



## The Historical Study and Technological Representation of the Documentary "*Rebuilding the Tong-an Ships*"\*

**ZHOU Weiqiang**

Department of Rare Books and Historical Documents  
National Palace Museum

The documentary "*Rebuilding the Tong-an Ships*" (再現同安船) is an original video created under the National Palace Museum's vision "Forming new vitality for the collection. Creating new value for the museum". Starting from the National Palace Museum's "The Diagram of the Tong-an Ship *Ji*" (〈集字號大同安梭船圖〉) and related Qing archives, the task group begins a journey to salvage a long forgotten history. They used technologies such as building scale models, creating 3D models, and many other visualization tools to restore 19th century Southeast Asia's oceanic glories and disclose the Tong-an ships' multiple faces in its long history.

The increased oceanic activities of the early 19th century demanded Qing Empire's increased military presence in that area to police the oceans. However, Vietnam's internal conflicts made well-armed Chinese pirates sought-after allies to Vietnam's warring factions. Pirates became more and more powerful during Vietnam's conflicts. The Qing Empire deployed naval fleets in southern China, Taiwan, and Penghu in order to police the seas and also keeps the seas safe for the merchants. This is the historical background for Tong-an ships' era.

Ships are not just a means of transportation. They project a dominating country's politics, military force, economic power and culture to the rest of the world. As a new sea-worthy ship developed since mid-Qing era, Tong-an ships were used not only by merchants, but also by the pirates. In the end, they became the backbone of Qing navy's fighting power. They were built in great numbers. They were customized for various purposes. Qing stationed them from the Bohai Sea to Taiwan. Before the invention of steam-powered ships, they were the zenith of Chinese wooden sailing vessel's development.

"The Diagram of the Tong-an Ship *Ji*" and "The Diagram of the Tong-an Ship No. 1" (〈一號同安梭船圖〉), both owned by the National Palace Museum, are the key historical pictorial data for our research. They described the heaviest and most powerful two classes of Tong-an fighting ships.

---

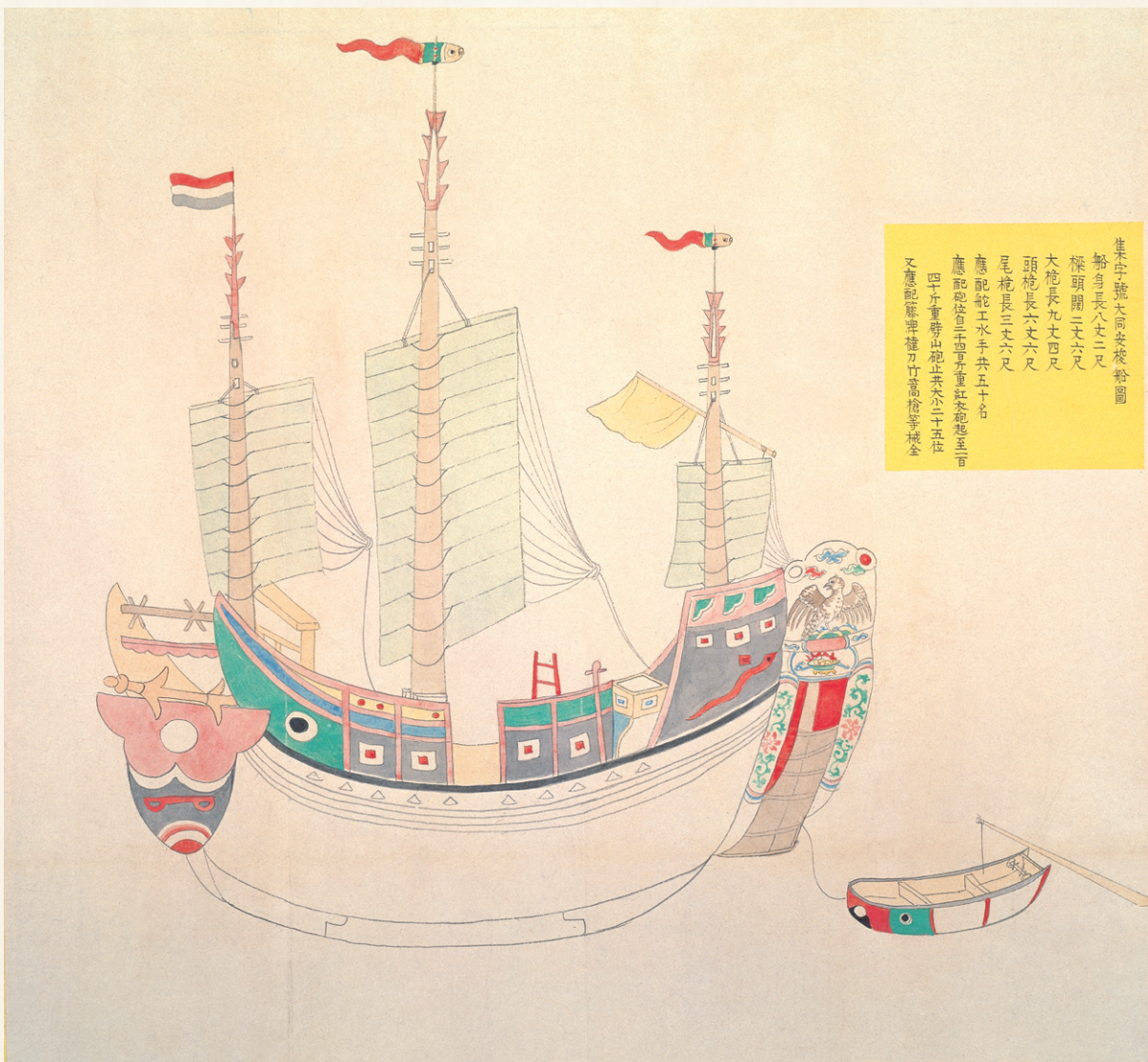
\* Special thanks to the help of Dr. KUO Chen Wo, Assistant Curator of Department of Education, Exhibition and Information Service, National Palace Museum.





They are also very special because they contain formerly unknown details and these evidences are collaborated by official memorials and other texts. They are not only very unique collected items for a museum. They lead us to an unexplored area of the history of oceanic exploration and Taiwan studies.

The historical study behind *"Rebuilding Tong-an Ships"* is based on "The Diagram of the Tong-an Ship *Ji*" and "The Diagram of the Tong-an Ship No. 1" ("The Diagrams"). This scholastic work, when transferred to the screen, employed the building of a wooden scale model and rendering of 3D imagery to supply its footage. The finished documentary is fifty minutes long and consists of three acts. Act One explains the historical background of the Tong-an ships' rise. It contains a reenactment of the deadly sea battle between Li Changeng, the Provincial Commander of Zhejiang (浙江提督李長庚, 1750-1807) and Cai Qian (蔡牽, 1761-1809), a pirate. It then shows the establishment of Qing's Tong-



Submitted by Wang Zhiyi, Governor-General of Fujian and Zhejiang. "The Diagram of the Tong-an Ship *Ji*." "Attachments to Grand Council Memorials." The 27th Day of the First Month of the 22nd Year of Jiaqing, 35.5 cm×40.5 cm, National Palace Museum





an ship fleets. Act Two elaborates the restoration of Tong-an ships. We see how the task team digs deep inside historical records to learn about the two-hundred-year-old Chinese sailing ship and how the craftsman builds the 1/20th model of the Tong-an ship. In Act Three, we analyze the Tong-an ship's main structure and design using 3D visualization technologies.

### **Tong-an Ships as Merchant Ships, Fighting Ships and Pirate Ships**



The completed 3D model (with texture)

The two key issues about the historical study of Tong-an ships are reconstruction of their activities and valuation of their importance. We can see their great contributions to Qing's coastal defense.

Tong-an ships were merchant ships first built in Tong-an, Fujian. They were widely seen off the coasts of Fujian and Zhejiang. As late as late 18th century, they were already used off the coast of Zhejiang to fight pirates. In early 1794, Jueloujiquing, the Provincial Governor of Zhejiang (浙江巡撫覺羅吉慶, ?-1802), reported:

"Our naval ships are too heavy to be maneuverable, especially in shallow waters such as around islands or within bays. We used to use Fujian's Tong-an ships to patrol the seas and catch the pirates. However, hiring them takes much time. Now we have built twenty of them. They are deployed in naval bases of Ningbo (寧波), Huangyan (黃巖), Dinghai (定海), and Wenzhou (溫州). They will be very helpful to our coastal law enforcement."

This paragraph tells us that Tong-an ships have already been hired to fight pirates. They were later built by the government. Jueloujiquing built sixty Tong-an ships. He ordered Wenzhou, Dinghai, and Huangyan to build twenty of them each. In another memorial submitted in 1796, he reported that in early summer, 30 pirates led by Zhang Guan (張觀) who belonged to Cai Cupi's (蔡粗皮) gang turned themselves in. They were using Tong-an ships.

The government phased out old ships and replaced them with Tong-an ships. In 1796, the government ordered Fengtian (奉天) to build fighting ships after Tong-an merchant ships. In 1797, the design of Tong-an ships was standardized to be 22 meters in length and 5.7 meters in width. In 1798, the government ordered that older ships to be renovated according to Tong-an ship's design. In 1799, four more such ships were ordered. The Tong-an ship became the standard fighting ship at that time. However, these early Tong-an ships were smaller than the "Ji" ships pictured in the diagram owned by the National Palace Museum.

### **The Rampant South China Pirates**

During early years of Emperor Jiaqing's reign, ship-based Vietnamese mobs teamed up with





Chinese pirates to raid Chinese coastal areas. Later, these ship-based mobs were either killed by Qing navy or lost during a typhoon strike. The surviving mobs joined Cai Qian and made his gang much more powerful than ever. Ruan Yuan, Zhejiang's Provincial Governor (浙江巡撫阮元, 1764-1849), urged merchants to donate money to Li Changgeng to build larger ships called "Ting Ships" (霆船) in Fujian and made over four hundred guns to arm these new ships. After Li Changgeng became the Provincial Commander of Zhejiang, he used these Ting Ships to strike Cai Qian off the coasts of Sansha (三沙) and Wenzhou (溫州). These pirates really hated Ting Ships. Therefore, they paid a great amount of money to bribe Fujian's merchants to build even larger ships for the pirates illegally. These large pirate ships changed the name of the game. In 1804, pirates crossed Taiwan Strait to plunder Taiwan. Hu Zhengsheng, Regional Commander of Wenzhou (溫州鎮總兵胡振聲, 1746-1804), was killed by the pirates when he tried to capture the pirates.

Because pirates used larger ships, the navy found it very difficult to catch them. As a result, local governments started to build more and larger Tong-an ships. In 1805, in order to defend Taiwan from the pirates, Yu De, the Governor-General of Fujian and Zhejiang (閩浙總督玉德, ?-1808), built 30 new Large Tong-an Ships and assigned each of them one hundred sailors and soldiers. Emperor Jiaqing (1760-1820) ordered Yu De to demand the Regional Commander of Taiwan Aixintai (臺灣鎮總兵愛新泰, ?-1807) to assemble the fleet. Aixintai requested soldiers for this project.

Pirates' ships are taller than navy's ships. Their numbers are increasing. In early summer, Emperor Jiaqing learned from Li Changgeng's reports that Cai Qian was about to raid some merchant ships off the coast of Dinghai. Cai Qian's fleet had up to 90 ships. About 30 of them were tall ships. They formed two groups and fired guns against the navy. Yu De reported more than 90 pirate ships moved to Meizhou (湄州) on their way to Zhejiang. Emperor Jiaqing took this information very seriously and ordered the navy to intercept the pirates.

In the summer of 1805, Yu De assigned sixteen recently built and armed Taiwan Strait-worthy Large Tong-an ships to General Wang Delu (王得祿, ?-1842) and ordered him to deliver the ships to Zhejiang's Li Changgeng. Cai Qian attacked Taiwan in early winter. Later, Cai Qian's fleet of dozens of Tong-an ships broke out from Luermen (鹿耳門), Taiwan. Even though Li Changgeng was after them, Cai Qian finally escaped the pursuit.

The navy's failures in catching pirates resulted in suggestions of building larger ships. In 1806, Censorer Chen Lanchou (御史陳蘭疇, ?-1808) proposed:

"Cai's pirate ships are called 'Ocean-Crossers' (Hengyangchuan). They are tall and capable of carrying up to three-hundred persons. Our navy ships are low and only carries about forty to eighty soldiers. It is very difficult to attack them from below. Please allow us to rent larger civilian ships so we can attack them."

Emperor Jiaqing agreed with Chen's idea to use larger ships. However, he was conservative regarding hiring merchant ships:





"If we rent larger civilian ships, local officials may use catching pirates as an excuse to grab civilian ships for their own use. This policy may result in serious problems. We already have many fighting ships in Fujian. If we renovate them when they are scheduled to enter shipyards, it may still be very costly. Rather than building many less useful small ships, we'd better to modify smaller 'mi boats' (米艇) and 'shuttle ships' into larger ships during scheduled maintenance in order to catch pirates."

The Emperor thinks that renting larger merchant ships to catch pirates is not necessary if the navy's smaller "mi boats" and "Tong-an ships" are to be renovated into larger ships.

### The Dismissal and Prosecution of Yu De, Governor-General of Fujian and Zhejiang

In spring 1806, Emperor Jiaqing learned that ships renovated in Fujian were still lower than the pirate ships. Their masts were very low. They could not defeat pirate ships. The local government was believed to be corrupted. As a result, the Emperor sent Wen Chenghui (溫承惠, 1755-1832), the Provincial Governor of Fujian, to investigate. Later, Emperor Jiaqing accused Yu De for the failure to acquire new fighting ships. He wrote: "I demand Wen Chenghui to capture Yu De and escort him to Beijing to be trialed." Then he fired Yu De and assigned Alinbao (阿林保, ?-1809) to replace him as the new Governor-General of Fujian and Zhejiang.

船內護副將項統統額眉頭髮右手均被火傷又  
傷斃兵丁練民共十名受傷傷兵共二百零三  
名當即知會潮陽縣知縣到船一同照料將李  
長庚身後事宜妥為預辦一面將浙江提督印  
信封固聽候  
奏明委署至該提督僅存三船乘風逃竄該提督仍  
與總兵許松年統帶舟師探明逆蹤上緊剿捕  
現在閩浙兩省水師將弁兵丁因李長庚中砲  
身故無不切齒切齒切齒切齒切齒切齒切齒  
解究等情並據總兵許松年稟報相同臣等接  
閱之下不勝駭愕伏思李長庚在洋捕盜實力  
有年今因察逆逃往粵洋該提督不分畛域儘  
力窮追中砲陣亡殊堪憫惻臣等現已派委候  
補同知歸善林撫標右營遊擊儲士維前赴潮  
陽縣將李長庚棺木安送接護回閩送至該提  
督同安縣本籍交屬妥為安葬至該逆一犯在  
洋肆惡罪不容誅總兵官兵跟蹤追剿乃敢於垂  
危之時猶復抵死拒敵傷害提督人員實堪令  
人髮指臣等現已飛咨張見陞並劉飭向隨李  
長庚緝捕之總兵許松年趁此水師志切同仇  
之際鼓勵將弁兵丁奮力追剿務將該逆剋期  
弋獲以除惡逆而洩眾忿一面飛咨兩廣督  
吳熊光迅派舟師調頭迎擊所有浙江提督印  
信查南潯鎮總兵王得祿緝捕勇性調度有方  
素為賊匪所畏懼臣阿林保現已飛調王得祿  
由粵省之佛堂門洋面折回湖州之海門接署  
提督印務並統帶李長庚原管兵船會同張見  
陞許松年等嚴擒該逆不使與朱潰勾結聯幫  
其浙江提督一缺俟聞緊要並懇  
聖主迅賜簡員補授以重責成再該逆現竄避粵  
洋誠恐聞知李長庚已故又復潛竄回閩現在  
王得祿尚未接任總統之人臣阿林保於拜摺  
後即日馳赴廈門漳州一帶駐劄調度并就近  
探聽粵洋剿捕信息所有據報提督劉匪陣亡  
緣由謹恭摺馳  
奏伏乞  
皇上睿鑒謹  
奏  
嘉慶十三年正月 初七 日

札飭海豐縣丞就河庄廉潔船工分撥各  
船以為引導再行趕往並剿又據金門鎮許松  
年稟稱正月初五日隨同提督督勇在汕尾  
攻獲盜船之後即就汕尾雇集兵丁於初九日  
及別駛至龜嶼外洋見有賊匪船隻五十餘艘  
甚為夥數當與眾見陸軍砲台環攻擊致匪  
等放砲甚眾十餘江王首先被創船隻一僅幸  
遊擊莊元外奉查莊兩共獲賊船一僅幸  
備在增龍龍德島船隻船隻均獲賊船一  
隻奏請發交國守備陳飛鳳等會同先後擊  
沉盜船二隻追捕至晚各匪船俱見冒火外洋  
四散逃竄隨將長嘴賊四牛脚川逐一查獲除  
擊斃落水各盜不計外共擒盜犯王瑞等五  
十五名獲賊船二隻燒沉一僅擊沉二隻起  
獲寶山等砲十門鎗刀八十餘件什物四十餘  
項併水密鎗等項現將所獲賊匪犯交海  
豐縣縣丞嚴訊辦解省督帶辦詳以軍件留於  
兵船暫用等情又據總兵王得祿稟稱該逆  
劉木濱已至廣州府屬之澳門至派兵追剿  
在澳擊外洋當即會同廣東總督嚴查於上  
年十二月二十四日前往追剿並嚴查州鎮李  
慶雲督糧探得賊船虎尾在澳門由澳門往  
追水逆竄逃聞風先行東竄去船亦即派追  
逼現已回至歸善縣之大皇洋面及等賊匪來  
等查該逆僅剩賊船二隻一同尋獲並連獲由  
牛脚川西遁木濱賊船又復由潮縣外洋東竄  
恐難保無勾結幫匪等情臣張見陞許松年所  
帶兵船由東而西擊已兩次追擊獲人船足  
使賊匪膽落虎尾得獲又已率領舟師自  
西而東正可兩路夾擊連獲賊船多艘惟衆  
見陸王得祿等相機取賊匪並知會兩廣督  
臣吳熊光飭粵省各屬會同剿辦外所有關  
粵省原洋面等項亦派李長庚統帶原管領  
大船在於銅山南澳一帶嚴密緝捕該逆匪  
逃竄回閩之路其營是亦擊及擊及賊船仍  
飭屬兵周圖查獲大開等嚴行哨捕以淨根株  
除將此次剿辦出力將弁功過逐條除補  
外合將現在賊情并閩浙大船在粵洋捕獲  
勝緣由謹恭摺具  
奏伏乞  
聖鑒  
臣等謹將該逆匪  
實深逃竄情形見陸王得祿等不忠為賊報仇  
嘉慶十三年正月 二十四  
甘心逆避則非我大清國臣子矣特此通指  
浙閩水師知  
臣等謹將該逆匪



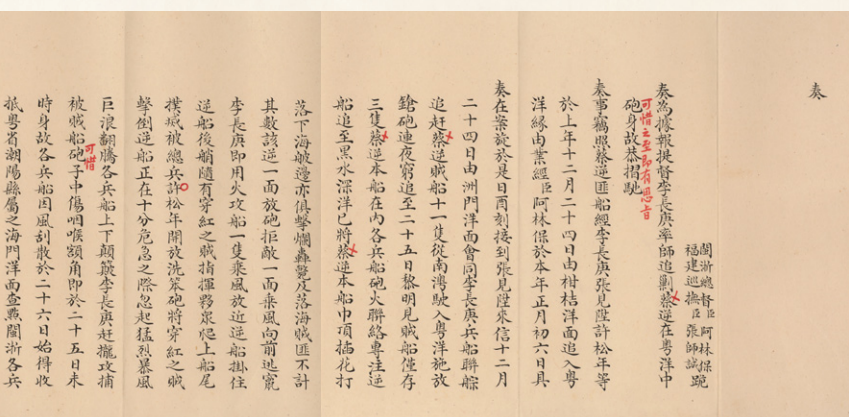


To make sure the navy would obtain ships that can be used to fight pirates, later, Wen Chenghui, requested Generals including Li Changgeng for their opinions. Li urged the building of sixty Large Tong-an ships. Emperor Jiaqing demanded "the construction of the ships shall be by experienced craftsmen and accompanied by supervisors." These ships were standardized to be 8.2 meters in width. Each of these Large Tong-an ship cost 147 kilograms of silver to build. In order to keep Cai Qian from hijacking civilian ships, the Emperor ordered "newly built or renovated merchant ships are at most 5.7 meters in width. The Emperor also requested that newer fighting ships "shall spare no labor and expenses in building them."

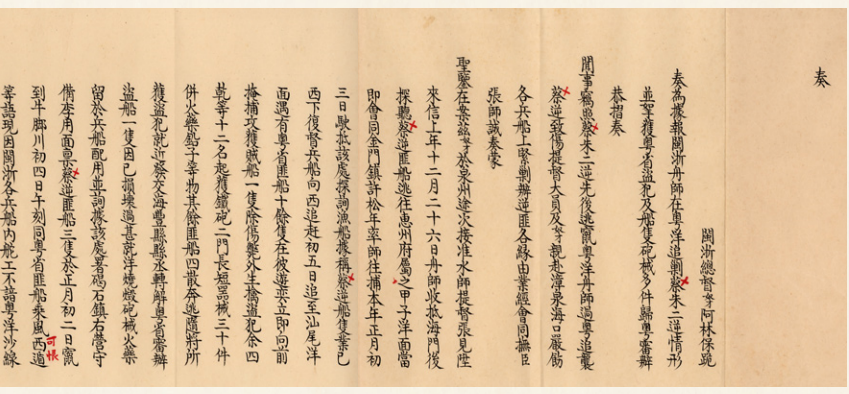
On the other hand Emperor Jiaqing changed his mind regarding hiring civilian ships. He ordered Wen Chenghui:

"I heard that among Fujian's Taiwan Strait-worthy ships, many of them are 8.2 meter wide ships. In fact, rebel Cai stole many of them. If Wen Chenghui can demand local officials to hire or buy suitable ships from these ships. Otherwise, order current merchant ships to narrow their bowheads. If this can be done, largest ships shall all be controlled by the government. Rebel Cai will have no new ships. Since our navy already know how to operate these ships, the war against the pirates shall be easier."

In summer, the government hired fifty merchants and assigned them to General Zhang Jiansheng (總兵張見陞, ?-1813) while the new ships were being constructed.



The memorial that reported Li Changgang's death by Alinbao, Governor-General of Fujian and Zhejiang, and Zhang Shicheng, Fujian's Provincial Governor (福建巡撫張師誠, 1762-1830). "We report that Provincial Commander of Zhejiang Li Changgang was killed by gunshot when he was off Guangdong coast to pursuit Cai the Traitor. We sincerely urge Your Majesty to assign a replacement officer so we can carry on with his unfinished job." The 7th Day of the First Month of the 13th Year of Jiaqing, 12 folds, 21.5 cm×10.1 cm, National Palace Museum



The red-colored comment by Emperor Jiaqing to the fleet of Fujian and Zhejiang to seek revenge for Li Changgang's death. "Report the Situation of Fujian and Zhejiang's Navy's Pursuit of Traitors Cai Qian and Zhu Fen off the Coast of Guangdong and also the Capture of Several Pirates with Their Guns and Their Transfer to Guangdong for Trial." The 24th Day of the First Month of the 13th Year of Jiaqing, 14 folds, 21.6 cm×10.1 cm, National Palace Museum





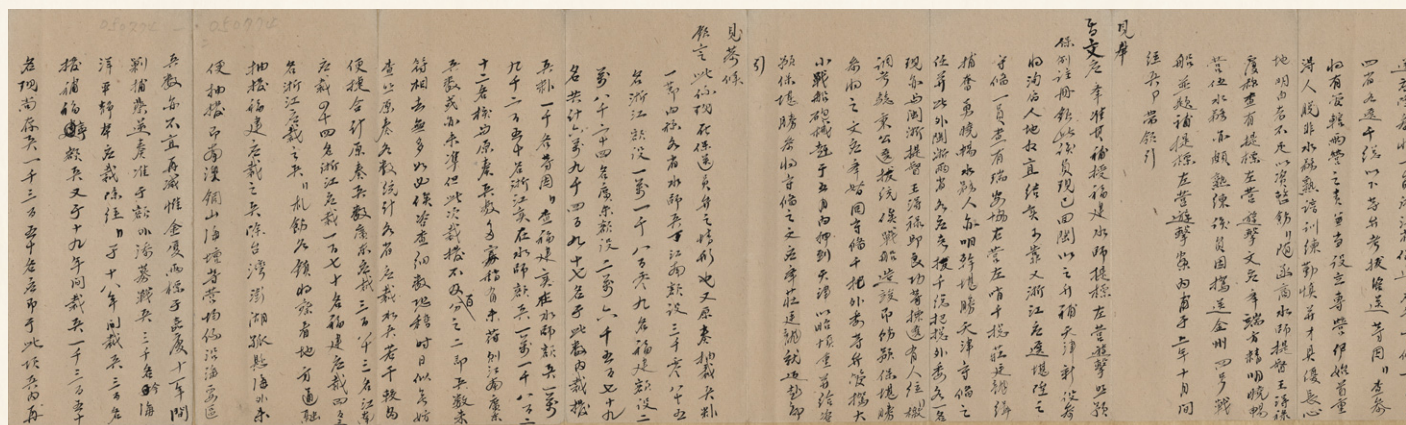
## The Untimely Death of Provincial Commander of Zhejiang Li Changgang

However, the height issues of Qing's fighting ships plagued the pirate catching mission once again. One night in the summer of 1807, Li Changgang chased Cai Qian to Changtu's coastal waters (長塗洋面). In order to get away, Cai Qian cut off the main mast of his own ship. The next morning, Cai Qian was caught up by Li Changgang off the coast of Yushan. Li Changgang burned one pirate ship and sunk another. A couple of hundred pirates were killed. However, Cai Qian's ship was tall and he still could fire his guns at the navy. Because Cai Qian's ships were several meters taller than navy's ships, soldiers could not aboard his ship to capture him. Cai Qian fled for another time. Emperor Jiaqing was unwilling to accept the outcome when he heard about the failed close call. He said,

"Li Changgang's memorial told us that his flagship was the largest one of the navy. They are still several meters lower than Cai the Traitor's ships. They could not aboard his ship. If Li Changgang's ships are as tall as enemies' ones, we probably had already captured Cai the Traitor. It is sad we let him run away like a rabbit."

Since building and hiring of ships are both ongoing, Emperor Jiaqing ordered, "The war against the pirates is now critical. However, Li Changgang's fighting ships now require maintenance. In addition to asking him to hurry up with hunting, the local Inspector shall work harder in ship building so new ships can be delivered to Li Changgang for him to fight pirates." Therefore, Alinbao, hired forty tall and strengthened Ocean-Crossers from Xiamen and Hanjiang.

To let Li Changgang receive new ships and guns as soon as possible, Alinbao ordered Li Changgang to move to a new flag ship which was a 7.9 meters wide pirate ship captured in Shuiao by Xu Songnian (許松年, 1767-1827). Alinbao also informed Li Changgang the news of the hiring of forty tall merchant ships. Among them, more than twenty of them were over 8 meters wide. The rest of them were at least more than 5.6 meters in width. Li Changgang was very pleased hearing the good news. He said, "When I have the ships and more soldiers, I can certainly eliminate the pirate boss." Finally, Qing navy acquired the tall ships needed by them. Since hiring the ships went smoothly, Emperor Jiaqing agreed to reduce the number of Large Tong-an Shuttle ships to be built in Fujian to forty.







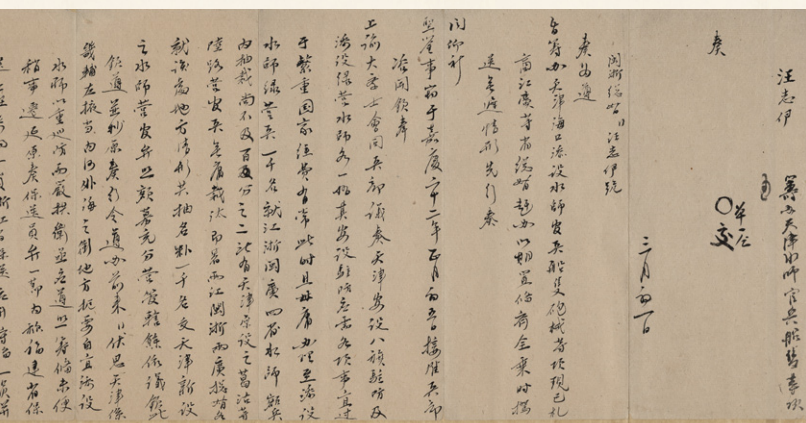
In winter, Emperor Jiaqing heard from Wen Chenghui's report that the twenty Large Tong-an Shuttle ships were completed and they were "built solidly to the specs and the materials and workmanship are not compromised in any manner ... no other fighting ships are as tall and as strong like these ships. Very few merchant ships are of comparable quality. They are certainly sea-worthy for future sea battles." Emperor Jiaqing was very satisfied with these newly built Large Tong-an ships. One month later, these twenty Large Tong-an Shuttle ships were deployed to the navy. They went southeast to pursuit Cai Qian's fleeing fleet.

Sadly, just as Li Changgang assembled a fleet capable of catching pirates, he was killed in a failed operation. In early 1807, Li Changgang, Zhang Jiansheng and Xu Songnian took their fleets to chase Cai Qian from the Ganji Sea to off the coast of Guangdong Province. Cai Qian's eleven pirate ships ran away from Li Changgang all night. They sailed from Nanao to Guangdong's coastal waters and exchanged fire with the Qing navy. At the dawn of the next morning, including Cai Qian's flagship, the pirates had only three ships and they still could not get rid of the navy. When they went to the open sea then called "Deep and Black", Cai Qian's ship had already taken serious punishment. Several sails and one of the ship's side boards were destroyed by the navy's gun fire. Many pirates were killed but Cai Qian kept on firing. Just as Li Changgang's fleet was about to encircle Cai Qian, strong wind suddenly disrupted Li Changgang's formation. Li Changgang was hit in the throat and forehead by enemy fire. He was dead by noon. Qing navy's formation was disrupted by the wind and they could not keep on the hot pursuit.

On the 7th day of the first month of the 13th year of Jiaqing (1808), when Emperor Jiaqing heard about the report that Li Changgang was killed for his country, he was sad and angry. He wrote with red ink "Really sad, I was just about to award him", "How unfortunate!" "I and the Grand Councils are in deep anger!" He crossed each of the word "Cai Qian" with red ink as a ritualistic death sentence to show his anger. On the 21st day of the first month, he wrote:

My hands were shaking and my mind was at a loss when I read the report. I have never seen Li Changgang face to face. However, his works at the seas have been awarded so many times. I already decided to grant him a heritable noble title when he finally captures the pirate's head.

Li Changgang has always been loyal to me. However, he was killed when he was just about to finish his great job. I burst into tears when I read the report."



Submitted by Wang Zhiyi, Governor-General of Fujian and Zhejiang. "Memorial to Report the Status of Preparation of Tianjin's Naval Ships and Crew." The 27th Day of the First Month of the 22nd Year of Jiaqing, 26 folds, 23.2 cm×10.1 cm, National Palace Museum





In addition to sadness and anger, on the 24th day of the first month, he ordered Alinbao that the fleet of Fujian and Zhejiang shall seek revenge for the death of Li Changgang:

"I order the navy to capture the Cai the Traitor immediately. Capturers will be awarded. Deserters will be punished. I am enraged by Li Changgang's ultimate sacrifice. If Generals Zhang Jiansheng and Wang Delu fail to revenge and step away from the fight, they shall not be a citizen of the Qing Empire! I order the Zhejiang and Fujian's fleets to follow my command."

In the summer of 1809, after more than a decade's fighting, Cai Qian was finally killed by General Wang Delu's fleet of Tong-an ships. Peace finally came to the seas.

## The Origin of the National Palace Museum's Tong-an Ship Diagrams

The key clue that leads to the discovery of the two diagrams is the "Memorial to Report the Status of Preparation of Tianjin's Naval Ships and Crew" (奏報籌辦天津水師官兵船隻情形). These two diagrams are attached to that memorial. The memorial was filed by Wang Zhiyi, Governor-General of Fujian and Zhejiang (閩浙總督汪志伊, ?-1818). The memorial itself is lost. The National Palace Museum only has its appendix and its two attached diagrams, "The Tung-an Shuttle Junk 'Ji' Diagram" and "The Tung-an Shuttle Junk 'No. 1' Diagram". All of these items are stored in the National Palace Museum's vault.

Cross-reference this memorial and related documents in our museum archive shows that in the summer of 1816, British envoy William Pitt Amherst (1773-1857) reached Tianjin without Qing's authorization. Later, he reached as far as Tongzhou (通州). His unstoppable and unwelcomed entering of Chinese inland alerted Emperor Jiaqing. As a result, he ordered the founding of Tianjin Naval Fleet and also ordered his officers to work out a fleet-building plan. Based on the proposal of Xu Kun (徐錕, 1768-1842), Provincial Commander of Zhejiang of Zhili, the Tianjing Naval Fleet shall consist of four Large Tong-an ships and four Small Tong-an ships. They shall be built by four southeastern provinces, Jiangnan (江南), Zhejiang (浙江), Fujian (福建) and Guangdong (廣東). Wang Zhiyi, Governor-General of Fujian and Zhejiang, recommended that the Tong-an ship "Ji" and the Tong-an ship "No. 1" be used because they were more suitable for Tianjing's sea conditions.

To standardize the design of each province's Tong-an ships, Wang Zhiyi, Governor-General of Fujian and Zhejiang filed "Memorial to Report the Status of Preparation of Tianjin's Naval Ships and Crew" in 1817). He made two ship diagrams and labeled them properly. He also prepared both ships' detailed Bill of Materials (BOM) that listed each wood part's dimensions and specifications. These documents were planned to be given to Sun Yuting, Governor-General of Liangjiang (Jiangsu and Jiangxi) (兩江總督孫玉庭, 1752-1834), Jiang Youxian, Governor-General of Liangguang (Guangdong and Guangxi) (兩廣總督蔣攸銛, 1766-1830), and Yang Hu, Provincial Governor





of Zhejiang (浙江巡撫楊護, 1744-1828) in order to standardize the ships made by them. After Emperor Jiaqing approved this memorial, it was sent to the Grand Council to make two copies. The attached two ship diagrams were reattached to the copies. This was the origin of the National Palace Museum's two Tong-an ship diagrams. However, the accompanied BOM is still lost.

### The Analysis of the National Palace Museum's Tong-an Ship Diagrams

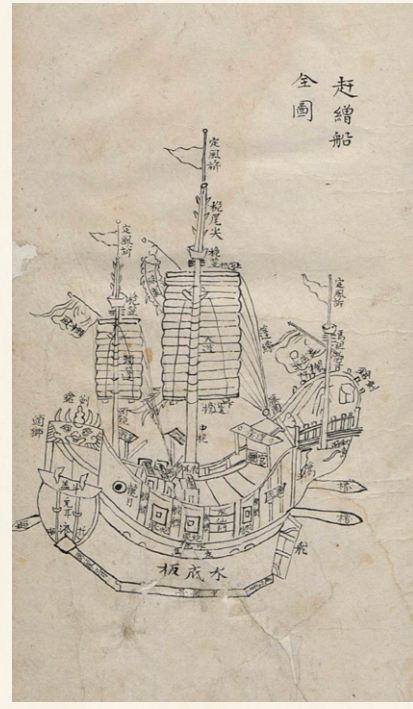
"The Diagram of the Tong-an Ship Ji" of the National Palace Museum is 35.5 cm long and 40.5 cm wide. Its title was written using brush calligraphy. The diagram is completely colored. The diagram contains a picture of the Tung-an Ship "Ji" and its accompanying sampan (a Chinese boat). The upper-right corner label contains the title written with brush calligraphy. The square label on the right of the tail mast has the title, ship's length, width and number of crew and weapons. The contents are:

- Length: 27.33 meters, Width: 8.66 meters, Main mast: 31.33 meters, Head mast: 22.00 meters, Tail mast: 12.0 meters, Crew: 50
- Each ship was equipped with twenty-five cannons of various calibers from the 83 kilograms "Mountain Cleavers" (Pishan pao) to the 1400 kilograms "Red Clothes" (Hongyi pao). As to cold weapons, there were shields, knives with long poles, and bamboo spears.

This is a very rare painting of a Chinese fighting ship in color. It shows the Tong-an ship's vital parts. Take the mast as an example, the head mast flies a Dutch national flag on the top. The main mast and tail mast each has a wind vane. Each mast



Submitted by Wang Zhiyi, Governor-General of Fujian and Zhejiang. "The Diagram of the Tong-an Ship 'No. 1'." "Attachments to Grand Council Memorials." The 27th Day of the First Month of the 22th Year of Jiaqing, 35.5 cm×40.5 cm, National Palace Museum



"Illustrations of the Ships of Fujian Province's All Naval Bases." (閩省水師各標鎮協營戰哨船隻圖說) Collection of the Staatsbibliothek zu Berlin (The National Library of Berlin)





has a pulley on the top. Parts are clearly visible whether they are on the deck, or under the deck. On the deck parts include the front winch, pulleys, sail support, toilet box, gun holes and side gates. Under the deck parts include rudder bands' holder(rabbit ears) side reinforcement parts (running horses and water snakes), the beam and the rudder.

"The Diagram of the Tong-an Ship 'No. 1'" of the National Palace Museum is another attached item of the "Memorial to Report the Status of Preparation of Tianjin's Naval Ships and Crew" filed by Wang Zhiyi, Governor-General of Fujian and Zhejiang. It is 35 cm long and 39.5 cm wide. The diagram is completely colored. Its title was written using brush calligraphy. The diagram contains a picture of the Tong-an Ship "No. 1" and its accompanying sampan. The layout of this diagram is very similar to "The Diagram of Tong-an Ship Ji". The square label on the right of the tail mast also has the title, ship's length, width and number of crew and weapons. The contents are:

Length: 23.97 meters, Width: 6.33 meters, Main mast: 23.98 meters, Head mast: 16.65 meters  
Tail mast: 7.326 meters, Crew: 40

Each ship was equipped with fourteen cannons of various calibers from the 47.2 kilograms "Mountain Cleavers" (Pishan pao) to the 590 kilograms "Red Clothes" (Hongyi pao).

As to cold weapons, there were shields, knives with long poles, and bamboo spears.

Even though there exists no other first-hand historical sources for Tong-an ship's structure, we have found that the structure of earlier Ganzeng ships, which also belonged to the same Fujian Family, was very similar to the Tong-an ship. The hand copy of "Illustrations of the Ships of Fujian Province's All Naval Bases", collected by the Staatsbibliothek zu Berlin, happen to have the Ganzeng ship's structure. As a result, we can label each part of the Tong-an ship "Ji" according to the corresponding Ganzeng ship's part name.

### Building Ship Models and Filming the Documentary

To let us fully comprehend Tong-an ship's internal construction, the task team



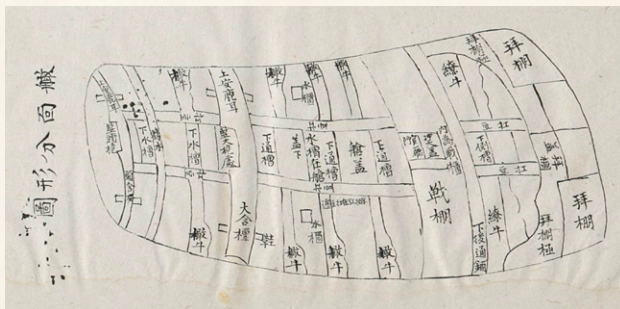
Tong-an ship's part names



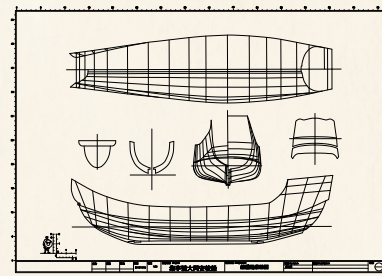


supplies Tong-an ship's specifications obtained from historical sources and let experienced ship model technician Tseng Shu Ming to build the Tong-an ship model for us. There are four steps: building the structure test model, drafting the ship blueprint, making the sailing test model, and making the display model.

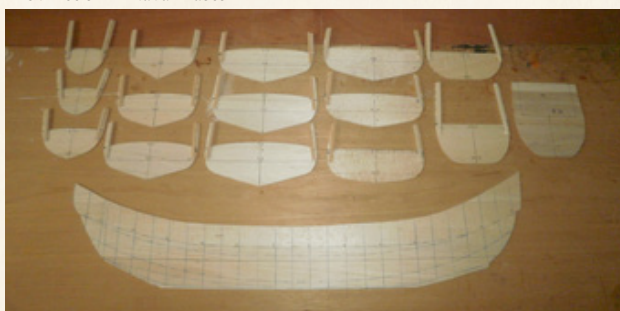
The first step is making the structure test model. We used the historical Tong-an ship "Ji" data obtained from the "The Diagram of Tung-an Ship Ji" and another related ship, the Ganzeng ship's data, compartment layout and deck layout obtained from the "Illustrations of the Ships of Fujian Province's All Naval Bases", and then adjusted these numbers based on the Tong-an ship's properties to compile the final specifications. Then we draft the blueprint and build the structure test model in order to see if the historical data contains discrepancies or errors, or if the compartment and deck layouts are infeasible. When the structure test model is completed, the task team approves the design; we draft the restored deck layout and create the final blueprint. In the end, we generate an AutoCAD file from the



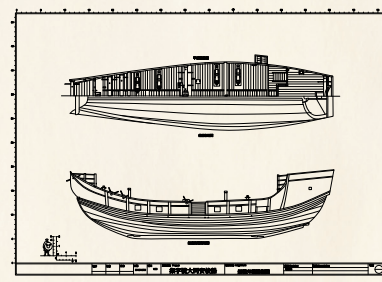
The layout of compartments, "Illustrations of the Ships of Fujian Province's All Naval Bases"



Cross-sections of the Tong-an Ship "Ji"



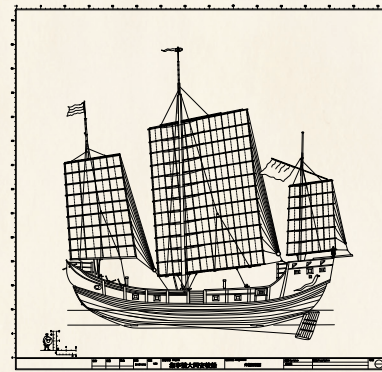
Ship structure tests



The reconstructed deck layout

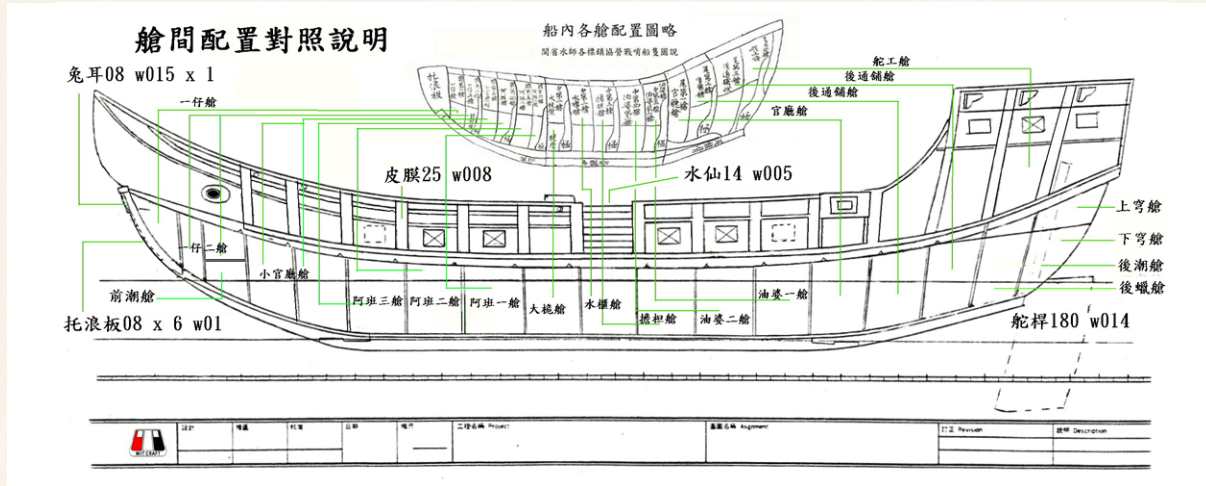


Ship structure tests



The reconstructed





Compartments of the Tong-an Ship "Ji"

finalized design.

In addition to strictly adhere to historical specifications, we still have to test and make sure the ship is really sea-worthy. We let Mr. Tseng Shu Ming build a 1/30 sailing test model and took it to the Dahu Park of Neihu, Taipei for tests. Except for a radio controlled rudder, the test model is only powered by its sails. The tests show the model is sea-worthy.



Mr. Tseng Shu Ming works on the ship model

To allow easy transportation, maintenance, building and displaying, the display model is set to be 1/20 in scale. In order to be configurable during display, the masts, sails, rudders, guns, hatches, gates, gun ports, and gun seats are all movable. We also have built accessories such as cannonballs, gunpowder barrels, soldiers, flags, and cables. Finally, the display model is detailed and painted. The coloring scheme is true to the original colors of the "The Diagram of Tongan Ship Ji". However, the model's coloring must be adjusted to compensate for the fading of the aged inks.

After the ship's AutoCAD model is completed, it is given to the 3D effects house to convert to the 3DS Max format. Then we render images of TGA format. In the end, we use Fusion and Adobe After Effects for post-production.

The documentary film is consists of parts such as reenactments, scholar interviews, location shootings and 3D computer graphics. For reenactments, we used a number of film-making techniques to keep the costs down without sacrificing the required sense of epic. Due to limited budgets, we cannot afford to build full-sized sets for the required scenes such as the pirate's den, pillaging, sailing and sea battles. As a result, the director used green screen photography to film the actors and then compose the final image using computer-generated background elements. We used 4k-resolution RED





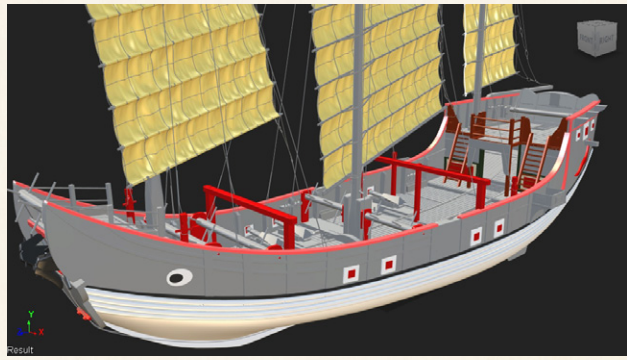
cinema cameras for principal photography. Then we used Fusion and Adobe After Effects for post-production. The final output is then color graded in order to correct each shot's color.

### Conclusion

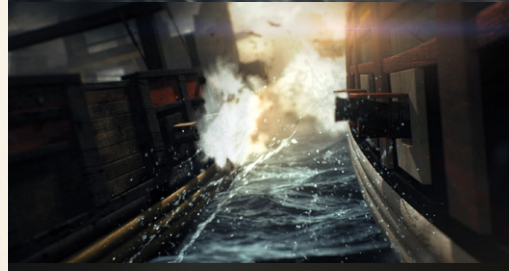
As a new sea-worthy ship developed since mid-Qing era, Tong-an ships were used not only by merchants, but also by the pirates. In the end, they became the backbone of Qing navy's fighting power. They were built in great numbers. They were customized for various purposes. Qing stationed them from the Bohai Sea to Taiwan. Before the invention of steam-powered ships, they were the zenith of Chinese wooden sailing vessel's development.

Due to very limited historical sources, it is a very difficult job to restore a complex engineering such as this. By studying the "Illustrations of the Ships of Fujian Province's All Naval Bases", we finally learned much about the lost details of the National Palace Museum's two Tong-an ship diagrams. After countless times of discussions between the task team and the ship modeler Mr. Tseng Shu Ming, we finally drafted the three views of the Tong-an ship and used these diagrams as the basis of our restoration.

To increase educational value, we have built a 3D model of the Tong-an ship in order to facilitate future developments. Not only we can keep on developing interactive software, we saved a lot money on actually rebuilding and maintaining the ship. This is a cost efficient way to revitalize historical technologies.



The completed 3D model (without texture), Courtesy New Folder Man



Scenes divided by 3D and CG, Courtesy Bronze Visual Art Co., Ltd.



An illustration of the Tong-an ship's history, Courtesy Bronze Visual Art Co., Ltd.