Maritime technological Innovation in the Indian Ocean

During Antiquity

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Throughout history, maritime technology has advanced. While most maritime technological innovations have generally been towards the same direction, certain aspects of practice have been isolated to certain locales. In the basin of the Indian Ocean, the largest disparity between technological advancements occurred between the Chinese maritime culture and the culture of the Arabian Sea and East African Coast. Advancements in maritime technology in antiquity largely revolved around improving the speed and safety of a voyage. Most technological innovations can be separated into 3 categories: hull design, rigging design, and navigation. Practical change is persistent, but technological changes due to cultural ideology may also exist and drive change in practical ways.

Regardless of the type of sailing craft, many ships contain similar structures or styles that can be found on any sailing craft, regardless of its location of origin. As marine ships became more advanced, additional technologies were added on and integrated into many vessels throughout the Indian Ocean basin. All boats possess a bow, stern, keel, hull, stays, and many additional aspects. It is important to understand what each of these items represent in order to understand how new technologies affected them. The hull of the boat is the planking around the shell of the boat that provides much of the buoyancy to stay afloat. The keel of the boat is the center of the hull of the boat, underwater, that provides lifts when sailing on closer reaches (angles to the wind). Stays were created because; as the mast of sailing ships grew taller it became necessary to stabilize them to prevent the mast from falling out due to top heaviness. The beam and draft of the boat are ways of measuring the width and depth of the boat, respectively. A rig is the general style of the setup of mast and sail. For example, a lateen rig consists of a mast with a triangular sail.
First of all, it is important to point out that maritime technologies varied throughout the Indian Ocean basin. While many technologies were similar and used in comparable settings, the distinctive details of each ship provide a larger view of the cultural identity of the ship’s original construction location. For example, ships that were made on the Coromandel Coast of India differed slightly from those built on the other side of the Indian subcontinent, on the Malabar Coast (Ray 2003: 32). For example, smaller “life” boats were more common on the Malabar Coast of India, due to ships on that coast needing to anchor further offshore than on the Coromandel Coast (Hourani 1995: 152). While ships that were very closely located to each other differ only slightly, ships across the wider Indian Ocean differ in a much greater magnitude. The Chinese junks were starkly different from the Indian dhows and outriggers that were more common on the East African Coast and in the Arabian Sea. Such differences can be explained by the different types of wood that were located in the internal forests of that particular region or because of cultural and religious practices that contributed to ship building design, such as the lack of iron nails on sewn Indian ships.

As shipbuilding practices grew, the number of different types of vessels grew be upwards of one hundred. Different types of boats were created for different situations and jobs to which they were delegated. Each type of vessel additionally had its own name, which created a very large vocabulary of boats and boat types. Most vessels in the Indian Ocean basin could be categorized into one of three general categories for the type of job that the vessel would undertake: the river crafts, the coastal crafts, and the open ocean crafts. One of the most interesting and unique crafts that cropped up in the Indian Ocean basin is the Chinese junk that was able to span nearly all three of these categories.
During earlier Chinese history (Zhou Dynasty) many of the Chinese ships were particularly long in relationship to their beam, usually around a 6:1 or 8:1 length: beam ratio (Gang 1997: 58). Around 310 B.C. a new development of construction of overlapping planks created a sturdier hull and deck, which could withstand greater wave force which led to the creation of wider hulls. Before the increased strength of the hull, the boat was dependent upon riding over the waves to refrain from the waves crashing full force into the side of the boat and staving in the wooden planks. During the Qin period (221-207 B.C.), the ships became much beamier down to about a 4.5:1 ratio (Gang 1997: 60) and could begin to be seen as the modern general term for a Chinese ship: a Junk. The wider beam of the boat increased the stability, and thus the safety of traveling in rougher seas. During the Han Dynasty (206 B.C. – 220 C.E.) many ships instituted the use of multi-decked junks along with a ballast system and watertight holds (Gang 1997: 31). Ballast within a boat allowed for more stability during rougher seas. Increased ballast lowers the boat in the water, reducing the pitch and roll over rough waves. Watertight holds made the ship last longer because rotting would occur less frequently along the deck.

In the Chinese maritime culture, there were a plethora of different vessels that each performed a distinct job. In the lakes, there were smaller vessels called wanshichuan that were designed for fishing in the flat, calm waters of lakes (Gang 1997: 23). In the canals, the Chinese developed a specific boat called the bianhechuan that was designed for transporting trade goods through canals and in rivers in China (Gang 24). Lastly, there were the fuchuan that were the long-range vessels that traveled across the oceans (Gang 1997: 25).
The *fuchuan* were the most common vessel by the late Han/early Sui Dynasty government (589-618 C.E.), these ships also consisted of the greatest number of newly integrated technologies: including a ballasted keel and bilge system for increased ability, a v-bottomed hull and multiple sails for increased speed, multiple rudders for increased steering, and a broad stem and stern for easier and quicker construction. A broader stem and stern meant that the planking of the ship would not have to be bent, which is how the pointed stem and stern were created. As time progressed, the draft of the larger *fuchuan* ships began to decrease and by the Tang Dynasty (618-907 C.E.) the *fuchuan* had evolved into the *shachuan*, a shallow water ship without a keel (Gang 1997: 29). The purpose of such a ship without a keel allowed junks to skip stopping in a port and go directly into a river, saving on cost and time. However, along the middle of the hull of the boat, underneath the water was a harder log called a *longgu*, which was placed there to minimize damage to the hull if the boat accidentally grounded on a sandbank (Dreyer 2007: 68).

The flat bottom of the unique Chinese junk was a large departure from the norm in the Indian Ocean basin. The distinct sails were another unique feature within the Chinese maritime tradition. Instead of a traditional single cloth sail, the Chinese junk had a series of battens along the entire height of the sail, creating a ladder pattern. This set-up allowed for most of the sail to continue to be used even if a tear occurred in the one of the battened sections. The battens prevented rips from spreading to other flakes of the sail, making the entire sail useless.

Sails in the rest of the Indian Ocean basin were mostly made up of a single cotton cloth, or stitched leaves of a coconut palm tree, that was not battened throughout the entire sail
Therefore, if a rip occurred in any part of the sail, the rip had to be patched quickly or else it might spread and ruin the entire sail. The most common sail used was the simple square rig that only had the ability to go downwind or on very broad reaches. This limited potential port of calls dependent on wind directions. Even while the square sail was in use, innovations were made upon this setup to enhance sailing ability. For example, by the second century C.E., ships had grown to having two masts that were held upright using stays. Most of the larger craft in the Indian Ocean basin used an old style square rigged sail until Medieval times, when the lateen and settee sails were included onto the larger ships (Whitewright 2008: 147). Before this, the triangular sail pattern was used on the larger vessels for ocean traveling, the lateen and settee sails were used extensively among the smaller watercraft for light coastal traveling by the second century A.D. (Whitewright 2008: 205). The triangular sail plan allowed for ships to sail much closer to the wind, increasing their potential port of calls without depending on a single wind direction. Even though the triangular sail plan allowed for greater mobility, the square sail plan was still around until the 19th century. The African *mtepe* was still known to carry only square-rigged sails (Sheriff 2010: 83). While all the lateen sails had the general triangular shape, various styles were created to match the differing monsoon winds. In the lighter winds a larger sail would be hoisted, while during squalls, a much smaller sail was put up so as to catch less wind (Mathew 1997: 50).

The sails and rigging were an important way of keeping a heading in relation to various types of winds, but the hull of the boat was important for providing cargo space and safety to the crew of the ship. Hindi shipbuilders came from their own workmen caste: the *Odayees* (Mathew 1997: 20). These workers would build the hulls of their ships through an oral tradition.
For example, one tradition was passed down via a song of a goddess that described the dimension of the boat (Mathew 1997: 21). The hulls (and other aspects of the ship) were usually built by either teak or coconut palm wood (Hourani 1995: 90). These woods were commonly used, because they are much more workable and flexible for shaping. To fashion the hull of the boats, the keel would be laid out and then the planks would be sewed up from the central keel. Unlike in European crafts, ribs (to strengthen the hull) were not placed until after they had been completed (Hourani 1995: 92). The largest transition among Indian Ocean hull design came as a result of the Portuguese expansion. As Portuguese presence became more common in the Indian Ocean, the square transom became more common in Indian crafts (Mathew 1997: 46). The square transom not only made a ship more similar to the Portuguese, but also increased the amount of cargo space within a trading ship.

The most peculiar tradition in the Indian Ocean for boat building was the absence of iron nails to connect the wooden planks of the hull together. Instead the planks of the hull were stitched together using a coconut fiber stitching (Parkin and Barnes 2002: 50). In each of the sewn planks, holes would be bored through at regular intervals and the coir made of coconut fibers would be used to connect two planks together (Hourani 1995: 92). While fish oils and tree resins would be used to try and waterproof the planking of the sewn ships (Mathew 1997: 45), the seam were still incredibly leaky, and sailors would continuously have to bail out water (Hourani 1995: 95). One of the reasons for this absence of iron nails was the Indian myth of magnetic rocks in the ocean that would drag the boat down under the waves (Sheriff 2010: 87). Iron nails would not be introduced into Indian shipbuilding until the eighth century C.E. when the Arabs expended into India (Sheriff 2010: 89). Even then, the shipbuilders tended to sew
their boats together. A possible reason for keeping the tradition of stitching the planks together was that with the abundance of coral reefs in the Indian Ocean the stitched boats would not break as extensively if the ship ran on top of a coral reef (Parkin and Barnes 2002: 120).

Many other various innovations were also integrated into boat design that did not consist of the hull or sails. The mast of many ships were altered throughout time to include wood that was much longer and tougher so that it would not crack from extended exposure to the sun (Mathew 1997: 16). In order to steer the ships, many of the earlier vessels held what were called steering oars, which were long paddles that were placed at the stern of the ship. A steering oar would be placed on either side of the hull because, with the advent of the lateen sail, boats would keel to a side and the windward oar could lift completely out of the water (Hourani 1995: 98). Eventually, the steering oars were replaced with axial and stern post rudders, which are more similar to the modern-day version of a rudder on a sailing vessel. The stern post rudders and axial rudders were permanently connected to the boat using various forms of cables and hinges (Parkin and Barnes 2002: 58). Different types of treatments were also created to help protect and extend the life of each sailing vessel. Fish oil was used to waterproof the keel and soften the wood so that corals would do less damage if the ship ran against them (Mathew 1997: 65).

Navigation was also an important factor into which innovations were developed. With better navigational techniques, the time it took to voyage from one port to another could be significantly decreased. One of the first advancements in navigational sailing was the identification of the monsoon winds trend that consist of blowing from the Southwest during
the spring months and then the winds blow from the Northeast during the winter months (Parkin and Barnes 2002: 212). While sailing on the open ocean, many navigators used the stars to determine latitude (Sheriff 2010: 127). During the Abbasid Caliphates, astronomical studies increased greatly, and further advanced astronomical navigation (Hourani 1995: 109). Navigators would identify most positions related to the rest of the ocean by identifying various landmarks and other characteristics of the surrounding environment (Ray 2003: 99). For example, as stated in the Periplus of the Erythraean Sea, the coast was determined by the types of snakes and the color of the water visible to the navigator, who was trained to identify and precisely locate where the ship was in the Indian Ocean (Schoff 1912: 34).

Many inventions were used to make identifying the latitude easier for the navigator. The astrolabe evolved from the cross staff for determining star height, which in turn evolved into the qiyas, a collection of tablets that helped identify star formation, which was later condensed onto one tablet (Sheriff 2010: 136). Another similar book to the qiyas was the rahmanis, which were a nautical book that included not only astronomical information, but information on the winds, coasts, reefs, and anything else a captain might need to know (Hourani 1995: 107). The compass became one of the essentials of navigation and found a place in many navigators’ arsenal of tools. Although the compass had been around for centuries, it was more commonly used on land by the Chinese. The first recorded use of a compass in the maritime setting (recorded in literature) was in 1232 A.D. (Sheriff 2010: 134).

Innovation in boats within a society in the Indian Ocean basin was constant. Nearly every section of the boat from the bottom of the keel to the top of the sail was altered through
time. Such advancement in maritime technology not only aided in increased capability to sail various places, but increased the amount of cross-cultural interaction within the Indian Ocean. Crafts from China, India, Arabia, and Africa all became much more common sights in far-off places within the Indian Ocean basin, from their homeland due to the innovations that enabled maritime travel to be, much more reliable and safe.
WORKS CITED

Barnes, Ruth, and David Parkin.  

Deng, Gang.  

Dreyer, Edward L.  

Hourani, George F.  

Mathew, Kuzhippalli Skaria.  

Ray, Himanshu Prabha.  
2003 The Archaeology of Seafaring in Ancient South Asia. Cambridge: Cambridge UP.

Schoff, Wilfred H.  
1912 The Periplus of the Erythraean Sea; Travel and Trade in the Indian Ocean. New York: Longmans, Green.

Sheriff, Abdul.  

Whitewright, Richard J.  
2008 "Maritime Technological Change in the Ancient Mediterranean: The Invention of the Lateen Sail." Ph.D. Dissertation, School of Humanities, University of Southampton.