Yellow River to invade. The scholar-officials were concerned about the defense of their hometown, so they raised funds to rebuild the city walls. Han Yun and his brother were determined to strengthen the city's defense. At that time, very few members of the royal family and rich households answered their call while complaints were heard all over. For over ten years, nothing had been completed and only several artillery bastions had been built until the time when Sun Shun was Subprefectural Magistrate. In the warfare of the sixth year of Shunzhi's reign (1649), the enemy approached the city. Thanks to the thundering cannons on the bastions, the city was saved. (Liu and Tao 1670, chap. 1, 6-7)[43]

After 1630, Jiangzhou had long been threatened by "roving bandits" from Shaanxi. The war cost many lives, while people who lived there also suffered from famine. Han Yun and the Han Lin brothers helped to organize militias and made donations for famine victims. In 1632, Han Lin wrote "Jiangzhou xiucheng chengci" 絳州修城呈辭 (A proposal to renovating the city wall of Jiangzhou), requesting the Subprefectural Magistrate He Yan 何言 to take charge of construction. Soon after his proposal was approved, Han wrote "Mu xiu Jiangzhoucheng shu" 募修絳州城疏 (A proposal calling for donations to reinforce Jiangzhou city wall) on behalf of He Yan. However, the project was suspended because of the high costs. In 1635, Han Lin submitted a petition to Wu Aheng 吳阿衡 (?–1638), the General Administration Circuit of Hedong 河東分守道, titled "Yi xiu chongtai" 議修銃臺 (On building artillery fortresses). According to Han's defense plan, one large artillery fortress would be built on the small hill at the north of Jiangzhou city, while at the four corners of the city wall, new artillery bastions would be built or the old ones be rebuilt, so that cannons would be able to provide crossfire when enemies approached. In this way, the cost would be much lower than reforming the city walls. Han believed that the advantages of building defense works at

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42 "今之所采，止可通行郡邑，與中國合式者。至西法全書譯成，當呈御覽，以爲鞏固神京，於萬斯年之助。"

43 "崇禎年間，秦寇西渡，蹂躪境內，士大夫謀爲牖戶之計，募資修城。韓鄉宦雲兄弟，銳意守圉。於時宗侯富室，鮮有應者，而怨讟之聲，且盈道矣。曆十年許，迄無成功。至知州孫順僅築砲臺數座。至順治六年之變，敵近城下，賴臺上火砲雷轟，固守無失。"

critical positions would definitely overweigh the effort required, so he took down the map of Jiangzhou city and marked out the graphs of the bastions in his proposal. Since Lei Chong 雷翀, the Subprefectural Magistrate, had approved the project, Han Lin was now requesting support from Lei's superior, Wu Aheng, to avoid controversies. He suggested that the artillery fortress could be built while the cannons were being cast. When the cannons were ready, the cost of the garrison (soldiers without firearms) could be saved. What Han advocated here are European-style cannons and angled bastions. He also said to Wu that he had discussed this project with Master Gao from Europe. Gao would elaborate on that when he met Wu in person (Han [1636] 2005, chap. 5, sec. 4, 51b–57b). So the Jesuit Alfonso Vagnone (Gao Yizhi) must have contributed to Han's project of building fortifications.

In 1636, as the Deputy District Magistrate of Pucheng County 署蒲城县事, Shaanxi Province, the elder brother Han Yun stated in a proclamation:

> The notice is for the construction of a fortress to protect people. I, as the magistrate, have quite some knowledge about the construction of defense works. I find that the fortifications of various places are far from the proper standard. No wonder they were lost to the rebels. I am attaching a plan of a fortress to be distributed. Rebuilding the fortress accordingly can make sure that it is impregnable. If there are any questions, just come to the county government to consult. (Han [1636] 2005, chap. 2, sec. 2, 65a–66b)[44]

The plan that Han Yun published is of a standard square-shaped fortress with four angled bastions in the corners (Figure 10), similar to the Fortaleza do Monte built not long before (1617–1626) in Macao by Portuguese (Figure 11).

In the petition to Wu Aheng, Han Lin mentioned that one main obstacle to constructing fortifications, apart from the most serious one, the lack of money, was that "people disregard the advantages of tangible ideas while being trapped by intangible ones" and "the public earnestly believe in *fengshui* and are very difficult to persuade." "Shexian pian" even puts "[people] being controlled by *fengshui* words" as one of the five most serious disadvantages of the design of city walls at that time (Han [1636] 2005, chap. 2, sec. 1, 14b).

Johann Adam Schall von Bell encountered similar problems in Beijing. In 1643, when he was directing the casting of cannons in Beijing, the Chongzhen Emperor consulted him about defense works. He made a wooden model of the bastion and proposed to construct an angled bastion at a certain location outside of the capital's city wall. The project was approved by the Ministry of War but opposed by a eunuch. The eunuch agreed with the opinions of his subordinate mathematicians (referring to *fengshui* masters) that the shape of the triangle, according to the *fengshui* theory, would

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44 "爲築堡安民事。本廳於修築城池，頗有別傳。目睹各處堡寨，俱不如法，無惑乎賊之能破也。今將堡式開列於後。互相傳説，照式修補，可保無虞。倘未明白，不妨直上堂，面請講説。此諭。"

Figure 10: Han Yun's design of the fortress. *Shouyu quanshu*, chap. 2, sec. 2, 66a.

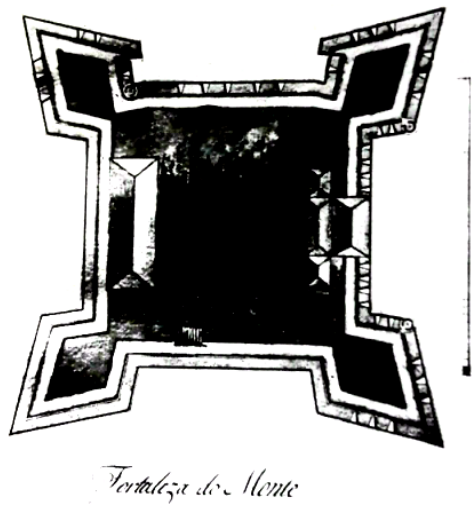

Figure 11: Fortaleza do Monte in Macao (Graça 1990, 53).

benefit the enemy while bringing misfortune to the defense. The project was finally rejected (Shall von Bell [1661] 1942, 90–93). The opinions of *fengshui* believers could be used as an excuse for opponents in certain cases, yet it is also a reminder of the important role that cultural factors can play in the transfer of technology.[45]

In 1641, after Sun Shun 孫順 was appointed Subprefectural Magistrate of Jiangzhou, a small part of the Han brothers' project of strengthening city defense was finally carried out. The biography of Han Yun in *Jiangzhou zhi* reported that:

> [Han Yun] built artillery bastion(s) on the city wall, and dozens of cannons were set. In the warfare of the sixth year of Shunzhi's reign (1639), the thunder of cannons was shocking. At that time, this is what city defense relied on. (Liu and Tao 1670, chap. 2, 13, 56)[46]

In late 1649, Jiang Xiang 姜瓖, the former Regional Commander of Datong 大同總兵, rebelled against the Qing dynasty. The major part of Shanxi Province was drawn into a war that lasted for over a year. This is what "the warfare of the sixth year of Shunzhi's reign" refers to. During the war, Jiangzhou was saved thanks to the cannons

[45] The author would like to thank Professor Zhang Jiuchen 张九辰 for reminding him about the cultural factors.

[46] "於州城議築銃臺，作銃數十門置臺上，六年之變，轟雷震撼，守圍增壯，實攸賴焉。"

and bastions. At that time, Han Lin had retreated to the neighboring county, Jishan 稷山, as he might have been ashamed of having previously surrendered to Li Zicheng 李自成 and accepting a high position from Li in 1644. In 1649, Han Lin was killed with his two sons in the chaos after Bai Zhang 白璋, Jiang Xiang's subordinate general, seized Jishan (Huang 2008b, 249–250).

4 Ma Weicheng and his angled bastions

From 1639 to 1643, Ma Weicheng 馬維城 from Xiong County 雄縣 allegedly designed and built 32 European angled bastions in three cities of inland China. This is probably the most widespread construction of European fortifications in the late Ming period. This section attempts to provide a study of this legendary story, based on mainly historical gazetteers from Xiong County and on the writings of Ma Zhishuang 馬之驌 (1622–later than 1695), the eldest son of Ma Weicheng. If not specified, the biographical materials of Ma Weicheng in this paper are all taken from a detailed account of his life, written by Ma Zhishuang in *Xiongxian zhi sixiu xiangkao* 雄縣志四修詳考 (Notes on the fourth edition of the *Gazetteer of Xiong County*) (Ma 1691, chap. 3).[47]

From the mid-sixteenth century, the Ma was a notable family in Xiong County, a small place 130 km southwest of Beijing. Ma Wenxue 馬文學 (1518–1594), the grandfather of Ma Weicheng, was a *Jinshi* in 1559 and formerly Prefect of Linjiang Prefecture 臨江知府 and Assistant Administration Commissioner of Shanxi Province 山西參議. Ma Jintu 馬晉圖 (1549–1581), the eldest son of Ma Wenxue, and Ma Chutu 馬出圖 (1551–1601), the second son, as well as nine of Ma Wenxue's grandsons, were all Government Students 生員. As a member of this affluent family, Ma Weiyuan 馬維垣 (1576–1621), the second son of Ma Chutu, once offered a hundred *mu* of land to Zhang Jiuzhou 張九州 (later Assistant Prefect of Dengzhou 登州通判), who was diligent despite his poverty (Ma 1660a, chap. 1, 1–7; chap. 2, 1–2, 6–7).

Ma Weicheng (1594–1659), whose style name is Youji 幼基 and art name is Shiliang 石梁, was the sixth son of Ma Chutu. According to his biography, during the years of Chongzhen's reign, there were many military conflicts all over the country, so he paid special attention to military works. Ma Weicheng had also been instructed by Schall von Bell on firearms, angled bastions and battlewagons, and became an expert. Details

[47] The only extant manuscript copy of *Xiongxian zhi sixiu xiangkao* is kept in the Palace Museum Library 故宮博物院圖書文獻館 in Taipei. It is an unpublished draft of the fourth edition of the gazetteer of Xiong County, which was compiled around 1691. The manuscript, which is unpaged and incomplete (only chapters 1–4 survive), could have been transcribed in the nineteenth century. The biography of Ma Weicheng was slightly abridged in later gazetteers. See Liu 1905, chap. 4, 12–13, and Qin and Liu 1929, vol. 5, 31–33. For a brief biography of Ma Zhishuang, see Liu 1905, chap. 4, 17.

of the interaction between Ma Weicheng and Schall von Bell are still unclear. Toward the end of Chongzhen's reign, while casting cannons for the Ming court in Beijing, Schall von Bell was also teaching Jiao Xu 焦勗 from Ningguo 寧國, who compiled *Huogong qieyao* 火攻挈要 (Essentials of gunnery) (1643). This book systematically discussed how to produce and operate European cannons. The section titled "Shoucheng shuolüe" 守城説略 (Brief notes on city defense) focuses on angled bastions:

> The firearms employed by the Europeans in city defense have nothing special, only that a bastion is constructed wherever the city wall protrudes. The bastion is built in the shape of a triangle and is six *chi* higher than the city wall. On each bastion, three or five big cannons are set so the fire can be laid out continuously. Besides, other cannons for defense should be equipped in case the target is close. Chain-shots should be prepared against scaling ladders. A two-story watchtower, which is three *zhang* in height, is built on the bastion and equipped with a telescope to look into the distance. The bastions will be able to reinforce their neighbors, so that not only the foot of the city wall, but also the foot of the bastions can be protected. Thereby the bastions can protect the cannons while the cannons can protect the city. With such a design, it is possible for few soldiers to provide a secure defense, and for small efforts to yield huge results. (Tang and Jiao [1847] 1994, chap. 3, 15a)[48]

In July 1636, Manchu troops detoured around the Ming's Ningyuan-Shanhai frontier and marched to the southern environs of Beijing. Two groups from a banner army led by Manchu generals Tuerge and Samushika joined forces to attack Xiong County (Tu et al. 1983, vol. 2, 393). The county town was lost on August 30. Li Shengzhi 李盛枝, the District Magistrate, fled. The residents had enjoyed peace for so long that they were determined not to resist. Since Xiong County is close to Baiyang Lake, they moved to the water areas. It is said that "only several persons were killed or injured" (Qin and Liu 1929, vol. 8, 37–38).

In 1637, Zhang Bingli 張秉禮, who was a *Juren* and from Datong 大同, was appointed District Magistrate of Xiong County (Yao 1671, chap. 2, 15). In Shi Kefa's 史可法 (1601–1645) letter to friends in the spring of 1639, Shi said that:

> I thought of promoting Zhang Bingli, the District Magistrate of Xiong County. I heard he is the son of Zhang An, the Regional Commander. He is reportedly free from corruption but has abundant wealth, affording strong horses and good guards. Last spring, he donated a

[48] "西洋城守，所用火攻，無甚奇異，但凡城之突處，必造銃臺。其制捏腰三角尖形，比城高六尺，安大銃三門或五門，以便迴圈迭擊，外設彖銃，以備近發，設鏈彈以禦雲梯。（合）[臺]上另築眺臺二層，高三丈，上設視遠鏡，以備瞭望。且各臺遠近左右，彼此相救，不惟可顧城腳，抑可顧臺腳。是以臺可保銃，銃可保城，兵少守固，力省而功巨也。"

> great amount of money for military use, which demonstrated his wish to defeat the enemy. This man would be a great help if he could join us. (Shi 1984, 72–73)[49]

From Shi's words one may get some idea of Zhang.

In the same year, at the invitation of Zhang Bingli, Ma Weicheng selected 600 local soldiers to train, and built two large European angled bastions on two corners of the city's northern wall. In the late autumn of 1638, the Manchu troops once again invaded and took 48 towns in the capital's environs. In the winter, Sun Chengzong, the former Grand Secreteriat, was killed in his hometown Gaoyang 高陽 when the county town was defeated. The Manchu troops advanced along three routes, one of which was from Xincheng County 新城 to Xiong County (Sun and Li 2005, 325–326). Details of the battle at Xiong County town were not recorded and the gazetteer compiled in the late seventeenth century only reported that "the defense was effective" (Liu 1905, chap. 2, 8).[50] In the early years of Kangxi's reign (ca. 1671), Yao Wenxie 姚文燮, the District Magistrate of Xiong County, also claimed that Ma Weicheng "had paid special attention to military strategies and mastered the operation of European cannons, which proved effective in the defense of Xiong County" (Yao 1671, chap. 2, 65). Because of his contribution to defending the county town, Ma Weicheng received an award from the central government. In 1639, he was granted the title of *Dusi* 都司 (junior military officer) and was dispatched to serve under Yang Wenyue 楊文岳 (?–1642), the governor of Baoding, as his staff officer. Throughout 1640, Ma assisted Yang in his military operations against the rebels at various places in the Baoding 保定 area and achieved significant success.

In the spring of 1641, at the invitation of Cao Liangzhi 曹良直 (?–1643), the new District Magistrate of Xiong County, Ma Weicheng built two European angled bastions at the city wall's southern corners, and three angled bastions attached to the eastern and western side of the walls, respectively. Up to that point, ten angled bastions had been built around Xiong County.

Cao Liangzhi was from Fenyang 汾陽 and received his *Jinshi* title in 1637. Cao was District Magistrate of Xiong County from 1640 to 1642 and then promoted to Supervising Secretary in the Office for the Scrutiny of War 兵科給事中. In 1643, he submitted a petition to the throne, impeaching Zhou Yanru 周延儒 (1593–1643), the Senior Grand Secretary, for ten serious crimes. In the same year, a plague was raging in Beijing, to which Cao Liangzhi succumbed at the age of around 35 (Fang 1884, chap. 6, 16–19; Huacun 1916, chap. 1, 2; Li 1987, 128–129). Cao Liangzhi and Fu Shan 傅山

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[49] "故復擬用雄縣令張秉禮，聞此人乃總兵張安之子，做官有清名，而家計饒裕，常養壯馬健丁，且於去歲春間，傾家相濟軍，有剿賊之志。若得此人，可助一臂。"

[50] A poem by Ma Zhishuang about his father's career also mentioned this success. See Ma [1660b] 2000, chap. 1, 2a–3a.

(1606–1684) used to study together at the Sanli Academy 三立書院 in Taiyuan 太原 and were close friends. In 1636, when Yuan Jixian 袁繼咸 (1593–1646), the Education-intendant Censor of Shanxi 山西提學, was wrongly arrested, Fu Shan and Cao Liangzhi wrote petitions to plead his case. Han Lin also participated in this action (Shi 1708, chap. 16, 6–8; Ding [1911] 2002, 32–33). Cao Liangzhi must have been familiar with Han Lin; he may even have learned about the angled bastions from *Shouyu quanshu*.

The contour of Xiong County's city wall is longer from the north to the south and shorter from the east to the west and somehow resembles a crucifix ().[51] The total length of the city wall is nine *li* and thirty steps (approx. 4500 meters). Its height is three *zhang* and five *chi* (11.2 m), while the width is one *zhang* and five *chi* (5.25 m). The wall has altogether three gates, at the east, the south and the west. In 1551, Hu Zheng 胡政, the District Magistrate, built 2984 brick crenels, 24 bastions and two drawbridges. From 1637 to 1641, all the new angled bastions that were built when Zhang Bingli and Cao Liangzhi were in office were strengthened with brick and ash (Qin and Liu 1929, vol. 2, 1–2). Cao Liangzhi asked all those who wanted to cultivate wasteland to provide brick and ash, in exchange for permits. Furthermore, he dredged the moat and dug a new one on the outside the original one to strengthen the defense (Yao 1671, chap. 1, 54). In 1641, the earth that was used to construct the angled bastions was also taken from the ruin of the ancient outer city, which was built in the Song period and lay one *li* to the east of the city (Ma 1691, chap. 1; Qin and Liu 1929, vol. 1, 68).

Ma Zhishuang also said:

> When constructing the bastions, both Zhang and Cao invited Ma Weicheng, who supervised all day long and decided on the shape and size of the bastions. Everything from the eyebrow, the eye, the nose to the cheeks [of the bastions] are identical to the European ones and is very solid. Almost six decades have passed; the bastions are as strong as before. On every bastion, a room for the commander and another room that stores gunpowder were built. All of these rooms were torn down for other use during the years of Shunzhi's reign (1644–1661). (Ma 1691, chap. 2; Qin and Liu 1929, vol. 2, 2)[52]

Strengthened by brick and ash in their construction and reportedly extremely solid, the bastions could have been built with brick covered by *sanhetu* 三合土, a mixture of lime, sand and earth. The materials would not collapse easily during bombardment. The moats were both deep and wide. Moreover, the bastions were angled and had

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[51] The contour of Xiong County's city wall in the 1640s was learnt from the maps of two gazetteers published in 1608 and 1671. See Feng and Wang [1608] 1992, chap. 2, 48b–49a, and Yao 1671.

[52] "張、曹先後建臺，皆禮聘馬維城，彌日坐守，指示規模，眉、目、鼻、頤，一如西制，且極堅實，迄今幾六十年，凝峙如故。又每臺之上，建將廳一間，火藥庫房一間。順治中盡拆去他用。"

orillons, curved flanks, pointed tips and faces. All of these elements adhered to the standard of constructing angled bastions, as described in *Shouyu quanshu.*

According to the gazetteer of Xiong County, in the 1660s the local armory still had six European-style cannons, approximately 700 pieces of various smaller firearms and 1700 *jin* (approx. 1014 kilograms) of gunpowder (Yao 1671, chap. 1, 75).

Such an armory is impressive for a small county with no strategic importance at the time. It is worth mentioning that neither bows nor matchlocks were found on the inventory; all the long-distance weapons were either large or small guns. A considerable amount of ammunition was probably left over from the turbulent 1630s and 1640s. In the inventory, the two *Xiyang pao* 西洋砲 (The European-style cannon) and four *Shenwei pao* 神威砲 (The almighty cannon) were made of cast iron in the late Ming period in imitation of the European pieces (Zheng 2012). These six iron cannons belong to heavy guns of that time, while others, including three-barrel handguns and breech-loading swivel guns, are light weapons. Given that saltpeter had been one of the local products of Xiong County since the mid-sixteenth century, it should have been convenient for gunpowder to be produced there (Wang [1537] 1962, chap. 1, 39).

Illustrations of the city walls are featured in different editions of the *Gazetteer of Xiong County*, but the angled bastions are not included. The city wall of Xiong County has altogether eight corners, and the southern city is longer and slim in shape. Among the ten angled bastions, four of them were located at the two northern corners and two southern corners. As for the three angled bastions attached to the eastern and western sides of the walls, respectively, one possible arrangement would be that four bastions were located at the other four corners and two at the middle of the southeastern and southwestern wall, respectively. Arguably, with the angled bastions and guns, the city wall of Xiong County had already been protected from crossfire. The enemies would suffer great losses if they failed to gain the upper hand over the bastions before they crossed the moats. If they aimed at the center of each side of the city wall, they would be trapped in the crossfire laid out by the bastions on either side. Even if they were able to reach one side of the bastion, the fire from the neighboring bastions would reach them.

So, as early as 1642, Xiong County already had ten angled bastions, yet afterwards they were not used in actual combat. In the same year, the Qing troops advanced south. The county was heavily guarded and was not attacked. In 1644, after the loss of Beijing, Xiong County surrendered to the Qing dynasty and a long period followed with hardly any military conflict (Wang 2011, 380–383). The county enjoyed lasting peace for over two hundred years after 1673; before this time it was sometimes beseiged by bandits. The peace, however, finally came to an end in 1900 when the county was seized by the Franco-German allied force on their way to attack Baoding (Liu 1905, chap. 10, 2, 3, 5; Qin and Liu 1929, vol. 8, 37–38; Li et al. 1990, 359). In 1921,

Gao Maocong 高茂枞, the District Magistrate, ordered the county "after discussion to tear down the western gate and *the ten bastions*, and use the bricks to build a dam at Liupu outside the western gate" (Qin and Liu 1929, vol. 1, 91). Thus, the angled bastions were still extant in the first decade of the Republic of China. Before the end of the 1980s, however, most of the city wall had been demolished, with less than 100 meters remaining (Li 1992, 487).

During the three years before Beijing was lost in 1644, Ma Weicheng served successively in four official posts. In 1642, Ma Weicheng went south at the invitation of Gao Guangdou 高光斗 (1566–1642), the Grand Coordinator of Fengyang 鳳陽巡撫. After Ma Weicheng arrived in Fengyang, the cannons under his orders drove back the rebels who attacked the Zhengyang Pass. Soon afterwards, at the invitation of Wang Dingzhen 王鼎鎮 (1603–?), the Regional Inspector of Huaiyang 淮揚巡按 [53], Ma Weicheng, was commissioned to manage the military defense of Sizhou and built two European angled bastions, which were attached to the city wall. Wang recommended him to Shi Kefa, the Grand Coordinator of Huaiyang 淮揚巡撫. A warrant was received from Shi, and Ma Weicheng was appointed as Mobile Corps Commander to construct 20 European angled bastions in the new city and the old city of Yangzhou. Another warrant was received that awarded Ma Weicheng the title of Assistant Regional Commander before he was formally appointed.[54] Nevertheless, so far no records of bastion construction in the 1640s have been found in all of the gazetteers of Sizhou[55], Yangzhou or in other materials.

In 1643, Ma Weicheng accepted the offer from Xu Biao 徐標 (1592–1644), the Grand Coordinator of Zhending 真定巡撫, and traveled north to help with the city's defense. In the same year, Xu Biao recruited 7000 soldiers who were trained to operate battlewagons and firearms (Dai 1986, 344). Ma Weicheng may have participated in the project. In 1644, Xu Biao was killed by his subordinate when the forces of Li Zicheng 李自成 approached Zhending. The rebel Xie Jiafu 謝加福 declared himself as Marshal and appointed all kinds of officials. Because he admired Ma Weicheng's expertise in firearms, Xie forced Ma to serve as his deputy. Ma refused and was therefore imprisoned with all those who had not accepted offers. When the prisoners were interrogated for a second time some days later, they were told that those who surrendered would receive the post right away while those who refused would be

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[53] Ma Weicheng's biography mistakenly identifies Wang Dingzhen as "the Grand Coordinator of Huaiyang."

[54] In 1642, Ma Zhishuang was with Ma Weicheng in Yangzhou and saw the European style cannons. See Ma [1660b] 2000, chap. 1, 6b–7b; chap. 4, 8b–9a.

[55] In the mid-seventeenth century, the Yellow River changed its course and Sizhou city was submerged in 1680. In recent years, as the water level has fallen, the ruins of the old city have partly reappeared. In the southeast corner of the city wall, there is a place called Paotai *tan* 炮台滩 (Artillery bastion beach). See Chen 2001.

executed at once. Ma Weicheng, however, did not change his mind. He was kept in prison until the Great Army (troops of the Qing dynasty) arrived and was finally able to return home. This marked the end of Ma Weicheng's life in the army.

In 1645, Ma Weicheng was appointed as a military official in the Qing dynasty but he soon resigned. In 1647, the Manchu banners seized a large area of land around Beijing (Ba et al. 1983, vol. 3, 245). Ma lost most of his farmland (Ma 1660a, chap. 5, 11–12). He spent his final years in Xiong County writing treatises (Ma [1660b] 2000, chap. 1, 3a). Unfortunately, all of his works were lost in the early twentieth century (Qin and Liu 1929, vol. 5, 33). In 1659, Ma died of an illness at the age of 66 (Qin and Liu 1929, vol. 5, 33). After he passed away, Ma Zhishuang wrote a poem titled "Xiyang tai 西洋臺 (The European bastion)" to commemorate his father:

> At the end of the Ming, fortresses rose up all over
> European Angled Bastion Fortresses [Omission]
> Created by my late father and bequeathed to those who come after far into the future.
> Now, I write these words to commemorate the start of things,
> So there will be no forgetting what he created.
> (Ma 1691, chap. 2; Qin and Liu 1929, vol. 10, 69)[56]

5 Knowledge of European fortification in the Qing period

Toward the end of the Ming dynasty, Xu Guangqi, Sun Yuanhua, Han Yun, Han Lin and Ma Weicheng contributed to the introduction of knowledge about European fortifications either by writing or through actual practice. Additionally, there was also *Chongtai shuo* 銃臺説 (On fortresses) by He Liangtao, which describes the technology of European fortifications in detail (Zheng 2012). Looking at their influence, one would conclude that in the mid-nineteenth century Qing period, the major available Chinese source for European fortifications was *Shouyu quanshu* and its derivatives.

The Ming dynasty was replaced by the Qing less than ten years after *Shouyu quanshu* (1636) was published. A book about the defense of the Ming dynasty became particularly ill timed, or even dangerous. A handwritten note by Qian Qianyi 錢謙益 (1582–1664) in 1646 in one copy of *Shouyu quanshu*, for example, warned that the book was not suitable to read for the time being because of the change of dynasties. He suggested that readers should be cautious and not casually show the book to others (Han [1636] 2005, Huang Kuang's preface, 1a).[57] After the Manchu conquest, there were many new taboos and sensitive topics. In 1777, Yang Kui 楊魁, the Grand

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[56] "明季增城壘，西洋鋭角臺。神威曾震疊，物望益崔嵬。創自先君子，貽諸久後來。將無忘締造，特與記胚胎。" The incomplete English translation is from Andrade 2016, 215.

[57] For a clear copy of Qian's inscription, see Shanghai Cultural Relics Preservation Committee 1983, vol. 3, plate 1.

Coordinator of Jiangsu 江蘇巡撫, submitted a petition to the throne, suggesting a list of books to be prohibited, including *Shouyu quanshu* (Lei 1989, 156). His proposal was approved at once. In the late eighteenth century, the Qing government ordered the destruction or ban of more than 3000 titles, more than half of which had been published in the late Ming. Some contained racial slurs and insulted the Manchus, and were thus destined for destruction. To my knowledge, among hundreds of catalogues of libraries in Qing dynasty, *Yifu shumu* 怡府書目 (The catalogue of Prince Yi's library, ca. 1750) is the only one that records *Shouyu quanshu* (Anonymous 2005, 536). As far as we know, there are now only three extant copies of *Shouyu quanshu*: one incomplete copy in the Shanghai Library 上海圖書館 (the first section of Chapter 3 is missing) (Han [1636] 2005), one complete copy in Shanxi Provincial Library 山西省圖書館 (Liu 1998, 390–391) and an odd volume in Fu Ssu-nien Library 傅斯年圖書館 (only the first three chapters survive).

On April 24, 1644, Beijing was lost and the Chongzhen Emperor committed suicide shortly afterwards. On June 19, the Hongguang Emperor 弘光帝 was enthroned in Nanjing. In July, Qian Zhan 錢栴 (1598–1647), a Jiaxing native 嘉興, published the five-chapter *Chengshou choulüe* 城守籌略 (The strategies of city defense) to deal with the worsening situation. His son, Qian Mo 錢默, was District Magistrate of Jiading 嘉定知縣 at that time, so the book was printed at the county government's office. Qian Zhan was a *Juren* in 1633. In 1644, he was appointed Director of the Bureau of Operations 職方司郎中 under the recommendation of Chen Zilong 陳子龍 (1608–1647) and dispatched to inspect the city's defense at the Yangtze River delta. Nanjing was also lost in 1645 and Qian took refuge in his home village. In 1647, he was arrested for his involvement in a rebellion against the Qing dynasty and was executed on the same day with others, including Xia Wanchun 夏完淳 (1631–1647), his son-in-law (Huang 1999, 216–217).

As a compilation of military monographs of that time, *Chengshou choulüe* has a well-arranged structure. Chapter 1 "Xianshi fangyu" 先事防禦 (On precautions) has four entries. In the fourth one, "Chengbao" 城堡 (The fortress), the contents concerning *zheng ditai*, *bian ditai*, *du ditai*, *shuangmeishuangyan ditai* 雙眉雙眼敵臺, *shuangbi ditai* (see section 3.3), as well as five illustrations, are obviously all drawn after "Shexian pian" in *Shouyu quanshu*, with the aim to introduce the angled bastions. Many other entries in the book are also identical to those in *Shouyu quanshu*, from which they must have been copied.

Qian Zhan was on friendly terms with Han Lin (Huang 2008b, 239). There might be some hidden reasons why Han Lin's name never appears in *Chengshou choulüe*. At the beginning of the 1644, Han Lin surrendered to Li Zicheng in Shanxi, followed him to Beijing, and was subsequently appointed to an official post. In the summer of the same

year, a declaration of the literati from Jiaxing Prefecture accused Wei Xuelian of following Han Lin, the traitor, from Shanxi (Ji 1984, 609–613; Huang 2008b, 191). Wei Xuelian 魏學濂 (1608–?) was a native of Jiaxing and received his *Jinshi* title in 1643. Soon after Beijing was lost, Wei was given a post in the short-lived dynasty of Li Zicheng, to which Han Lin had made a contribution. Thus it can be seen that Han Lin's submission to Li Zicheng's regime was well-known in the summer of 1644 and the scholar-officials in southern China despised this fact. No wonder, then, that Qian Zhan cited Han's book without acknowledging his name.

Wei Xuelian, who was also a Catholic, was very talented and interested in practical subjects. Fang Yizhi 方以智 (1611–1671) recorded that Wei told him:

> The bastion should be built in the shape of triangle, like a water caltrop, and should be attached to the city wall. One small exit will be opened on each of its flanks while the enemy's artillery fire is kept outside. The foundation of the city wall will be built with rocks, and the upper part will be built with earth. The cannon balls that hit the earth will stick. (Fang [1884] 1995, 443)[58]

This is a good summary of the angled bastion's structure and its author might have learned this from Han Lin's book.

In 1664, Xue Fengzuo 薛鳳祚 (1599–1680) from Yidu 益都 compiled and published "Zhiyong bu" 致用部 (Practical subjects) of his voluminous *Lixue huitong* 曆學會通 (Unified comprehension of heavenly learning), which covers knowledge of ten subjects, including trigonometry, theory of harmony, medical science, astrology, divination, fortune-telling, hydro science, firearms, mechanics and military science. Combining Chinese knowledge and European knowledge, the book intended to "unify and comprehend (會通)." Xue's predecessors had previously written some of the materials in this book. For instance, the chapters on hydro science and mechanics are taken from *Taixi shuifa* 泰西水法 (Hydraulic methods of the great West) and *Yuanxi qiqi tushuo* 遠西奇器圖說 (The record of the best illustrations and descriptions of extraordinary devices of the far West), respectively. "Zhongwai shixue bu" 中外師學部 (Military science of China and abroad), which has two chapters, is signed as being "compiled by Hanlin and extracted by Xue Fengzuo (晉韓霖雨公編 齊薛鳳祚儀甫選)." Entries in Chapter 1 are the core content of "Shexian pian" in *Shouyu quanshu*, whose illustrations of angled bastions were mostly included. The entries in Chapter 2 on how to train soldiers and how to select generals are taken from "Shenling pian" 申令篇 (Chapter Six: On army management) in *Shouyu quanshu*. In the preface, written by Xue Fengzuo, he claims that:

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[58] "敵臺宜築三角，附城如菱芰，兩腋皆有小門可出，而外砲不能攻也。城址砌石，上即以土築之，砲子入土，便陷不出。"

> Since the mathematical science [referring to artillery] prevailed over the arrows and stones, no city could be safe in this situation, . . . [thus] mastering the knowledge of city-wall construction can help the weak to defeat the strong, and help the smaller forces to defeat the larger ones. (Xue [1664] 2000, 560)[59]

In a word, apart from *Shouyu quanshu*, Chinese readers before the nineteenth century could also learn about European fortifications from *Chengshou choulüe* and *Lixue huitong*, although these books were quite rare.

After the First Sino-British Opium War (1839–1842), European fortification regained attention. *Yan pao tushuo jiyao* 演礮圖說輯要 (Illustrations and descriptions of artillery) (1843) by Ding Gongchen 丁拱辰 (1800–1875) included "Folanxi paotai tushuo" 佛蘭西礮臺圖說 (Illustration and description of the French artillery fortress) and three other articles on how to construct and arrange angled bastions (Ding 1843, chap. 3, 18–26). The third edition of *Haiguo tuzhi* 海國圖志 (Illustrated treatises on the maritime kingdoms) (1852), a very influential work compiled by Wei Yuan 魏源, included three articles on European fortifications from Ding Gongchen's aforementioned work in chapter 90 (Wei [1876] 2002, 515–519).

In 1849, an influential collectanea "Haishan xianguan congshu" 海山仙館叢書 published in Guangzhou included a nine-chapter edition of *Shenshou yaolu* 慎守要録 (An outline of city defense) and marked it as "written by Han Lin, Ming dynasty (明韓霖著)" (Han [1849] 1991).[60] This book, which has neither preface nor postscript, is actually an excerpt from *Shouyu quanshu* and not one-tenth as long as the original work. Around one fourth of the descriptions concerning European fortification construction in "Shexian pian" of *Shouyu quanshu* were omitted in the second chapter of *Shenshou yaolu*. "Daoyu chongtai," for example, is not found in the latter. Only six of the 20 illustrations of "Shexian pian" were preserved in *Shenshou yaolu* and are not quite true to the original. The "General Notices" of *Shouyu quanshu* pointed out that as the book was too long, a *Shouyu zhaiyao* 守圉摘要 (A concise edition of *Shouyu quanshu*) was to be published. Yet, before 1849, when the collectanea was published, there was no mention of *Shenshou yaolu* so the book was more likely an abridgement of *Shouyu quanshu* from the Qing period, rather than something extracted by Han Lin himself.

In 1876, *Yingcheng jieyao* 營城揭要 [61] and *Yinglei tushuo* 營壘圖說 [62] were both

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[59] "自度數之學出，以較矢石，萬不當一，以言保土，百無一全……明此城法，可以弱制強，可以少敵眾。"

[60] To my knowledge, in 1964, Kang Ning 康宁 gave a brief discussion of the angled bastion in the Qing period, mainly based on *Shenshou yaolu*. The illustrations of angled bastions in his book are without sources but likely come from *Shenshou yaolu*. See Kang 1992, 296–297.

[61] Translated by John Frye and Xu Shou 徐壽, from "Fortification" in *Encyclopaedia Britannica*, 8th edition.

published by the Kiangnan Arsenal 江南製造局 (Bennett 1967, 98, 104; Yan 2007, 209–210). The knowledge about European defense works was once more translated and introduced systematically. At that time, relevant military technology had not completely turned away from the system of angled bastions, a topic that the readers of *Shouyu quanshu* would have already been familiar with.

6 Concluding Remarks

European artillery and the art of *trace Italienne* were introduced to China at approximately the same time and were advocated by the Catholic literati of the late Ming period. European artillery played an important role in the wars during the Ming-Qing transition. Xu Guangqi and his colleagues had hoped that European artillery could save the Ming dynasty, and it did help the Ming troops to win several victories in Ningyuan (1626) and afterwards. Yet things went contrary to their wishes when the new weapons turned out to provide powerful aid to the Qing troops in their defeat of the Ming Empire (Huang 2004b). The most serious concern of Xu Guangqi and Li Zhizao had unfortunately come true; that, in their words, it is possible "that our loyalty to the country might instead open endless disasters" (Xu 1984, 179–181).

In stark contrast, the art of *trace Italienne* was rarely put into massive practice toward the end of Ming and had a very limited influence on the military situation. Then, in the late seventeenth century, when the cannon casting technology of China was at approximately the same level as the European countries, the Qing government (and its main opponents) deployed a large number of European-style cannons in the wars. In spite of this, the Qing failed to develop new types of defensive works like their European counterparts. This section aims to briefly explore the reason why, during the late Ming and early Qing periods, European artillery methods were widely imitated while European defensive works were not successfully employed.

According to military historian Geoffrey Parker, early modern China had no need of Western examples in the art of defensive construction. The massive fortifications erected during the Ming dynasty had been designed to resist artillery bombardment. The towns surrounded by massive walls could even withstand modern shells. Citing the observations of two British forces, Parker argued that a fort near Guangzhou City (1841), as well as the city wall of Beijing (1860), was impregnable. He supposed that in China heavy guns were certainly employed to defend the massive wall, but were seldom used offensively in sieges (except during the 1670s, during the Revolt of the Three Feudatories 三藩之亂) (Parker 1996, 143–144).

However, recent research has proven that European-style artillery played an

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62 Translated by Carl T. Kreyer and Li Fengbao 李鳳苞, from "Improvised Fortifications" by Henri-Alexis Brialmont.

important role in siege warfare during the Ming-Qing transition. Artillery was used to effectively destroy gates and parapets. Interpreting the usage of artillery merely based on the thickness of several city walls is not that convincing, not to mention that the forts at Bocca Tigris 虎門砲臺 (near Guangzhou) and the city of Beijing were quickly lost in the two Opium Wars (1841, 1860) respectively, and their walls provided very limited protection in the battles.

The art of *trace Italienne* was introduced to China in a unique historical background. In the 1610s, the final years of Wanli's reign, the Ming army were equipped with such firearms as small cannons, breech-loading swivel guns and matchlocks, yet the way of warfare did not change much from the past (Liu 2004, 73–74). In the Battle of Ningyuan (1626), the power of heavy European cannons was brought into play, while at the same time the limitations of the traditional square-shaped bastions were exposed.

Shen Hongzhi (ca. 1635) once said,

> In the sixth year of Tianqi's reign (1626), Nurhaci attacked Ningyuan in Liaodong. Yuan Chonghuan, the Circuit Intendant of Ningyuan, using European cannons, opened fire from the barbican (in front of the gate) and the bastions at the wall's corners. Unable to approach the city wall, the barbarians turned to the bastions at the corner of the wall. [When they reached the foot of the bastion,] Holding the shield above, they were unable to be shot and hid under the shield to chisel the wall. Not long afterwards, the holes in the wall were as large as the gate. The city wall would have collapsed if Jin Qizong 金啟倧, the Assistant Prefect, had not employed *wanredi* 萬人敵 (gunpowder explosive). Then it became known that the bastion at the corner should be angled and project from the wall. By projecting further from the wall, the bastions at corners would be able to protect the city wall. By being angled, it is possible for [the firearms on] the city wall to protect the bastions at corners. (Fan [1638] 1997, chap. 9, 28b–29a.)[63]

Chen Renxi 陳仁錫 (1581–1636) states in "Ji jing bian zao chongtai" 紀京邊造銃臺 (On artillery fortress construction of the capital and the frontier) that:

> The most efficient aid to defend a city is artillery. Now we have artilleries in store while the artillery fortresses have not been built, that is, the useful weapons installed in a place where they cannot play a role. In the southern coast, the artillery fortresses of Macao are elaborate in design. The bastions are attached to [fort] walls. Under the parapet are embrasures for cannons. The wall was thickened from inside [with traverses?] as protection against recoil. This is both very solid and very flexible, and is totally different from the bastions in Ningyuan which are specifically designed for *folangji*

63 "天啟六年，建夷奴兒哈赤攻遼之寧遠城。寧前道袁崇煥，以西洋大砲，及從月城及角臺上橫擊之。虜不敢近城身，乃攻角臺。以牌倒倚牆上，人從牌下鑿牆，銃砲不能及。頃刻而城鑿穴如城門大。非通判金啟倧用萬人敵以燒之，則城崩矣。乃知角臺當斜出而長，長則可以顧城身，斜則城身可以護角臺。"

> [breech-loading swivel guns]. It would be wise if this kind of bastion could be built in the capital as well as at the frontier. (Chen [1633] 1997, "Manji yi" 漫集一, 59a–b)[64]

In *Huogong yaolüe* 火攻要略 (Brief notes on firearms, ca. 1625), Xu Guangqi said:

> The bastion is an indispensable facility for city defense. Firearms were only regarded as an aid (not the main weapon) in the past, so old city walls are suitable for artillery. It could not be helped if the enemies had approached the wall, as they could find refuge at the foot of the wall and would not be reached by the gunfire. According to the new method, bastions should be built attached to the corners of the city wall, so that the city wall and the bastions can reinforce each other. Guns large and small should be set on the bastions. They can shoot at targets near and far, so the enemies will not be able to approach the wall. Even if they did, they would be open to attack from three sides. (Xu 1994, 309)[65]

Unlike early modern Europe, European-style cannons of the Ming troops were basically employed to defend the cities. At this point, Parker is partly right. There was mainly the need to help increase the power of the cannons used for city defense, rather than the need to defend against bombardment, which motivated the reconstruction of defensive works. When Xu Guangqi and Sun Yuanhua expended great efforts in advocating the angled bastions, their primary concern was to diminish the dead angles of firing, so as to make full use of European cannons. Moreover, as early as the beginning of the war, Xu Guangqi foresaw that the Manchu troops would finally master the art of artillery. The rules of gunpowder warfare are that "the larger guns will overcome the smaller, more guns will overcome less, the one of higher quality will overcome the one of lower quality, the one with defensive works will overcome the one without" (Xu 1984, 173–177). The "defensive works" here refers to European-style bastions or artillery fortresses. Yet after all, this is only the insight of a few pioneers. In the early stage of the war, there was hardly any threat from Manchu firearms, and therefore there was very limited motivation to rebuild the defense works according to European knowledge.

Ultimately, the new defense works derive from heavy artillery so it is necessary to master artillery technology and to integrate artillery as an effective military power in order to develop a new system of defense. The Ming troops in the Liaodong Peninsula

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64 "夫守城之最得力者，莫利於神砲。今神砲已貯而銃臺未築，是有用之器，置之無用之地也。詢歷覽海島，見濠鏡澳夷所築銃臺，制度極精。大約造之城上，於城頭雉堞之下做一石竇，以便發銃。城內仍加厚一層，以防銃之伸縮。真堅固之極，活動之甚，比之寧遠銃臺專爲佛郎機等銃用者，大不相同。今京師及邊關險隘之處，宜仿此式造之。"

65 "守具必用敵臺，古人止以火器爲一節，所以舊城皆不可以置銃。敵臨城下，便無法可制。因城腳有躲避之處，即發火器，亦不能中耳。今法須於城隅建造附城敵臺，相互照見。臺上各設大小火銃，遠近擊打，使敵人不能近城。即近城，亦可三面橫擊。"

suffered several serious defeats from 1618 to 1623. At that time, having just been introduced to China, European cannons had not been used in real combat and their power was not widely known. Meanwhile, at that time, Xu Guangqi and Sun Yuanhua had no real power. It was thus natural that their suggestions to build fortifications, which were ahead of their time, met with great difficulties. It was not until European cannons played a significant role in the battle of Ningyuan (1626) that both sides (Ming and Qing) started to imitate European artilleries in the arms race. At that moment, the Ming regime was stranded by serious internal problems and had repeatedly suffered great losses. To make matters worse, in 1633, the rebellion of Kong Youde brought the elite artillery forces, which had been trained by the Portuguese gunners, to Manchu/Qing. While the Ming troops used European cannons in combat earlier than their opponents, they were very slow to improve the usage of guns and relevant research and development. As for the proposals to employ new defense works, most of them came to nothing. Meanwhile, the Qing troops quickly gained the upper hand in utilizing and developing cannons (Li 2002). In 1644, joining the Manchu cavalry, the Han artillery corps, which had been reorganized by Hong Taiji 皇太極, entered the Shanhai Pass carrying around 100 European-style cannons. Most of the important military posts inland did not have enough high-quality cannons, nor did they have enough well-trained artillerymen. The old-fashioned city defense works were vulnerable when confronted with heavy guns. And at this time, it was already too late to rebuild the city walls.

Only very few attempts at building European fortifications in the late Ming period have left any conclusive evidence, like the ones in Jiangzhou and in Xiong County. Originating from the cooperation between local elites with European connections and local officials, these are only experimental practices and were in the primary stage. After 1642, Ma Weicheng successively built angled bastions for Sizhou and Yangzhou, indicating that some senior officials with real power had already accepted the European knowledge. Following this trend, if the Ming regime had been able to preserve half of its territory and maintain a south–north confrontation with the Qing dynasty after 1644, perhaps some other strategically-important places would have have their city walls rebuilt and adopted new defense systems of angled bastions. However, the quick collapse of the Ming dynasty eliminated the possibility of spreading the new defense technology. European fortification also lost the chance of proving its advantages in real combat.

The fighting power of Qing's artillery corps reached its peak in the late seventeenth century, after the Ming-Qing transition wars and the Revolt of the Three Feudatories. In the eighteenth and early nineteenth centuries, the progress of military technology almost stopped. When the First Opium War broke out (1839), the artillery of Qing troops was not as powerful as they had been in the mid-seventeenth century. Throughout the eighteenth

century, the interior of China enjoyed long-term peace, and the frequent warfare at the frontiers brought hardly any threats to the city walls in the interior, so it was never urgent to develop new defensive works.[66] It is therefore easy to understand why European fortification, an outcome of the gunpowder warfare that was introduced into China in the late Ming period, sunk into oblivion for such a long time.

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[66] An interesting interlude is that in 1769, French Jesuit Jean-Mathieu de Ventavon (1733–1787), who had worked as an artisan for the Qing court in Beijing for three years, submitted to Emperor Qianlong a plan for European fortification and some wooden models of bastions. He was trying to please Qianlong by providing military technology, but in the end failed. See Pfister 1934, 914; Waley-Cohen 1992.

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