THE DEVELOPMENT OF ASIAN WATERCRAFT: FROM THE PREHISTORIC ERA TO THE ADVENT OF EUROPEAN COLONIZATION

Volume I

A Dissertation

by

RICHARD D. HERRON

Submitted to the Office of Graduate Studies of Texas A&M University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 1998

Major Subject: Anthropology
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ABSTRACT

The Development of Asian Watercraft: From The Prehistoric Era to the Advent of European Colonization. (May 1998)
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The development of Asian watercraft began with simple flotation devices: the log float, bundles of vegetation, inflated animal skins and pottery vessels. From these, developed skin boats, basket boats and, most fundamental to the evolution of Asian watercraft, the dugout and the raft. Some form of raft or dugout was used by Australoid and Austronesian peoples to sail to the islands of South and Southeast Asia, possibly as early as 80,000 years ago.

Shell-first construction dominated the development of Asian watercraft. In South and Southeast Asia, planked hull vessels built up from a dugout base were common. Apparently, planks were originally attached using only ligature fastenings. In time, a combination of ligatures and dowels was used, and eventually boatbuilders, especially in Southeast Asia, increasingly relied only on dowels without any ligature fastenings along the planking seams.
The majority of East Asian vessels was also based on the dugout, but in China both the dugout and the raft greatly influenced vessel development, resulting in the sharp-bottomed southern type and the flat-bottomed northern type of watercraft. By at least the first half of the second millennium A.D., in the areas of the South China Sea, a possible hybrid vessel type was being built which combined Chinese and Southeast Asian vessel features.

Restrictions on Chinese shipping during the Ming dynasty resulted in the flat-bottomed, northern type of Chinese craft becoming dominant. Western observers give evidence that by this time the builders of some Chinese watercraft were using a combination of shell- and frame-first construction methods. After the advent of European colonization, some traditional Asian vessel types were changed due to Western influences. Nevertheless, recent research supports the knowledge that the majority of Asian watercraft continued to be built in traditional fashion, many of which still exist in some form today.
To all the Gods and Goddesses who help us along our individual paths:

zhong gua de gua; zhong dou de dou.
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Above all, however, my utmost gratitude is reserved for Kim, my wife and compatriot. Few are fortunate enough to be blessed with someone whose help, love and support transcends all human understanding.
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CHAPTER I

INTRODUCTION

Anyone with knowledge and understanding of nautical matters appreciates the profound importance watercraft and navigation have had on the history of humankind.

Over 70 percent of our planet is covered by water.\textsuperscript{1} In only the most arid environment is it possible to travel any significant distance without encountering a body of water.\textsuperscript{2} The impact of this is often lost upon many of us today, however, because of the environment created by modern technology. Bridges -- connecting roads, highways and superhighways -- span rivers, lakes and other waterways. What we cannot build over, we tunnel beneath. And when neither of these options are available or convenient, we can choose to fly. Actual transportation by water has become fairly uncommon for most people. Thus many forget the integrality of navigation to human history.

Because we cannot travel on this wet planet without inevitably encountering water (even to live we must encounter water), it is hardly surprising that the world's first civilizations developed along some form of major water supply.\textsuperscript{3} As our ancestors traveled from place to place, as hunters, warriors, traders or settlers, their

This dissertation follows the style and format of the American Journal of Archaeology.
ability to negotiate the water obstacles encountered was proportional to how far they were able to go -- or, in many cases, how far they had to go.\textsuperscript{4} If the body of water encountered was only a shallow stream, for example, then the obstacle to overcome was obviously rather minimal. If, on the other hand, water conditions made it impossible to simply travel across by foot, then only three options were immediately available. First, give up the trip, turn around and go back -- a choice undoubtedly made by many. The second option was to find a way around the obstacle. Depending on the circumstances, this was quite viable if, for example, the obstacle was a lake with a perimeter easily skirted. If, however, the obstacle was a river, such as the Ganges, merely going around it was not so simple a task.\textsuperscript{5} The third option was to find or devise a way to navigate across the obstacle.

The most direct way to navigate our hypothetical water obstacle would probably be to swim across it. This was certainly not an uncommon solution (Fig. 1). But depending on several factors, including the individual swimmer's ability in particular, swimming away across the water could quickly turn into swept away across the water and thus fatally exaggerate the definition of navigation. A safer, and for the most part, more efficient method was to use some form of flotation device other than just one's
Fig. 1: Besieged Assyrian soldiers swim to the safety of a fortress. One individual is atop an inflated skin, while his companion relies on his swimming ability alone (ca. ninth century B.C.). (After de Graeve, pl. X)
own body. Herein lies the antecedents to the nautical history of mankind and the beginning of water navigation.

For many people the subject of seafaring and navigation brings to mind the grand ocean liners of the twentieth century, such as the Queen Mary or the ill-fated Titanic and Lusitania. Others may be reminded of the great European and American clipper ships, beating their way across the oceans of the world, setting speed records previously believed impossible. Still others may think of the vessels of explorers, such as Columbus or da Gama, whose ships, and others similar to them, made the Great Age of Discovery possible. Those with a broad understanding of world maritime history will include Asian examples such as the legendary, almost mythical ships sailed by the Chinese explorer Zheng He. All of these are indeed some of the "most marvelous structures ever built by humankind." Moreover, they are all examples of mankind's evolving technological endeavor to overcome the age-old challenge of water navigation. And this technological evolution did not begin with fully developed ships, but with comparatively simple devices fabricated from the most readily available materials.

Ceramic vessels (made watertight or held in such a way as to prevent water from entering), inflated skins and buoyant wood were some of the earliest, most typical
flotation devices used throughout the world -- some or all of which are still used even today. From Europe to Egypt, from Mesopotamia to the Indus River Valley, from the Far East to the Americas, anywhere there was a water obstacle to negotiate, some form of these flotation devices was used. Even in their humblest form, these early flotation devices mark the evolutionary beginning of the ships of the world. This issue will be addressed again. Of more immediate concern is the fact that although these "ships of the world" played an integral role in the history of humankind, relatively few were ever documented, and even fewer were recorded with any real degree of accuracy.

Some may think this opinion too extreme, considering the many extant vessel representations that geographically range from the Mediterranean to northern Europe and cover a time period of several thousand years. Ship scholars, especially those studying the maritime history of the Far East, however, must often rely on only an occasional smattering from an unrelated text, a handful of extant stylized models or equally stylized iconographic representations, all of which frequently reflect the fanciful imagination of the artist rather than reality. Moreover, many of those artistic renderings and documentations from the Mediterranean and Europe are open to criticism as to their accuracy.
Rather than lamenting this fact any further, let us consider the possible reasons for this paucity of reliable information. Perhaps the most obvious is that many representations and descriptions simply have not survived or, more optimistically, have not yet been discovered. This perennial hope of bringing to light some kind of new information is a primary inspiration for most researchers. Another factor to consider, but not an easily, if at all, verifiable one, is the attitude contemporaries had toward watercraft.

Often and understandably, many scholars adamantly try to avoid humanizing the data taken from cultural material, perhaps leaving the facts to speak for themselves. To cross the line separating facts from interpretation, especially when this involves interpreting the minds, concepts and thoughts of those no longer living, is a compelling but potentially hazardous endeavor. Inherent to this is the unavoidable tendency to speak in absolutes, and to do so is to bury oneself in a morass of exceptions-to-the-rule. Nevertheless, however slippery it may be, interpretation is a fundamental and ultimately unavoidable element of any research. Not to belabor this point with the absurd, but without interpretation how can we possibly know what a thing is? How can we know, in the present instance, that certain representations we will be
discussing are even ships if not for interpretation? The way we know is through inference, based on shared concepts that transcend time and culture. On a larger scale, there are always pitfalls and gray areas from which we may never arrive at the truth. Caution is vital. But to be so cautious as to reject any kind of interpretation, speculation or inference is to invalidate our research and fact-finding endeavors altogether. Thus we return, cautiously, to the possible attitudes contemporaries had toward watercraft.

Artistic representations that are apparently inaccurate or even fanciful can be judged to be the work of an artist unfamiliar with the subject. This is certainly not to suggest that all inaccurate representations were done by ignorant artists. Frequently the medium of the representation dictated form. Ships with orbicularly exaggerated hull shapes depicted on round coins is one such example. Nevertheless, regardless of how accurate or inaccurate we today may deem a work to be, we can assume that the artist was portraying a scene or a subject that the intended audience could readily identify. And the audience itself, possibly due to its own ignorance of the subject, may have preferred stylistic representations rather than technically accurate ones. As Whistler answered when the likeness of one of his portraits to his
sitter was questioned, "likeness, O that is the last thing I think about!" This was often the case in China during the Ming dynasty (A.D. 1368-1644), when the intelligentsia concerned themselves more with the profundity of artistic expression rather than detailing the minutia of crass technology. As a result, many artists eschewed depicting in a detailed, accurate manner the ships and other technological entities of their otherwise cloistered world. But what of the technician, the craftsman, the boatbuilder?

Shipwrights, carpenters, sailors and others intimately involved with the shipping and shipbuilding industry occasionally turned their hand to producing models, drawings or other representations, providing us with an invaluable legacy that depicts at least a segment of these individuals' lives and material culture. This artistic musing has been particularly true in the Western World for approximately the past 400 years, often done for no other apparent reason than simply for the sake of art. A naval officer or shipping magnate without some form of maritime art adorning his environment would be a stoic individual indeed. It is no secret that we in the Western World have greatly romanticized and thus popularized our maritime history over the past few centuries. But what of the shipwrights and sailors of the centuries before? Did
they view their ships and other vessels as mere tools and nothing more? The tomb of Eleventh-Dynasty Egyptian nobleman Meket-re, from the second millennium B.C., contained as part of its funerary gear detailed boat models that reveal their creator or creators as having acute artistic ability. However, because these models were likely intended to be used in some utilitarian way in the afterlife, they were more than mere *objets d'art.*

Considering the elaborate ornamentation embellishing many ships and other vessels over time, especially those sailing in Asian waters, we can deduce that watercraft themselves were occasionally considered works of art, or at least worthy canvases on which to display such finery. Perhaps the shipwrights, builders or carpenters who did not reproduce images of these craft did not do so because all artistic expression was taken up by the production of the vessels themselves. Also in some cultures to do such a thing was taboo. Vessels, as most everyone is undoubtedly aware, are commonly anthropomorphized, particularly by those who sail them. On the island of Bali, in the Indonesian archipelago, vessels are imbued with a living spirit, and some shipwrights contend that a representation of a vessel may endanger the actual vessel by capturing its soul and thus, in effect, killing it.
Another point to consider is the fact that commonly the shipwright, the sailor and most everyone else in past societies were illiterate, or mostly so. This is not a slight upon their intelligence. It is simply a fact that relatively few people throughout history were able to read or write; the ability for the majority of a population to do so is a rather recent phenomenon of our modern world. If one cannot write, one obviously cannot create textual documentation; and those who could, with a few exceptions, did not concern themselves with the philosophies, theories and methodologies of shipwrights and shipbuilding.

So where does this leave us? We have artists who knew little of their subject or who portrayed it in a form modified by special constraints or artistic convention; craftsmen who may have considered their product a work of art in and of itself, or who were culturally or technically unable to depict it in any other way; and a literati who addressed themselves to matters other than nautical affairs. These are all valid reasons for the lack of information, at least in many cases, concerning watercraft. But, again, where does this leave us? In one respect, this leaves us with the material culture itself.

We cannot go back in time and interview the shipwrights, carpenters or sailors, but we can induce much about their world from the materials that survived them.
Frequently an artifact itself can tell us more than any artistic representation or even documentation. Like fingerprints to the criminologist, the details of ship remains can provide an acute observer with information about how a vessel was constructed, its use, its age and (if the vessel was wrecked or abandoned) its demise. Over the past several decades archaeologists have brought to light a considerable amount of information concerning ships, their cargoes, their construction and the maritime cultures associated with them. By learning such things we not only add to the general details of history, but, perhaps most significantly, we gain a clearer insight into the lives of those who lived this history.

Relative to this, ship scholars have directed considerable energy toward understanding the design and construction of vessels and the reasons for their variation, both geographically and chronologically, as well as culturally. From this has emerged many, sometimes conflicting, ideas on how to classify and categorize ships and other vessels. Much information is available concerning these various classification schemes and how they developed. Most of them pertain to the Mediterranean and northern Europe. Thus a detailed description of all of them is unnecessary here. Most of the classification schemes germane to this study involve a dichotomy:
vessels that evolved from the dugout and those that evolved from the raft; vessels with laced hulls and those using mortises and tenons or nails; vessels with flush-laid planking and those with lapstrake planking; shell-first construction and frame-first construction, the second developing out of the first with molds possibly playing a part in the transitional phases. A fairly recent hypothesis of a bottom-based shipbuilding tradition will also be of interest to us.

As we have seen, and will see again, the first watercraft (to use the broadest sense of the term) were simple flotation devices such as inflated skins, buoyant wood or ceramic vessels. These devices alone, however, were exceptionally limited as far as carrying capacity and, of no little importance, the comfort they provided the would-be navigator. To correct this, modifications were made, marking a notable evolutionary stage in vessel development. One of the most basic of these developments was the creation of the raft. By joining logs or other material together, a buoyant platform was created that could support passengers and cargo -- a vast improvement over clinging precariously to a wet and rolling log while attempting to hang on to whatever valuables one was trying to carry. To improve on this basic design, builders positioned the raft platform atop floats such as inflated
skins, ceramic vessels or buoyant wood. These floats, attached to the underside of the platform, created, in effect, a kind of freeboard that helped prevent the upper surface of the raft from becoming swamped or awash with water. The raft, although indeed an improvement, remained a floating platform. Unlike the dugout, this floating platform required more design-specific applications to become an actual boat.

To create a dugout a suitably sized log was hollowed out, often through the use of only simple stone tools or a combination of tools and fire. A vessel capable of carrying a burden equal to the amount of wood removed was in this way produced. A dugout represents the most basic design of a watertight vessel, from which a myriad of others was developed. One of the most commonly recognized types is the planked hull with a keel. Many scholars contend that the development of this type of vessel began by adding side strakes to a dugout, which increased the vertical dimensions of the vessel and turned the dugout itself into a kind of keystone, a predecessor of the keel.\(^{15}\) A problem with this design, however, was that the lateral dimensions of the hull were limited to the size of the dugout. One solution to overcome this was to rely on planking to create the shape and dimensions of the hull, with the dugout eventually evolving into a keel.
A dugout, when completed, is already an open, watertight vessel -- in other words, a boat. Regardless of the modifications made over time, its elemental design or form is not changed by adding to it. To convert the raft into a watertight vessel, on the other hand, may not require any monumental insight on the part of a builder, but it does require more design-specific applications and thus a construction ideology that differs from that required to build a dugout. Vessels originating from rafts exist throughout the world, but nowhere are they more prevalent than in eastern Asia.

Also prevalent in Asia are vessels having lace construction.\textsuperscript{16} As will be seen, evidence indicates that lace construction was the antecessor of construction methods using mortises and tenons and, later, nails. Even so, it was never fully replaced by the latter two methods.

As in northern Europe,\textsuperscript{17} some Asian vessels were built using either lapstrake- or flush-laid construction methods. Knowing when the one replaced the other, or perhaps why the one became favored over the other, can help to indicate a shipbuilding chronology and possibly a change in the construction ideology on the part of shipwrights.

This concept of a changing ideology has received considerable attention from Western ship scholars. Of
particular importance is the question concerning how the shipwright viewed the vessels he built. In modern parlance the terms shell- and frame-first construction are frequently used in describing how vessels were built. Probably for a modern observer the most readily identifiable construction method is frame-first construction in which the keel, stem, sternpost and major frames are erected first, in order to create a skeletal-like structure to which is then added the hull planking, or shell, of the vessel. In frame-first construction the pre-erected skeleton determines the shape of the hull and provides its primary strengthening. The function (and certainly a vital function) of the plank-formed shell of the vessel is simply to close the framework and make the hull watertight. In theoretically pure frame-first construction, the real essence of the hull is determined by the ship's framework, a skeletal structure wrapped with a watertight skin of planking.

With shell-first construction the concept is reversed. The hull shape is determined by the planking, built up from the keel (if used) and fastened in place well before the permanent emplacement of any frames. This watertight shell takes preeminence over the framing, and the planks and the way they are fastened together provide the primary source of hull strength. Whatever framing
is placed in later acts as a secondary, or "passive", means of strengthening, whereas in frame-first construction frames are the primary, or "active", means of strengthening and shaping of the hull.\textsuperscript{19}

Archaeological evidence, as we shall see below, suggests that, at least in the Western World, ships were originally built using shell-first construction and that this method, over time, was largely replaced by frame-first construction. Parenthetically mentioned above was the idea that molds played a part in this transition from shell- to frame-first construction. Molds are basically patterns or templates from which frame shapes can be established. Molds can also be used as guides against which hull planking can be bent or shaped and fastened together, after which the molds are then removed. The problem with validating the use of molds is that they neither remain with the ship nor does any easily detectable indication of their use. The archaeological existence of molds as well as contemporary examples of their employment indicate that they were used in the past as well as today. Ships from the archaeological record, however, with no shipwright or builder to speak for them, give no direct indication of which ones were constructed using molds and which ones were not.\textsuperscript{20} The use of molds in construction is nevertheless an interesting and viable
consideration when discussing the possible mind-set of a shipwright.

Here we arrive at a very gray area indeed and a morass of exceptions-to-the-rule as previously forewarned. Did shipwrights at any time really view their vessels as strictly shells and in more modern times as strictly skeletal frameworks covered with a skin of planking? They probably did not. At least no more so than we view our own bodies as an assembly of bones supporting a covering of skin versus a covering of skin containing a reinforcement of bones. Very likely the perception of the shipwright was a more integrated one. Nevertheless some vessels were built having no frames at all,\textsuperscript{21} while others relied predominantly on their framework. The apparent transitions from the one extreme to the other are really too compelling to ignore, but at what point did the one method evolve into the other, if, in fact, it ever did?\textsuperscript{22}

It has been argued that to build a planked hull shell first with a shape not resembling a spoon requires the use of a mold or molds on which to bend the planks to achieve the desired, artificial shape.\textsuperscript{23} In this way the mold functions in a manner similar to the frame in frame-first construction and may indicate a transitional element between shell- and frame-first construction. The truth is, however, vessels can be built in a shell-first manner
without the use of template-like molds and still result in a shape other than that of a spoon. Perhaps our definition of "molds" and "frames", in this particular instance, is too specific. Perhaps we need to consider a rather more esoteric concept of the term "mold" and, in the broadest sense, exactly what is a "frame". Vessels built in a shell-first manner not only rely on whatever fastening method is used (such as lacing or lashing, mortise-and-tenon joints, nailing, etc.) to hold the planking together, but these very fastening methods can also serve as a primary means of strengthening the hull, as do mortise-and-tenon joints in Greco-Roman hull construction. In this case, the vessel is provided with framing that is not in the form of actual frames. Has there ever been, therefore, any vessel constructed in a pure shell-first manner or, perhaps more accurately, a frame-last manner? The simple dugout may be the only example of a vessel created purely shell first.

As to the question of molds, has any vessel ever been built without the use of some kind of mold? Again using the simple dugout as an example, the dugout, when added to or extended in some way, acts as a mold in that its shape will likely determine the shape of the final product. Even the use of shores to hold planking in place or lashings to force planking into the desired shape can be
seen as types of molds. But perhaps the most fundamental mold is that which exists within the mind of the builder: how and what he perceives the vessel to be.

To pursue this line of inquiry further would be tiresome and probably not very productive. The only reason I have done so here is to express the difficulty of describing things in absolute terms. This is not to say that these descriptive techniques have no merit. On the contrary, they provide us with a kind of common denominator by which we can communicate our topic, provided that we remember there are usually exceptions to every rule.

Adding to the depth of our tapestry of description is the idea of a bottom-based shipbuilding tradition. This concept maintains that flat-bottomed vessels comprise a distinct class of vessel and are not merely hybrids of those craft using shell- or frame-first techniques. Although flat-bottomed vessels may share construction details similar to those built in a shell- or frame-first manner, they are distinctive because the way they are constructed places emphasis on a flat bottom as a separate, primary unit which describes the shape of the vessel. From this basic design developed vessel types such as the cog of northern Europe, and the concept is particularly applicable to many of the traditional vessels built in Asia. As will be seen, however, not all flat-
bottomed vessels are bottom-built. The hull shape of some are determined by their separately constructed sides, so that the sides, rather than the bottom, are the primary structural element. 25

Let us turn now to five examples of vessels from the archaeological record whose design features and methods of construction illustrate what has been discussed and will pertain to the Asian examples that will then follow. 26

In 1954 the timbers of a Bronze-Age Egyptian vessel, dated to about 2650 B.C., were discovered in a limestone pit beside the Great Pyramid at Giza. 27 This, the Fourth-Dynasty Royal Ship of Cheops, is the oldest vessel to be documented. It is not, however, actually a "ship" at all, but a luxury barge likely intended for use by the pharaoh in the afterlife. 28 Because of the way the vessel's hull was constructed, using lashing as the primary fastening and unpinned tenons (pegs) for planking alignment, it lacks the structural integrity of an oceangoing ship and therefore was intended for use only on inland waters. 29 Furthermore, it is very likely that the vessel was never sailed by itself, but towed by other, possibly smaller auxiliary vessels. 30

To construct this royal barge (Fig. 2), the builder first assembled the eight bottom planks of the hull. Two planks made up the forward section of the hull, three were
Fig. 2: Midship section of the Royal Ship of Cheops. Note the deck beam notched to take the side girders and stanchion-supported central girder. Sheer-to-sheer lashings pass over battens and through V-shaped slots cut into the hull planking. (After Lipke, 1985, fig. 3.6)

positioned in the middle, and three in the after section. At either end of this bottom planking assemblage were placed two shorter lengths of wood, called "backing timbers", that joined the sides and supported the stem and sternpost. To align these various pieces together, the builder used pegs inserted into mortises cut along the edges of the planking. Rope-like ligatures, passing through slots cut into the inside surface of the planking, were then used to lash the planking together. The ends of
the assembled bottom planking were raised until they achieved the desired longitudinal curvature and were then supported by shores. Beginning with the bottom row of side strakes, the edge-joined side planking was built up from the bottom planking assembly using pegs to align the strakes, and the strakes were then secured with lashing. The sheer strakes were notched to receive the deck beams, a few of which were installed at this point to help support and strengthen the hull. Next, battens were longitudinally aligned along the planking seams and held in place with additional lashing running continuously from sheer to sheer. Frames, notched to fit over the battens, were installed and lashed to the planking. A notched central girder, fitted against the bottom of the deck beams and supported by stanchions resting on the frames, increased the longitudinal strength of the hull. The were attached notched side girders which, along with the central girder, also provided longitudinal strengthening. After the final lashings were completed, the last items to be added were the decks and superstructure.\textsuperscript{32}

The Royal Ship of Cheops is an example of fine technological artistry and craftsmanship. The builder succinctly understood what was needed and what was not; no more, no less.\textsuperscript{33} The vessel's hull strength came primarily from the planking. Wood cut too thin would not be
strong enough. Wood that was too thick would cause the ends of the hull to sag and break apart, and no hogging truss was employed on this vessel. In addition to using the correct thickness of wood, the builder also joggled the edges of his planks so that they would, in a sense, lock together and provide additional longitudinal stability.\textsuperscript{34} Thus the proper fitting of each plank was of vital importance. This was done so accurately that only the addition of battens was needed, without any caulking between planks, to make the hull watertight. Lashings bound all the primary structural elements of the hull together; the only metal fastenings used on the hull itself were copper staples for lashing stops. All together this created a vessel that indeed did not have the structural integrity of a seagoing craft, but the Royal Ship of Cheops was apparently never intended for such service.

In 1937, along the Humber River at North Ferriby, Yorkshire, a site was discovered containing three Bronze-Age boats with construction characteristics reminiscent of the Cheops vessel. The best preserved boat, dated to the twelfth or thirteenth century B.C., was made of oak planks lashed\textsuperscript{35} together with separate withies of yew.\textsuperscript{36} The vessel's bottom assembly consisted of three strakes.\textsuperscript{37} The central strake was 14 cm thick (almost twice as thick
as the two side strakes) and was made from two planks scarfed together -- both of which were cut from the center of a log that must have been at least 1.1 m in diameter.\textsuperscript{38} The two side strakes were rabbeted to either side of the central strake. The seams and corresponding withy holes cut along the length of each strake were caulked with dry moss, held in place by battens of oak inside the seams (Fig. 3). The lashings of yew withy, running across the battens and through the strakes, were tightened and then further secured with an inboard wedge driven into the wider of the two withy holes. Lugs, carved from the inboard surface of the bottom planking, had holes cut in them to take transverse wooden bars of ash that provided lateral strengthening for the bottom assembly. The various reconstructions of this vessel depict the hull as having three additional withy-lashed strakes per side and additional lugs that supported some form of lateral framing or bulkhead members.\textsuperscript{39}

Both the Cheops and Ferriby vessels can be classified as having been built in a shell-first manner. Their hull planking and how this planking was fastened together provided the vessels' primary structural elements. Both also depended on lashing as the main method of binding the hull together (rather than only mortise-and-tenon joints or, as with later ships, nails). This general method of
Fig. 3: The strakes of the Ferriby vessel. These are lashed together with yew withies passing through corresponding holes cut into the hull planking. Battens, secured by the lashing, held the moss caulking in place. A wooden, triangular-shaped chock (seen here to the right of the withy) wedged the lashing in place. (After Wright, 1985, fig. 8.9)

construction is similar to that of early Asian vessels, as is the use of lugs like those found on the Ferriby boat. Also notable is that both the Cheops and Ferriby vessel were constructed in a kind of bottom-first manner. Whether or not this fits the earlier discussed bottom-built hypothesis is debatable. With its pronounced
central keel plank, perhaps the vestigial indications of a
dugout, the Ferriby boat could also be seen as having
evolved from the built-up dugout or logboat. This will be
of concern when discussing Asian vessels.

The way the Cheops vessel was constructed suggests
that it was intended for use only on inland waters, but
the Ferriby boat may have made open-water passages during
times of fair weather.\textsuperscript{40} Regardless of the use or
potential use these vessels may have seen, evidence
indicates that over time, particularly in the
Mediterranean, a stouter form of shell-first construction
came into ascendancy that used mortise-and-tenon joints.
Moreover, it appears that this shell-first construction
using mortise-and-tenon joints eventually gave way,
although never entirely, to frame-first construction
methods with planks nailed to a pre-erected skeletal-like
framework.

During the last decade of the fourth century B.C. a
Greek merchant vessel, now known as the Kyrenia ship, went
down in 30 m of water about 1 km off the north coast of
Cyprus near the town of Kyrenia.\textsuperscript{41} In 1968 and 1969
nautical archaeologists excavated the ship's cargo\textsuperscript{42} and
its hull structure, of which about 75 percent remained.
Evidence taken from the hull remains and what was learned
from the subsequent vessel reconstruction provide a fairly
clear and complete example of shell-first, mortise-and-tenon construction.

The construction, here described in abstraction, began with the shaping and laying of the keel, stem and sternpost. The garboards were fitted to the keel and attached by means of mortise-and-tenon joints. The bottom planking was then edge-joined (or flush-laid) up from the garboards and fastened together, as were all the subsequent hull strakes, with pegged mortise-and-tenon joints. The floor timbers were then positioned within the hull, followed by the flush-laid side planking. Finally the half-frames, futtocks, internal timbers and topsides were installed. Evidence that the frames "did not even touch the keel ... and it was not physically possible to bend some of the planking shapes around molds or frames while aligning 50 or more standing tenons" conclusively indicated that the vessel was built in the shell-first manner.

About A.D. 625, nearly 900 years after the sinking of the Kyrenia ship, a slim-bodied Byzantine wine carrier hit a reef off the coast of the Turkish island of Yassi Ada. The wreck was excavated between 1961 and 1964 and the information gleaned from the exiguously preserved remains indicated that hull construction had changed since the time of the Kyrenia ship, suggesting a transitional stage
between shell- and frame-first construction. From the archaeological data, along with experiments made with scale models, we now have an idea, albeit tentative, of the vessel's construction sequence.

Like the Kyrenia ship, construction of the Yassi Ada vessel began with the shaping and joining of the keel, stem and sternpost. The planking method used, however, differed considerably from that of the Kyrenia ship. The garboards of the Yassi Ada vessel, after being positioned along the rabbeted keel, were nailed to the keel to hold them in place. From the garboards up to the fifth strake on both sides of the hull, the flush-laid planking had mortises cut wider than the tenons, "which facilitated a slight shifting of the strakes while fitting them but did not keep the seams from pulling apart." These strakes expressed the approximate contour of the hull. It is likely that at this point the installation of short floor timbers was necessary in order to secure the strakes. Planking continued in this manner probably up to the tenth strake, at which point long floors were positioned in the hull. The shell-first construction ended at strake 16. No mortises were cut on the top of this strake. An overly simplified description of the remaining construction is that half-frames and futtocks were installed and the planking nailed to them. The
ceiling planking was then put in place followed by heavy wales, clamps and beams of the topsides and, finally, the remaining strakes between the wales. For hull strength the Kyrenia ship relied heavily on the internal frame-like support provided by the multitude of tight-fitting, pegged mortise-and-tenon joints; whereas the builders of the Yassi Ada vessel used loose-fitting, unpegged mortise-and-tenon joints as mere guides for fitting each strake in turn. The abandonment of mortise-and-tenon joints in the upper strakes was an economical move away from the more costly method of construction found on the Kyrenia ship and thus indicates a transitional stage toward our modern concept of total frame-first construction.49

Between the seventh to the eleventh century A.D., ship construction had again changed markedly. A wreck found in the bay of Serçe Limani, Turkey provides evidence for this. Excavations, carried out from 1977 to 1979, revealed that the vessel was a merchantman, hauling among its cargoes approximately 3 tons of broken glass and glass cullet intended for use in glassware manufacturing.50 The hull construction of this vessel was unlike that of the Kyrenia ship or the seventh-century Yassi Ada vessel. The planking was not joined with mortise and tenons, but, instead, was nailed directly to pre-erected frames. After
the keel, stem and sternpost were laid, four floor timbers and two complete midship frames were drilled and nailed into the keel afore and abaft the keel's longitudinal center point. The garboards were nailed to the keel followed by strakes 2 through 5 which were nailed to the floor timbers and "braced together with formers or cleats attached to the outside of the planks by nails driven from within."\textsuperscript{51} Having described the bottom shape of the hull by these strakes, the shipwright began planking the sides up to perhaps strake 9, after which were installed, allowing the placement of the upper stakes. Because frames were erected prior to planks and because of the absence of edge joints, the Serçe Limani ship has been described as a "skeletal-built" vessel. This construction, however, "was no more a pure skeletal process than that of the 7th century Yassi Ada ship was a pure shell process. Our shipwright was still essentially using planks to determine frame shapes in all but the middle of the ship."\textsuperscript{52} An important contribution of this wreck is the lateral symmetry of the hull indicating "a system of controlled measurement in the shipyard."\textsuperscript{53} This could indicate a change in the minds of shipwrights away from the traditional method of building by eye, based on a legacy of conventional ship forms and types, to a more
modern concept of pre-established measurements determining
the construction of a given vessel.

These five vessels provide a very brief overview of
the development of ship construction in the Western World.
The Cheops barge and the Ferriby boat are examples of
early building techniques using ligature fastenings and
shell-first construction for riverine-based vessels.
Although this method of construction is frequently
associated with inland watercraft, nevertheless vessels
built in this manner have commonly made open-water
passages, as perhaps did the Ferriby boat. The Kyrenia,
Yassi Ada and Serçe Limani vessels provide a tantalizing
glimpse at the possible shell- to frame-first evolutionary
sequence of later ship construction (Fig. 4). And from
this we derive a basic concept of ship construction from
which come many ramifications.

Thus far this discussion of ship development has
largely applied to those examples very loosely designated
as "Western". But Asian, or "Eastern", vessels followed
similar paths with many interesting and unique variations.
In the past scholars frequently attempted to show that
Asian and Western vessels developed from a similar, if not
the same, origin. This "diffusionist theory" contends
that ship construction techniques that developed in one
geographical area were diffused to other, less evolved
Kyrenia Ship

Seventh-century Yassi Ada Vessel

Serçe Limani Vessel

Fig. 4: The transition in planking joints. From the mortise-and-tenon joinery of the Kyrenia ship and the seventh-century Yassi Ada vessel to the Serçe Limani vessel with no mortise-and-tenon joints at all. (After Steffy, 1994, fig. 4-8)

areas. Often the Egyptians or Phoenicians were believed to be the originators of the earliest, most advanced techniques. This concept of diffusionism has a certain amount of validity. Watercraft, by the very nature of their use, have indeed been one of the most portable means of transferring potential technological influences from
one area to another. However, the applicability of the diffusionist theory begins to break down with the increase of the geographical area considered. Although vessels sailing the upper Yangzi River may have had certain characteristics that resembled those of ships from early Egypt, it is difficult to believe, and even more difficult to prove, that Egyptian craft were the progenitors of those in China.

Scholars following the "evolutionist theory" argue that "cultures acquire evolved techniques independently ... and the fact that one or more similarities may be detected between the techniques of different cultural areas does not necessarily mean that those similarities have a common origin, or that one area has influenced another."\(^5\) The farther apart people are from one another geographically and, perhaps just as important, the further apart they are culturally, the greater the likelihood is for independent development. To imply that Egypt, for example, was the world's center for nautical technology is rather like saying that humans have only been allowed a handful of original ideas and that these were given to the Egyptians. Actually, in a way, the Egyptians not withstanding, this can be seen as true in that humans often develop nearly identical solutions to similar problems -- as the evolutionists would point out. Therefore it seems
most sensible to approach the question of ship origins and development in an eclectic fashion rather than subscribing to a single theory, in this way validating certain aspects of both the diffusionist and evolutionist theories.

The intent of this dissertation is to examine the development of Asian watercraft from the earliest known period to roughly the advent of European colonization, which brought with it many non-Asian influences that often abruptly altered the evolution of indigenous craft. Even prior to European colonization, however, many Asian vessels were evolving in ways similar to those vessels in the Western World. An outline of the basic developments in the construction of Western vessels will here provide a framework from which we can better understand the evolution of Asian watercraft.

The terms "Western" and "Asian" vessels are often my own somewhat arbitrary designations by which Western vessels, regardless of the absolute geographical or cultural accuracy, refers to those vessels developed and constructed in the regions of the Mediterranean and Europe. The term Asian vessel in this study can be somewhat ambiguous, but in general the term refers to those vessels developed and constructed in the regions of insular and continental Southeast Asia, China, Japan and Korea. The Indian Ocean regions and the eastward-most
extent of insular Southeast Asia mark the periphery, with Africa, the Near East and the regions of the South Pacific being excluded. Admittedly, this designation is arbitrary and done for convenience. In reality human borders are not so easily defined, and it is difficult and undesirable, especially when dealing with cultures and cultural developments, to confine one's discussion to a precisely limited region.

This research is broad and in no way all-inclusive. It is intended as a base from which further research may develop and, with luck, to inspire others who may be far more adept at filling in the gaps and correcting the inevitable inconsistencies that occur. If the work presented here accomplishes nothing more than inspiring interest in Asian maritime research, then it has fulfilled at least one important purpose. Compared to the nautical research done and being done elsewhere in the world, the work being done in the Asian sphere is relatively limited, and there is an undeniably disparaging number of available publications, especially in the West. This dissertation, therefore, is an attempt to synthesize what we know and to provide new conceptual avenues for the study of the development of Asian ships and nautical technology.
Notes


2Even in the most arid environment, natural events, such as flash flooding, can create potential water obstacles.


4Natural barriers, such as mountain ranges, have also hindered human migration and travel but to a lesser extent than have bodies of water.

5The construction of some kind of bridge could be included here as a possible solution, but the obstacle would still initially have to be dealt with in order to join one side of the bridge with the other, assuming there was no tree or similar vegetation to be felled across the obstacle or no way to belay a rope or line to the opposite side allowing one to pull oneself across. A bridge is really more of an eventual convenience, in this case, rather than an initial solution: M. de Graeve, *The Ships of the Ancient Near East (c.2000-500 B.C.)*, pp. 144-148.


7Not until fairly recently, around the fifteenth to sixteenth century, did shipwrights record in a scientific manner the design and fabrication of vessels. An invaluable source to ship scholars is an anonymous fifteenth-century Venetian document entitled the *Fabrica di galere*, now in the Agliabechiana Library, Florence, which documents hull and rigging proportions. One of the best and earliest examples in the English language is Mathew Baker's *Fragments of Ancient English Shipwrightery* in the Pepysian Library of Magdalene College, Cambridge University. This manuscript, begun in 1586, contains drawings, mathematical applications and descriptive texts pertaining to English ship design and construction.

8I value the lengthy, lively and still largely unresolved debates on this subject provided me by Professor Richard W. Unger at the University of British Columbia.


11Pak Agung Akan Murje, Balinese boatbuilder, pers. comm.

12This is certainly not to dismiss the value of artistic representation or documentation -- quite the contrary. Material remains can validate artistic and textual documentation, and, in turn, artistic and textual documentation, when available, can provide information that may no longer be obtainable from the material remains alone.


15B. Greenhill, Archaeology of the Boat: A New Introductory Study, p. 94.

16See Glossary for definitions of "lace construction", "mortise-and-tenon construction", "lapstrake construction" and "flush-laid construction".

The addition of frames, in some cases, can be optional. The Dashur boats from Egypt, dated to the second millennium B.C., were apparently built without any frames at all. Similar to their modern counterparts in Upper Egypt, the Dashur boats had no keel, and their hull planking was assembled using mortise-and-tenon joints. Beams, notched into the upper side strakes, provided some lateral strength and supported the decking: C. W. Haldane, "A Fourth Boat from Dashur," American Journal of Archaeology 88 (1988): 389; D. L. Patch and C. W. Haldane, The Pharaoh's Boat at the Carnegie, pp. 32-40; Hornell, supra n. 14, p. 217.

The terms "passive" and "active" frames is taken from Lucian Basch, supra n. 13, p. 16, who wrote: "In the 'shell' technique the form of the planking determines that of the framework, for which reason I shall call it 'passive'. In the 'skeleton' technique, the shape of the framework dictates the shape of the outer planking, so I will call it 'active' . . . although the 'passive' framework is merely a reinforcement, the 'active' framework is a guide and a reinforcement."

Ibid., p. 35.

Haldane, supra n. 18, p. 389.


Basch, supra n. 13, p. 35.

Hocker, supra n. 13, pp. 22-24.

B. Greenhill, Boats and Boatmen of Pakistan, pp. 177-178; supra n. 15, p. 68 and Fig. 22.

The description of these vessels given here is in no way complete, nor does it give justice to the quality of archaeological research done to bring the information about these vessels to light. The intention here, using these few examples, is to illustrate briefly the fundamental ideas we currently have concerning the evolution of early ship construction in the Western World.

When the remains of this vessel were excavated, it was discovered that its timbers were largely disarticulated but carefully stacked in a kind of construction-sequence order. Partly because of this there is some debate as to whether or not this royal barge had been previously sailed. If it had, it may have been to transport the pharaoh's remains to the necropolis at Giza for burial. Wear marks on some of the wood suggest that the vessel had previously been used, but because of the value of imported wood, it is just as likely that these few worn pieces may have been salvaged from another vessel: P. Lipke, "Retrospective on the Royal Ship of Cheops," in Sewn Plank Boats: Archaeological and Ethnographic Papers Based on Those Presented to a Conference at Greenwich in November, 1984, eds. S. McGrail and E. Kentley, p. 30.

This is not to suggest that vessels relying on some form of ligature fastening are inferior, as will be pointed out in detail later.

Lipke, supra n. 28, p. 34; Steffy, supra n. 6, p. 28.

Lipke, supra n. 28, p. 23.

Steffy, supra n. 6, pp. 25-28.

P. Lipke, The Royal Ship of Cheops, p. 117.

A design feature found on some Asian vessels.

P. Johnstone, The Sea-craft of Prehistory, p. 144. Although the term "laced" is used in many of the publications describing this vessel, the term "lashed" is used here because it more accurately distinguishes this separate-ligature form of fastening from other methods, as found elsewhere in the world on vessels that use a continuous line of ligature. See Glossary for a description of "laced" versus "lashed" construction.

These withy ligatures, formed by pounding and twisting thin branches of yew into a flexible state, differed from the lashings on the Cheops vessel which consisted of cordage made from three-strand, right-hand laid halfa grass (Desmostachya bipinnata): Lipke, supra n. 28, p. 21.

A distinctive design characteristic we will see again on small boats (sampans) from Asia.

39 Wright, supra n. 38, fig. 8.12.

40 Ibid., p. 132. For further, more recently published details, see E. V. Wright, The Ferraby Boats: Seacroft of the Bronze Age.

41 Almost none of the crew's personal possessions were found, possibly indicating that they were able to escape with their belongings before the ship sank. Beneath the ship, however, eight concreted spearheads were located, some with bits of the hull's lead sheathing attached to them, indicating that they had been imbedded in the side of the ship prior to sinking. Not enough evidence exists to know for certain, but it indeed appears that the Kyrenia ship met a violent end at the hands of pirates, and her crew, rather than escaping, were very likely abducted and later sold into slavery: M. Katzvev, "The Ancient Mediterranean: The Kyrenia Ship Restored," in The Sea Remembers: Shipwrecks and Archaeology. From Homer's Greece to the Rediscovery of the Titanic, ed. P. Throckmorton, p. 56.


43 Steffy, supra n. 6, pp. 43-51.


45 Many vessels met their demise along this submerged reef at the western tip of the island of Yassi Ada, colorfully described by Steffy, supra n. 6, p. 19, as "a bleak little rock that seems to have no other purpose than to get in the way of passing ships."

46 Ibid., p. 80.

47 Throughout the hull of the Kyrenia ship spacing of the mortise-and-tenon joints averaged 11.7 cm between
centers and had an average depth of approximately 8 cm. The center-to-center spacing of the mortise-and-tenon joints of the Yassi Ada vessel was 35-50 cm in the stern, upwards of 90 cm near midships and as much as 2.23 m along the garboards. The tenons were tapered at either end and were left unpugged, thus fitting loosely within the mortises; whereas those of the Kyrenia ship were rectangular in shape, cut to fit securely within the mortises and were pegged to further create a solid unit: Ibid., pp. 48, 80.


52 Ibid., p. 32.

53 Ibid., p. 32.

54 Basch, supra n. 13, p. 9.

CHAPTER II

EARLY ASIA: FROM THE STONE AGE TO THE CHRISTIAN ERA

Cultural, Prehistorical and Historical Developments

Describing the prehistory and history of maritime Asia with any degree of acceptable thoroughness, even in a summary or an overview format, is a daunting task. Numerous aspects, facts and details deemed by many readers as vital to the story may inevitably be glossed over or omitted altogether. Attempting to deal with Asia as a whole also lends itself to innumerable problems. The land, the people and the cultures of Asia are far from homogeneous. Not surprisingly most scholars tend to focus their research on one area or country. By doing so, however, certain biases tend to arise. Some sinologists, for example, tend to view the whole of Asia, and sometimes it seems even the world, as being centered around the cultural developments and the dynastic histories of China. Similarly, scholars specializing in Indian studies will often emphasize the Indianization of Asia, while scholars of Southeast Asian studies tend to see Southeast Asia as the hub of Asian history, and so on. Admittedly, focusing on the history of Asia through maritime events provides its own biases by the very fact of emphasizing nautical matters. Nevertheless, as pointed out in the previous
chapter, nautical matters have played an integral role in the history of the world and are therefore no less important to that of Asia -- regardless of the inherent biases.

Another potential concern to some may be the way dates are expressed in this study as before or after the Christian era, which discloses an ethnocentric bias, in this case a Western one. Perhaps a more ethnically acceptable way of determining Asian time periods would be to classify them as occurring either before or after the Buddhist era. Probably the least objectionable method would be simply to state time periods as however many years they occurred before the present, based on our modern method of reckoning time. Nevertheless, the designation of B.C. and A.D. are used in this study because this form is easily understood by most readers and, moreover, it is the most common method of time designation used in Asian scholarship, both in the West and Asia.

For clarity, the various countries of modern Asia and their current names are referred to in this study. One must bear in mind, however, that these politically imposed modern geographical boundaries are not the same as those of the past, and even today they have only limited relevance to some still-existing cultures.1
A really complete description of the prehistory of Asia would include what is known about proto-human species, such as *Homo erectus* that emerged some 1.5 million years ago and inhabited areas ranging from China and Korea to the island of Java.\(^2\) But since we are still uncertain as to the connection these early hominids had with modern humans, we will leave the subject of proto-humans in the hands of the paleontologists and move on to that of modern man (*Homo sapien sapien*) from the Upper Paleolithic period (c. 50,000-12,000 B.C.) to that of the Neolithic (c. 12,000-2000 B.C.).

Scattered evidence of prehistoric hunting sites and agricultural settlements indicates that humans have roamed the Indian subcontinent for more than 50,000 years.\(^3\) Likewise in China scientists have uncovered the settlements of at least six different, but technologically similar, cultures dating to the Upper, or Late, Paleolithic period. Although these settlements in China were widely dispersed geographically (from the middle Yellow River valley to the loess plateau of Shaanxi province and the North China plain), each was typically situated along waterways where mountains descended into plains, and hunting and gathering could be combined with fishing.\(^4\)

Although the archaeological evidence is still somewhat sketchy, it appears that the lithic technology
and means of subsistence for human populations in Korea during the Upper Paleolithic period was comparable to that found in China. Settlements, or at least seasonal foraging sites, located along rivers and lowland coastal areas were inhabited by small bands or groups of extended family members who occupied themselves with fishing and utilized the upland forests for hunting and gathering.\(^5\)

In Japan little is yet known, but stone tools have been found indicating the presence of human populations during the Paleolithic period. The origins of those who made these tools is still a matter of considerable debate. Most authorities agree, however, that the arrival of these early inhabitants occurred in several separate waves of immigration. The Tungusic people (an Altaic language group originating in eastern Siberia and related to the Manchus) and others of Mongoloid origin came by way of Korea and Hokkaido, probably across a land bridge created by lower sea levels.\(^6\) Other, possibly Malayan, immigrants from South China or perhaps Southeast Asia came by way of Formosa and the Ryukyu islands.\(^7\)

The prehistory of Stone-Age island and mainland Southeast Asia is complex and still not well understood, even though in a few isolated cases, such as in Kalimantan, Irian Jaya and the Philippines, the Stone Age has technically not yet ended. Much of our prior
knowledge of Southeast Asia came from Chinese, Indian, Arab and European chroniclers of relatively recent periods. Fortunately, however, archaeological and linguistic studies have more recently added many details to the prehistory of Southeast Asia, resulting in a multitude of various interpretations and hypotheses. In general most authorities agree that the early populations of insular Southeast Asia originated in the areas bordering what is now southern China. Following a pattern of slow migration to the south, possibly compelled by other population groups pushing from the north, these early nomads eventually inhabited areas ranging from Madagascar in the far west, through peninsular Southeast Asia and Indonesia, and eastward into the South Pacific. Who exactly these people were is uncertain. Although they are known collectively as the Hoabinhians (the name being derived from the Hoa-bin archaeological site in northern Vietnam), it appears certain that they were not of a single ethnic and linguistic stock.

The ethnic group known as Australoids (which includes the Australian Aborigines, the Ainu of Japan, the Dravidians of India, the Veda of Sri Lanka, and possibly the Melanesians, Negritos and Papuans) appear to have played at least an initial part in the Hoabinhian cultural complex. The archaeological remains of these early
peoples are limited, and usually consist of lithic hand tools made from pebbles that were worked and polished only on one side of the cutting edge. Pottery was apparently unknown to these people, and no form of agriculture or animal domestication, with the possible exception of the dog, was practiced. This parallels closely with the Upper Paleolithic inhabitants of Sri Lanka. 9 By at least 30,000 B.C., however, the Australoid's technology had developed to the point that they were able to create watercraft that could take them as far as Australia. 10 This appears to predate the arrival of the Austronesian peoples by at least 5,000 years, and recent archaeological evidence indicates that the Australoids may have arrived in Australia as early as 80,000 to 100,000 years ago. 11

The Austronesians (related linguistically by a family of agglutinative languages spoken in areas extending from Madagascar to the Malay peninsula and Indonesia and including nearly all the native languages of the Pacific Islands) are a second group within the Hoabinhian cultural complex. Linguistically they are not related to the Australoid ethnic groups. Whether or not the Austronesians played any part in effecting Australoid migration is uncertain. If they did, the pressure was only slight, because human migration during the Paleolithic appears to have been gradual and characterized
by small family or extended family groups exploiting and depleting the resources of one locale and then moving on to another.\textsuperscript{12}

By approximately 13,000 B.C., roughly the beginning of the Neolithic period, the people of the Late Hoabinhian culture in mainland Southeast Asia, which most scholars describe almost exclusively as being Austronesian, made and used cord-marked pottery\textsuperscript{13} and were "engaged both on land and at sea in hunting, food-gathering, and fishing" and may possibly have been "the first to practice the art of horticulture in Southeast Asia, though it is not firmly established whether they carried out intentional planting or whether plants underwent genetic changes from their former wild forms."\textsuperscript{14}

From 13,000 to 8000 B.C. the use of cord-marked pottery was widespread as was the cultivation of a number of different types of plants, including rice, and the domestication of animals such as the dog, chicken and perhaps cattle.\textsuperscript{15} The lithic tool industry was also changing from pebble choppers to more refined cutting implements made from flakes chipped from stone cores. During this period many of the mostly sedentary population groups were gradually forced to relocate because of the rising sea levels that occurred toward the end of the Late Pleistocene. With the advent of the rectangular adze,
woodworking was improved and so too were the watercraft that could be constructed. People became increasingly mobile.\textsuperscript{16} By 4000 B.C. copper-socketed tools were being made which further improved woodworking, and the watercraft constructed were built well enough to carry these Neolithic settlers to Japan and further into the islands of Southeast Asia.

During the fourth and third millennium B.C., the continued development of plant and animal domestication as well as the availability of bronze tools resulted in a marked population increase and a rapid increase in the need for more land. Southeast Asians were moving out into the Pacific and westward along the east coast of India to Sri Lanka and perhaps as far as Madagascar.\textsuperscript{17} Also during this time arose what archaeologists have classified as the Dongson cultural complex, a term which has become somewhat synonymous with the Bronze Age period of Southeast Asia. What scholars have meant by the "Dongson culture", however, and which population groups it comprised is not at all certain.\textsuperscript{18} Robert von Heine-Geldern, who was among the first to describe the Dongson culture (the name having been derived from the Dongson archaeological site in Vietnam), stated that the Dongson culture consisted of all the Bronze Age civilizations of "Yunnan, Indochina and Indonesia."\textsuperscript{19} Many of these early hypotheses concerning
the Dongson culture have been refuted, however, especially the idea presented by Heine-Geldern that the Dongson culture originated somewhere in eastern Europe.\textsuperscript{20} Artistically the Dongson culture is characterized by a style of ornamentation that consists of geometric, often complex, interconnecting lines and spirals, as well as animal and human motifs incised on pottery. Megalithic monuments, another characteristic of the Dongson culture, were decorated in a similar manner. The artifacts probably most readily associated with the Dongsonian people, however, and the ones most germane to this study, are the bronze kettle drums depicting sailors and watercraft. This will be discussed in more detail later.

For now let us look at a more recent hypothesis concerning the Dongson cultural complex that Wilhelm Solheim has amended with his term the "Nusantao" culture.\textsuperscript{21} Solheim argues that previous discussions of the Dongson culture has largely been a detailing of the spread of a certain ornamental art style; whereas in reality much more was going on between the fourth millennium B.C. and the advent of the Christian era than merely the sharing of artistic expression.\textsuperscript{22} Solheim views the Dongson culture as simply one phase of early Vietnamese history. Neither the Dongsonian people nor any other single group was responsible for the development and
spread of those elements that make up the traditional Dongson cultural complex. Of more widespread significance than any possible influence the Dongsonian people may have had, Solheim hypothesizes, was the initial formation of a Nusantao cultural focus in eastern Indonesia and the southern Philippines that occurred during the separation of insular Southeast Asia from the mainland.\textsuperscript{23} Improvements in watercraft construction and deep-water navigation allowed the Nusantao people to increase their range of migration, which in turn increased the range of their cultural influence.

By perhaps as early as 5000 B.C, bronze metallurgy was invented somewhere west of the Mekong drainage area. As knowledge of this technology spread southward along the Khorat plateau, trade networks were developed to supply the metals and other materials needed for bronze casting. Some sort of extended political organization that maintained this movement of trade must have been developed, and effectively so, since there is no evidence so far of any fortification of sites or of warfare.

During this time the migration of Solheim's Nusantao peoples continued throughout island Southeast Asia and pushed further eastward into the South Pacific.\textsuperscript{24} Evidence indicates that Nusantao fishermen, sailors and traders plied the coastal areas of the South China Sea, as
well as that of Korea and Japan. "They would live primarily on their boats, fishing and trading along the coast, intermarrying with the local population. They would have developed a trade language that was basically Austronesian and that would have been found all around the South China Sea." By the third millennium B.C., bronze and related trade items were being moved along the coast of the South China Sea and north into southern China. Much of this was transported by sea and very likely by Nusanta traders.

By at least the second millennium B.C., some form of early state development was beginning in Vietnam and possibly in northeastern Thailand. The site of Co-loa near Hanoi verifies that the centralized government of the Vietnamese Hung kings predates any historically documented contacts with China. The casting of iron and a variety of bronze alloys was beginning at this time. Trading activity and cultural circulation around the South China Sea became increasingly intensified. The people of the Yueh culture, originating somewhere in what is today southern China, began infiltrating the Red River Valley of Vietnam. The tonal languages spoken in modern mainland Southeast Asia are likely indicative of the linguistic influences brought by the Yueh people who spoke a form of Austro-Asiatic and Austro-Thai languages. Solheim
contends that the coastal Yueh, however, either spoke an Austronesian language or at least adopted some variant of an Austronesian trade language. He further hypothesizes that the Cham boat people, whose Austronesian language originated in central Vietnam, and the Austronesian-speaking Yueh boat people developed separate trade routes throughout the South China Sea. The Yueh boat-people traders extended their operations as far as western Indonesia. They had a major influence on the language of the people living on Sumatra and brought with them the Dongson bronze drums and possibly some elements of Late Zhou art associated with southern China. The range of cultural influence of the Yueh people, however, was not as extensive as that of the Cham. Speaking a dominant Austronesian trade language used along the coast of Vietnam and China, which developed into the original Malay language, the Cham traders, by about 1000 B.C., were exploiting the coastal markets of southern and western Sumatra and those at least as far south as Bali. From 1000-500 B.C. the Cham had established trading networks and settlements in Borneo, Sri Lanka and along the southeastern coast of India, and they had established settlements, if not actual trading routes, as far west as Madagascar.29

One of the major questions amongst scholars of Southeast Asian prehistory is how the peoples and cultures
of southern China were related to those of northern China and Southeast Asia. Solheim argues that it was not until the unification of the Qin (221-207 B.C.) and Han (206 B.C.- A.D. 220) dynasties that China and the Chinese actually began.\textsuperscript{30} The people of the State of Yueh and those of the Shang and Zhou dynasties, occupying territories in what is now southern China, were eventually absorbed by China and the Chinese culture. However, before approximately 300 B.C., as Solheim estimates, they stood alone and should not be considered as part of China. If anything they "could well be called Proto-Chinese, the so-called Yangshao, Longshan, and other similar cultures called pre-Chinese."\textsuperscript{31}

John K. Fairbank painted a slightly different picture. He described that, by 12,000 B.C., Neolithic agricultural settlements were spreading throughout much of China. In the north-central regions humans increasingly exploited the cultivatable grasslands and hunted the upland forests. Below the southern bend of the Yellow River thousands of Neolithic sites reveal that humans subsisted on a diet of cultivated millet (supplemented by hunting and fishing), wove hemp into fabrics and raised pigs and dogs as their principle domesticated animals. By at least 4000 B.C., sericulture had begun and rice was cultivated as a principle crop in the south. According to
Fairbank the ceramics of the Yangshao (or "Painted Pottery") culture and the later Longshan (or "Black Pottery") culture, both of which Solheim contends are not Chinese in origin, were developed in northern China, and its wide distribution was due to the great cultural expansion that occurred during the Neolithic.\textsuperscript{32}

The question of whether the Yueh, Yangshao or Longshan peoples should be classified as Chinese or not remains unresolved. Of more immediate importance is the fact that by approximately the middle of the second millennium B.C. the prehistory of China had ended with the rise of the Shang dynasty (c. 1600-1040 B.C.). Pictographic characters written on "oracle" bones, shells and, later, bronze implements provide insight not only into some of the historical details of the Shang dynasty but of the preceding, possibly mythical, Xia dynasty (c. 2100-c. 1600 B.C.).\textsuperscript{33}

The Shang, its heartland located in the present-day Henan province, was an aristocratic culture still largely reliant on a Neolithic agricultural base. The use of irrigation was developing, and in the south rice cultivation was becoming increasingly important. The unsurpassed quality of bronze craftsmanship, producing items such as weapons and ceremonial implements, was a hallmark of the Shang dynasty. The Shang leaders,
"addicted to warfare, hunting, wine, and human and animal sacrifices on an enormous scale", were also adept at mobilizing vast amounts of human labor for public works.\textsuperscript{34} Construction methods developed during the Shang dynasty, such as the pounded earth walls that surrounded the capital at Zhengzhou, were still employed as late as the Ming dynasty (A.D. 1368-1644), some 3,000 years later. The centralized authority and military strength of the Shang leaders allowed them to systematically expand their domain by building new towns governed by preselected members from the Shang aristocracy.\textsuperscript{35} This Shang ascendancy, however, would eventually be eclipsed by a small northern tribe known as the Zhou.

The Zhou people, ethnically related to the Shang, settled in the Wei River valley and became vassals of the Shang. By 1040 B.C. the military strength of the Shang king, Dixin, had been seriously depleted due to his campaigns against invading tribes to the east. King Wu of the Zhou took advantage of the situation, rebelled against Dixin and defeated the Shang at the battle of Muye.\textsuperscript{36} The Zhou dynasty that followed was the longest lived (1040-221 B.C.) in the whole of Chinese history, and its founders, Kings Wen and Wu, and Wu's brother the Duke of Zhou, have become legendary for supposedly creating a virtuous, golden-age utopia "to which all later rulers
aspired."37 Confucius (551-479 B.C.), who lived during the reign of the Zhou dynasty, is said to have remarked in despair that he, unlike the Duke of Zhou, had failed to reform the society of his own times.

Much of the initial success of the early, or Western, Zhou dynasty was due to the fact that its rulers made use of Shang skills in government and ritual and absorbed the Shang elite into the Zhou ruling class. Territorial expansion against the nomads of the northwest and southward into the Han, Yangzi and Huai River areas followed. Rule was maintained through a kind of feudal network in which the sons of Zhou rulers were given an enfeoffment of 50 or more vassal states. Like the Shang, the Zhou continued to use kinship as a primary element of political organization. Unlike the Shang, however, the Zhou espoused the theory of Heaven's Mandate, claiming that rule was sanctioned by God and that any family morally worthy of the responsibility may receive this mandate. Thus the ruler was accountable to a supreme moral force that guided the human community.38

To describe the myriad causes that eventually led to the demise of the Zhou dynasty is beyond the scope of this overview. Suffice it to say that as the dynasty extended its rule, so too did it overextend its ability to maintain its control over the many growing aristocratic family-
states. In an attempt to centralize its power, the Zhou capital was moved from the Wei Valley to Luoyang, thus inaugurating the Eastern Zhou (770-256 B.C.). During what is called the Spring-and-Autumn period (722-481 B.C.), there existed approximately 170 aristocratic family-states that formed their own leagues and alliances and engaged in what Fairbank called a "diplomatic-military free-for-all". By the Warring States era (481-221 B.C.), only seven major family-states remained.

Of particular interest to this study is the fact that the power of the Shang and Zhou kingdoms, as pointed out by Fairbank, was based on land-locked agriculture and not on mobile, waterborne trade with other areas. The growth of central political authority was maintained by a cross-societal reverence for the hierarchical lineages of kinship, state-controlled religious ritualization and warfare. Unlike the Western World, particularly the Mediterranean, where the growth of empires was often based on the ability to command commerce, especially on the sea, the inland kingdoms and empires of ancient China made no attempt to access the coastal or sea trade of East Asia. Although some Chinese shipping had developed along the coast and on the Yangzi River, the land-locked heart of the Chinese dominion remained cut off and relatively unaffected by Asian seaborne commerce. Merchants were
viewed as unimportant and ideologically disesteemed. This attitude, which persisted throughout much of Chinese history, made it easier for the Qin and Han rulers to assert control over the burgeoning merchant class that had arisen in their societies.\(^{41}\)

Until the end of the Tang dynasty in the tenth century A.D., the seaborne commerce between China and the rest of Asia was primarily conducted by foreign peoples in privately owned vessels. This illustrates the negative attitude China's officialdom had toward maritime trade. This attitude, however, did not apply to the development of ships and naval warfare. As early as the Spring-and-Autumn period, the Chinese government was building large ships for large-scale naval engagements along the coast, the Yangzi River and on the lakes of southeastern China. In 308 B.C. the Qin launched an attack on the family-state of Qu with an armada of over 10,000 vessels, and during the second century B.C., Han naval expeditions, equipped with multiple-decked ships (lou chuan), were sent to Vietnam and Korea. Thus early in history naval affairs were of interest to Chinese officials, but the large warships and transports plying the inland and coastal waters of China were government vessels and were not involved in trade.\(^{42}\)

Out of the turmoil of the Zhou dynasty's Warring States era arose the house of Qin, one of the seven
remaining family-states. The Qin were wealthy and powerful enough to build an armada, as previously mentioned, and were armed with bronze and, newly developed, iron weapons. Employing advanced strategies in warfare, such as the use of cavalry, which proved more mobile and effective than the traditional horse-drawn chariot, the Qin defeated the other family-states and what little remained of the Zhou dynasty in 221 B.C. King Zhang, who awarded himself, based on Heaven's Mandate, the title of First Emperor (Shi Huangdi), ruled the short-lived Qin dynasty with a heavy hand. Legalist governmental doctrines were written to enforce laws that supported agriculture and strengthened the state over the family. Administrators and farmers (who also served as soldiers) were exalted, and artisans and merchants were downgraded. Writing, as well as weights, measures and currency, were standardized. Over 4,000 miles of imperial highways were built, and the construction of waterways and canals allowed water transport for 1,200 miles along the Yangzi River. However, the obdurate exactions of men and taxes exhausted Qin's resources such that when the emperor died in 210 B.C. his empire quickly crumbled. The succeeding Han dynasty (206 B.C.—A.D. 220), which had already begun its ascendancy four years before the death of the Qin emperor, continued Qin's methods of bureaucratic control, but did so gradually and incorporated a
moral cosmology focused on the emperor. Over the next two centuries the wealth of the Han dynasty, grew as did its geographical borders and its population. Urban trade was strictly controlled by the government and, in deference to Confucian ideology, which disesteemed the profit motive, merchants were heavily taxed and regulated. Outside the cities, however, the unregistered merchants and entrepreneurs trading in the quickly growing foreign markets became increasingly wealthy and powerful. Gaining control of the lands of impoverished peasants, these merchant families acted as local magnates, exacting their own taxes and thus growing ever more powerful. By the first century B.C., the government had already been compelled to lessen its restrictions on commerce. As a result foreign trade and Chinese military expansion penetrated into Manchuria, Korea and southward into northern Vietnam.\textsuperscript{46}

Much of what we know about the ancient history of Korea and Japan has been provided by Chinese chroniclers living during the Han dynasty. Modern archaeological research on the prehistory of Korea has been done, but few of the resulting publications are available outside of Korea.\textsuperscript{47} From the information that is available, we learn that during the Neolithic period humans had settled at least semi-permanently along waterways, particularly along the coastal areas, and manufactured stone tools,
reminiscent of those from Southeast Asia. By at least as early as 5000 B.C., a type of comb-marked (or geometric) pottery was being made by, who archaeologists have labeled, the Cholmon people. Subsistence consisted of hunting and fishing, and, as was the case in China, the cultivation of grains, such as millet, was beginning.\textsuperscript{48} Of particular interest is the archaeological evidence indicating that some form of maritime trade was going on between Korea, Japan and possibly Southeast Asia.\textsuperscript{49} Seaworthy dugout canoes have been found in Japan that date to the first part of the Jomon period (8000-250 B.C.).\textsuperscript{50} This along with the presence of non-local obsidian, cultivated plant material (not associated with the Jomon people) and Korean-style pottery has caused many authorities to speculate that people were communicating by sea between Japan and Korea as early as 8000 B.C.\textsuperscript{51}

Korea's Bronze Age was relatively short lived, covering a time period of about 200 years from the sixth to approximately the fourth century B.C.\textsuperscript{52} The Chinese are credited for the introduction of bronze into Korea, and between the fourth and second centuries B.C., both the Chinese and Koreans brought bronze as well as iron implements to Japan.\textsuperscript{53} Between the third century B.C. and the first century A.D., Chinese influence in Korea and Japan increased steadily. In Korea tribal-states had
developed and had become centralized, producing the kingdom of Chosan. In Japan, however, leadership was still divided between more than 100 semi-independent communities. Not until the Yamato period, during the second century A.D., would Japan have any kind of centralized governmental rule.\textsuperscript{54}

During the last centuries of the pre-Christian era migration throughout insular and mainland Southeast Asia continued along with the development of extensive trade networks. Concerning the development of early kingdoms in Southeast Asia, D. R. SarDesai wrote that among "the several factors responsible for the rise of principalities and kingdoms in early Southeast Asia, agriculture and maritime trade must be deemed the most important."\textsuperscript{55} Tributary trade from mainland and insular Southeast Asia was brought to Han China. The demand for Asian luxury goods in the Western World brought traders and merchants from the Mediterranean and, in particular, from India and China to Southeast Asia.\textsuperscript{56} Due to their geographical location, the areas of Southeast Asia bordering the South China Sea, the Strait of Malacca and parts of the Indian Ocean served as mid-points along the various maritime trading routes.\textsuperscript{57} The Indians and Chinese who came for trade and, later, conquest had a major impact on the cultures and politics of Southeast Asia, but, as SarDesai
pointed out, "because of the earlier separate development, the indigenous cultures never lost their identity, even as they developed a 'family resemblance' derived from their common borrowings, mostly Indian."\(^{58}\)

Claude Buss wrote that India, unlike China, "has no carefully compiled body of historical records. What is known of India's early history has been derived from India's treasure house of literature, accounts of foreign travelers, and recent archaeological discoveries."\(^{59}\) Excavations of the ancient cities of Mohenjo-Daro, Harappa and, more recently, Dwarka and others along the Gujarat and Tamil Nadu coasts indicate that by the fourth millennium B.C. civilization in India was flourishing and was comparable to those of Mesopotamia, Egypt, Sumeria and China.\(^{60}\) From roughly 2000 to 1000 B.C. the Aryans, related to the Indo-European, Indo-Iranian peoples, invaded India and, after driving the Dravidians into the south, established their political capital near Delhi. Aryan migration expanded southward, fused with the Dravidians and absorbed much of their culture.\(^{61}\) By the fourth century B.C., and probably long before, Indo-Aryan mariners and emigrants had well established themselves amongst the people of Sri Lanka.\(^{62}\) There is little documentation concerning Indian maritime activity before the fourth century B.C., but archaeological research has
revealed that many of the ancient coastal cities with sophisticated docks, waterways and means of water control were built. This certainly suggests that sea traffic was well established and probably extensive as early as the second millennium B.C.\textsuperscript{63}

After the decline of the Greek conquests under Alexander the Great (327-325 B.C.), the Indian dynasty of the Maurya arose and succeeded in dominating the scattered kingdoms of the north. During the third century B.C., the emperor Asoka (274-237 B.C.) invaded the south, but reportedly was so filled with remorse over the resulting human carnage that he committed himself to the Buddhist faith and spent the rest of his life in meditation and doing good works. His zeal for sending Buddhist missionaries abroad to propagate the faith also contributed to the spread of Indian civilization.\textsuperscript{64}

During the last centuries of the pre-Christian era, Indian and Sinhalese trading networks were established with Southeast Asia and as far east as China. Ships carrying Chinese traders, perhaps as early as the fourth century B.C., were plying the waters of Sri Lanka and India.\textsuperscript{65}

From the stone age of prehistory to the period of burgeoning empires and the advent of the Christian era, maritime affairs have played an integral role in the
development of humankind in Asia. And, of course, key to this were the various vessels themselves and their own development that made it possible.

The Watercraft: Early Flotation Devices

Basil Greenhill opined that humans will turn to the sea only when support from the land alone is not enough, and the vessels developed are "almost invariably built for basic utilitarian requirements." More emphatically, as pointed out in the previous chapter, adaptation to, if not actual reliance on, a littoral environment is inevitable. The first vessels developed were indeed basic and utilitarian, but they provide clues about the origins from which other, more sophisticated watercraft evolved.

Based on similar, previously established classifications, Greenhill divides the roots of boatbuilding into four main categories: the raft, the skin boat, the bark boat and the log boat. The "bundle boat" and "basket boat" are designated as two separate subcategories. Predating any of the craft fitting the above categories were the more simple flotation devices such as log floats and floats made from bundles of vegetation. Because little if anything is needed to modify a log or a plant bundle into a flotation device, we have no real archaeological evidence to verify when these devices were first used. Nevertheless, considering the extent of early human
migration and the water obstacles that must have been encountered, it is logical to assume that some form of these flotation devices were used very early during the course of human migration.\textsuperscript{68} James Hornell even speculated that humans first learned to swim by using their arms and legs to propel themselves while supported by log floats.\textsuperscript{69}

Other forms of early flotation devices include gourds, ceramic vessels and inflated skins. As recently as this century fishermen along the rivers of southern India strapped round-bottomed earthenware jars or gourds to their bodies to keep them afloat while manipulating a handled dip-net (Fig. 5).\textsuperscript{70} In Japan and Korea the recorded use of gourds as flotation devices dates to a period before the Han dynasty. Of more recent date gourds have been used by Korean and Japanese female divers as floats for their catch-nets, and as a means to get to and from their dive sites.\textsuperscript{71} No mention is made in the ancient records of gourds, ceramic vessels or inflated skins being used as floats in China, but undoubtedly one or all were used, especially in the north where access to wood was scarce. During the Song dynasty (A.D. 960-1279), a traveller in northern China reported crossing rivers using inflated goat skins. During the Yuan dynasty (A.D. 1271-1368), the Khan's Mongolian soldiers commonly used
Fig. 5: A south Indian fisherman using a wooden float and dip-net. (Drawing Hornell, "Primitive Watercraft", fig. 1)

inflated skins to cross streams and rivers (Fig. 6). The skin floats used by the Khan's troops appear to have been of two different types: one round in shape "carried in the armpit", and the other maintaining the shape of the animal. Shinji Nishimura explained that the latter type of inflated skin float (although the illustration does not bear this out) was used by lying flat on top of the bag and stroking the water with one's limbs, "just in the same way as people do with floating bags on the Mesopotamian rivers." An aquatic scene sculpted on the western gateway of the Buddhist stupa at Sanchi, India depicts a rather fanciful, ornately embellished rivercraft (Fig. 7). Along side are at least five individuals on inflated skins and possibly, as Nishimura believed, one individual is
Fig. 6: Inflated skins used as swimming floats in China. Note the variation in shape of the two floats. (From Nishimura, 1936. pl. 8)

hanging on to a long, cylindrical-shaped calabash. Near the stern of the vessel is a person who appears to be attempting to climb into the boat. The helmsman and the individuals in the water are all wearing similar, rather elaborate clothing which suggests that those in the water were not there for the fishing. Could this scene be depicting some kind of maritime accident? Although there
Fig. 7: Inflated skins and possibly a gourd used as floats. Sculptured on the western gateway of the Buddhist stupa at Sanchi, India. (From Nishimura, 1936, pl. 5)

is no written evidence to support this conjecture, we know that very early in history large Chinese vessels were equipped with lifeboats. Other Asian craft may have carried floats for the same purpose. Perhaps individuals clinging to life-floats is what is shown on the Sanchi sculpture.
Developments Beyond Simple Flotation Devices: The Raft, the Dugout and Peripheral Vessel Types

Simple flotation devices are useful and effective when little else is available, but they obviously have their limitations. Rafts and logs hollowed out to become dugouts are two of the simplest, and therefore likely the earliest, structures built to overcome the limitations of simple floats. For some time scholars have argued that rafts, originally created by simply bundling together floats, predate the development of the dugout.\textsuperscript{74} We have no conclusive evidence to indicate when in Asia rafts and dugouts were first used or which of the two was developed first, but very likely they were developed almost contemporaneously and very early in time. The stone tools used by Paleolithic humans were adequate enough to create dugouts and certainly rafts, and some form of either dugout or, more likely, raft was used to carry humans as far south as Australia, perhaps as early as 80,000 to 100,000 years ago.\textsuperscript{75}

Regardless of whichever was developed first, the raft and dugout can be seen as two distinctly different types of craft. Their development over time, however, and their influence on other vessel types, is not nearly so easily categorized.

There is no extant primary documentation to tell us when rafts were first used in China, but the historian Lou
Xin, who lived during the tenth century A.D., wrote that as early as the fourth millennium B.C. humans were crossing streams and rivers on gourds, rafts and raft platforms atop gourds. Wong Jia, writing during the fourth century A.D., recorded that in the third millennium B.C. rafts were sailed in and around China on the rivers and open sea. It is believed that also during that early period the Yellow Emperor (Xuan Yuan Shi) was the first to convert a raft into a boat. In the sixth century B.C., Confucius talked of wanting to sail aboard a raft to the eastern seas.

In China, particularly in the north, reed-bundle rafts were in use at least as early as the Zhou dynasty. Similar to several types of craft used today, these rafts (Fig. 8) consisted of one or as many as five large bundles. Each bundle was about 2 m long, 1 m wide and consisted of about 100 reeds or rushes lashed together with rope and tied to wooden spars positioned perpendicularly beneath the bundles. Wood rafts made of bamboo or conifer, depending on the availability of material, were built by either lashing together two or three logs (perhaps the early predecessor of the sampan) or as many logs as were needed to bear the load (Fig. 9). Some rafts were built using dowels, but evidence of this for the pre-Christian era is rather limited. In some
Fig. 8: A Chinese reed-bundle raft. These watercraft could consist of multiple bundles tied to spars positioned perpendicularly beneath them. (From Nishimura, 1925, fig. 37)

cases wood rafts were used to carry more than 100 people at a time. Rafts were largely used for utilitarian purposes, but often followed rather ingenious designs to fulfill this purpose. Soldiers crossing rivers made floating platforms from their spears (Fig. 10). Occasionally the spearheads were removed to protect them from being damaged, but when they were left on the shaft, they provided a somewhat bristling means of defense as
Fig. 9: A Chinese log raft. Note the curved bamboo railings that provide a fulcrum for the two sweeps along the side, and the possible evidence of dowels used to fasten the logs in the bow and stern. (From Nishimura, 1925, fig. 36)

well as a floating weapon with which to attack the enemy in the water. Other rafts were made from the very material that was intended for sale at markets down river. Rafts made from logs to be sold as lumber could be as large as 151 m in length and 21 m in width with a village-like on-board complement of passengers, crew, barbers, cooks, merchants and livestock.

Not surprisingly the recorded distribution of the simple wood raft extends throughout much of maritime Asia. In India, particularly along the Coromandel coast but
Fig. 10: A Chinese raft made from spears. Often the spear heads were removed, but when they were not they served as both offensive and defensive weapons. (After Ling, 1956, fig. 1)

elsewhere as well, for thousands of years rafts have been made from rushes, reeds and wood. The simple three-log rafts, called catamarans, are reminiscent of those used in China (Fig. 11). Larger rafts of five or more logs were also constructed, and more modern examples show them fitted with a mast, sail and rudder. But the most simple, and possibly one of the earliest, form of raft
Fig. 11: An Indian catamaran. Three timbers joined side by side, reminiscent of some early vessels types built in China. (Drawing Hornell, "Primative Watercraft", fig. 6)

still in use throughout Asia is the mud sled. It is used to skim across the soft, unconsolidated mudflats of coastal and riverine intertidal areas. This raft, or sled, consists of a single flat board on which a fisherman -- foraging for mollusks, crustaceans and fish -- either stands and uses a hand-held pole to propel the craft or kneels on one leg and pushes himself along with the other. Authorities agree that this type of craft was very likely used as early as the Paleolithic period.\(^8\)

We may know very little about the early development of rafts, but more contemporary examples indicate that they evolved into relatively sophisticated vessels. The Malaysian riverine rafts of Pahang measure some 12 m in length and are constructed of three layers of bamboo poles lashed together with about 20 poles per layer. A central raised platform and shelter for 15 to 20 persons is built
raised platform and shelter for 15 to 20 persons is built on top, and sweeps fore and aft are fitted for steering and propulsion.\textsuperscript{84}

Seagoing sailing rafts made of bamboo have for centuries plied the waters and coastal areas near Taiwan. Although today they are most often constructed of plastic tubing rather than bamboo, their simple yet sophisticated design is ancient and may provide us with at least a limited glimpse at the kinds of craft used by Asian sailors in antiquity.

The bamboo rafts of Taiwan were built using about 12 bamboo poles, approximately 3.5 m to 12 m long, lashed together with the tapering ends forward, which caused the slightly upturned bow to be narrower than the stern. Smaller, floor-like poles were lashed athwartships and were spaced fore and aft atop the main poles of the raft. These smaller poles, which helped stiffen the craft laterally, were spaced at intervals relative to the size of the raft. A bamboo mast, stepped in a wooden tabernacle, carried a square-headed lug sail with 13 battens. When not under sail the craft was propelled by four \textit{yaolu} (or "yuloh"). Two yaolu were on each side, lashed to thole pins that were lashed to the outside lengths of the raft's bamboo poles. Instead of a rudder, the raft was steered by means of two additional yaolu over
the stern quarters. To prevent lateral drift, the craft was fitted with three removable centerboards that were pushed down between the bamboos and repositioned as required. Although these craft were frequently swept by waves and appeared quite fragile, G. R. G. Worcester wrote that "these magnificent little vessels are undoubtedly a close approach to perfection and the safest and most efficient type of craft in the heavy swells and surf landings which are to be found on so much of the Formosa coast."85

Similar rafts of ancient design are still constructed in Vietnam. Like the example from Taiwan, the rafts known as ghe be, of Sam Son in northern Vietnam, are made from a single layer of 15 to 21 lengths of bamboo, and the finished craft are usually about 9 m to 10.5 m in length and 1.6 m to 2.3 m in beam (Fig. 12). After the bamboo poles are cut to the desired length, construction begins by "skinning" the bamboo with a machete used like a draw-knife. At this point the wood is highly susceptible to insect infestation, thus a repellent wash made from "seawater, hydrated lime and crushed leaves of the Japanese lilac" is used to dress the bamboo.86 After applying heat, traditionally by means of dried palm fronds used as torches, the forward ends of the bamboo are bent into an upward curve. The bamboo is then set on trestles
and arranged so that the closest fit possible is achieved for each. The builder then clamps the lengths of bamboo together with bamboo lashings and a Spanish windlass. Once the lengths of bamboo are seized together, additional bamboo lashing is used to secure transverse frames to the body of the raft. In cross section the raft is flat in the middle with an upward curve along the sides. Three masts, that will carry lugsails, are stepped on the raft. The semi-permanent aft mast is the tallest of the three and is stepped along the raft's centerline. The forward mast and midship mast, in order to minimize sail overlap,
masts, that will carry lugsails, are stepped on the raft. The semi-permanent aft mast is the tallest of the three and is stepped along the raft's centerline. The forward mast and midship mast, in order to minimize sail overlap, can alternately be stepped on either side of the centerline, and "they can also be raked forward or aft and canted to port or starboard." Two or three centerboards are fitted along the centerline, one in the forward half, a second at midships and a third, if used, in the stern. At least two small sweeps, one on either side of the vessel, are lashed to short uprights (approximately 1 m high) that are positioned in corresponding mortises bored into either the mast tabernacle or transverse frames. A longer, single sweep, hung from an upright in the port quarter of the stern, serves as a rudder. To add strength to the raft and to help maintain its shape, additional wale-like lengths of bamboo are lashed along either side. Like the raft from Taiwan, the ghe be is an excellent sailor and can make nearly 4 knots when beating to windward.

Flat-bottomed vessels with shallow draft, in this case rafts, have very little lateral resistance in the water while under sail. The very force of the wind upon the sail can push the craft sideways and off course. To compensate for this, as we have just seen, one or more
Fig. 13: The po chuan fa. Note the unusual lashing method with lashing apparently wound around dowels, and the bottom poles, extending from the side of the raft, serving as floats. (From Kanazawa, p. 252)

dagger boards, or centerboards, lowered into the water between the poles (or of whatever the vessel is made) provide sufficient resistance to prevent or lessen the effects of lateral drift without unduly hindering the forward movement of the craft.

A watercraft known as a po chuan fa ("split bamboo boat") employed a different means than the centerboard for reducing lateral drift (Fig. 13). This raft, approximately 10 m to 20 m in length, was constructed using five lengths of large bamboo poles lashed together at either end. The remaining lashing was unusual in that it was wound around dowel- or peg-like projections driven into the upper surface of the poles. Another unusual feature about this craft was the way it was positioned atop 16
shorter lengths of bamboo (two groups of four poles per side) that were lashed together at their projecting ends and to the main body of the raft. These four groups of shorter poles curved slightly downward into the water and apparently provided buoyancy and some lateral stability. These side-projecting poles were more akin to outriggers than centerboards or lee boards. This craft, however, was likely a river raft and never carried a sail, thus whatever lateral stability it was reported as needing did not come from resistance to the wind. Kanazawa Kanemitsu, the author of the eighteenth-century Japanese source from which this information was taken, alluded that this type of vessel was to be found in Japan, China and possibly Korea, and it was dated to at least as early as the Song dynasty and possibly before.\textsuperscript{90} But because any lateral stability provided by the projecting poles must have been only minimal, and the fact that they would have certainly hampered the vessel's forward movement, it seems hard to believe that this was ever a very popular type of craft. Nevertheless, it illustrates well the variation that can occur in vessel construction.\textsuperscript{91}

Four of the vessel types listed above -- the bundle boat, skin boat, basket boat and bark boat -- do appear in Asia, but are peripheral to the raft and dugout (or log boat), which are the two primary roots of Asian vessel development. Bundle boats, skin boats and basket boats
are often, but not invariably, constructed when suitable
timber is unavailable to construct wood rafts or dugouts.
The use of bundle boats in Asia dates back to at least the
Indus Harappan civilization, and Paul Johnston states that
they geographically range from India to China, Japan,
Australia and New Zealand. Bundle boats are created by
lashing together reeds, rushes, bark or similar material
to form an open, watertight vessel. Evidence of their use
in East and Southeast Asia is limited but not improbable.
More common to these regions, however, were bundle rafts,
not bundle boats. Nevertheless, bundle boats appear in
India and as far away as New Zealand.

Three other ancient vessel types found in Asia are
skin boats, basket boats and bark boats. Scholars
speculate that skin boats developed as an improvement over
the inflated skin float. Skin boats are made by covering
a preconstructed framework, usually of bone or wood, with
animal skin. Their shape can be either elongated or
round. Evidence of their use geographically ranges from
South to East Asia, and they very likely date back to at
least the second millennium B.C. That which describes
the skin boat also describes the basket boat except that
instead of skin, a woven covering of reeds, rushes, bamboo
or similar material is used (Fig. 14). Although skin
boats and, in particular, basket boats are still used in a
Fig. 14: A Chinese skin boat and a Southeast Asian basket boat. (From Kanazawa, p. 252; Nishimura, 1931, fig. 16)
few areas of Asia today, this type of craft seems to represent a kind of evolutionary cul-de-sac in the development of Asian vessels. As will be explained in detail later, the evolution of Asian watercraft, like that of watercraft in the Western World, appears to follow the shell- to frame-first paradigm discussed in the previous chapter. Skin boats and basket boats, however, are built in a frame-first manner, as mentioned above, with a preconstructed framework that is subsequently covered with animal skin or a fabric of woven plant material. Presumably skin boats and basket boats predate the advent of dugouts and planked hull vessels, and they are perhaps nearly as old as the various early types of rafts. Thus frame-first construction in Asia is as old as shell-first construction (if one can classify rafts as built shell first) and may possibly be older. However, advancement of this archetypal construction feature required different structural and design elements that were evidently not apparent to the early builders of skin boats and basket boats. Instead, the raft and dugout gained eminence over any of these early frame-first constructed vessels of prehistoric Asia. Metaphorically speaking, the development of skin boats and basket boats should not be described as an evolutionary dead end, which would imply that these vessels had no further development and likely
became extinct. Their evolutionary path is more like that of a cul-de-sac. They are still in use today, and they have evolved into a number of different types and forms -- some becoming elongated, curragh-like in shape and design. As will be discussed again, a unique type of planked hull vessel was developed in Vietnam having a woven, dugout-shape base; and the planked hull vessels known as "turtle boats" built in Japan and Korea may have evolved from the skin boat or basket boat.

Material evidence for the development of the dugout in Asia during the pre-Christian era is limited. Hornell speculated that the bark boat predated the dugout. Not until after "the earliest pioneers of civilization . . . decided to leave the homeland of river, lake and forest for coastal regions where the bark canoe which they had hitherto used were found too frail and unstable" did the construction of dugouts begin.96 Bark boats (Fig. 15), as the name implies, are "made by stripping a continuous cylinder of bark from a suitable tree and then forming a boat shape out of the bark itself. The ends are sealed and the shape maintained by building a strengthening framework of wood . . . lashed together inside it."97 Bark boats have been built and used throughout much of Asia, but, according to Hornell, nowhere is their earliest use more obvious than in Indonesia and India. Pursuing
Fig. 15: A model of an Ainu birch-bark canoe, called a yachip. No examples of an actual craft have survived. (From Nishimura, 1931, pl. 22)

his argument that the dugout evolved from the bark canoe, Hornell stated that the diversity of dugout canoe forms in India and Indonesia provide vestigial evidence of an earlier bark canoe ancestry. He argued that features such as "rib-like ridges running transversely across the bottom and up the sides of dugouts" indicate a copying of the frame used in the pre-existing forms of bark boats.98 Because these carved ridges ran across the wood grain of the dugout hull, they did little to strengthen the hull,
the dugout hull, they did little to strengthen the hull, and, in fact, on more developed hull types they disappeared altogether. If Hornell was right then the bark boat represents another kind of evolutionary cul-de-sac. The shell of a bark canoe is ideally created from a single piece of wood (bark), but in some locations and under certain conditions, this is not always possible, and multiple strips of bark must be used. It seems reasonable therefore to imagine planked hull vessels evolving from an earlier form of multi-piece bark boat. However, to paraphrase Hornell, the environment in which bark boats are used either requires or allows no real evolutionary change. If through environmental alterations real changes do become necessary, then the bark boat itself will likely not be changed, but other varieties, possibly reminiscent of the bark boat, will arise.

Because material and documentational evidence is still so limited, we must continue to rely largely on speculation and conjecture as to the earliest development and use of the raft and dugout. Hornell's hypothesis that the bark canoe was the forebear of the dugout remains an interesting consideration amongst ship scholars, but thus far little can be done to prove or disprove this claim. What can be said of both the raft and dugout is that they were invented very early during the history of humankind
in view of their worldwide distribution and the prehistoric archaeological evidence that we do have. For example, as previously mentioned, dugout canoes have been excavated in Japan that date to the Neolithic Jomon pottery period, possibly as early as 8000 B.C.\textsuperscript{100} Edwin Doran conservatively estimated that the first appearance of dugouts may have occurred as early as 10,000 B.C.\textsuperscript{101} Hornell, regardless of his bark-boat postulation, agreed that dugouts can be made using simple stone tools (or even hard mollusk shells). Thus the dugout could very easily have been developed independently of other forms of craft, and it may be nearly as old as the raft and bark canoe.\textsuperscript{102}

Adrian Horridge points out, however, that the raft predates the canoe by several thousand years. He estimates that the earliest human occupation in Australia occurred some 80,000 years ago -- more recent research suggests 100,000 years. Although sea levels were lower, crossing by water was still necessary. Since stone tools adequate for hollowing a dugout, according to Horridge, do not appear in Australia until approximately 18,000 B.C., he contends that the early aboriginal inhabitants of Australia arrived there on simple rafts most likely made of wood. Horridge further proposes, and somewhat imaginatively, that the early Austonesians, as soon as they were able to hollow out a log, used the raft in
conjunction with the dugout log by placing the raft atop the dugout and thus, in effect, creating a kind of double-outrigger canoe. Horridge, however, does not make clear why it required the invention of the dugout, rather than just the use of a simple log, before the Austronesians could fit a raft on top. Furthermore, Horridge alludes that a single dugout positioned beneath a raft could have been, at least in certain cases, an antecedent of the keel. Unless the weight of the raft was great enough to submerge the single dugout, additional floats of some kind would be needed along side the raft to prevent it from dipping into the water like a floating see-saw.

Nevertheless, Horridge goes on to say that the sailing rigs developed for rafts were applicable to the double-outrigger canoe and that Austronesian boatbuilders of Indonesia over a period of about 20,000 years were able to develop "the internal lugs and lashings needed for fixing the outriggers into a dugout canoe" and transferred "raft rigs into outrigger canoe rigs." Austronesians, equipped with this advanced form of nautical technology, migrated further and more regularly throughout the islands of Southeast Asia, displacing the coastal Papuan and Australoid population and forcing them inland.

In their most basic forms, rafts and dugouts are conventionally viewed as two distinct types of vessels.
However, if Horridge is right, the development of the
dugout, at least in the Indonesian archipelago, was
directly connected to the pre-existing raft. Elsewhere in
Asia, however, this hypothetical connection is not readily
apparent.

Regardless of its ancestry, Hornell indicated that
the simplest form of dugout was the "open-ended half-
cylinder or trough with each end closed by a massive plug
of stiff clay." Inland canoes of the Celebes islands of
Indonesia have a similar configuration, but instead of
clay, a bulkhead-like board partition is placed in either
end. The number of different types and designs of dugout
canoes in Asia is myriad. The design of their ends
alone can range from bluff and rounded to sharp and
pointed. They can be upturned and curved at different
angles, with or without a decorative figurehead. They can
even have a bifid end suggesting the gaping mouth of some
mythical creature. Even Hornell, the acclaimed "great
collector of data on traditional boats world-wide", displayed some frustration when he wrote that these:

... variations defy any arrangement into a true
evolutionary series; local practice was and often is
arbitrary and seldom affords explanation for any
particular design; ... dugouts of neighbouring
island groups may differ radically and no one can
decide which is the older in evolution; both may be
more or less contemporaneous in origin, the outcome
of the fancy of some bygone canoe builder in each
group working independently -- his design may have
had some attribute or quality appealing to his clan and thenceforward became the standard pattern of his village or island group.

Certainly by the Upper Paleolithic period, timber suitable for dugouts was available in Asia throughout the regions (here conservatively estimated) between 30 degrees north and south latitudes. The first dugouts, created by using simple stone or even shell tools, may have been the open-ended structures, described by Hornell, that were made watertight by the addition of some kind of stopper placed at either end. If the dugout was based on the bark canoe, as Hornell suggested, the reason for this particular configuration becomes apparent. Simple dugouts, however, can just as easily be made by hollowing a log, thereby producing a vessel capable of carrying a burden equal to the amount of wood removed, while leaving the ends in place and thus requiring nothing more to be added to make it watertight.

In constructing a dugout, external shaping of the log improves its operational capabilities, but its inherent stability is limited by the breadth of the parent log. Improving the stability of the dugout may be accomplished in basically four different ways. First, by expanding the sides of the boat. This was often done by wetting and heating the wood which made it more elastic and allowed the builder to shape it, usually by inserting thwarts
which also helped maintain the expanded shape after the wood had dried.

A second method was to link a pair of dugouts side by side (Fig. 16). This method was a common one used throughout Asia, and could result in a vessel consisting of two separate hulls joined together or, as Horridge may have intended, two or more supports on which a raft-like platform could be set.

Longitudinal timbers attached to either side of the hull at the waterline was another way to provide extra buoyance and stability. A method similar to this was seen on the po chuan fa and the Chinese ships sailing the waters of the Philippines.

A fourth way of increasing stability was to fit the vessel with either a single or a pair of outriggers. This is similar in concept to method number two, where a pair of dugouts are linked side by side. The age and chronological distribution of double-dugout canoes and vessels equipped with double or single outriggers has been a topic of some debate amongst ship scholars. Because much of the evidence used to debate this is conjectural and based on vessels that either existed or exist during the modern era, this discussion will not be covered here. Interested readers should address the works of Doran, Horridge, Haddan and Hornell.110
Fig. 16: An Indian double-dugout canoe. (Drawing Hornell, Water Transport, fig. 28)

Of more immediate concern is the development of vessels fitted with side strakes. The addition of side strakes to a dugout base did nothing to increase the vessel's lateral stability, thus we see the persistence in some instances of the double or single outrigger. Other than increasing the freeboard that produced a greater and potentially drier carrying capacity, what the addition of side strakes did provide was the potential for the development of more diverse types of vessels.
The Development of Planked Hull Vessels: South and Southeast Asia

We do not know exactly when in the maritime history of Asia craftsmen first developed the technique of side planking. The earliest evidence of watercraft in India, dated to approximately the fourth millennium B.C., consists of two artistic representations, one from a seal and the other found on a potsherd (Fig. 17). The seal representation depicts an Egyptian-like papyrus boat with cross-lashings along the bow and stern of the hull. The second vessel representation is plainly different than the papyrus boat. It apparently has a single quarter rudder (that some have claimed to be fitted with a tiller and attached to a rudder post) and perhaps a tripod mast.\textsuperscript{111} One may suggest that this second vessel is not a bundle boat, as the first one appears to be, but unfortunately we can only imagine how it was made and what materials were used. If it was some form of planked hull craft, very likely these planks were attached by ligature fastenings. The influence that Mediterranean ship construction, or more specifically Egyptian ship construction, had on the whole of Asia is debatable.\textsuperscript{112} But trading links between Egypt and India may have resulted in at least some sharing. Thus it would not be overly surprising to find early Indian vessels having certain features similar, say, to the Royal Ship of Cheops.\textsuperscript{113}
Fig. 17: The earliest known examples of vessels associated with the Indus civilization. The vessel on the left is a bundle boat shown on a seal, and the vessel on the right is graffito on a potsherd possibly showing a vessel with a planked hull. (After Bowen, fig. 2)

Ligature fastening was likely the earliest means by which a builder attached planks to a vessel. According to Pierre-Yves Manguin, nautical archaeological evidence in Southeast Asia, albeit limited, indicates that all ships structures predating the fourteenth century A.D. belong to one specific technical tradition. They all show indication of being developed from an earlier simple dugout canoe to which more and more planks were added to either side and fastened together with vegetal ligatures, predominantly made from the fiber of the sugar palm (Arenga pinnata).114 The earliest example of this found thus far in Southeast Asia was discovered at Pontian (Pahang) in western Malaysia and is dated to approximately A.D. 293. Further discussion will be given on this vessel
in the next chapter. The reason that it is mentioned here is to indicate that its manner of construction, in which a combination of dowels, lashed lugs and ligature fastenings were used, suggests a transition from earlier construction methods using only ligature fastenings.\textsuperscript{115} Although we have no material evidence earlier than the Pontian boat to indicate when internal lugs and dowels were first used, Horridge believes that certainly lugs as fastening components were being developed in Southeast Asia at least 20,00 years ago.\textsuperscript{116} Before this, boats, especially simple dugouts with only a single wash strake attached to each side, were likely constructed with simple lashing and ligature lacing (often referred to as "stitching"). It is not surprising that this method would be the earliest used on such vessels considering the legacy of lashing, lacing and weaving on earlier watercraft: rafts that were lashed together, the ligature-attached frames of both basket boats and skin boats, the woven material used to create basket boats and the ligature fastenings used to hold together the various structural components of bark canoes.

Thus throughout much of Asia the progenitor of many planked hull ships was a simple dugout fitted with at least a single pair of ligature-fastened planks.\textsuperscript{117} Although throughout much of island Southeast Asia and coastal India, vessels were commonly fitted with either a
single or double outrigger, a practice still in use today, other vessels were also developed having no outriggers at all.

During the third millennium B.C., and possibly earlier, Dongson artists (see discussion above) and others throughout insular Southeast Asia were creating bronze kettle drums, the best known of which were decorated with elaborately stylized ship motifs. Although these vessels may have represented spirit ships in connection with funerary rituals that were practiced in many areas of insular and continental Southeast Asia, their design, although stylized, was likely based on actual vessels.118 Characteristically these vessels are shown having long, crescent-shaped hulls with bird-head ornamentations at their stern and at their possibly bifid bows.

On an Indonesian kettle drum, found on the island of Sumbawa near Bali, a vessel is shown with a hull built up using either a latticework of some kind of woven material or planking (Fig. 18). The older vessel from Vietnam (Fig. 19), predating the Indonesian example by perhaps 500 years or more, shows a similar pattern along its hull.119 On the Indonesian example, dated to approximately the sixth or seventh century B.C., the single quarter rudder has markings similar to those along the hull. Because of this similarity, and the fact that it is unlikely that the
Fig. 18: A Dongson-style vessel decoration on an Indonesian kettle drum from Sumbawa. Note the striations along the hull possibly indicating planking. (From van Heekeren, fig. 12)
Fig. 19: A vessel decoration on a Vietnamese Bronze-Age kettle drum from Ngoc-lu. Note the bow rudder, or stemboard, and the striations along the hull that may represent some kind of woven, basket-like material. (From Goloubew, pl. 27)
rudder was made from woven material, the markings along the hull probably represent lengths of planking. In Vietnam vessels with a combination of woven bottom and planked sides exist, thus the kettle drum example from Ngoc-lu may very well represent a boat with a woven basket-like hull or a type of bundle boat. Another similarity the Ngoc-lu representation has with modern basket-hull boats is what appears to be a rudder, or stemboard, in the bow. For thousands of years this has been a distinguishing feature of many Vietnamese vessels; in contrast the Indonesian vessel is equipped only with a quarter rudder. One should not rely too strongly on conjecture, but it does appear that the Indonesian vessel is larger than its Vietnamese counterpart. Today Vietnamese vessels having a stemboard are usually inland rivercraft. Do the illustrations therefore depict two vessels that are similar in design but built for different usage -- a smaller, basket-hull river boat and a larger seagoing (or at least island-hopping) ship? What does seem clear is that the Ngoc-lu vessel is intended for military use, as may be the Indonesian example. At least two of the individuals aboard the Ngoc-lu vessel are armed with spears and a third individual, positioned on a platform above what appears to be a kettle drum, has in hand a bow already nocked with an arrow.
The sailors depicted on all kettle drums are typically shown either wearing elaborate, feathery headdresses or surrounded by wing-like plumage. Other depictions, particularly on those drums from southern China's Yunnan province, show two rows of seated human figures, possibly behind bulwarks, facing forward and using paddles. Many of the kettle drum depictions show watercraft having a raised platform, or similar type of structure, at or somewhere near midships. How these watercraft were constructed is, of course, unknown. However, as we have just seen, they may have been constructed from a variety of materials and in rather different ways. Most very likely had planked hulls, built up from a dugout base, with ligature fastenings. Having no outriggers, the Dongson-style watercraft -- especially those like the one from Indonesia that may have been a large, multi-planked vessel -- must have been designed so that their planking, built up from a dugout base, provided adequate lateral stability in the water. In other words, the planking, rather than being built straight up like a vertical wall, would by necessity have to provide a stem-to-stern sheer curvature adequate enough to prevent the vessel from simply rolling over. This might also indicate that these vessels needed support for their planking from internal lugs or at least simple framing members like
those of the bark canoe. Also, depending on the length of the vessel, some form of hogging truss may have been necessary to support the ends of the hull, similar to those on many ancient Egyptian vessels and modern-day dragon boats.

In India vessels similar, at least in silhouette, to the Dongson boats have been constructed, but no real ancestral connection can be made. More specifically, some authorities contend that the Dongson vessels were the antecedents of the modern dragon boats of Southeast Asia and China.¹²²

The Development of Planked Hull Vessels: East Asia

The origins of Chinese watercraft is an issue of some confusion and debate. The evidence is limited and often conjectural. A fundamental characteristic of Chinese vessels is their diversity.¹²³ Nevertheless, certain common features tend to link them which observers and scholars have accredited as uniquely Chinese. The traditional Chinese ship, before any Western influence, has commonly been described as a flat-bottomed vessel (with no keel, stem or sternpost), bluff-ended and with multiple watertight bulkheads serving as frames. This description is largely accurate for many Chinese vessels, but does not apply to all of them. The bulkhead is an exceptionally salient feature of Chinese vessels, but has
engendered some rather debatable remarks. The bulkhead is not, as many purport, an exclusively Chinese discovery.\textsuperscript{124}

The Clapton boat, a late Saxon-period log boat discovered in the Borough of Hackney, London, provides clear evidence of having a carved bulkhead. Analysts believed that it "was no doubt the seat for the rower", and thus, as a structural feature, it cannot equally be compared to the bulkheads seen on fully developed Chinese ships.\textsuperscript{125} It does indicate, however, that at least the rude antecedents for bulkheads did not solely belong to the Chinese and, more importantly, that even dugcots can be associated with this feature.

Joseph Needham theorized that the origins of all Chinese vessels is based on builders observing split bamboo. He stated that "it is clear that the ships of East Asia cannot be genetically explained on the theory of the simple floating hollow log" and earlier attempts to describe Chinese vessels in this way were totally erroneous.\textsuperscript{126} Bamboo, with its internal bulkhead-like separations of \textit{nodal septa}, greatly resembles the inner hull of a Chinese ship. But bamboo, if seen as a hull model, is rounded on the bottom and not flat as traditional ships should be. Needham qualified this by explaining that early ships began as bamboo rafts whose sides were gradually built up and their ends closed off.
As the sides increased, this natural lateral curve of the bamboo raft approximated the curve seen in that of split bamboo. When wood planks replaced bamboo, the easiest method of construction was to build a hull with a raft-like flat bottom and hard chine. Later, more sophisticated building techniques allowed the shipwright to construct a hull with a fair lateral curve and thus again resembling the split bamboo. At some evolutionary point between the raft and before the wood-planked hull, Needham apparently believed that, unlike in the Western World, fully developed bulkheads were installed rather than frames.¹²⁷

In reality, what we can say with any certainty about the development of ancient Chinese ships is limited. This is even more true for the ancient ships of Korea and Japan.¹²⁸ As we have seen, in East Asia simple flotation devises were likely the first watercraft used. Relying largely on documentational evidence, Ling outlined the development of ancient Chinese watercraft beginning first with simple flotation devises and then the development of the raft. The next stage, which Needham eschewed, was the development of the canoe, followed by the outrigger canoe, the double canoe, the sampan¹²⁹ and finally the ship. Ling pointed out, as previously discussed, that according to historical records flotation devices were converted into
rafts sometime during the latter half of the fourth millennium B.C. During the third millennium B.C., the raft was converted into a dugout. How exactly this was accomplished, Ling did not venture to say. If his interpretation is correct, presumably then this raft must have consisted of logs, other than bamboo, that were large enough to be converted into canoes. Elsewhere, however, Ling stated that this legendary raft was converted into a boat rather than specifically a dugout. This variation in terms might seem as supporting Needham's idea of Chinese vessel development. Nevertheless, other sources plainly indicate the early existence of dugouts in China.

In the year 2852 B.C., Fu Xi, described as the "Father of Civilization", supposedly was the first to hew a log to form a boat.\(^{130}\) A passage from the Canon of Changes, written during the Zhou dynasty, states: "'To make a boat, scoop a block of timber; to shape an oar, sharpen a log of lumber; with a boat and an oar, one can travel to any nook not penetrable on foot.'"\(^{131}\) The fact that canoes played at least some role in the early maritime history of China is attested to by the canoe burials (dated to the Warring States era of the fifth century B.C.) that have been excavated in Fujian province. In Jiangsu province, there was among the burial items recovered from third-century B.C. tombs a terra-cotta
model of a dugout with a single bulkhead, not unlike the Clapton boat in England.\textsuperscript{132}

According to Ling, textual evidence indicates that double-outrigger canoes and double canoes were used as war vessels during the Zhou dynasty, and that from the double canoe was developed the sampan. He believed that the space between the two dugouts was closed in with a single plank forming a flat, solid bottom.\textsuperscript{133}

Found along the coasts of India and particularly Sri Lanka is a vessel employed in the seine-net fishery, called, among other names, a \textit{madel paruwa}.\textsuperscript{134} It is a flat-bottomed craft built up from several planks laid longitudinally and lashed together. Chine strakes, developed from a split dugout canoe, are attached to the bottom planking. The side planking is then built up from the tops of the chine strakes, and finally the internal members are fastened to the hull.\textsuperscript{135} The hull shape of the \textit{madel paruwa} is strikingly similar to that of the traditional Chinese ship. Hornell did not entirely refute the concept that Chinese vessels may have had an ancestry similar to the seine-net boats of India and Sri Lanka. He did argue that it is unlikely, however, because of the lack of evidence indicating a Chinese dugout canoe tradition and that "it is a far cry from the east coast of India to China."\textsuperscript{136} While there is no direct material
evidence to link Chinese ships with the madel paruwa type, this does not negate a dugout canoe tradition.

Ling postulated that by increasing the size of the sampan (the double canoes becoming chine strakes or wales), closing in the bluff ends and fitting the craft with sails and a stern rudder, the Chinese ship was born. His idea on how this theoretical evolution relates to vessels that may have originated from the raft, however, are not at all clear.\textsuperscript{137}

Horace Underwood reported that of all the many different types of vessels found in Korea, the very oldest were dugouts and craft based on the dugout from. Common to the inland waterways, dugouts were made in all sizes depending on the availability of timber. Underwood observed that ferry boats made from dugout logs were internally strengthened by raised, rib-like sections carved from the inside of the hull. As Hornell pointed out, dugout canoes from India and Indonesia displayed similar early construction methods. There appears to be no evidence, however, that this construction method in Korea had any link to bark canoes, as Hornell believed it did for the canoes of South and Southeast Asia.\textsuperscript{138}

Of particular interest is an anonymous report that describes a type of Korean vessel constructed in a manner similar to the madel paruwa of Sri Lanka and the early
Fig. 20: A Korean vessel with chine strakes made from dugouts. (After Anon., "Boats of Sung-jin, p. 405)

sampans described by Ling. Seen sailing along the northwest coast near the port of Sung-jin (Sunch-on), this type of vessel was constructed from two large, hollowed out pine logs laid side by side (Fig. 20). At the bow the logs were firmly fastened together, leaving the stern ends separated from one another by a distance equivalent to one third the overall length of the logs. Bottom planking was installed between the dugouts as well as side planking atop the dugouts. Presumably the open stern was closed with a transom. How these various members were fastened together is not mentioned. Neither is any information given about how the vessel was propelled, or what it was used for other than the fact that those who sailed them "affirm that they are the best boats used." 139

Greenhill emphatically believes that the lineage of traditional Japanese ships is directly linked to the built-up log boat, and that the raft played no part in
built-up log boat, and that the raft played no part in this evolution. Apparently assuming that the only shipbuilding influence that could have come from China was from ships whose ancestry is based on the raft, Greenhill further contends that although the Chinese may have influenced Japanese culture in many ways, they had nothing to do with the development of Japanese ships. To support this argument, Greenhill describes the construction of the *Yamato-gata* type of craft which is an edge-joined, plank-built, frameless vessel having "a massive hog" instead of a keel.\(^{140}\) The *Yamato-gata* type of vessel does indeed appear to have evolved from the built-up log boat, but the *Yamato-gata* design was not developed until the sixteenth century when Japan had officially closed itself off from foreign contact. Thus the development of the *Yamato-gata* itself may have been independent of outside influence, but this was not necessarily true for its earlier dugout-based ancestors.\(^{141}\)

Some time during the second century A.D., shipwrights from the Korean kingdom of Silla were reportedly sent to Japan to teach the Japanese the art of shipbuilding.\(^{142}\) Thus if, as Underwood suggested, the majority of Korean ships were based on the dugout, similar Japanese ships may represent a Korean legacy. Furthermore, by at least as early as the Han dynasty, China played an integral role in
the history of both Korea and Japan, and if, as it seems, at least some of the ship types in China were developed from the dugout, then it also seems plausible that China may have been a source of shipbuilding influence for Korea and likely Japan as well. In fact, in the Chinese provinces of Hunan and Guangdong, ship models recovered from Han-dynasty tombs resemble models of a similar age from Japan.\textsuperscript{143} Let us also not forget that the Austronesian Nusantao sailors were plying the waters of East Asia, and they too may have influenced vessel development.

Trying to make sense of the different theories and conflicting data on the early development of Asian watercraft is a slippery business indeed.\textsuperscript{144} To say that the earliest watercraft in Asia were simple flotation devices is a safe assumption. Most authorities also agree that from these simple floats were developed skin boats and basket boats as well as the raft and canoe which carried the Australoid and Austronesian peoples throughout insular Southeast Asia and as far west as Madagascar and east into the Pacific.

In ancient China the official attitude toward commercial maritime affairs was traditionally a negative one. When it came to military naval affairs, however, Chinese officials readily supported the development of war
vessels. The diverse types of naval craft developed, and the possible effect this diversity had on Chinese ships in general, will be addressed again later. Of more immediate concern is the fact that although the Chinese officialdom apparently had little interest in commercial shipping, trade by sea was nevertheless carried out, but by foreign enterprises. Records indicate that before the Han dynasty, pre-Islamic Arab and Persian merchants and traders were sailing to China. I do not believe, however, that this trade was carried out in Arab or Persian vessels. Most likely the foreign vessels along the coast of China were from Southeast and possibly South Asia. When not involved in trade themselves, the owners and captains of these South and Southeast Asian vessels were hauling Arab and Persian merchants. Whatever Western-like influences these vessels brought with them to China and the Far East did not necessarily come from the Mediterranean, but more likely from Asia. The vessels of the Yueh and Nusantao people provide clues as to what these foreign influences may have been.

The conventional scholarly view that the raft was the only ancestor of Chinese vessels is obviously far too narrow. Whether or not we can accurately say that there was a northern and a southern tradition of Chinese vessel development is debatable. What does seem obvious is
that vessel development in China, in the broadest geographical sense, had a duel ancestry — the dugout and the raft. This topic will be explored further in the next chapter. Let us leave our present discussion with the knowledge that, however they were constructed, by at least the fourth century B.C. Chinese vessels were actively plying the waters of Southeast Asia and may have been venturing as far west as India.¹⁴⁸
Notes


4J. K. Fairbank, China: A New History, p. 31.

5S. M. Nelson, The Archaeology of Korea, pp. 55-56.


7M. Hane, Premodern Japan: A Historical Survey, p. 10.


12Solheim, supra n. 11, p. 150.


14D. R. SarDesai, Southeast Asia: Past & Present, p. 9; Solheim, supra n. 11, p. 150.
15 Solheim, supra n. 11, p. 150.

16 Hardjowardojo, supra n. 13, p. 5

17 Solheim, supra n. 11, pp. 152-153. Much of the current research being done on the prehistory of Southeast Asia tends to focus almost exclusively on Austronesian cultural groups. The information available on the Australoid peoples, however, remains somewhat obscure, even though they too apparently had occupied almost as wide a geographical range as the Austronesians. Undoubtedly the arrival of the Australoids in Japan and Sri Lanka, for example, was via, for lack of a better term, land bridges that were created by lower sea levels during the Pleistocene. However, the presence of Australoids elsewhere, Australia in particular, indicates that they were equipped with some form of sailing technology. Much more information is needed before we can really begin to understand these fascinating, somewhat orphic people.


20 Certain artistic stylizations and other cultural aspects of the Dongsonian people appear to be related to that which was produced by people living in eastern and northern Europe. Although through trade some cultural borrowing may have occurred, it is nevertheless highly unlikely that the Dongson culture originated in Europe. Recent archaeological evidence has shown that the Dongson culture predates any similar culture in Europe by more than 1,000 years. In light of this it seems even more likely that Europe was the receiver of Asian cultural influences rather than the other way around: Solheim, supra n. 18, p. 191; T. B. Allen, "The Silk Road's Lost World," National Geographic 189 (1996): 46; O. R. T. Janse, "The Lach-Truong Culture -- Western Affinities and Connections with the Culture of Ancient Ch'u," in Early Chinese Art and Its Possible Influence in the Pacific Basin, ed. N. Barnard, pp. 199, 204.
22 Solheim's term "Nusantao" is based on the root words of nusa (an Indonesian word meaning "island" or "native country", nusan meaning "archipelago") and tao (a word in many of the Philippine languages meaning "person" or "man"). The people Solheim refers to as Nusantao are those who speak the Austronesian languages including "all the native languages of Polynesia and Micronesia, most of the native languages of Island Melanesia, a few of New Guinea, all of the aboriginal languages of Taiwan and the Philippines, most of the languages of Indonesia, Malay of western Malaysia, Cham, Radai, and other languages of present day mountain peoples of Southern Vietnam and Laos, and Malagache, the language of Madagascar": W. G. Solheim II, "The Nusantao and South China," Journal of the Hong Kong Archaeological Society 6 (1975): 108-109.

23 W. G. Solheim II, pers. comm.

24 That which describes the Austronesians, already mentioned above, is in essence the same for what Solheim classifies as the Nusantao. Why there is need for a new classification is uncertain, but Solheim tends to believe that the term Nusantao is more culturally specific, particularly for those who inhabited the geographical areas bordering the South China Sea: Solheim, supra n. 18, p. 196; W. H. Scott, Prehispanic Source Materials for the Study of Philippine History, p. 17.


26 W. Meacham, Archaeology in Hong Kong, pp. 21, 48, 79.


29 Solheim argues that the Cham traders settling on Madagascar were of the same group of traders who settled in southern Borneo, the "ancestors of the present-day speakers of the language in Southeast Asia most closely related to Malagache": Solheim, supra n. 18, p. 199.

30 See Appendix I for a chronological list of the Chinese dynasties.

31 Solheim, supra n. 18, p. 200.


34 C. Blunden and M. Elvin, Cultural Atlas of China, p. 54.

35 Fairbank, supra n. 4, pp. 34, 38.

36 Ibid., p. 39; Blunden, supra n. 34, p. 59.


38 Fairbank, supra n. 4, pp. 39-41.

39 Ibid., p. 49.

Fairbank, supra n. 4, pp. 35, 42.


The militaristic ambitions of Qin Shi Huang, whose real overwhelming interest was to discover an "elixir of immortality", is well displayed by his now famous tomb located near the city of Xian: O. L. Mazzatenta, "China's Warriors Rise From the Earth," *National Geographic* 190 (1996): 69-85.

Blunden, supra n. 34, p. 80; Fairbank, supra n. 4, pp. 55-56.


W. J. Joe, *Traditional Korea: A Cultural History*, pp. 7-9; W. K. Han, *The History of Korea*, pp. 4-5.


Joe, supra n. 48, p. 11.

Hane, supra n. 7, p. 13.

55 SarDesai, supra n. 14, p. 21.


61 Buss, supra n. 59, p. 53.


63 S. R. Rao, pers. comm.

64 Buss, supra n. 59, p. 53.


66 B. Greenhill, The Archaeology of Boats & Ships, p. 15.


Hornell, supra n. 67, p. 2.

Ibid., p. 5.

S. Nishimura, *A Study of Ancient Ships of Japan: Floats*, p. 27. In the Chatham Islands, southeast of New Zealand, native fishermen used inflated kelp bladders as flotation devices. By the time this rather unusual but brilliantly adaptive invention was recorded in the nineteenth century, the inflated bladders had been converted into flotation supports for punt-like rafts of various sizes: H. D. Skinner, "Moriori Sea-Going Craft," *Man* 12 (1919): 34; A. C. Haddon and J. Hornell, *Canoes of Oceania: The Canoes of Polynesia, Fiji, and Micronesia*, pp. 218-220.

Ibid., supra n. 71, pp. 96-98.


Solheim, supra n. 10, p. 152; Bellwood, supra n. 10, pp. 20-21.


J. Wong, *Shi Yi Ji (Lost Histories)*, pp. 6-7. How this was accomplished was not explained. Presumably to convert a raft into a boat would at least require the addition of some kind of sides to make it watertight, although some authorities contend that the raft was turned into a dugout: K. Qiu, "Ping 'Zheng Guo Yuanyu Gu Taiping Yindu Liang Yang de Fanfa Ge Chuan Fengzhou he Louchuan de Yanjiu' (Comments on 'Research on the Remote Antiquity of China -- Sailing Rafts, the Twin-Hull Boats and the Multiple-Decked Ships')," *Haijiaoshi Yanjiu* 2 (1987): 75.

Some writers have speculated that Confucius was referring to the islands of the South Pacific or even the New World: S. S. Ling, "Formosan Sea-Going Raft and Its Origins in Ancient China," *Bulletin of the Institute of Ethnology, Academia Sinica* 1 (1956): 51.

80. Ibid., p. 29; Nishimura, supra n. 71, pp. 101-102.


87. Ibid., p. 232.


89. Burningham, supra n. 86, p. 232.


91. Chinese ships sailing to the Philippines were lashed with a "wreath" of bamboo poles to increase buoyancy. Although this did little to prevent any leeway drifting, one Western observer noted that the ship on
which he sailed would have been lost in a typhoon if it had not been for the "immense wreath of bamboo" encircling the vessel's hull. Perhaps this provides some justification for the design of the po chuan fa: J. A. Clare, "Origin of Leeboards," The Mariner's Mirror 53 (1967): 209.

92 Johnstone, supra n. 68, p. 15.

93 Hornell, supra n. 67, p. 40.

94 S. Nishimura, A Study of Ancient Ships of Japan: Skin-Boats, p. 139; R. Cairo, "A Note on South Vietnamese Basket Boats," The Mariner's Mirror 58 (1972): 135-153. An interesting variation on these coracle-forms of craft are those that are in essence large, floating bowls. Though bowls they may be, made from earthenware turned on a potter's wheel, nonetheless they are capacious enough to carry at least a single individual. They have no framework, thus they are truly shell-first constructed vessels and geographically range from India to mainland Southeast Asia, China, Korea and Japan: B. Prashad, "The Tigari -- A Primitive Type of Boat Used in Eastern Bengal," Journal of the Royal Asiatic Society of Bengal 16 (1920): 35-36.

95 Burningham, supra n. 86, pp. 232-235.

96 Hornell, supra n. 67, p. 186.

97 Greenhill, supra n. 66, p. 74.


100 Matsumoto, supra n. 90, p. 29.

102 Hornell, supra n. 67, p. 189.


104 Hornell, supra n. 67, p. 190; Qiu, surpa n. 77, p. 76.


106 Horridge, supra n. 103, p. 85.

107 Hornell, supra n. 67, p. 190.

108 The shaping of a simple canoe hull can result in a highly insightful, ingenious design. Magellan in 1521 recorded observing an exceptionally fast, lightweight watercraft that was built on the Ladrone Islands and sailed the eastern waters of Southeast Asia. It was fitted with a single lateen sail and an outrigger. Its hull was built up from a dugout with a single wash strake attached to each side to increase its freeboard. The unique feature of this craft was that its hull was shaped so that one side was relatively straight from end to end, and the other side was convex. By shunting the sail, the curved side of the hull was always kept to windward. Hydrodynamically this had a similar effect as air moving across an airplane wing. The curved side of the hull displaced more water than the straight leeward side, thus the curved side was drawn to windward. This force, coupled with the weight of the single outrigger attached to the curved side of the hull, helped balance the force of the wind against the sail. This design allowed this relatively narrow craft to carry a large sail without being capsized: H. C. Folkard, The Sailing Boat, p. 462-466; Johnstone, supra n. 68, pp. 203-204.


Horridge, supra n. 11, p. 155.


T. Harrison, "50,000 Years at Niah," The Straits Times Annual 2 (1967): 82-85.


126 Needham, supra n. 124, p. 389.


128 The time-honored use of the somewhat disparaging term junk to describe the traditional ships of East Asia and some of those of Southeast Asia is avoided whenever possible in this dissertation. The term itself is a Western bastardization, probably based on a Malaysian word for "ship" with no similar-sounding counterpart in the languages of East Asia. Because the conventional classification of junk refers mostly to flat-bottomed, bluff-ended vessels, it detracts from the many diverse types of Asian watercraft that do not fit this classification.

129 The term sampan is often ambiguous in its usage. Translated the word means "three boards", properly pronounced as "san ban". Although larger vessels are occasionally called sampans, traditionally the word refers to a small, fairly standard type of skiff-like, wedge-shaped boat that is shallow, keelless and very broad in the beam at the after end and has three planks that constitute the flat bottom of its hull, hence its name: N. Peri, "A propos du mot 'sampan'," Bulletin de l'Ecole Francaise de l'Extreme-Orient (Hanoi) 19 (1919): 14.


Ling, supra n. 79, p. 217. Tomb paintings made during the Han dynasty depict small, crescent-shaped craft on which warriors stand fighting. Although little detail is shown, these may represent a kind of double-dugout sampan described by Ling: E. Chavannes, La sculpture sur pierre en Chine au temps de deux dynasties Han, p. 78.


Hornell, supra n. 124, p. 336.

Ling, supra n. 79, pp. 215, 218.


142 Underwood, supra n. 138, p. 23.


CHAPTER III

TEN CENTURIES OF ASIAN SHIP DEVELOPMENT:
PROTOHISTORIC AND HISTORIC

Trade and Politics

From the first century A.D. to about the year 1000, political and commercial developments in Southeast Asia flourished. For this same period, however, Claude Buss describes a different and rather gloomy condition in India. After the death of the emperor Asoka in 237 B.C., India fell victim to internal strife, political and social decay and warfare. Various Indian kingdoms, such as the Cholas, Pandyas, Pallavas and Kalingas, rose and fell during the first 1,000 years of the Christian era, but none of the rulers had any real effect on changing the perilous condition of the country. As a result colonists and fleets of traders were dispatched, or fled, to various areas of Southeast Asia such as Cambodia, Malaysia, Sumatra and Java. Capitalizing on commercial contacts and trading networks that had already begun some four or more centuries before the Christian era, Indian and Sinhalese immigrants further opened Southeast Asia (Fig. 21) to the trade in luxury goods that were in such high demand in the Western World.¹ Cinnamon, pepper, cloves and all the other natural products that would later bring Europeans to
Fig. 21: Map of the trading regions of the Indian Ocean and South China Sea. (After Chauduri, p. 35)
the "spice islands" of Southeast Asia were greatly valued by those in the Roman world and elsewhere in the West.² Also in demand were products from the Far East such as Chinese silk and ceramics that were brought in exchange for Southeast Asian goods by Chinese as well as South and Southeast Asian traders.³ Roman, Greek and Egyptian traders came to India, but most scholars believe that if they had traveled much farther than the Coromandel coast, it was a rare occurrence. Persian and particularly Arab traders tended to monopolize the trade in Asian goods to Western markets but while in Southeast Asia relied on the auspices of Asian traders and sailors.⁴

G. F. Hourani believed that because the Arab ships were built using laced-plank construction, they were weak and likely to disintegrate in heavy weather.⁵ Depending on the vessel, this type of construction may have been susceptible to rough conditions, but craft built in this manner certainly were not too weak to sail the full distance to the Far East. Their supposed weakness was therefore not the reason for South and Southeast Asian dominance of maritime trade. A more salient reason was that, in many cases, it was more financially lucrative, not to mention physically safer and easier, to rely on the trading acumen and experienced pilotage of a native.⁶
Indian trading settlements were established along the coasts of mainland Southeast Asia and on islands such as Sumatra, Java and Kalimantan (Borneo). From these settlements grew principalities and kingdoms which adopted Indian religions, used Sanskrit as the sacred language and followed Indian codes of law and political administration. The Hinduized state of Funan, founded in the first century A.D., arose and became for 500 years the dominant power in Southeast Asia. With its capital at Vyadhapura, which was located near the present Cambodian capital of Phnom Penh, the Funan sovereigns extended their rule to southern Vietnam, Cambodia, central Thailand, northern Malaysia and southern Myanmar (Burma). Armed with a powerful naval fleet, the kingdom of Funan became the dominant intermediary in maritime trade between the Far East and South Asia.

During the reign of Funan, immigrants from regions in and around southern China were moving south. The Burmans established their capital of Pagan near the modern city of Mandalay in Myanmar, and Thai immigrants moved into Siam. Contemporaneous with Funan was the Cham kingdom of Champa near the Vietnamese city of Hue. Both the Chams and Khmers gradually gained control of previously held Funan lands until the middle of the seventh century, when the
Khmers overthrew the kingdom of Funan and supplanted the Funanese supremacy.\textsuperscript{9}

After the fall of Funan to the Khmers, two powerful Indonesian kingdoms arose. Enriched by the maritime trade previously dominated by Funan, the kingdom of Srivijaya, its capital probably located near Palembang on the island of Sumatra, was essentially a maritime state. Geographically it was in a far better position to access the sea trade passing to and from South and East Asia than were the Khmers at their inland capital of Angkor.\textsuperscript{10} The first recorded extant description of Srivijaya was made in 672 by a Chinese Buddhist pilgrim, I-Ching, while en route from China to India. In his account I-Ching described the well-facilitated port of Palembang that, during his six-month stay, harbored no less than 35 Persian merchant ships as well as many other vessels from South and Southeast Asia. The king, armed with a powerful naval fleet, suppressed piracy in the Strait of Malacca which further attracted international shipping to the harbors of Srivijaya. From taxes and tolls excised on shipping, the kingdom flourished such that, as an example, support could be given to Buddhist monasteries that housed more than 1,000 inmates in the fortified city of Palembang.\textsuperscript{11}

A century after the establishment of Srivijaya, Funanese descendants living on Java, known as the
Sailendras, developed their own dynasty and, according to D. R. SarDesai, became Srivijaya's major competitor in maritime trade for the next 100 years.\textsuperscript{12} C. D. Cowan, however, argues that the "two were not so much rivals as neighbors operating within different political and cultural systems, geographically and functionally in balance."\textsuperscript{13} Sailendra prosperity was agriculturally based on the cultivation of sawah, or irrigated rice. In contrast Srivijaya's wealth came predominantly from trade, and they relied on the import of Javanese foodstuffs. The Sailendras, with surplus wealth from agriculture, invested much toward the construction of monumental Buddhist structures such as the magnificent Borobodur. However, not all of their energy was directed toward the building of monuments, which raises the question of just how peacefully integrated the Sailendras really were.

During the last decades of the eighth century the Sailendras, possibly to reclaim their patrimony, invaded and overtook the old Cham kingdom of Champa. Thus, for a brief, shining moment in time, "the Sailendras became the only indigenous power in history to rule over substantial territory in both mainland and insular Southeast Asia."\textsuperscript{14} The Sailendra rule was soon extinguished, however, when in 802 the Khmer king, Jayavarman II, defeated the Sailendras and reclaimed political control. Over the next three
decades political factionalism ensued between the ruling families on Java. Prince Balaputra, the last of the Sailendra line, was forced to flee to Sumatra where, in 850, through marriage he ascended the throne and became the ruler of Srivijaya. Thus the Sailendra line ended in Java, and, adopting "the Srivijayan policy of giving primary attention to trade and commerce", so also ended the Sailendra's "traditional devotion to building Buddhist monuments."\(^{15}\)

Elsewhere in Southeast Asia other conflicts continued to rage. In Vietnam the Sino-Yueh Vietnamese people had for centuries battled the Chinese for dominance, while from their kingdom of Au Lac in the Red River Delta, the Sino-Indian acculturated Vietnamese people would continue to battle the Chinese until the collapse of the powerful Chinese Tang dynasty in the tenth century.\(^{16}\)

Chinese political influence was widely felt throughout much of Southeast Asia. Chinese rulers followed a policy of keeping "the peoples on the periphery of the empire in a weak and fragmented state."\(^{17}\) During times of political consolidation in China, most of the states of Southeast Asia underwent periods of political intervention and at least minor attempts at subordination by the Chinese. Conversely, disunity in China resulted in greater autonomy and independence of China's vassals in
Southeast Asia. In much of Southeast Asia, the basis of this Chinese influence was trade. Usually three times a year tribute was sent to the Chinese emperor, whose reciprocity in economic benefits and military protection was greater in value than that which was sent as tribute. The benefit received by China was the assurance that its imperial power would remain paramount, but the actual extent of this imperial power was in reality rather superficial.

Although Southeast Asia was affected by and often benefited from events in China, the majority of Southeast Asians, with the possible exception of the Vietnamese, never adopted the many rich aspects of Chinese culture. Instead, Southeast Asia maintained its Indianized cultural patterns, but without losing its own unique identity. Southeast Asia never became a cultural battlefield between China and India. On the contrary, in the realm of religion, after the introduction of Buddhism to China in the first century A.D., Chinese pilgrims often traveled to places such as Borneo and Sumatra to learn Sanskrit and Pali before journeying on to India.¹⁸

As introduced in the previous chapter, the political and economic situation during the final two centuries of the Han dynasty was characterized by a decline in centralized authority caused by the rise of the powerful
landed gentry. To increase its economic base China endeavored to extend its geographical borders, but by doing so it overextended its military ability to maintain these borders. Burdened with the constant threat of invasion along the northern as well as the southern borders, China's difficulties were further exacerbated by increasing power struggles amongst the various factions of the ruling class. The widespread acceptance and popularity of Buddhism provides some indication of the societal breakdown that was occurring and the disillusionment people had with many aspects of traditional Chinese mores based on Confucianism and Legalism.¹⁹

During the centuries following the end of the Han dynasty in 220, China was divided into a multitude of various competing kingdoms and principalities. The demand for foreign commodities and luxury goods was high, but records indicate that trade in China was sporadic. Reoccurring rebellion and warfare often made it impossible to profitably trade along China's coasts. Between the years 300 and 400 (during the reign of the Eastern and Western Jin dynasties), only three tribute missions were sent to China. These came from a small kingdom called Linyi in Vietnam, and were intended not as trade missions but as diplomatic missions to negotiate the annexation of
Annamese lands. In 419 only one tribute mission was sent to China, and this came from Sri Lanka.\textsuperscript{20}

During approximately the next two centuries, China remained in a largely disunified state, and there continued to be a high demand for foreign goods. Trading went through periods of florescence and decline, depending on the political environment at the time. Nevertheless merchants, particularly along the southern coastal regions, became progressively more wealthy and influential.

By the time of the Sui-Tang dynasties (581-907), the Chinese, benefiting from a kind of Buddhist-age reunification, were able to reestablish their ideal of unity that had developed during the Han. Foreign trade increased dramatically. Although we have no record of large Chinese ships sailing westward to Southeast Asia and India during this period, we do know that China sent large oceangoing vessels to Korea and Japan.\textsuperscript{21} This trade and maritime expansion that was begun during the Sui and Tang dynasties would continue into what John K. Fairbank declared "China's greatest age", the period of the Northern and Southern Song dynasties (960-1279).\textsuperscript{22}

In Japan, from the first to approximately the fifth century A.D., the political scene was largely characterized by rival clans battling for preeminence. By the
seventh century the Soga family emerged as the chief imperial clan and rigorously pursued Buddhism and Chinese learning that had been introduced to Japan over the previous centuries. Reforms and methods of governing were put into effect that imitated those of the Chinese Tang dynasty, and during the Nara period (710-784), the capital at Nara, ruled by the hereditary Yamato clan, was built in accordance with the Tang capital at Chang'an (Xian). Chinese influence was still evident during the Heian dynasty (784-1185), when the new capital, again patterned after that of the Tang, was moved to Kyoto. But this period also marked the beginning of renewed political upheaval in Japan that would continue throughout the following centuries until the introduction of the Tokugawa reign in 1603.23 Foreign affairs were dangerously unstable. Although some Japanese monks and students continued to travel to Chinese centers of learning, no official mission was sent to China after 890. Japanese pirates prowled the China seas, and raiding missions were carried out along the Korean coasts.

Through trade and academic exchange, and through territorial expansion on the part of the Chinese, Korea early on was in contact with China and was influenced by Chinese culture. By approximately the fourth century, the three kingdoms of Koguryo in the north, Paekche in the far
south and Silla geographically in between were established. With Tang Chinese military support, however, Silla gained dominance over its two rival kingdoms in 668, and so began the age of a unified Korea. But long before this, Korea had come under the sway of Chinese civilization. Chinese statecraft, Chinese writing (the characters adapted to the Korean language) and Confucian philosophy (and later Buddhism) were introduced to Korea probably before the time of the Han dynasty. In turn, through the introduction of many technological and cultural aspects to Japan, Korea became "the wellspring of Japanese culture before 700." 

In 676 Silla forces drove those of the Tang dynasty off the peninsula, but Chinese cultural influences remained. When the rival northern kingdom of Parhae emerged in the eighth century, its capital was fashioned after Chang'an -- just as the Japanese did with their city of Kyoto. Both Silla and Parhae sent students to China to learn under the tutelage of Tang-dynasty scholars, and in both the Parhae and Silla kingdoms, Buddhism was embraced. This sinofication continued during the Koryo dynasty, whose rulers, claiming lineage to the earlier Koguryo kingdom, marshalled their forces and defeated Parhae and Silla in 935. Like the Chinese, the Koryo government encouraged trade and supported commercial sea ventures.
Ports were open to foreign merchants, profits rose and new technologies were developed. The situation in Korea during the Koryo dynasty was similar to that in neighboring China during the contemporaneous Song dynasty. However, just as the Song dynasty was brought down by internal disorder and the advancement of Mongolian forces, so too, and for almost exactly the same reasons, did the Korean Koryo dynasty fall.²⁵

During the centuries of the first millennium A.D., trade and commerce played an important role in the political and cultural developments in Asia. Much of this trade was carried via land routes, such as the silk roads that connected the Far East with the Western World, but trade by sea was of paramount importance, especially to the insular regions of Southeast Asia. Unfortunately, as is so often the case, we know little about the ships and other watercraft that made this trade and the resulting cultural developments possible.

**More Than Just an Old Boat**

In 1926 the remains of an ancient vessel were recovered from the river at Pontian in south Pahang, Malaysia. When first discovered by locals a few years previously, the craft was partially embedded in the riverbank and covered by jungle growth. By the time the
site was investigated by I. H. N. Evans in 1926, the remains had been eroded from the bank and deposited in the river about a mile from the sea.

The Pontian boat is important not just because it is an "old boat", as both Evans and C. A. Gibson-Hill referred to it in their publications, but because it is the oldest boat of its type thus far recovered in Southeast Asia, and, most importantly, it provides valuable information concerning structural changes in hull construction that were occurring at that time.\textsuperscript{26} Carbon-14 testing, done on a sample of wood taken from the vessel's hull, yielded a date of approximately A.D. 293. Although this testing was done almost 50 years after the vessel had first been exposed, it closely corresponds with the date of the ceramics that were recovered from the wreck.\textsuperscript{27} Thus the Pontian boat was roughly contemporaneous with the rise of the Funan Empire.

The remains of the vessel consists of four planks (broken off at one end), seven rib-like framing members and a sternpost (Fig. 22). The planks are approximately 30 cm wide and 5 cm thick, and range from about 4.5 m to 6 m in length. The framing members, each carved from a single piece of wood, are a little more than 1 m to 1.5 m long and are slightly curved. The structural piece that Gibson-Hill labeled a "stern plank" is about 2 m long,
Fig. 22: Remains of the third-century A.D. Pontian boat. Note the frames set atop the carved lugs of the planks, and the "stern plank" at the far left of the photograph. (From Evans, 1927, pl. 25)
31.25 cm wide at its center and tapers to a width of about 18.75 cm at either end. Gibson-Hill identified the four plank fragments as being the aft-end remains of a keel plank, the port-side garboard strake and the garboard and second strake of the starboard side. The description given by both Gibson-Hill and Evans of what the stern plank was and how it was positioned, however, are not altogether clear.

The Pontian boat is a lashed-lug vessel built up from a single keel plank. Both Evans and Gibson-Hill stated that although the keel plank (originally about 9 m to 10 m long) was slightly rounded on the bottom, its inboard surface was flat, rather than chiseled out, and therefore the hull "was clearly not built up from a dug-out base."\textsuperscript{28}

Along the inboard length of the keel plank were carved lugs, each about 50 cm long and spaced at intervals of about 45 cm. Corresponding lugs were also carved along the inboard lengths of each of the remaining strakes (Fig. 23). Two rectangular holes were drilled through each of the lugs. The lugs along the keel plank were carved so that their thickest part, forming a kind of ridge, was roughly along the centerline of the lug. The lugs along the side strakes, however, become thicker near the upper edge of the strake.\textsuperscript{29}
Fig. 23: Hull section of the Pontian boat. Lower illustration shows the conjectural arrangement of frames and "ground futtocks" lashed to the lugs. (From Gibson-Hill, 1952, p. 114)

The flush-laid strakes of the Pontian boat were fastened together with wooden dowels and lashings made from ijok, or sugar palm (Arenga pinnata). Pierre-Yves Manguin, who observed the vessel firsthand in 1982, explains that the lashing holes, likely created by using a hot iron, "are pierced in pairs (3 cm apart, 1 cm in diameter), on each side of the carved lugs (thus approximately 45 to 48 cm apart), and would face similar holes in the adjoining strake. The holes are bored from
the inside of the hull and into the seams of the planks (thus leaving, in a regular South-East Asian design, the outer side of the planks untouched). Caulking was likely placed between the strakes, and may have been made from thin, paper-like strips of tree-bark material similar to that used on some Indonesian vessels. Following the emplacement of caulking, if caulking was laid along the seams first rather than being driven in after the planks were in place, the next step in construction was the placing of dowels within corresponding holes bored along the planking seams. The planks were then brought together, and ties, running through the lashing holes, were secured and likely made fast by some kind of wedge. The frames were then positioned atop each set of lugs. Lashing was passed through the lug holes, around the frames and tied off in a figure-eight knot. Gibson-Hill's conjectural arrangement of the framing pieces (Fig. 23) bears little resemblance to the shape of those shown in Evans's photograph of the actual remains (Fig. 22), and he admitted that no timbers were found that resembled the "short ground futtocks" shown in his sketch. Considering the shape of the frames as seen in Evans's photograph, the angle of deadrise for the original hull would not have been nearly as great as that depicted by Gibson-Hill.
Apparently the "stern plank" was positioned athwartships with its base resting on the end of the keel plank. Aft of this was the sternpost, that was ostensibly rabbeted to take the ends of the strakes, and "it seems likely that the upper third of the post rose above the level of the gunwales, which puts the vertical height of the sides at the stern at about four feet [c. 1.20 m], or seemingly four strakes."³⁴ No illustrations or descriptions are available, however, that describe how the stern plank (presumably the large timber shown at the extreme left of Evans's photograph) or the sternpost were attached to the hull. Since there is no indication that a sternpost rudder was attached, the Pontian boat was likely steered by at least one quarter rudder or sweep. Since the forces acting on the steering assemblage of a vessel can amount to as much as three-quarters of the weight of the boat itself, the function of the stern plank may have been to provide extra strength at the point where the sweep or quarter rudder was attached.³⁵ Some traditional boats of much later date have construction features reminiscent of those of the Pontian boat.

Approximately 35 miles off the southeast coast of Taiwan is located a tiny island traditionally called Botel Tobago. The native vessels (Fig.24) built there as late as the twentieth century were still constructed using
Fig. 24: The Botel Tobago boat. (From Worcester, 1956, fig. 2)

planks fastened with dowels and frames lashed to perforated lugs. Both the upturned stem and sternpost of the smaller Botel Tobago boats rise to a height of about 1.35 m. This is close to the height Gibson-Hill estimated for the stern of the Pontian boat. In the stern near the attachment for the quarter rudder of the Botel Tobago boats is located a framing member similar to the stern plank of the Pontian boat. Different than the Pontian boat, however, is the way the frame lashing passes
through the frames rather than around them in order to hold the frames more tightly in place -- a design feature that Gibson-Hill described as an advancement over the lashing method found on the Pontian boat. Since the framing of the Pontian boat was rather insecurely lashed in place, Gibson-Hill speculated, without any supporting evidence, that on the Pontian boat, thwarts, similar to those of the Botel Tobago boats, may have been wedged beneath the lugs of the gunwales and lashed to the lugs of the keel plank. This configuration, as seen on other Southeast Asian vessels, helps secure the side planking to the keel or keel plank. If thwarts as well as frames were lashed to the keel-plank lugs of the Pontian boat, this might explain why the holes cut through these lugs are larger than those of the lugs along the side planking.\(^{37}\)

The heavy, roughly cut timbers of the Pontian boat were all identified as being Hopea wood, of which about nine different members of the genus exist throughout Southeast Asia from Myanmar to Cambodia. Thus little can be discerned about exactly where the vessel originated based on this evidence alone. Considering the fragmented ceramic remains taken as the vessel's cargo, the best that can be said is that the bulk of it coming from areas along the Gulf of Thailand and along the coast of Vietnam may best indicate where the Pontian boat sailed. Gibson-Hill
argued that the design of the Pontian hull reveals that it is undoubtedly an early version of a vessel called, in Thailand, a rua chalom. In Cambodia this same vessel is called a tuk chaleum or tuk chap pok. In Vietnam it is known as a ghe no, and a perahu pukat in Malaysia. J. B. Piétri declared that certain elements of this type of vessel relates it to those depicted in the twelfth-century Bayon carvings at Angkor in Cambodia. Thus Gibson-Hill believed that the construction of the rua chalom (Fig. 25) may best be used to interpret that of the Pontian boat. He explained that the rua chalom:

... is a moderately large, partly decked boat of shallow draught. It is carvel built and round-bottomed, with a stem, stern and keel-piece, but usually no projecting keel. The keel-piece is set with its breadth horizontally, not vertically, and if there is any projection below the hull it is in the form of a rubbing strake ... fastened as a false keel, but even this is generally absent. The inside of the hull is rounded, and there is no kelson. The ribs are arranged in pairs, but they stop short of the keel-piece: alternating with them is a series of ground futtocks which overlap the ends of the ribs by one or two strakes, but lie about a foot away from them. The stern post, which is nearly plumb, is set in the same manner as in the Pontian boat, with about one-third of its height rising above the gunwales. The stakes are fastened to each other with pegs, and to the ribs and ground futtocks with nails. These boats have thinner planking than the Pontian hulk, but the only major difference in their construction appears to be the use of nails, and more extensive pegging, in place of the cords of ijok fibre.

The rua chalom is usually stepped with a single mast on which is set a large lug sail. The height of the mast is customarily 30 cm to 60 cm less than the length of the
Fig. 25: The Southeast Asian craft called a *rua chalom*. The shape of the hull and the bow and stern are similar to those of vessels depicted at Bayon, Cambodia. Note also the U-shaped timber from which the quarter rudders are hung. (From Gibson-Hill, 1952, p. 120)

hull at its waterline. The overall length of the average *rua chalom* is about 12 m with a waterline length of roughly 11 m. To avoid shifting a single quarter rudder from one side of the hull to the other when altering course, a pair of quarter rudders, or "paddles", is
carried. During fair weather usually only one rudder is used at a time, hung from the leeward side of the U-shaped support in the stern.\textsuperscript{41}

The vessels depicted in the twelfth-century Bayon carvings at Angkor are predominately rivercraft and resemble many of the modern watercraft sailing the Gulf of Thailand.\textsuperscript{42} Some are obviously war vessels manned by as many as 11 to 17 rowers a side (Fig. 26). The oars of the war vessels pass through a woven matting that serves as a bulwark. The vessels' hulls are slightly crescent shaped in profile and sharply ended, rising well above the sheer of the hull. Nearly all the war vessels are shown having a single quarter rudder, many fitted with a tiller. Other vessels are shown having either quarter rudders, similar to those of the war vessels, or simple steering paddles.\textsuperscript{43}

The craft that Gibson-Hill believed is of the rua chalom type has a hull similar in shape to those of the war vessels, but the stem and sternpost are lower and the bulwark matting extends the entire length of the hull (Fig. 27). It is steered by a single quarter rudder, and it is stepped with a single mast that is set with a diminutively portrayed fore-and-aft sail. The sail appears to be made from some kind of matting, but this, as well as its dimensions in particular, may reflect artistic convention rather than reality.
Fig. 26: Oared war vessels of the twelfth century A.D. depicted at Bayon, Cambodia. Note the oars passing through a woven bulwark and the quarter rudder fitted with a tiller. (From Gibson-Hill, 1952, p. 123)

The idea that the Bayon vessels are related to the rua chalom and the Pontian boat is conjectural. Similarities are apparent, but evidence used to link all three as the continuation of a single type of craft is flimsy. Of far more significance is the evidence provided by the Pontian boat indicating a transitional stage in construction using "three techniques seldom found together on the same craft: sewing [lashing] of the planks, edge-dowelling and frames lashed to carved-out lugs."44 A similar but possibly more advanced method was used on vessels built in the Philippines.
Fig. 27: A twelfth-century A.D. vessel depicted at Bayon, Cambodia. The hull shape resembles that of the modern rua chalam from Southeast Asia. Note the woven bulwark extending the length of the sheer, the quarter rudder and the mast with a diminutively represented sail. (From Gibson-Hill, 1952, p. 123)

The Butuan Boats of Mindanao, Philippines

In 1976 near Butuan City on the island of Mindanao, excavators uncovered two ancient vessels built having lashed lugs and dowels.\(^{45}\) Classified as a type known in the Philippines as a barangay, similar vessels were sailed throughout much of Southeast Asia during the first millennium A.D.\(^{46}\) Both the Butuan Boat One and Boat Two have been radiocarbon dated to A.D. 320 and A.D. 1250 respectively.\(^{47}\) The remains of Boat One consist of a keel plank, both garboards and the second strake of, probably, the starboard side. Each of the strakes and the keel.
plank are in one continuous piece without scarfs and run the entire length of the vessel — approximately 15 m. Boat Two’s remains consist of a keel plank, two strakes on one side and five strakes on the other. The keel plank is approximately 4 cm to 5 cm thick and 45 cm wide at midships. The side planking is 20 cm wide and 3 cm thick. Thus the keel-plank scantlings are only slightly greater than those of the side strakes.48

The flush-laid planking of both vessels were fastened together with dowels, inserted into holes bored into the edges of the planks, and lashed lugs, carved from the inboard surface of each strake and the keel plank. Boat Two has at least 14 sets of rectangular-shaped lugs aligned laterally across the hull. Each lug (or tambuko) is approximately 32 cm long and 3 cm thick. The lugs along the keel planks of both Boat One and Boat Two, however, are double. William Scott speculated that a keelson-like longitudinal timber, running the length of the keel plank and notched to fit over the frames, may have been slotted between the double lugs.49 However, since the frames cover most of the upper surface of these lugs, little space is left to fit this hypothetical keelson into the slot. It is unlikely, therefore, that this is the reason why the lugs along the keel plank were cut in pairs. Also, since no such keelson-like timber has
been located, it is unlikely that any such timber was used.

Much of the internal strengthening appears to have come from a combination of frames and lashings. Frames positioned atop the lugs were secured with lashing that passed through holes drilled in the frames and through corresponding holes in the lugs. When tightened, this lashing forced the frames and the side planking together and ultimately bound the sides of the vessel against either edge of the keel plank.

Before the lashing was installed, however, dowels along the edge of each strake helped align the planks and keep them in place. Along with the lashing, the dowels also helped lock the strakes together, and they provided longitudinal stability by minimizing sheer forces along the seam of each strake. An intriguing design feature found on the Butuan Boat Two is the way the dowels appear to be grouped in sets of five or, as more recently reported, sets of six. Why this was done is still unclear, but it is apparent that some kind of template was used to mark the location of the dowels, thus indicating a conscious effort for control on the part of the shipwright.

The Pontian boat and the Butuan Boats One and Two are similar in that they are all built shell first with the
lashing and frames installed after the dowel-articulated strakes. Important differences occur, however, in certain other aspects of their construction. Besides using frames lashed to lugs, as did the Butuan boatbuilders, the builders of the Pontian boat also used a combination of lashing and dowels spaced along the plank seams of the hull. Earlier vessel types were probably constructed without dowels and used only lacing or lashing along the entire length of the planking seam. The lashing on the Pontian boat was used only where dowels were placed, and the spacing between dowels is as much as 92 cm to 94 cm. On the Butuan Boat One, the dowels are spaced about 16 cm to 18 cm apart, and on Boat Two the dowels are spaced every 12 cm.

During roughly the same period, shipbuilders in the Mediterranean appear to have been moving away from the use of mortise-and-tenon joints. This reduction in the number of edge joints meant that other means of strengthening the hull had to be relied on, such as frames. This is part of the evidence of a transition in the Mediterranean from shell- to frame-first construction. In Southeast Asia, on the other hand, boatbuilders were becoming increasingly reliant on edge joints, in the form of dowels, to fasten strakes together. The situation in Southeast Asia, however, was a bit different than that in the
Mediterranean, and we can only loosely compare the contemporaneous vessels of these two areas. Unlike the Kyrenia and the Yassi Ada vessels, for example, the Pontian boat and other, later examples like her are more closely related to earlier craft that probably were constructed using only lacing and lashing. The ancestors of ships such as the Kyrenia and the Yassi Ada vessels may have been watercraft that were built having laced or lashed construction, like the Royal Ship of Cheops, but both the Kyrenia and Yassi Ada vessels are plainly only distantly related to these earlier forms of craft. In Southeast Asia the transition from strictly laced construction to doweled construction probably began centuries before the Christian era, but, as is evident from the Pontian boat, this transition was still being worked out in certain parts of Southeast Asia as late as the third century A.D. By the fourth century, however, at least in the Philippines, the transition from laced to doweled planking was complete, and by the end of the millennium, the number of dowels used to fasten planks together had increased, and cross-pinning of the dowels was done to further increase their strength. Thus it would appear that, at least in Southeast Asia, builders were becoming ever more reliant on shell-first
construction, whereas in the Western World frame-first construction was becoming increasingly common.

In Asia the transition from shell- to frame-first construction is not as simply defined as it may be in the West. Rather, as Southeast Asian shipwrights increased the number of dowels used to fasten planks together, they also increased the number of frames used to strengthen a vessel's hull. Moreover, this framing occasionally developed into rather intricate forms consisting of multiple interlocking and lashed pieces all serving to further increase the strength of the frame or the framing unit.53 Elsewhere in Asia, such as in China, edge-joined planking was used, but, in most cases, it was eventually abandoned. Frames and frame-like units (often in the form of bulkheads) became the primary means of strengthening the hull.

Parallel and Separate Developments in East Asia

At least as late as 1980, in the southern Chinese province of Guangdong, some vessels were still built by the ancient method of lash construction. Exactly how many still exist today is uncertain, but their numbers are surely dwindling.54 These vessels are of a shipbuilding traditions not normally associated with the Chinese, but one which has in fact existed in parts of China for probably more than 4,000 years.
At first glance, these "butt-joint" vessels (Fig. 28), classified as such by Chinese ship scholars, appear to resemble the Pontian and Butuan boats. But in reality the method used to construct them is probably much older, and they are more akin to the mtepe lamu, from the east coast of Africa, and other types of craft from South Asia. This is not to suggest necessarily an African or even South Asia origin, however, because similarly constructed vessels appear throughout Southeast Asia and the South Pacific.

The butt-joint vessels of Guangdong are built shell first. Unlike the Pontian and Butuan boats, however, the Chinese craft are built up from a keel, rather than a keel plank, their frames are lashed directly to the planks of the hull, rather than to lugs, and no edge-joints are used other than lashing to fasten the planks together. Also the stem-to-stern longitudinal curvature of the Chinese craft is more fair than probably that of the somewhat bluff-ended Southeast Asian examples.

The construction of the Chinese butt-joint vessel begins with the laying of the keel, stem and sternpost. The keel (approximately 6 m long) is in two parts, joined together at midships by a butt joint fastened with two internal metal dowels. The stem and sternpost are also fastened to either end of the keel in this manner,
Fig. 28: Guangdong "butt-joint" vessel. The keel, stem and sternpost are joined with dowels, and planks are lashed to this assembly and to each other. (After Dai, p. 86)

resulting in an overall vessel length of about 9.5 m. For centuries the Chinese have used metal fastenings in their vessels. Earlier, however, wooden dowels were used, as is the case elsewhere in Asia, and originally this type of vessel likely had a solid keel that would be stronger than one joined together with wooden dowels. Based on what we know of some Southeast examples, this type of Chinese craft may originally have had a keel plank or very likely a dugout base that later evolved into a keel.\textsuperscript{56}

On the modern butt-joint craft, after the keel, stem and sternpost are in place, corresponding holes are drilled through them and along the slightly chamfered bottom edge of the garboard strakes. The holes passing
through the keel, stem and sternpost are drilled at a slight angle so that they pass from the upper surface of these timbers and out through the middle of their sides. The garboards are put in place, and lashing, made from the fibrous husks of coconuts (called coir), are passed through the holes. Before the lashing is tightened, a grass-like straw, pounded together with tung oil and calcium oxide (lime), is driven into the planking seams and sealed with lengths of bamboo strips (Fig. 29). The remaining upper-two, flush-laid strakes on each side are caulked and fastened to one another in the same manner, except the lashing holes are drilled straight through the wood rather than at an angle. A similar method of caulking secured with laths is seen on the Ferriby boat.

Installed next are six frames that span from sheer to sheer the width of the hull (c. 2 m at midships). They, like the keel, are carved from bailan mu ("white orchid wood") and are notched to fit over the lengths of bamboo laths. Lashing, passing through corresponding holes drilled through the frames and the side strakes, is used to secure the frames in place. Two shorter, floor-like timbers, one near the bow and the other near the stern, are lashed in place across the keel and garboard strakes. Three "thwarts", or more accurately beams, are lashed to the upper edge of the sheer strakes. The beam ends extend
Fig. 29: Lashed planking of the Guangdong "butt-joint" vessel. Holes drilled through the planking receive coir lashing that passes from the outside of the hull to the interior. Laths, with the lashing tied over top, secure the caulking. (After Dai, p. 86)

beyond the sides of the hull, and fishing nets can be secured to them -- fishing being the activity for which these vessels are employed. The bow and stern beams are smaller than the more robust third beam. This beam, which is about 4 m long and 50 cm wide, is placed directly above the first frame aft the midship frame. On the upper surface of the beam, where it extends outboard from the starboard side of the hull, a pair of square thole pins are placed. Rather than a sail, a single sculling oar, lashed to the thole pins, is used to propel the boat.57

The design of the "butt-joint" vessel of Guangdong poses many questions concerning the conventional view of how Chinese ships evolved. The vessel itself is indigenous to southern China, but in design it also
closely resembles those vessels of Vietnam that have been recorded since the nineteenth century.\textsuperscript{58} Dai Kai Yuan, who recorded the construction of the Guangdong vessel, states that documentary evidence of this type of craft dates to at least the beginning of the ninth century A.D. during the Tang dynasty.\textsuperscript{59} Plainly this type of craft is radically different from the other, more typical vessels that were built in China having flat, keelless bottoms and planks without edge joints.\textsuperscript{60}

In 1973, under the direction of the Nanjing Museum, excavation was carried out on a vessel that was constructed in, what many scholars have described, the conventional Chinese manner. Based on the coins and the ceramic material associated with the ship, she was dated to approximately A.D. 650 to A.D. 655 during the Tang dynasty. She is a flat-bottomed vessel, 17.32 m long and 3 m wide, with a fairly hard chine.\textsuperscript{61} Several lengths of planks, probably stapled together, form the bottom of the bluff-ended hull.\textsuperscript{62} At either end of the hull the bottom planking curves upward to the height of the sheer (c. 1.5 m) Thus the hull is not entirely box shaped. Framing and thwart-like timbers, together possibly creating a bulkhead, divide the hull into nine sections. To these timbers were nailed the flush-laid bottom and side planking. About three strakes of the side planking has
survived. A mast partner, located approximately 2.5 m forward of midships, was positioned against the upper forward edge of the "bulkhead" that divides compartments 2 and 3. The mast partner is notched at the center of its forward edge to take the mast. How the mast was stepped, however, is uncertain. The mast itself has not survived.63

Comparing this Tang-dynasty ship with the modern "butt-joint" boat from Guangdong, it becomes evident that we are looking at two distinct traditions in Chinese ship construction. The Tang-dynasty ship was built in the "traditional" manner having a flat, keelless bottom and strakes attached to frames and frame-like bulkheads rather than to one another. In the past this basic method of construction has been attributed to nearly every vessel built in China.64 Almost completely opposite to this is the Guangdong boat having edge-joined planks built up from a keel, internally strengthened with frames and no bulkheads. The Guangdong boat follows the tradition of planked vessels built up from a dugout base, the dugout, in this case, having evolved into the keel.

Joseph Needham, although reluctant to admit that any Chinese vessel had a proper keel, nonetheless stated that there appears to be a northern and a southern tradition in Chinese ship construction. He wrote:65
North of Hangchow Bay . . . [30 degrees N. Lat.] . . . the coastal and seagoing craft are flat-bottomed and hard-chined with relatively large, heavy and square rudders which can be lowered well below the ship's bottom or raised up high. They are thus fitted for frequent beaching in the shallow harbours or muddy estuaries of the north, where the tidal effects are most noticeable, while at sea the rudder acts as an efficient drop-keel. South of Hangchow Bay the coastal waters are deeper, the inlets fjord-like, and the islands more numerous. Here the underwater lines of the vessels become progressively more curvaceous, with a sharper entry, softer chine and rounder stern; at the same time the rudders, often supplemented by centre-boards, become sometimes narrower and deeper, sometimes fenestrated and rhomboidal.

The idea of a northern and southern Chinese shipbuilding tradition is culturally debatable. This idea of north and south is largely influenced by the modern geographical borders of China, but these have not remained static throughout history. As pointed out in the previous chapter, scholars such as Wilhelm Solheim believe that the people, such as those of the Yueh culture, inhabiting the areas of what is now southern China were not Chinese, and the area cannot accurately be considered part of China until the Han dynasty. In many ways the Yueh were culturally related to the people of Southeast Asia. Thus, in terms of ship construction, Southeast Asian traditions appear to play an important role in the shipbuilding of southern China.\(^66\)

Cultural debates and border disputes aside, it is apparent that two distinct shipbuilding traditions have
existed along the coasts of southern and northern China. If Needham is correct, these two traditions seem to merge somewhere around Hangzhou. In contrast to what Needham believed, however, there is increasing archaeological evidence indicating that the construction of many Chinese vessels was based on the built-up dugout rather than the bamboo raft. In 1979 archaeologists from the Shanghai Museum excavated a twelfth-century Chinese vessel that was built having a heavy, log-like dugout keel. The two garboard strakes, attached to the upper edge of the keel, were supported by a series of multiple through beams. No frames, bulkheads or additional planking were identified. This vessel clearly indicates the presence of a built-up dugout tradition in China that, based on artistic and documentary evidence, is certainly as old as the flat-bottomed vessels described by Needham. Vestiges of Southeast Asian edge-joint construction still exist in Yunnan province where certain lake boats are built having "planks . . . fitted edge to edge with occasional tongues of wood mortised into both sides." Southern Chinese vessels, either with a keel or a keel plank, have been described by many modern observers as being the product of Western influence. Although some Asian vessels did later adapt certain Western features, those with keels and keel planks from southern
China were more likely the product of a far older Asian tradition that persisted well into the modern age. In fact during the Tang and Song dynasties non-Chinese observers, such as the Koreans, considered the majority of Chinese vessels to be characteristically sharp-bottomed with a V-shape profile. An account taken from the records of a Chinese embassy to Korea in 1124 described the ship carrying the ambassador's staff as being shaped like the blade of a knife to cut through the waves. Thus sailors did not fear the deep water of the open seas but, instead, they feared shallow waters where their vessel might run aground and be wrecked.

To state again, regardless of whatever cultural or geographical border disputes may exist, it is clear that in China there has evolved two distinct shipbuilding traditions. And these two traditions are most easily classified, in compliance with the previous nomenclature, however inaccurate that may be, as southern and northern shipbuilding traditions.

Although we may broadly classify Chinese ships as either flat-bottomed or sharp-bottomed, in reality the most distinguishing aspects of Chinese vessels is their diversity. Although much of this has changed today, it remains true that as early as the first of this century Chinese vessels were still built in a multitude of
different ways, sometimes subtle and sometimes not so subtle, but all largely conforming in some manner to either the southern or northern traditions. Louis Audemard explained that one reason for the staggering diversity amongst Chinese vessels had to do with protecting one region from being commercially monopolized by another. The vessels of each region of China are acutely adapted to that region's environment, although at first glance this may not always appear to be the case. If regulations had been implemented promoting a standard vessel type, as was proposed in later centuries, then only the regions with environments suitable for these standardized vessels would prosper. Aside from the sometimes burdensome taxation on commercial activity, the disregard of commerce (with the possible exception of the fishing industry) shown by the Chinese officialdom prior to the Tang dynasty resulted in a kind of laissez-faire attitude when it came to private enterprises. Thus with no government aid and, more significantly, little to no government control, the development of maritime industries and ship construction occurred independently and relative to the environment of the local area.

Another factor that may have had an effect on the diversity of Chinese craft, and one that apparently has not been considered before, is the promotion and
development of government naval vessels. As pointed out in the previous chapter, although the Chinese government traditionally had little interest in commerce, which would include commercial shipping, Chinese rulers nevertheless had early on had a keen interest in naval affairs. Shipwrights and others involved with commercial shipping have been described as being characteristically conservative in nature when it comes to ships and the conveyance of goods. In any business venture, risk can prove costly and must therefore be kept to a minimum. Thus if a system works, many shipwrights, merchants and sailors are loath to change it. Conversely, in military affairs, change, innovation and improvement is often tantamount to superiority over the enemy. Chinese officials enthusiastically pursued new and, they hoped, superior developments in their naval force, often resulting in many unusual and innovative vessel designs.

Ships such as the *lou chuan* had multiple decks that provided archers with a superior vantage over the enemy. And other vessels of unique design were developed, such as the *liang jie tou*. This vessel, built in two sections, was fastened together at midships with pins. Used as a military personnel transport, this craft could be disarticulated into essentially two separate vessels which
enabled it to sail around tight river bends that were otherwise unnavigable by vessels of similar size. Also dividing the vessel in two facilitated the speed by which troops could be disembarked.

Other naval innovations included the side-mounted paddle wheel and iron plating fastened along the freeboard surface of a vessel's hull. In the realm of naval armament, mentioned here mainly as an interesting side note, was the development of onboard catapults and the huo yüe during the fifth century A.D. This latter weapon, called "fire drug", consisted of lime and sulphur enclosed in a paper bag that, when ignited, exploded on contact with the water -- remotely reminiscent of the weapon known as "Greek fire" used in the Mediterranean.76

It is unlikely that vessels such as these military examples would ever have been developed independently in the private sector. Experimentation to arrive at such designs would probably have been cost prohibitive. However, once these designs had been developed and their efficacy proven by the military, Chinese boatbuilders had no compunction toward borrowing certain designs or adopting the actual vessel itself. For example, the liang jie tou proved useful as a commercial vessel.77 In contrast with more conventional ships of similar size, which did not have the ability to disarticulate themselves
(outside of being wrecked), the liang jie tou could carry the same amount of cargo in a single trip through waterways that were otherwise navigable by only smaller vessels. Also by dividing the vessel in two while negotiating potentially hazardous areas, the boatmen doubled their chances of having at least half of their cargo survive. Another example of ships that may have originated with the military are commercial vessels with multiple decks. Originally intended as platforms for archers, these multiple decks also enabled a vessel to carry more cargo than those with only a single deck.

A description of all the various types of Chinese vessels is beyond the scope of this study. The interested reader should refer to the seminal works of authors such as G. R. G. Worcester, Ivon Donnelly or Louis Audemard. One unusual and uniquely Chinese type of vessel that must be mentioned, however, is the waipi gu, or "crooked stern junk". This strange yet functionally designed vessel, which probably no longer exists today, was unlike any other in the world (for a description of this craft, see Appendix III). Its origins are unknown, but its design was unlikely developed by the military, thus not all vessels of innovative design would appear to have been directly due to the military. However, if Needham was correct in claiming that northern Chinese vessels are
predominantly of a flat-bottom type, the reason for this may also be related to the military.

From the inland capitals of northern China, the military campaigns were on land and naval engagements were mostly carried out on lakes and other inland waterways. Whatever sea battles did occur were usually fought within sight of land. Given this environment, flat-bottomed vessels with shallow draft were more adaptable than those with deep, V-shaped hulls which, when run aground, could be wrecked. The influence military vessels may have had on watercraft in general, and the fact that nonmilitary northern vessels usually operated in the same environments as those of the military, may be two reasons why flat-bottomed vessels predominated in the north. The restrictions limiting maritime trade to inland and coastal water, more strongly enforced in the north than elsewhere in China, coupled with a flat-bottom tradition of vessel construction already established by the military, may be why boatbuilders followed the flat-bottom boat tradition. If this were not at least partially true, and perhaps because Southeast Asian influences were less of a factor north of Hangzhou, why then did northern boatbuilders not build more seaworthy craft like those in the south? By the time these northern craft began regularly to venture beyond the confines of the northern coast during the Tang
dynasty, perhaps the flat-bottom tradition was so engraved in the minds of the conservative shipwrights that outside influences would have little effect. Also in certain environments, such as those of the reef festooned waters of insular Southeast Asia, flat-bottomed vessels were in fact quite adaptive.

What we can say with some degree of certainty is that by at least the Tang dynasty, the construction of vessels in northern China followed a bottom-based shipbuilding tradition that possibly combined both shell- and frame-first methods.

To construct a typical northern Chinese ship, the builder begins by shaping and laying out the flat bottom planks of the hull. These planks are fastened together with wooden dowels, nails or staple-like clamps. This method of fastening often differs from that of the side planking. At least on later vessels of the nineteenth and twentieth centuries, side planking was usually nailed directly to frames and bulkheads in a typical frame-first manner. The bottom plank assembly determines the general overall shape of the hull, thus this method of construction conforms well to the idea of a bottom-based shipbuilding tradition as described by Frederick Hocker. In bottom-based shipbuilding the bottom of the boat is seen as a "structurally distinct component that is
assembled first (often in a different manner than the sides) and defines the essential shape of the rest of the hull.\textsuperscript{80}

Shell- and frame-first construction has simultaneously existed in northern China since at least the eighteenth century.\textsuperscript{81} Builders of frame-first vessels installed frames and fully fabricated bulkheads atop the bottom-plank assembly before the addition of side strakes.\textsuperscript{82} Vessels built in a shell-first manner had the first run of planking, or "chine strakes", attached with nails or clamps to the bottom-plank assembly. The remaining side planks were positioned atop one another (at least up to the proposed level of the waterline) and were held in place with shores. Frames and bulkheads were installed last, and the pre-erected planking was nailed to them. Other vessels, built using a combination of methods, were constructed shell-first up to the hull's waterline level. The height of the bulkheads that were installed afterwards, however, rose above these strakes to about deck level. The rest of the hull was built in a frame-first manner with the remaining side strakes nailed to the bulkheads. Thus we have an example of shell-first construction (up to the waterline) combined with frame-first construction with planks nailed to frame-like bulkheads up to deck level.\textsuperscript{83}
We have no real evidence to indicate when the transition from shell- to frame-first construction occurred in China, or if the two construction methods always existed simultaneously in some manner. Given what we know about ship construction elsewhere in the world, however, I contend that frame-first construction appeared no earlier than the end of the first millennium A.D. Before this shell-first construction predominated.\(^{84}\) If Shun Sheng Ling\(^{85}\) is correct, some vessels of northern China may have evolved from watercraft like the mael paruwa.\(^{86}\) The large chine timbers, or girders, of this type of craft may have evolved into the heavy wales found particularly on northern Chinese vessels. Having no keel, the flat-bottom craft of northern China relied on wales to provide longitudinal strength to the hull. By A.D. 1000, however, due to increased population and the smelting of iron ore, many of the forests of northern China had been greatly depleted.\(^{87}\) This may mark the period when Chinese shipwrights first began building vessels having multiple, smaller wales rather than the robust waterline wales seen on ships of earlier periods.\(^{88}\) The Chinese shipwright had ready access to nails and other iron fastenings which were strong enough to connect the side planking of the hull to the flat bottom planking without the need of additional support from the chine wale.\(^{89}\) As wood became increas-
ingly scarce, vessels were built from smaller, more numerous pieces of timber that were salvaged whenever possible from other vessels. Strakes made from multiple pieces of wood scarfed together are not as strong as those made from single lengths of wood. Thus internal strengthening became increasingly necessary, and bulkheads, made from salvaged wood or short lengths of timber, were an economical means of providing framing support. Because of the increasing emphasis placed on framing, the shipwright likely became increasingly focused on the design and placement of frames and away from the concepts of pure shell-first construction.

Bulkheads, erected prior to the side planking, act as a kind of permanent mold determining the shape of the hull's sides. This may indicate a conceptual change on the part of the shipwright whereby vessels are constructed using predetermined shapes and measurements to control the shape of the vessel rather than the more arbitrary method of building by eye and relying on the natural characteristics of the material that is used to determine the form of the final product. However, both shell- and frame-first construction, and a combination of the two, have persisted in China well into the modern era. Thus perhaps what we are looking at is the remnants of a transitional stage in wooden ship construction that was never able to develop
further before it was superseded by the modern use of iron and steel.

Another development that may be attributed to China's flat-bottomed craft is that of the stern rudder. When the stern rudder was first introduced is unknown. The oldest evidence we have thus far is that of a pottery boat, which dates to sometime between 206 B.C. and A.D. 220, found in a Han dynasty tomb. The model's rectangular-shaped rudder, passing through an opening in the stern, is slung from lines which, on an actual ship, would have been used to raise and lower the rudder depending on the depth of water.90

The origin of the rudder may have been an oar or sweep over the stern. Worcester believed that the transition from the sweep to the stern rudder occurred rapidly, and the reason he gives for this was the fact that "the ancient Chinese shipwrights were in no way embarrassed, as were their brothers in the West, by the shape of the stern of their junks, which in China from time immemorial had been square, and was therefore eminently adapted to the rudder as it was unsuitable to the paddle or rudder-oar."91 As we have seen, not all Chinese craft were square-ended. Those that were, however, could easily adapt the stern rudder. The development of the Chinese stern rudder is, however,
probably more accurately associated with that of the leeboard. In nearly all the conventional literature discussing the Chinese stern rudder, comparisons are made with how late the stern rudder was developed in the West perhaps as late as the mid-thirteenth century. These comparisons, however, are not altogether legitimate. Western shipwrights were faced with, among other problems, the difficult task of figuring how to hang a functioning rudder from typically a curving sternpost. In China the rudder was not attached to a sternpost, but simply let down through an opening in the stern. Its function was not only to steer the ship, but to help prevent it from drifting to leeward. As noted in the previous chapter, centerboards and leeboards were used particularly on flat-bottomed vessels to keep them form being blown sideways and off course. On some vessels with stern rudders, leeboards were still required. Thus the stern rudder alone did not always completely solve the problem. Nevertheless it is easy to imagine that the Chinese stern rudder was born when someone ingeniously decided simply to hang a leeboard, that could be lowered or raised and turned on its vertical axis, through the stern of a square-ended vessel, thus providing a means to steer the vessel and to some extent help it maintain its forward course. This stern-rudder technology, however, was
apparently never applied to sharp-ended vessels until approximately the tenth century. And it was in South and Southeast Asia, rather than China, where shipwrights began fitting their vessels with rudders lashed or, later, mounted with pintle and gudgeon to the sternpost.\textsuperscript{94}

In Korea flat-bottomed boats were built in many ways similar to those of northern China. Exactly how much influence Chinese vessels had on those from Korea is uncertain, but some of the design features recorded from the archaeological remains of the Wando vessel may illuminate what I suspect to be true for early Chinese craft.

The Wando vessel, discovered in southwestern Korea in 1984, is a flat-bottomed craft (about 9 m long) built in Korea sometime during the latter half of the eleventh century. Her bottom planking assembly consists of five heavy, flush-laid planks pinned together with long mortise-and-tenon joints (Fig. 30). The side planks are joined together in a similar manner, but instead of being flush-laid, they are rabbeted to each other, resulting in a lapstrake-like appearance.\textsuperscript{95} This method of construction was still being used as late as the twentieth century.\textsuperscript{96} Of particular interest are the L-shaped chine girders joining the bottom and side planking. Early Chinese ships may have been constructed in the same way
Fig. 30: The eleventh-century A.D. Wando vessel. The bottom and side planking are pinned together with mortise-and-tenon joints. Note the L-shaped chine girders and the rabbeted side strakes. (After Green and Kim, fig 14)

before the use of iron nails which allowed the side planking to be fastened directly to the bottom planking. Certainly, as will be shown later, a form of lapstrake planking was used in China during the thirteenth and fourteenth centuries and probably long before. It is not known when in Korea side planks were first joined to the bottom planks of flat-bottomed hulls without the use of chine girders. Our earliest documentary evidence of this dates to the nineteenth century (Fig. 31).\(^\text{97}\)

Craft such as the Wando vessel were likely steered by a stern rudder similar to those used in China. In the
Fig. 31: Planking plan of a nineteenth-century Korean vessel. This "Example of Boat Construction" shows a flat-bottomed, square-ended watercraft without chine girders. Note the wider center bottom plank with five planks on either side. This central "foundation plank" is labeled as being over 11.5 m long. (From Kim, 1977, p. 88)
modern era sizable fishing boats (approximately 21.5 m in length) were equipped with Chinese-like stern rudders that were as large as 6.5 m long with a blade width of over 1.5 m, and during the time when the Wando vessel was still sailing even larger ships with far larger rudders likely sailed the China seas.\(^98\)

An interesting type of craft built in both Korea and Japan during the medieval period was a vessel called a "turtle boat". Based on the basket boat or skin boat, which were believed to resemble the shell of a turtle, the hull of these flat-bottomed, plank-built turtle boats were very rounded in shape. These were war vessels, usually rowed and heavily armored with thick additional planking along their sides. Some were completely enclosed by a domed, roof-like structure occasionally designed to look like the back of a turtle.\(^99\) Thus, in at least one case, we have evidence of a planked vessel that evolved from the basket boat or skin boat.

Information concerning Japanese vessels and their development during the first centuries of the Christian era is limited. What we do know is largely based on vessels built after the fifteenth century. As previously discussed, Japanese vessels were alike in many ways to those of Korea. At least some, if not the majority, had a dugout ancestry and evolved into craft very similar to the
Yamato-gata type. Typically most seagoing Japanese craft were built up from a relatively narrow length of flat planking called a "hog" (Fig. 32). Many Japanese vessels had a sharp bow with a stempost. This gave the vessel a finer entry through the water than that of bluff-ended, flat-bottomed boats, and the hog assembly helped prevent at least some lateral drift. The stern was usually flat, and the stern rudder was modeled after those from China. Unlike so many of the Chinese vessels, however, that relied on bulkheads for much of their internal strengthening, Japanese vessels mainly used sets of arched crossbeams placed in vertical rows. This method of internal strengthening was common in Korea as well as Southeast Asia.

Much research has yet to be done on the development of Japanese watercraft. What we know of the watercraft built in South Asia during the first millennium is also similarly limited.

Speculations Concerning South Asian Vessels

The only remains of sailing craft found in the Indian subcontinent predating the tenth century is a wooden plank from Farakka in Bengal. Reports, however, provide no information as to what kind of vessel it came from or how that vessel may have been constructed.
Fig. 32: The hog and side planking typical of Japanese seagoing vessels. Note the nailing, driven from the inside at various angles, holding the planking together. (After Pougade, fig. 73)

Much of our information concerning the watercraft of South Asia during this period comes from a handful of written descriptions and artistic representations. One of the earliest written sources referring to the vessels of South Asia is the Periplus Maris Erythraei (or "Periplus of the Erythraean Sea"). This document, originally written in Greek sometime during the first or second century A.D., provides a general description of the cultures, the geography and the commerce around the Indian Ocean. Although little information is given concerning vessel construction, the Periplus does mention that many boats had planks built up from a dugout base, fastened
together with coir ligatures. Mention is also made of two seagoing Indian vessels called respectively sangara and kolandiophonta. Both were considered large ships, and the former was described as constructed from whole logs rather than planks. James Hornell speculated that this craft may have been a "double-canoe made from two great hollowed out tree trunks lashed together", or it may have been similar in design to the madel paruwa of Sri Lanka. The kolandiophonta craft may have been "vessels of great bulk employed for overseas voyages to Bengal and Malaysia (Chryse), must almost certainly have been two-masted vessels with pointed ends and probably equipped with a stout outrigger, counterparts of the present-day Sinhalese yatra-oruwa (yatra-dhoni in Tamil), but unlike them, steered by quarter oars, the rudder not being then invented" -- or at least perhaps not in South Asia.

Artistic representations depicted on coins, sculptures and in paintings indicate vessels having sharply ended hulls with planks probably built atop either a keel or dugout base. Some are rowed or paddled, and many vessels are fitted with multiple masts and sails.

The Ajanta Cave wall painting is one of the more controversial of these vessel representations and dates to sometime between the fifth and seventh centuries A.D. (Fig. 33). The details of the painting have been obscured
Fig. 33: The Ajanta Cave painting. This depiction, dated to either the fifth or seventh century A.D., shows an Indian vessel with features, such as the masts and sails, that resemble those of East Asian ships. (After Ray, fig. 7)

by age, but still visible are the vessel's three masts with long square sails and the sail at the bow hoisted on a spar between a bowsprit and the foremast. Through-beams pierce the hull near deck level, and two curious, rectangular-shaped structures project from the hull at deck level, one forward from the bow, the other aft from the stern. Two quarter rudders are mounted in the stern, and carved or painted oculus are depicted at the bow above what may be a kind of floral decoration that appears on
both the bow and stern. Many scholars contend that the Ajanta ship either represents a Chinese vessel or an Indian vessel built in a Chinese manner.\textsuperscript{110} The mast and sail configuration and the overhangs at the bow and stern are perplexingly similar to features found on Chinese craft. However, the fact that the ship is steered by quarter rudders and its hull appears to be sharply ended, rather than bluff, suggests that the ship is not Chinese. This is presuming, of course, that Chinese vessels sailing to India had neither quarter rudders nor sharply ended bows or sterns. Perhaps most informative is the fact that the crew depicted on the Ajanta vessel are not Chinese, which strongly suggests that the ship was indigenous to the Indian Ocean. Certain aspects of this ship, particularly the masts and sails, may have been influenced by Chinese craft, but there is no reason to believe that these were not independently developed in South Asia. A Southeast Asian perahu, called a "danau" by Bugis sailors, is fitted with square sails reminiscent of those of the Ajanta ship. These may also be of Chinese origin, but authorities contend that they were developed independently in Indonesia. This may be also true of the sails of the Ajanta ship.\textsuperscript{111}

The vessel type most widely associated with the Indian Ocean region is the dhow. Although built in areas
geographically ranging from India to East Africa, the dhow originated in Arabia and the regions adjacent to the Arabian Sea. The term "dhow", derived from the Swahili daw, is not used by Arabs. Instead, both sailors and boat builders use names that describe the particular type of hull. Dows can be divided into two basic types: similar ended vessels (more commonly called "double-ended") and those having a transom stern.\textsuperscript{112} Similar-ended dhows are believed to be an older type than those with a transom stern. The latter, as many scholars contend, was copied from European ships by local boatbuilders.\textsuperscript{113} Some evidence exists, however, that during the tenth century dhows were constructed having a transom stern from which a stern rudder was hung.\textsuperscript{114} Thus if the builders of these vessels had been influenced by anyone, this influence more likely came from China than from Europe.

Dhows, like many of the other vessels of the Indian Ocean, probably originated from a dugout base built up with planking lashed or laced together. The evidence is limited, but it appears that the development of South Asian vessels parallels that of Southeast Asian vessels. A variety of watercraft existed including flat-bottomed vessels, possibly based on the raft. Those with a dugout ancestry varied in the ways they developed, such as the
madel paruwa that uses dugouts as chine girders versus the yatra-dhoni that was probably based on the single dugout that evolved into the keel.\textsuperscript{115}

Dowels, used alone or in combination with ligature fastenings, were likely used to fasten hull planking together, and "vessels on . . . coins show a crisp shape associated with internal framing" well before the tenth century.\textsuperscript{116} Various forms of edge joints were developed such as the tongue and groove seam, which probably appeared much later in time, and dowels, in some instances, were replaced with iron nails. Many scholars have argued that the use of nails is another European introduction. While it is true that the use of ligature fastenings was most common, documentary evidence nevertheless indicates that some vessels in South Asia had planks fastened with nails as early as the ninth or tenth century.\textsuperscript{117}

The Borobodur and Bayon Ships

One of the most famous iconographic ship representations depicting a seagoing craft is found amongst the carvings decorating the ninth-century Buddhist temple at Borobodur, Java (Fig. 34). Carved during the time of the Sailendra kingdom, this vessel, the largest of
Fig. 34: The ninth-century Borobodur vessel. Note the bipod masts, the quarter rudder and the outrigger with multiple floats. (After Ling, 1968, fig. 14)

the seven depicted, has been the focus of some debate concerning, among other things, its nationality. Some scholars contend that it is a depiction of an Indian vessel, while others believe it is Indonesian, and some observers have even suggested an East Asian origin.¹¹⁸ Nationality aside, what can be said with some certainty is that this vessel represents a type that was probably common throughout the eastern portion of the Indian Ocean
and at least the western regions of insular Southeast Asia. Similar vessels were still being sailed along the coasts of Malaysia as late as the eighteenth and possibly the nineteenth century.\textsuperscript{119}

The Borobodur vessel is depicted as being primarily a sailing craft, fitted with two bipod masts, on both of which is hung an obliquely set lug sail or, very unlikely, a fore-and-aft sail.\textsuperscript{120} Both masts are supported by a rope backstay, resulting in a kind of tripod configuration reminiscent of the tripod masts found on ancient Egyptian craft. The sail in the bow may be similar to the one found on the Ajanta vessel. On the end of what is possibly the bowsprit is an ornament that closely resembles the figurehead, called a "ganja", found throughout South and much of Southeast Asia.\textsuperscript{121} In the stern is a similar ornament positioned on top of a three-tiered base and projecting from the stern in a manner not unlike the bow and stern projections on the Ajanta ship.

The more recent Malaysian vessels of similar design were, like the Borobodur vessel, stepped with two masts with square sails. In addition to this, however, upwards of three banks of rowers along each side were used to propel the craft as well as eighteen paddlers positioned atop the outrigger floats on either side of the vessel.\textsuperscript{122} Likewise on the Borobodur-type vessel, oars were probably
used during windless periods or when sailing in or out of port. Also like their later counterparts, at least one quarter rudder was used, as seen on the Borobodur carving.

Although we have no sure evidence of how the Borobodur ship was strengthened internally, the hull of the vessel, based on what we know of similar South and Southeast Asian ships, was likely built from planks held together with dowels and ligature fastenings. The rather square-ended base of the hull, however, more resembles the flat-bottomed craft of East Asia.

The outriggers of the Borobodur vessel, probably one along either side, were fitted with multiple floats. Outriggers of similar design were used throughout South and Southeast Asia and, to a limited degree, in East Asia. During the first millennium A.D., however, a transition was occurring from large vessels with outriggers to those without. The Pontian and Butuan boats, none of which were associated with outriggers, may be indicators of this transitional period. However, neither the Pontian nor the Butuan boats were particularly large vessels. For evidence of a large, seagoing vessel without outriggers, we must turn to a ship representation at Bayon.

Unfortunately there is yet no archaeological evidence of large, seagoing watercraft without outriggers built in Southeast Asia earlier than the ship depicted at Bayon
Fig. 35: The twelfth-century A.D. ship depicted at Bayon, Cambodia. Although very similar to Chinese craft, this vessel was probably from Southeast Asia but built similarly to those of East Asia. Outriggers, common to many Southeast Asian vessels, were not employed. (From Groslier, fig. 73)
(Fig. 35) which dates to the twelfth century A.D. Many authorities have adamantly believed that it is a Chinese rather than a Southeast Asian vessel.\textsuperscript{123} Evidence indicating that the vessel is manned by Cambodians and that certain structural features are ornamented in a Southeast Asian fashion leads me, however, to agree with Gibson-Hill that this is a Khmer-built vessel, but one that was influenced by Chinese construction.\textsuperscript{124} This vessel is built rather differently than the Borobodur ship. Assuming that the Borobodur and Bayon ships are both Southeast Asian, then we may have illustrated evidence of two different Southeast Asian shipbuilding traditions, or, perhaps more likely, evidence of at least a hybrid type of vessel construction during the first millennium A.D. We have no physical proof, if it exists at all, of exactly what this hybrid type may have been precisely. Nevertheless, documentary evidence from that time period sheds some light on Southeast Asian ship construction and development. Manguin, quoting from an eighth-century text written by a Chinese monk in a commentary to the Buddhist Canon, states:\textsuperscript{125}

The bo are sea-going ships. They lie six or seven feet deep in the water. They are fast and can transport more than 1,000 men, apart from cargo. They are called kunlun bo. Many of those who form the crews and technicians of these ships are kunlun [Southeast Asian] people.

With the fibrous bark of the coconut tree, they make cords which bind the parts of the ship together
(. . .). Nails and clamps are not used, for fear that heating of the iron would give rise to fires. [The ships] are constructed by assembling [several] thicknesses of side-planks, for the boards are thin and they fear they would break. Their length is over sixty meters (. . .). Sails are hoisted to make use of the winds, and [these ships] cannot be propelled by the strength of men [alone].

Manguin surmises that these watercraft "probably had no outriggers, for such a conspicuous device would no doubt have struck the minds of Chinese witnesses, unfamiliar with this kind of gear; moreover, it is difficult to conceive the fitting of outriggers on such large vessels."\textsuperscript{126}

In general, the development of Asian vessels during the first millennium A.D. was based on shell-first construction. During the last centuries of the millennium, especially in Southeast Asia, we have evidence of increasing dependence on edge joinery as a means of strengthening the hull. We also have evidence, however, that the use of some form of internal framing was on the rise, such as in China, which later resulted in both shell- and frame-first construction -- and a combination of the two -- often being carried out in the same locale.

Let us turn now and analyze some modern Southeast Asian watercraft which still exhibit ancient construction methods and designs.
Notes


2 Spices were not only used to flavor food, as they are today, but they were also important as pharmaceutical ingredients. In fact the use of cloves, one of the most ancient medicinal spices, can still be detected by any modern patient who has noticed the characteristically distinctive odor of a dentist's office. Pepper is another spice still in high demand today as it has been for centuries. Now, the most widely and commonly used spice, is largely consumed as a flavoring agent, whereas in the past it was a key ingredient used in the salt-curing of meat products. The preservation of food, vital especially to those living in more northerly climes without a year-round growing season, has played a key role in the history of the spice trade. It was for this reason, rather than just some mad craving for the taste of pepper, that such a high demand and value was placed on this particular spice, compelling profit-hungry Portuguese captains to dangerously overload their ships often with this commodity alone. Disaster was frequently the result.

On the subject of preserved foods, a type of preserved food common to Rome and Greece, but now considered somewhat unusual, was a sauce or paste called *garum* made from fish steeped in strong brine. Interestingly, throughout Southeast Asia, Sri Lanka and parts of coastal India and southern China, fish sauce and fish paste (similar to the Mediterranean product) are traditional, key ingredients of the cuisine. The Indian and Indo-Malaysian word for salt is *garam*, almost identical to the Latin word *garum* for salted fish sauce. Thus it seems evident that Asia may have influenced some of the early comestibles in the West other than through just spices. See R. Brissenden, "Patterns of Trade and Maritime Society Before the Coming of the Europeans," in *Studies in Indonesian History*, ed. E. McKay, pp. 65-66; J. Gonda, "A Note on Cinnamon -- Trade in Antiquity," in *Selected*


5G. F. Hourani, Arab Seafaring in the Indian Ocean, pp. 91-92.


8Buss, supra n. 1, pp. 73-75; D. R. SarDesai, Southeast Asia: Past & Present, pp. 22-23; R. Braddell, "An Introduction to the Study of Ancient Times in the

9 SarDesai, supra n. 8, pp. 24-33.


12 SarDesai, supra n. 8, p. 43.


15 S. Syafei, "The Relations Between Cambodia and Indonesia in the 8th to the 9th Century," SPAFA Digest 11 (1981): 14; SarDesai, supra n. 8, p. 44.

17. SarDesai, supra n. 8, p. 15.


22. Fairbank, supra n. 19, p. 88.


24. B. Cumings, *Korea's Place in the Sun: A Modern History*, p. 34.

25. Ibid., pp. 39-44.


28 Gibson-Hill, supra n. 26, p. 112; Evans, supra n. 26, p. 93.

29 Evans, supra n. 26, p. 94.


32 A method similar to this was used on the Ferriby boat described in Chapter I.

33 Gibson-Hill, supra n. 26, p. 114.

34 Ibid., p. 113.


36 The similarity between these vessels and those of Scandinavia has, in the past, caused considerable speculation that the design of the Asian craft may have originated in northern Europe. More likely these vessels are descendents of the types of Southeast Asian craft depicted on Dongson kettle drums which, as previously discussed, had no plausible affiliation with the ships of northern Europe: G. R. G. Worcester, "Four Small Craft of T'ai-wan," The Mariner's Mirror 42 (1956): 307; J. Hornell, Water Transport: Origins & Early Evolution, p. 188.

37 Gibson-Hill, supra n. 26, p. 115.

38 Ibid., p. 118.

Gibson-Hill, supra n. 26, 119.


Manguin, supra n. 30, p. 333.


50 Clark, supra n. 35, p. 154.


52 Some Indonesian vessels still use this older form of lace fastening. For a brief account of this, see J. Poortenar An Artist in the Tropics, p. 34.


54 Li Guo Qing, pers. comm.


57 Ibid., p. 86.

59Dai, supra n. 56, p. 87.

60F. Li, *Tai Ping Yu Lan (Tai Ping Imperial Record)*, p. 768.


68Shanghai Communications University, "Zou Han Shi Qi de Chuan Bo (Ocean-Going Ships of the Han Period)," *Wen Wu* 4 (1977): 18.


J. Xu, Xuan He Fengshi Gaoli Tu Jing (Illustrated Record of an Embassy to Korea in 1124), pp. 4-5.


Worcester, supra n. 75, p. 327.

Ibid., p. 327; Donnelly, supra n 75; Audemard, supra n. 73.


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and a Description of the Country, Towns, Cities, &c., &c.,
pp. 143-144; C. Abel, Narrative of a Journey in the
Interior of China, and of a Voyage to and from that
Country, in the Years 1816 and 1817: Containing an Account
of the Most Interesting Transactions of Lord Amherst's
Embassy to the Court of Pekin, and Observations on the
Countries which it Visited, p. 96.

82Audemard, supra n. 73, p. 12.

83H. H. Brindley, "The 'Keying'," The Mariner's
Mirror 9 (1923): 90.

84K. F. Liu, "Shandong Lianshan Xien de Mingchu Bing
Chuan (Discovery of the Earliest War Ship in Shandong,
Lianshan County)," Wen Wu 2 (1958): 51.

85S. S. Ling, A Study of the Raft, Outrigger, Double,
and Deck Canoes of Ancient China, the Pacific, and the
Indian Oceans, p. 217.

86P. Paris, Souvenirs de marine: Collections de
plans ou dessins de navires et de bateaux anciens ou
modernes existants ou disparus avec le éléments numériques
nécéssaires à leur construction, vol. 6, p. 324.

87Fairbank, supra n. 19, p. 89.

88P. Pelliot, Mission Pelliot en Asie Centrale: Les
grottes de Touen-Houang, vol. 4, pl. 237.

89O. T. P. Roberts, "An Index for Flat-Bottom Boats," The International Journal of Nautical Archaeology and

90Q. P. Jin, Zhongquo Gudai de Zao Chuan he Hanghai

91Worcester, supra n. 75, p. 94.

92E. Doran, "The Origin of Leeboards," The Mariner's

93L. V. Mott, "The Development of the Rudder, A.D.
100-1600: A Technological Tale," M.A. thesis, Texas A&M
University, p. 85.

94Ibid., p. 92; J. B. Piétri, Voliers d'Indochine, p.
10; G. F. Hourani, Arab Seafaring in the Indian Ocean in
Ancient and Early Medieval Times, pp. 98-99.


97 Z. G. Kim, "Li-Chosen no Zosen Shikizu (Diagram of Ship Construction During the Li Dynasty)," Kaiji-shi Kenkyu 29 (1977): 88.


99 S. Nishimura, A Study of Ancient Ships of Japan: Skin Boats, pp. 100-101; Underwood, supra n. 96, fig. 40.

100 T. L. Xu, Chuan (The Boat), pp. 2-7.

101 J. Poujade, La route des Indes et ses navires, P. 270.

102 Paris, supra n. 86, p. 23.

103 S. S. Biswas, Terracotta Art of Bengal, p. 26. Planked vessels of the early centuries of the Christian era are alluded to but not described by S. Levi in "Manimekhala, a Divinity of the Sea," The Indian Historical Quarterly 6 (1930): 598.


106 Ibid., p. 142.

107 J. Hornell, "The Origins and Ethnological Significance of Indian Boat Designs," Memoirs of the


110 Needham, supra n. 65, p. 454-455.

111 Direktorat Jendraal Kebudayan, Jenis Jenis Perahu Bugis Makassar (Several Kinds of Bugis Ships from Makassar), fig. 39.

112 The term "similar ended" is used in this study instead of the more conventional term "double-ended". Both terms refer to vessels with bows and sterns that approximate the same horizontal shape -- either rounded, pointed or square. The term double-ended is a bit illogical, however, because the hull of every vessel has two ends. What is really meant is that the two ends are similar to one another, hence similar ended.

113 Green, surpa n. 61, pp. 2-3; E. Prados, "Indian Ocean Littoral Maritime Evolution: The Case of the Yemeni Huri and Sanbug," The Mariner's Mirror 83 (1997): 185.


119 Paris, supra n. 86, p. 324.

120 See the representation provided by R. Mookerji in Indian Shipping: A History of the Sea-Borne Trade and Maritime Activity of the Indians from the Earliest Times, fig. 1.


123 Paris, supra n. 43, p. 347; Needham, supra n. 65, p. 461.

124 Gibson-Hill, supra n. 26, p. 128.


126 Ibid., p. 263.
VOLUME II
CHAPTER IV

MODERN PARALLELS TO ANCIENT INDONESIAN WATERCRAFT

In 1993, with financial support provided to me by the Jordan Institute for International Awareness, I conducted independent field research in Indonesia, focusing on the traditional watercraft of Bali and Madura (Fig. 36). Based on the personal advice and helpful suggestions given to me by Adrian Horridge, I chose these locations for a number of reasons. Horridge's earlier studies of the traditional watercraft of these islands provided me with a framework with which to conduct my own research. One objective, based on Horridge's council, was to investigate the possible influence that Chinese vessel construction had on the traditional native craft along the north shore of Madura (Fig. 36). Although no conclusive evidence was discovered to indicate any such influence in this area, nevertheless valuable information was compiled on the details of many of the native craft still built in a traditional manner.

The traditional vessels found within the geographical area of my research, and those elsewhere throughout Southeast Asia, can provide, in a sense, a kind of time capsule of information concerning vessel construction. Knowing how these vessels are built enables us to
Fig. 36: A chart of eastern Java and the islands of Bali and Madura. (Chart author)

canonicalize more accurately the construction of Southeast Asian vessels that have been, and may yet be, recovered from the archaeological record. Since traditional vessels are rapidly being replaced by more standardized modern types, thus further research is immediately needed if we are to preserve even a semblance of the vast amounts of information yet available concerning traditional Southeast Asian ship construction.
The methodology of my research included direct observation of vessels, including measurements taken of actual vessels, the compilation of a photographic record and, when it was possible, tape-recorded interviews of boatbuilders and sailors. Unfortunately, I must point out here, nearly a third of the photographic negatives compiled were, for reasons inadequately explained, either destroyed before or during developing.

The second reason that I chose this geographical area for my research was a somewhat personal one, but one that was no less legitimate. This trip was my first opportunity to travel in Indonesia. Knowing the difficulties that a first-time traveler can have with a foreign itinerary, I decided on the islands of Bali and Madura because of their relatively easy accessibility, and because I, still juggling my recently acquired Indonesian language skills, predicted that whatever language barriers encountered would not be unmanageable. From the experience gained from this trip, I knew I could more confidently and competently access the remoter regions of the archipelago during future visits.

Balinese Outrigger Canoes

From my research done on Bali I learned that although fishing remains important to the island's economy, and fish constitute a large percentage of the local diet, the
Balinese do not generally consider themselves a seafaring people. The sea is considered to be a rather evil, unpredictable entity. Any activities associated with the sea are customarily viewed as being that of the lower classes and undesirables. Ironically, this disparaging attitude has actually helped preserve the island's traditional outrigger canoes, since they have not been considered significant enough to be part of the modern national development programs. Few things, however, remain exempt from the forces of change and modernization. Thus, not surprisingly, the traditional vessels of Bali are also changing. Nevertheless, traditional vessels can still be found, sometimes employed in very nontraditional ways.

At the town of Sanur, located on the southern coast of Bali, traditional trolling canoes, called jukung, ply the tidal waters near the beach, and one can easily study them on shore where they are hauled up to dry in the sun. Even though these particular vessels are now used to take tourists out for short pleasure trips, rather than for fishing, they still exhibit many traditional methods of construction.¹

Balinese canoes are identified by certain features they share in common. Differences do occur, however, and are determined by several, sometimes subtle, variations in
design relative to where the vessel was built and how it was intended to be used. For example, the jukung found at Sanur, and elsewhere along the southern coast, are usually built with a rounded or oval-shaped splashboard on the bows, whereas those built in the areas approximately northward of Serangang Island are usually equipped with a splashboard shaped like a square box. Depending on how they are used, canoes may have only a single outrigger, such as the jukung pemencaran, used for fishing with a throw net, or they may have no outrigger at all, enabling vessels such as the sampan jaring to negotiate narrow, shallow waterways. Furthermore, canoes can also vary in the artistic design of their bow and stern decorations. All of these variations aside, however, the shape of the outrigger is one of the main characteristics commonly used to distinguish Balinese outrigger canoes from those built elsewhere in Asia and the Pacific.

In 1920 James Hornell, based on his firsthand observations, described the design of Balinese canoes and their outriggers. The parts of a Balinese outrigger consists of a float (katir), the boom (bayungan) and the cedik which connects the boom and the float (Fig. 37). Today the gracefully upward-curving bayungan and cedik of the modern Balinese outrigger is distinctive. Before 1925, however, the outriggers of Balinese canoes were
Fig. 37: A stern view of a jukung pelasan. Note the lashings which connect the booms and cedik. (Photo author)

straight and curved downward only where the cedik was connected to the float. Horridge believes that the design of this upward-curving outrigger may have come to Bali via Madura and was further developed in southern Bali during this century. Several Balinese boatbuilders
assured me personally that the curved cedik is indeed an ancient form unique to their island. Nevertheless, I believe that Horridge is correct because photographic evidence from the nineteenth and early twentieth century indicates that the majority of Balinese canoes were fitted with almost straight outriggers. While studying the vessels near the village of Slompeng, on the north shore of Madura, I observed several canoes with booms having an upward-curving shape. The boatbuilders there, with unabashed pride, informed me that this feature did not originate with the Balinese -- several builders even laughed outright from the suggestion. They did agree, however, that the Balinese have developed it into a distinctive form.

Another distinction of Balinese canoes is the way the rudder is positioned. On Bali the rudder is always on the port side of the stern, whereas on most other islands it may appear on either side. Also, with Hinduism as their dominant religion, the Balinese commonly decorate the bows of their jukung with the head of the god Gajah, whose stylized countenance provides safety and fortune for the sailor and his vessel.

The five-part hull construction of Balinese outrigger canoes has an Austronesian ancestry that is at least 5,000 years old. Geographically, these five-part canoe types
range from the Comores Islands near Madagascar to Indonesia and as far eastward as Hawaii. The construction begins with the selecting of a tree suitable for a dugout. On Bali, as well as Madura and elsewhere, specialists will still occasionally be on hand during the felling of the tree in order to hew out the log slightly and roughly shape it into form before it reaches the boat yard. This is done largely to help prevent the wood from splitting as it dries. The preferred boatbuilding material comes from the belalu tree (Albizzia falcata) and the kayu suren (Cedrella sureni), but trees of suitable size are becoming increasingly scarce and, as a result, increasingly expensive. To reduce construction costs, boatbuilders are sometimes able to purchase solid logs and shape them themselves. Today, however, bargaining for solid logs is difficult because the owner of the tree usually cuts and shapes the log himself so that he can sell the extra left-over wood.

Once obtained, and depending on the available funds of the intended buyer, these roughly shaped logs are then allowed to season for approximately one month under the protective cover of palm-thatched awnings before any further construction is carried out. Considering that, from a Western view point, the daily religious observances followed by the Balinese encompass almost every aspect of
their lives, it is interesting that at this stage of hull construction there is relatively little ceremony or ritual.8 When asked about this, both boatbuilders and fishermen alluded to the idea that the rough-shaped log did not yet exist in the rohani, or spiritual realm. Horridge explains that once a tree is cut down, it has no spirit or life-force until reformed into a canoe.9 Although this certainly seems to be the case, some sense of spirituality may exist, nonetheless. This became apparent to me while staying in the Balinese village of Kusamba.

I was fortunate to have met a young Balinese fisherman who introduced me to Pak Agung Akan Murje, one of the elder boatbuilders living in the southern coastal village of Kusamba. From the outset this rather taciturn gentleman maintained a certain reticence toward me and my questions about vessel construction techniques and boat ceremonies. I have no doubt that he must have been more than a little chagrined over the heavy influx of tourists and the often negative impact of tourism that he and others of his generation had seen on the island over the past few decades. To him I was undoubtedly nothing more than yet another member of the rank-and-file of foreign sightseers. Not wishing to alienate myself further, I spent the remainder of the day quietly sitting and merely
Fig. 38: The first stage of vessel construction. Roughly shaped logs are seasoned for about one month before being carved into a dugout. (Photo author)
watching this skilled craftsman as he made repairs to an older jukung.

Just after daybreak the following day, I returned to the boat yard and patiently waited for Pak Murje to appear. When he did so, he was plainly surprised to see me. Little else transpired until midmorning when he, undoubtedly realizing the extent of my tenacity, disappeared into his house where I thought he might stay until I left. To my relief, he soon returned with two cups of tea, sat down beside me, and began trying to answer my questions.

Because Balinese differs from Bahasa Indonesia (the Indonesian lingua franca with which I had at least some limited ability), much of the information conveyed was through sign language and drawings. When I asked about the ceremonies that took place at the outset of canoe construction, Pak Murje gently took me by the arm and led me to a rudimentally shaped log which had not yet been fully adzed out (Fig. 38). With brackish-looking water from a small ceramic bowl sitting on the ground nearby, he silently sprinkled both my hands, handed me an adze, and allowed me to hew out some of the wood (Fig. 39). I am uncertain whether this was actually a legitimate pre-construction ritual, routinely followed by all boat-builders, or if it was merely something Pak Murje invented
Fig. 39: Boatbuilding tools. The adze, chisel, hatchet and saw lying in the bottom of a dugout jukung are the typical tools of the Balinese boatbuilder. (Photo author)
on the spot to placate me. In either case, I must have been rather abysmally suited to the task because, after only a few swings, he good-naturedly took the adze from my
hands, obviously preventing me from doing any further harm.

Regardless of the possible religious observances, and my inability as a boatbuilder, the actual construction of Indonesian jukung adheres closely to a rigorous system of proportions, and is not merely a haphazard method of building by eye. Handed down from generation to generation, this system of proportions is relative to the dimensions of the builder's own body. Pak Murje indicated on the log he allowed me briefly to adze that the inside longitudinal dimension would be three times the length of his outstretched arms, plus three times the width of his open hand at both ends of the hull. Interestingly, the older jukung that he was repairing had an inside length of nearly 6.36 m -- approximately 8 cm longer than Murje's intended jukung -- suggesting an original builder who was slightly larger in stature. Thus, no two vessels are completely identical. Horridge calculates that the ideal thickness of a canoe's sides is 3.5 cm and 8 cm thick at the bottom.¹⁰ I noted a variation of nearly half a centimeter in the top thickness of several jukung. Variations in the bottom thickness remains uncertain because I had no means to measure accurately this dimension. These measurements, however, were taken from older craft and, thus, may indicate wear and subsequent
repairs. Nevertheless, variations obviously occur, but what is most important is the manner by which the builder uses the system of proportions.

The hull is internally divided into six equal sections where transverse bars, called sendang, are usually placed. The mast is positioned so that the distance from the inside of the bow to the forward surface of the mast is one-sixth of the internal length of the hull. From this fractional distance, the boatbuilder determines the length and placement of the fore and aft outrigger booms, as well as the length of the mast itself.

With this rather intricately developed system of proportions in mind, the boatbuilder begins by hollowing out the seasoned log, making the naturally occurring narrower end the bow. Once this is completed, or nearly so, two hardwood planks, which will serve as sheer strakes, are fitted to the top of the dugout, one for either side of the hull. The thickness of these sawn planks are approximately one-quarter less than that of the uppermost sides of the dugout. This leaves a kind of inboard shelf-like surface on which flat transverse pieces (dolos) are fitted to provide internal support for the two strakes (Fig. 40). Holes of approximately 1 centimeter diameter are bored into the top edge of the hull with a brace and bit at about 1 hand-width apart. Their position
Fig 40: Jukung variations. Near the Balinese village of Kusamba, as well as the coastal area roughly northwest of the island of Serangan, vessels often have rectangular splashboards. Holes, frequently intricate in design, are sometimes cut in the dolos, a transverse board giving internal support to the sheer strakes. Lashing is run through them to secure the dolos to the sendang below. (Photo author)
is marked off along the bottom edges of the sheer strakes where corresponding holes are likewise bored. Hardwood dowels are temporarily placed in the holes of the hull, and the sheer strakes are positioned over top. An ingeniously conceived, sharp-pointed tool (today usually made of metal and in a variety of shapes) is run along the upper edge of the dugout so that the tool's sharp point scores a line along the bottom side of the strake at a constant distance from the dugout. An experienced craftsman can achieve a similar but slightly less accurate result by holding a straightedge between his middle finger and index finger, and the stub of a pencil between his index finger and thumb. While the straightedge is run along the top of the dugout, the pencil marks the strake. By removing the strakes and carving along this mark, whether made by a sharp tool or a pencil, the strakes can be made to fit almost perfectly to the dugout hull. Once the strakes have been properly shaped, and thin, paper-like strips of material made from tree bark are positioned so that they will be sandwiched between the dugout and the strakes, the strakes are firmly driven home with a large wooden mallet. The dowels are then secured with hardwood pins driven from inside the hull.
After the strakes are secured, the wishbone-shaped stem and stern pieces are added (Figs. 41-43). These solid pieces of timber are usually made from the naturally occurring forks of the belalu tree -- the same type of wood as used for the hull. The name for these pieces varies throughout Indonesia. At Sanur they are called kanti, but I have also heard them called ketua kuat (strong head) and sayap kuat (strong wing). The kanti are carved and positioned so that the two arms of the fork lie

![Image](image-url)

Fig 41: Traditional craftsmanship. Balinese traditional boatbuilder Pak Murje works on a fork-shaped kanti for an older jukung. (Photo author)
Fig. 42: The bow of a jukung showing where the replacement kanti will fit. Notice the notches for it in the ends of the side strakes. (Photo author)

Fig. 43: A new kanti is in place atop the bow of this jukung. (Photo author)
flush with the sheer stakes, and the third arm extends outward, forming the end of the hull. Once in place, these kanti provide valuable strength for the vessel. Occasionally, canoes are built without having a proper kanti in the stern and, therefore, as Horridge initially believed, these cannot accurately be called a jukung. Furthermore, Horridge claimed that invariably all Balinese canoes have a kanti in the bows.\textsuperscript{11} I personally received confirmation from Indonesian authorities supporting Horridge's claim. Evidence exists, however, that many jukung are built without having any kanti. Whether or not this is a recent change in design remains uncertain. Nevertheless, considering this construction method in which two side strakes and two end pieces are attached to a dugout, one can understand why these vessels are classified as five-part canoes. Other than the kanti, apparently the only major change in jukung today from those built nearly 5,000 years ago is that dowels, instead of lashings, are used to fasten the strakes and end pieces to the dugout. Today the only lashing or, more accurately in this case, lacing used on Balinese jukung is at the forward end of the bamboo floats where flat wooden plates are laced on to prevent water flowing through the hollow, tube-like floats.
Changes and variations in the internal supports, however, are myriad and most are fairly modern. Like the ancient five-part canoes, Balinese jukung still largely depend on compression to hold the vessel together. As previously mentioned, round wooden bars (sendang) are placed athwartships relative to the six internal divisions of the hull. Not all vessels, however, are fully fitted out with six sendang, and, at least in Kusamba, some sendang are rectangular rather than round. Nevertheless, at least one sendang will be placed in the bow and another in the stern. The sendang inside the bow and stern are usually positioned with their ends beneath carved lugs which help hold them in place. The fore and aft outrigger booms (bayungan) are then lashed to the sendang. Along the inside of the hull, the flat dolos, supporting the sheer strakes, are occasionally lashed to sendang positioned below them. Holes are drilled in either side of the hull through which the ends of these sendang are held in place. The ends of the protruding sendang are cut off flush with the outside surface of the hull, but they can still be observed. This is a very modern and structurally weak method of construction. Depending on the size of the canoe, and the amount of stress the outrigger booms are predicted to have on the sendang, the bow and stern sendang may also be simply held in place by
holes in the hull rather than by the more structurally sound lugs. The mast is seated in a rectangular step carved into the solid bottom of the dugout. The dimensions of the mast are determined by the system of proportions previously discussed, and usually the mast is stepped immediately aft the forward outrigger boom which provides longitudinal support. Associated with the mast is an important structural member called a layang-layang (Fig. 44). This flat board is attached to the hull and has a square or rectangular center-hole which takes the mast, thus serving as a kind of mast partner. In addition, two smaller square holes are cut near the forward edge of the layang-layang. Lashing is run through these holes, around the sendang, and over the forward outrigger boom which sits atop the layang-layang. As wind fills the sail, and the leeward outrigger float is pushed downward into the water, nearly equal but opposite stress from the mast and outrigger boom is placed on the layang-layang. In this way much of the load is transferred from the mast to the outrigger boom rather than along the length of the hull.

The penyankilang (Fig. 45) in the stern is similar to the layang-layang and is lashed to the aft outrigger boom in the same manner as the layang-layang is lashed to the
Fig. 44: Details of jukung construction. In southern Bali the splashboards in the bow are rounded. A flat, thwartship dolos supports the sheer strakes. The layang-layang, which is hidden in this view behind the dolos, supports the outrigger boom. The lowest transverse member visible here is the sendang which, positioned beneath lugs, is lashed to the outrigger boom. (Photo author)
Fig. 45: Internal members of a jukung. The aft outrigger boom is lashed to the thick, flat penyankilang. The empty, central square hole will receive the rudder support post. Notice the decorative carving on the fore-and-aft member at lower right. (Photo author)

forward boom. A square hole near the center of this thick, flat board takes the rudder-support post.

Balinese canoes are frequently fitted out with tungkoh (Fig. 46) or, as some fisherman pronounce it,
Fig. 46: Narrow, flat thwarts, called tungkoh, serve as seats for the fisherman or as platforms for loose bamboo decking. (Photo author)

tengah korsi (literally translated as "center seat"). The ends of these rectangular pieces of wood are secured to the edges of the hull with dovetail joints. Not only do they help strengthen the hull, but they also serve as
Fig. 47: Outrigger construction. The mortise in the top of this heavy outrigger boom reveals that a tenon will be used to secure the cedik to the boom. (Photo author)
seats for the fisherman, or as platforms for a kind of split-bamboo decking which can be later rolled up and removed.

Both the fore and aft outrigger booms, as previously described, are attached to the hull with only simple, but strong, lashings. Originally these lashings were made from rattan, but today only cheap, simple nylon rope is used. When the boat is not in service, the booms can be removed to prevent them from rotting in the humid environment. The cedik is attached to the boom by a lashing wound over a scarf joint secured by a wooden peg or tenon (Fig. 47). The opposite end of the cedik is carved down to a point which fits into a hole drilled through the upper surface of the float (katir). The bamboo float is then lashed to the cedik (Fig. 48).

An important engineering feature of these composite-like outriggers, in contrast to outriggers made from a single piece of wood, is that they displace stress in a manner not unlike a woven wicker chair. The stress loads experienced in a heavy sea are more evenly distributed along the entire length of the outrigger rather than being concentrated in a single area. Also, with their high-curving arch, the cedik are less likely to be swamped by waves, thus maintaining the optimum positioning of the floats.
Fig. 48: Roughly hewn outrigger wood. These logs are in the early stages of being formed into outrigger booms and cedik. (Photo author)

Exactly how the floats are positioned is apparently determined by the individual sailor. Nevertheless, all floats project out from the bow farther than they do from the stern, and the forward ends are farther apart from one another than those aft. The reason for this is to provide longitudinal stability in a heavy following wind, and to control the weather helm by preventing the forward ends from plowing into the sea. But variations of as much as 10 cm may occur in the exact positioning of the floats.
Fig. 49: Altering the outrigger. Additional holes for the cedik in an outrigger float indicate optional positions made by the individual sailor. (Photo author)

Frequently one sees floats drilled with several holes or the cedik indicating adjustments in their positioning (Fig. 49).

The origin of the simple yet very sophisticated Balinese jukung rig is unclear, and to describe the rig fully is an entire study unto itself. In general, Balinese canoes are fitted with a triangular sail held between two "booms". The upper boom, or spar, is supported in front of its point of balance by a rope looped through the head of the mast (Fig. 50). Both the boom and the upper spar intersect at the tack of the sail, and are commonly held in place by wedging them into the bows of the canoe. The only lines used to control the
Fig. 50: Details of a jukung. With her sail set, a Balinese jukung pelasan is nearly ready to get under way. The port-side rudder will remain raised until the canoe is clear of the shallows. The outrigger floats are connected to the hull with graceful, upward-curving booms and down-turned cedik. Note the extremely short mast and the sail's upper spar positioned inside the bow. (Photo author)
sail are the sheet attached to the boom and a brace-like top line, which also serves as a backstay, running from the upper spar. In operation the sail is moved by rotation of the boom and upper spar around the mast which serves as a fixed point for the upper spar. This type of rig is well-suited for these vessels, because with it in combination with the floats, a canoe can be steered without using the rudder at all.

The large, heavy jukung rudder (*pancer*), nevertheless, plays an integral part in controlling the vessel, and also acts as a kind of leeboard. The stock and part of the blade of the pancer is made from a single piece of wood. The remainder of the blade is cut from a second piece of wood, and is attached by dowels. A slightly rounded or rectangular hole cut in the rudder's stock serves to hold the tiller loosely in place. The aft end of the tiller is cross-pinned to prevent it from sliding forward. Just below the tiller, the rudder stock is lashed to the left side of the rudder support post (*tunguan*). By pulling the tiller forward, and pivoting the rudder stock on its lashings, the blade can be brought out of the water so as to prevent it from scraping along a shallow sea bottom. Because of its shape, one may initially think that this type of rudder was directly influenced by the Portuguese. In reality, the Balinese
pancer has a Southeast-Asian ancestry dating to about the sixth century B.C.\textsuperscript{12}

**Examples of Vessels from Madura**

Although differences may occur in the construction rituals and ceremonies that are practiced by the Hindu Balinese and those, if any, that are practiced by the Muslim boatbuilders of Madura, nevertheless the construction of both Balinese and Madurese jukung is similar and generally based on the traditional five-part hull canoe design. Also, like the jukung of Bali, the design of traditional Madurese canoes varies from village to village. Although some of the more isolated villages and hamlets located along the northern coast of Madura can be difficult to get to, the traditional craft that can be observed makes the effort worthwhile.

Because most of the timber suitable to build a jukung has been exhausted on Madura, builders today order their tree trunks from Java. Madurese boatbuilders believe that Javenese timber is superior to that obtainable elsewhere. The wood used, however, is *Albizzia falcata*, the same as the belalu wood of Bali.

Once a log has been obtained, it is placed within a frame to hold it and keep it out of the water at high tide. No ceremonial mysticism is associated with the
construction of a vessel. Horridge explains that:  

Whereas the Balinese build ceremony into every occasion, know every turn of the cycle of days, and seem conscious of every gesture, it is difficult to extract anything comparable from the Madurese. I believe this reticence arises from a tension between incompatible aspects of their philosophy. On the one hand the Madurese in general share with the Javanese the dislike of confrontation with the material world. To the knowledgeable Muslim (pribadi) especially, the technology of boatbuilding is not in itself important, but the activity of operating or building boats must be incorporated into a harmonious social scheme. Despite its practical importance, the manipulation of material things is at odds with their world view, i.e., materialism versus the spiritual life. The strength of natural materials and the way to catch fish or avoid the dangers of the unfeeling sea are alien to a spiritual view of the world. The other tension is between Islam and the old belief that fortune can be influenced by the manipulation of symbols, i.e., Islam versus animism. I think that neither the sailors nor the boatbuilders in Madura want to talk about ceremonies or magical practices because such matters are incompatible with both their practical professionalism and their official religion.

The influence of Islam can be seen in the way the vessels are painted today. Jan Poortenar, a visitor to Madura during the 1920s, described the brightly colored vessels painted blue, green and intense vermilion mixed with alternating shades of black and pure white.  

William Blake, who was also on the island during the 1920s, was struck by the fine woodworking and other decorative work that sometimes adorned even the humblest craft. Today, however, few of these adornments can be found. Like the ships of England during the Reformation,
Madurese craft are usually painted only black and white. Although a vessel newly painted in this way can have a rather crisp appearance, not unpleasant to the eye, the ornamentation is nevertheless a far cry from that of past generations.

Thus, replacing ceremonialism with pragmatism, the Madurese boatbuilder unritualistically hollows out the seasoned log for his jukung with an axe and adze. Once this is done, holes are drilled into the upper edge of the dugout and along the bottom edge of both sheer strakes. Although today metal dowels are occasionally used, traditionally wooden dowels fastened the flush-laid strakes to the dugout. Wooden splints, driven into holes passing through the planking, cross-lock the dowels in place. End pieces (sankel), not unlike the Balinese kanti, are put in place. The dowels used to hold the sankel in place also help to prevent sheer strain. It is not the dowels, however, but the tight lashings holding down the outrigger booms that primarily fastens the sankel in place.

Traditionally, crosspieces (sentang), like the Balinese sendang, were placed below lugs carved from the inboard surface of the dugout. Lashings wound around the outrigger booms and the sentang held the outriggers in place by compression.16 Today, sentang, like their
Balinese counterpart, are simply placed with their ends in holes that have been drilled through either side of the dugout, rather than beneath carved lugs.\textsuperscript{17}  

On Madura, boats most often have double outriggers, as opposed to only a single outrigger on one side as is seen elsewhere in Indonesia.\textsuperscript{18} The forward outrigger boom is called a barajungan, and the aft boom is called a katik. Horridge reports that this aft boom is also called a cetik,\textsuperscript{19} similar in pronunciation to the Balinese "cedik". On certain Madurese boats, however, the outrigger is attached to the hull in a different manner than on Bali.

At Slompeng, and at a few other villages, the double-outrigger, five-part canoe called a jukung polangan is still built (Fig. 51). Like the Balinese jukung pelasan, the jukung polangan also is used in trolling for fish. The Madurese vessel, however, has several interesting variations concerning her outriggers. The forward outrigger consists of two booms, each attached directly to a float. The inboard ends of the booms pass through a bamboo- or wooden-log tube (kolong) which is positioned laterally across the hull and attached to the sides of the canoe. The kolong, like the layang-layang of the jukung pelasan, helps hold the booms in place, yet also allows for some flexibility thus reducing the chance
Fig. 51: A jukung polangan near Slompeng, Madura. Note the fore-and-aft outrigger booms positioned in the kolong. Only the aft outrigger has a cedik; the upward curve of the aft outrigger boom helps keep trolling lines separate. (Photo author)

of breakage from stress while in a heavy sea. The aft outrigger booms are also positioned inside a kolong, but their upward-curving outboard ends are not attached to the floats. Instead, a cedik, or tencil, is pegged and lashed to the underside of each boom, and the boom ends extend outward beyond the cedik. The extension of the boom is used to keep the fishing lines separated when trolling. This jukung polangan, illustrated here, was classified as such by whom I assumed to be local authorities on the subject. In appearance, however, it also somewhat
Fig. 52: A perahu polangan near Slompeng, Madura. Although smaller than other perahu polangan, she has the typical multi-planked sides supported by stiff frames. (Photo author)

resembles the jukung pangope-an which are built at the village of Pasean, west along the coast from Slompeng. The main feature that distinguishes the jukung pangope-an from the jukung polangan is the unusually solid rudder posts. However, since I was unable to view this particular vessel closely enough to make my own determination, I must rely on the information given by local informants as to the type of vessel it was.²⁰
The perahu polangan, also found at Slompeng, is an interesting variation on the jukung polangan (Fig. 52). Although the perahu polangan employs many of the same construction techniques as the jukung, the reason she is considered a perahu rather than a jukung is because her sail is raised on a halyard, which is traditionally uncommon for a jukung, and most importantly because of the two or three side strakes used to increase the height of her sheer (Fig. 53). One obvious reason a builder might use additional side strakes is simply to create a larger vessel, and the term perahu is often used to refer to watercraft larger than a relatively simple jukung or canoe. Many perahu polangan, however, are not appreciably larger than jukung. This suggests, especially for those vessels built today, that the additional side strakes are not used simply to create a larger vessel, but a large-enough vessel. Timber suitable for a dugout is becoming increasingly scarce. Boatbuilders often must rely on younger, smaller trees for their dugouts, and then build up the sides of the smaller dugout with additional strakes to produce a vessel of sufficient size. Thus the term perahu is not simply a reference to large vessels, but is a qualifier word, used in conjunction with another to denote more precisely the use or construction of a vessel type.
Fig. 53: The bow of a Madurese *perahu polangan*. Note the two-part boom, normally positioned within a *kolong*, and the additional side strakes. (Photo author)

Strikingly, more vessels of the *perahu* type than *jukung* are being built in Madura, particularly along the island's northern coast. The rather generic, motorized *perahu besar* (or "big boat") are becoming an increasingly common sight, as are the outriggerless, plank-hulled *perahu jaring*. Whatever the economic or environmental reasons are for this change in native boatbuilding, change is definitely occurring.

Nothing remains static. Certainly nothing cultural has ever been exempt from the forces of change or modernization. Like anything else, Indonesian watercraft
have changed and will continue to change. In one respect, even calling them traditional is of only limited accuracy. The vessels built today, of course, are not the duplicates of those constructed thousands of years ago. But fortunately the vessels today have retained enough of their structural ancestry that we can study firsthand at least some of the ancient methods of Austronesian construction.

How many more years the jukung of Bali and Madura will be built and sailed is difficult to predict, but within a decade, most, if not all, will probably cease to exist. It is therefore imperative that we try to understand as much as we can now about these and other traditional types of Indonesian vessels. If we do not, vast amounts of information concerning this aspect of the world's wooden boats will likely be forever lost to the miasma of history.
Notes


4A. Horridge, Outrigger Canoe of Bali and Madura, Indonesia, p. 42.


6W. Müller, Baessler Archipel, fig. 22.


9A. Horridge, pers. comm.; Horridge, supra n. 4, pp. 58-59.

10Ibid., p. 61.

11A. Horridge, pers. comm.


13Horridge, supra n. 4, pp. 111-113.

14J. Poortenar, An Artist in the Tropics, p. 34.


16F. Diephuis, "Korte Verslag van de Prauwen-Revue en Wedstrijden," Djawa 7 (1927): 199. For a comparison with
vessels built on Java and Sumatra, see A. J. G. MacClaine-Pont, "De Prawen," *Djawa* 6 (1926): 281-293.


19Horridge, supra n. 4, p. 97.

CHAPTER V

THE SECOND MILLENNIUM: THE CENTURIES BEFORE THE ADVENT OF
EUROPEAN COLONIZATION

Asia During the Reign of China's Song, Yuan and Ming
Dynasties

During the centuries prior to the second millennium
A.D., China was often in a state of turmoil. Internal
political and economic strife gave rise to kingdoms and
relatively minor dynasties, none of which could maintain
any real centralized control as compared to the Han, Zhou
and Shang dynasties. During the Tang dynasty, China was
reunified and prospered for nearly 300 years, but this was
not to last. Political turmoil arose once again, and the
threat of barbarian invasion along the northern borders
exhausted what little military strength was left amongst
the Tang forces. John Fairbank\(^1\) explained that:

In its final half century the Tang was an object-
lesson in anarchy. Officials, both civil and
military, became so cynically corrupt and village
peasants so ruthlessly oppressed that the abominable
became commonplace. Loyalty disappeared. Banditry
took over. Gangs swelled into armed mobs, plundering
all in their path as they roamed from province to
province. Emperors, their eunuchs, and officials
lost control and were despised. For six years (878-
884) the major bandit Huang Chao led his horde up and
down the face of China, from Shandong to Fuzhou and
Guangzhou, then to Luoyang and Chang'an, which was
destroyed. By 907, the official end of the Tang
dynasty, Turkic and other non-Chinese peoples
occupied much of North China and warlordism
flourished elsewhere.
From this emerged in northern China the regional states known as the Five Dynasties and in southern China the Ten Kingdoms (907-960). During the last of the Five Dynasties, the northern Chinese military commander, Zhao Kuangyin, was acclaimed by his troops as the new emperor, thus inaugurating the Northern Song in 960.

The period of the Northern and Southern Song dynasties was, as many scholars contend, China's greatest age. China's dominance in Asia rose, and over the course of the Song and the following Yuan and Ming dynasties, the historical events in China often eclipse those of the rest of Asia. This is not to suggest, however, that China was free from its age-old problems of political strife and seemingly endless threats of barbarian invasion.

During the Song, population in China increased to some 120 million people. Waterborne trade along the canals of the Yangzi increased, and new technologies were developed. With the northern forest cover exhausted by A.D. 1000, Chinese iron smelters were forced to use coal rather than charcoal in coke-burning blast furnaces. The decarbonized cast iron that was produced provided weapon manufacturers with a superior material for arms. Coats of mail and steel weapons were made, and other tools of war were developed such as grenades and bombards. For a time, this initial superiority in warfare kept the barbarians at
bay along the northern borders. However, this war technology was soon taken over by the Ruzhen invaders, who, in 1126, reestablished their Jin dynasty in northern China. A new Song capital was set up in the south at the city of Hangzhou.

When Marco Polo visited this capital of the Southern Song in the thirteenth century, he noted the many ways it resembled the Italian city of Venice. Water flowing from the large West Lake filled the scores of canals of Hangzhou. Traffic and waterborne trade passed along these waterways, and sewage and other refuse was washed from out of the city to the tidal waters of the river estuary. With a city population of 2.5 million, this sanitation technology was of no little importance. Considering that Venice had a population of perhaps only 50,000, it is not surprising that Marco Polo was impressed by urban life in China.4

During the Southern Song the demand for luxury goods, especially spices, grew rapidly, and foreign sea trade increasingly dominated ports such as Hangzhou, Quanzhou and Guangzhou. The demand in China for foreign goods was so high that the exports of silks, porcelains and copper coins were often not enough to balance the imports of foreign goods.5 Nevertheless, the taxes on trade bulked the imperial coffers.
Although much of the Asian maritime trade was still handled by South and Southeast Asian merchants and sailors, whose trade networks had been established during the previous centuries, the Chinese were becoming increasingly involved in the foreign markets abroad. With governmental sanctioning of maritime trade, business activity increased and the social status of businessmen was elevated. The Chinese navy was deployed to suppress piracy and protect trade, thus insuring, at least as far as possible, the safety and smooth operations of maritime activity. The mood of the Chinese became expansive. "Among the manifestations of the new mental outlook were a spirit of adventure and enterprise and an interest in technology, science, and geography."

Equipped with seaworthy ships, the majority of which were built in southern China, the Chinese began regularly to sail the waters of East and Southeast Asia and India, following many of the same routes that Chinese travelers had charted centuries before. Chau Ju-kua, who held the post of Inspector of Foreign Trade in Fujian (sometime during the mid-thirteenth century), provided a description of the great ships that sailed the southern seas. He wrote:

The ships which sail the Southern Sea and south of it are like houses. When their sails are spread they are like great clouds in the sky. Their rudders are several tens of feet long. A single ship carries several hundred men. It has stored on board a year's supply of grain. They feed pigs and ferment liquors.
There is no account of dead or living, no going back to the mainland when once they have entered the dark blue sea. When on board the gong sounds the day, the animals drink gluttonly, guests and hosts by turn forgetting their perils. To the people on board all is hidden, mountains, landmarks, the countries of the foreigners, all are lost in space. If (the ship's master) says 'to make such and such a country with a favourable wind, in so many days, we should sight such and such a mountain, the ship must (then) steer in such and such a direction'; but if it happens that suddenly the wind falls and it is not strong enough to sight the mountains on the given day, it must change bearing. But if the ship has been carried far beyond (the land-mark), it has lost its bearings, it is blown hither and thither, gets in shoal water, comes on hidden rocks; then it is broken to pieces . . . . The ship with its heavy cargo has naught to fear of the great waves, but in shallow water it comes to grief.

The famous fourteenth-century Arab traveler, Ibn Battuta, remarked that the largest class of Chinese ship of his time had a crew of 1,000 men (consisting of 600 mariners and 400 soldiers), and each vessel had three tenders.\textsuperscript{10} Based on what we now know about the construction of southern Chinese ships, the large ships, described by Ibn Battuta in the fourteenth century and Chau Ju-kua in the thirteenth century, were likely sharp-bottomed with a keel. The flat-bottomed vessels, so frequently described by early observers such as Marco Polo and others, were more typical of northern types usually built at shipyards along the eastern coast of China.\textsuperscript{11} Perhaps the reason why these vessels appear so often in Western accounts was due to their uniqueness. Travelers are more likely to notice and remember the unusual aspects
of their journey, and, in many respects, these ships were unlike any vessel common to the Western World. But the Chinese merchant ships, on which Polo sailed from China to India, were not described as having flat bottoms. Polo merely remarked on the quality of their bulkheads.¹²

During the early years of the Song dynasty, as Chinese sailors and others came to India, they found the country in a similar condition to that of previous centuries. Xuan Cang, a Chinese traveler, described India as a land of past greatness, but present decay. The pasture land was overrun by savage beasts, ruined cities were overgrown by wilderness, bandits roamed the highways, and the Buddhist religion was on the wane.¹³ Meanwhile India's Muslim neighbors were becoming increasingly restive and ambitious.

In 998 the Turkish leader, Mahmud Ghazni, launched a series of invasions, considered brutal even at that time, and within 40 years had established an empire that extended from the frontiers of Mesopotamia to the river Ganges and to the deserts of Rajputana. During the reign of Ghanzi and his successors, great numbers of Muslims entered India peacefully.

In 1191, however, Mohammed of Ghur, an Afghan military leader, invaded India and gained enough territory and power that his successors, ruling from Delhi, were
able to establish the first series of Muslim dynasties. The hold these sultans of Delhi had on India, however, was rather tenuous. In 1398 they found themselves nearly overwhelmed by the repeated attacks of Mongol forces led by Timur the Lame, the dreaded Tamerlane of Western literature. The final blow to the Delhi sultanate was delivered by Baber, a Turkish-Mongol chieftain from Ferghana in Turkestan. Baber founded the Mogul dynasty (1526-1858), during which the control of India would later pass to the British.14

Trade in the Indian Ocean during the first centuries of the second millennium was markedly international in character. Merchants, traders and sailors from the Near East, East Africa, Southeast Asia and China filled the ports of India and Sri Lanka, but those who dominated the scene were the Gujaratis, the Indonesians and, to a lesser extent, the Chinese.15 In comparison, contrary to what most historians have believed, Arab merchants were of less importance during this period. The term "Moor" or "Moslem", used by early chroniclers such as Duarte Barbosa and Tomé Pires, did not specifically mean "Arab".16 By the time the Portuguese had arrived in Asia, many Indians and Indonesians had become followers of Islam and were generically classified as Moslems by Portuguese observers who often failed to distinguish nationalities. Thus this
term does not have the significance of the sort so often given it.\(^{17}\)

The spread of Islam in Southeast Asia was slow, and no deep roots were set until the establishment of the Muslim sultanate at Delhi. The Buddhist kingdom of Srivijaya maintained its control and influence over western Indonesia until it was defeated by the Javanese Mataram kingdom in 1026. Under Mataram rule both Hinduism and Mahayana Buddhism flourished. When the Mataram kingdom was replaced with the Kediri in 1042, social conditions remained much the same. By 1178, however, Kediri became the greatest maritime power in Southeast Asia, its political control extending from Bali, southeast Kalimantan (Borneo) and southern Sulawesi.\(^{18}\)

Kediri benefited greatly from the growing spice trade between India and the Mediterranean following the Crusades. Indian traders, mostly from Gujarat, flocked to the busy Kediri ports, and Kediri wealth and prestige grew. Kediri rule abruptly ended, however, in 1222 when the king was assassinated. From out of this rose the Singhasari dynasty which, in turn, proved short-lived when its king was killed by a rival during the Mongol invasion of 1292.\(^{19}\)

During this time Muslim traders from India, spurred by the increasing demand for spices in the West, came to
the ports of Malaysia and Indonesia, bringing with them the teachings of their Islamic faith. Like the spread of Hinduism and Buddhism in previous centuries, the acceptance of Islam in Southeast Asia was gradual. In the western Malaysian and Indonesian archipelago, however, acceptance was more rapid. "The superior position of the Indian Muslims in trade and business inspired the local rulers to convert to their faith", and the people, through marriage and a desire to follow their rulers' example, were also converted.20

In East Asia, however, Islam, although winning some converts, had far less impact. The development of trade in Song China required dealing with foreigners, but on the whole the Chinese remained immune from most of the influences outside their society.21 Ironically, regardless of however immune the Chinese remained from foreigners, it was foreign barbarians who brought down the Song dynasty.

Amongst the many and complex reasons for the decline and fall of the Song dynasty, two of the most important were the buildup of bureaucratism, which was increasingly burdened with the costs of defense, and the disregard of the military. Interestingly, during previous dynasties it was the military that held preeminence over the merchant class. During the Song, however, business became a
leading concern of the government and the people. Chinese society was divided into four occupational groups: scholar, farmer, artisan and merchant. The military was so devalued that it was not even figured in to this classification scheme. The military weakness of the Song government provided an opening for invasion by the Mongols who "looked upon China as the richest part of their vast empire, which extended across the heart of Asia to the borders of Arabia and far into Europe and Russia." The Mongol-ruled Yuan dynasty (1271-1368) was characterized by a return to militarism and attempts to expand China's power and commercial prestige. Though many Chinese fled their homeland, rule under the Mongolian empire was in reality more degrading for the Chinese than harsh. Chinese communities were left intact, which, in the long run, would become one of the factors leading to the downfall of the Yuan dynasty.

The Mongols could never release their grasp upon their nomadic past, always yearning to keep on the move, seeking more loot and slaves. With thousands of ships and the experienced captains and crews of the captured Song fleet, the Mongols attempted unsuccessfully to conquer Japan in 1274 and again later in 1281. In 1292 attempts were made to invade Java, Vietnam, Champa and the Liuqiu
Islands, all without success. The reasons for these failures were many, and the burden these expeditions placed on southern Chinese shipbuilding was considerable.26

During the reign of the Song and Yuan dynasties, the political scene in Japan was much like it had been during the first millennium. Powerful families such as the Hojo and Ashikaga vied for power, and the government was often in a state of flux. Nevertheless, the Japanese were organized well enough to repel the Yuan forces, and, over the first centuries of the second millennium, the economy of the country grew.27 With the general retreat of Yuan naval forces to the coastal borders of China, Japanese piracy flourished once again throughout the China seas.28

In Korea, under the reign of the Koryo dynasty during the first half of the millennium, merchants and others profited from shipping and trade. After numerous invasions, however, Koryo succumbed to Mongol dominion in 1254. The overthrow of the Mongols by the Ming dynasty in China (1316-1644) gave rise to the Chosun dynasty which lasted in Korea until the twentieth century (1392-1910).29

With an overburdened bureaucracy and pressure from large-scale rebellions in southern China, the Yuan dynasty fell in 1368. "The post-Yuan Mongols resumed their nomadic, tribal way of life, and used their acquired
knowledge of China to inflict misery upon the succeeding Ming dynasty through continuous frontier raids and skirmishes."\(^30\)

The Ming dynasty (1368-1644) was born of internal chaos and rebellion, but it became an empire of elegance, wealth and power. Over time, however, it became "sterile and tradition-bound in thought and political administration" and "plagued by depredations of northern border tribesmen, Japanese pirates, the appearance of Europeans by sea, and the rise of the Manchu power in the northeast."\(^31\)

Throughout maritime Asia during the first half of the second millennium, trade and shipping flourished, culminating in the legendary explorations of the Chinese explorer, Zheng He. Although we have much to learn about the trade, the explorations and the ships that were developed to accomplish it all, our knowledge of these matters is increasing.

**An Analysis of the Archaeological Remains of Four Song-Dynasty Ships**

In 1973 the remains of a ship were uncovered during dredging operations along a canal at Houzhou in Fujian province, approximately 10 km from the port of Quanzhou. Salvage excavation of the ship was carried out between June and August of that year, and the remains were
subsequently taken to the museum at Quanzhou where they were rebuilt and are now on display.\textsuperscript{32} Quanzhou, the fabled commercial center known to thirteenth-century Westerners as "Zaitun", was probably the home port of this important vessel.\textsuperscript{33} The ship is dated to approximately 1277, based on the 540 brass coins and the ceramics found with the wreck.\textsuperscript{34} Its construction is complex and differs considerably from what has previously been assumed as typical for Chinese craft.\textsuperscript{35} But it well supports the idea of a southern shipbuilding tradition as well as ideas concerning other aspects of Chinese vessel development.

The remains of the vessel consists of a keel, 12 bulkheads, a section of the transom and the sides of the hull to just beyond the turn of the bilge. On the port side 14 strakes have survived and 16 strakes remain on the starboard side. The ship is 24 m long by 9 m wide, but originally it may have been as much as 34 m long, 11 m wide and had a displacement of approximately 374 to 380 tons.\textsuperscript{36} The keel, made of pine, is in three sections joined together by complex scarfs. Both ends of the keel slope slightly upwards, the forward part more so than the aft.\textsuperscript{37} The bluff-ended stern is fitted with a transom that has a vertical groove carved into its outboard surface for the axial rudder. The bow is rather sharply ended, but
may have had a small, perhaps triangular-shaped transom to which the forward end of the keel and upper side strakes were attached.  

The hull planking, consisting of an inner and outer layer, is made of cedar and is constructed in a very complex manner (Fig. 54). The inner planking is 8 cm thick. The garboard is rabbeted to the keel and to the second inboard strake. The strakes lie flush against one another along the rabbeted seam. The second and third strakes are again rabbeted together, but in this case the bottom edge of the third strake overlaps the upper edge of the second. Strakes 3 through 5 are flush-laid and rabbeted together like strake 2 and the garboard. Strakes 5 and 6, however, repeat the rabbeted lapstrake joint as used for strakes 2 and 3. This method is repeated through strake 11, creating three sets of rabbeted flush-laid strakes joined to the next set by rabbeted lapstrake joints. Strakes 12 through 16, approaching the turn of the bilge, form yet another set of rabbeted flush-laid strakes, but with five strakes rather than three to the set.  

The outer planking is 5 cm thick. One strake is nailed to either side of the keel, perhaps to sheath the keel and to provide a rabbet to attach the outboard garboard. The outer strakes are flush-laid and nailed to
Fig. 54: The Song-dynasty Quanzhou vessel. Built in southern China, this sharp-bottomed ship has a sophisticated planking arrangement using a combination of rabbeted, flush-laid and overlapping strakes in multiple layers. (After Green, "Song Dynasty Shipwreck", 1983, p. 25, fig. 7)

the inner strakes. Where the inboard strakes overlap, however, the lower outboard strake butts against the protruding edge of the inboard strake, thus forming a flush joint over which the lower edge of the next outboard strake is placed in a lapstrake manner. This is repeated through strake 16. The flush-laid set of planking consisting of strakes 12 through 16 has an additional layer of outer planking. This second outside layer of flush-laid planking is 2.5 cm thick, is nailed against the
first layer of outer planking, covers the seams of this first layer and continues for five strakes up to where the hull preservation ends, near the turn of the bilge. The purpose of this second layer may have been to provide additional strength to this often weak point of a vessel's hull, and it may also have served as rubbing strakes to protect the inner planking.

Western observers, such as Marco Polo and others, described how Chinese sailors and boatbuilders would simply add additional planks of wood to the outside of a vessel's hull in order to cover damaged strakes. If there is any connection between this method and the way the Quanzhou vessel was built, the latter indicates a considerably more sophisticated building technology. The Quanzhou vessel was plainly not just some lumbering hulk, held together with trash wood until a time when it could sail no further.

Internally the Quanzhou vessel was well strengthened by 12 bulkheads creating 13 compartments. The bulkhead planks, made of cedar, are flush-laid and rabbeted together in a manner similar to the inner hull planking. Except for the forwardmost and aftermost bulkheads, the bottom plank of each bulkhead has a waterway, or "fairy door", cut through it. The inner planking was nailed to the bulkheads, but no evidence has yet surfaced to
indicate which of the two were erected first, or if a combination of shell- and frame-first construction was used.

The reports state that the inner planking was fastened together with iron nails driven diagonally from the outside through the joint. Nails, driven from the outside, were also used to fasten the inner planking to the edges of the bulkheads.\textsuperscript{41} This could indicate either shell- or frame-first construction. If there was evidence of a diagonal nail piercing, perhaps accidentally, the edge of a bulkhead, then this might suggest that the planks were fastened together after the emplacement of the bulkheads. No such evidence has been reported, however, thus the strakes may have been in place prior to the bulkheads. Another remote possibility is that each set of planking was fastened together separately as a single unit (prefabricated) before being nailed to the bulkheads. A similar method is used to construct dragon boats (see Appendix II) and some rivercraft in Pakistan.\textsuperscript{42} For a craft such as the Quanzhou vessel, however, this method of construction, although perhaps not impossible, would have been unnecessarily difficult. Thus she probably was not constructed in this way.

Before the strakes were nailed to the bulkheads, wooden laths were placed against the inboard lapstrake
joints to seal them. A similar method was described above for the Guangdong "butt-joint" vessel. After the strakes were nailed in place, *chu'nam* putty (a mixture of tung oil, jute fibers and shredded bamboo) was used to caulk the planking seams, the area around the nails and any other small opening or crevice. A putty made from tung oil, but without any jute fibers or bamboo shreds, was used to seal the joints of the bulkheads, and special care was taken to seal around the flat iron brackets that attached the bottom of the bulkheads to the hull.\(^{43}\) Why this was considered such a potential spot for leakage, over any other, was never indicated.

In addition to the bulkheads, internal strengthening also came from half frames that extend up to about the fourteenth strake on each side. The half frames forward of the mainmast step are positioned on the aft sides of the bulkheads, and those aft the mast step are positioned on the forward sides of the bulkheads. Each half frame also has a waterway cut through them.\(^{44}\)

The fore- and mainmast steps are located atop the keel. Originally the foremost was positioned against the forward side of the first bulkhead, and the mainmast was against the forward side of the sixth bulkhead. Both mast steps had two square sockets cut into them to take the mast tabernacle housing. The "main mast step was also
braced against the forward bulkhead by two beams running parallel to and on either side of the keel."\(^{45}\) The upper plank of the fifth bulkhead, which would have been forward of the mainmast, has a square section cut out of it. This was to allow the mainmast to be lowered.

Only a few years after the discovery of the Quanzhou vessel, another Song-dynasty archaeological site was discovered. North of Quanzhou at Ningbo in the province of Zhejiang, the remains of three wharves, a shipyard and a vessel were uncovered. Rescue excavations were carried out in August of 1978 and in April of 1979.

The shipyard could not be fully excavated because much of it lies beneath a main street. The remains that identified this area as a shipyard consisted of large quantities of "timber, boards, trees, wooden offcuts and chips, some ten stone mortars which had putty in them and heaps of putty, linen string, coir and bamboo rope as well as ship nails and other shipbuilding materials."\(^{46}\) The wooden wharves and the remains of the shipyard were both located within the Song stratum.

The ship was recovered from beneath Wharf 1. Exposure to the sun, however, caused the timbers to shrink and the various components of the ship to break apart, thus preservation was considered impossible. Observations made at the time revealed that this was a three-masted
ocean vessel with a sharp bow, a square stern and a V-shaped bottom.

A pine keel was in three sections, scarfed together with mortise-and-tenon joints. The remains of the keel measured 7.34 m long, 26 cm wide and 18 cm thick. Its original length was estimated to have been more than 10.5 m. Within the scarf joint of the keel and stempost, two rectangular "Holes of Longevity" had been cut, each hole containing six coins. All 12 coins date to the early Northern Song dynasty.47

The stempost, made of Chinese fir, was triangular in profile and measured 1.55 m long, 18 cm wide and 20 cm thick. The mortise-and-tenon joint, attaching the stempost to the keel, was further fastened with nails arranged in a pattern resembling a plum flower.48

Twelve planks were recovered, eight on the port side and four on the starboard. They were made of Chinese fir, pine or camphor, and, on average, measured 6-8 cm thick, 21-42 cm wide and 3-8 m long.

Unlike those of the Quanzhou vessel, the flush-laid planks of this craft were not rabbeted and were built up from the keel in only a single layer. How they were attached was not reported. We might assume, therefore, based on what is known about the construction of other Chinese vessels, that the planking of the hull began with
the garboards nailed directly to the sides of the keel, followed by the upper planking nailed to the frames and bulkheads. If this was the case, this vessel may have been built frame first, but without further information, this cannot accurately be determined. What is reported, however, is the way the planks are longitudinally joined to one another with oblique scarfs spanning one or two frames. Where the planks simply butted together, mortise-and-tenon joints were used and were further fastened with diagonally driven nails. Thus, perhaps, diagonally driven nails, but without mortise-and-tenon joints, were used to fasten the oblique scarfs. Furthermore, it also seems likely that diagonally driven nails may have been used along the entire length of each strake to fasten each to its neighbor, as was the case for the Quanzhou vessel and other Chinese craft. Assuming this to be true, then the same shell- versus frame-first paradigm concerning the construction of the Quanzhou vessel also applies to that of the Ningbo vessel. Additional information on this topic has been requested from those who headed the excavation of this ship. Unfortunately, no response has yet been received.

The scarf joints of the Ningbo vessel are an improvement over the weaker butt joints typically found thus far on other Song-dynasty vessels, while the butt
joints that are found on the Ningbo vessel are further strengthened with mortise-and-tenon joints and nails.49

The framing of the Ningbo vessel differs somewhat from the Quanzhou vessel. The primary means of framing on the Quanzhou vessel are the bulkheads, with adjacent half frames lending some secondary support. On the Ningbo vessel, however, frames are positioned along the length of the hull, and they apparently span the width of the hull up to approximately the fourth strake on each side. The bulkheads, rather than being fastened directly to the hull, are nailed to the top of the frames. Obviously the builders of the Ningbo vessel relied more heavily on frames than did the builders of the Quanzhou vessel. As we have seen, earlier vessels of the Tang dynasty were built having frames with crossbeams positioned above them. Perhaps the Ningbo vessel represents a transitional stage between the earlier Tang craft and the Quanzhou vessel. I suggest that over time builders increased the number of beams used in the vessels they constructed. This eventually developed into solid bulkheads above the frames. Bulkheads provided at least sufficient framing strength, and, compared to conventional frames, they were more economical to make. Frames require timber that, in its natural shape, approximates the desired internal shape of the hull. If for whatever reason timber with the
proper shape cannot be obtained, then that which is available, if used, will dictate the shape of the hull. Bulkheads, on the other hand, can be made to fit whatever hull shape the builder intends, and from less specific cuts of lumber. Thus the shipwright has at his disposal a more versatile framing member, and one that can be fashioned from more readily available material. A further advantage of bulkheads is that they can be used to create watertight compartments within the hull. Watertight compartments not only provide a safer way to haul cargo, they also make the ship safer by providing a means of closing off and containing a compartment that may become flooded -- the Titanic notwithstanding.

The Quanzhou vessel, having bulkheads as its primary means of framing and half frames as auxiliary members, may represent a particular evolutionary stage in ship development. From this particular stage were developed the "typical" Chinese vessels, described by Western observers, that relied almost exclusively on bulkheads for framing strength, but, for reasons described below, were flat-bottomed rather than sharp-bottomed. Based on what we thus far know about Song-dynasty vessels, how the design of the Quanzhou vessel's hull planking was developed remains an enigma. Very likely the multiple planking of the Quanzhou vessel and the single-layer
planking of the Ningbo vessel do not necessarily indicate an evolutionary stage from one to the other. Although I believe that the framing found on each may indicate a developmental stage, I contend that the vessels themselves are simply of two different classes or types of watercraft reflecting two different design motifs. In contrast to those who made the Quanzhou vessel, the builders of the Ningbo vessel may have anticipated that the hull of their craft would later be strengthened and repaired by the addition of side planking when needed -- as was done with other vessels. Instead of extra strakes at the turn of the bilge, a semicircular bilge wale was nailed to the planking along the joint between the seventh and eighth strakes. This not only added strength to the hull, but also served to decrease the roll of the ship. As described above, some later vessels were attached with a wreath of bamboo to improve stability.

The Quanzhou vessel, on the other hand, was given multiple strakes at the outset of her construction, thus producing a strong, sturdy hull. Instead of employing a wale, the builders increased the layers of planking at the turn of the bilge for strength. Also, by overlapping the strakes at certain points, they made it unnecessary to install wales along these junctures. The lapstrake design of the Quanzhou vessel proves that at least some Chinese
craft were constructed in this way. The development of this type of construction is not well understood, but, as we will see, pictorial evidence may indicate that lapstrake construction persisted until perhaps the beginning of the Ming dynasty.

The V-shaped hulls of the Quanzhou and Ningbo vessels both lend support to the theory of a southern boatbuilding tradition. The archaeological remains of two other vessels, recovered north of Hangzhou, provide evidence of a northern boatbuilding tradition with the port of Hangzhou as a kind of demarcation zone between the north and south.

In 1978 excavation was carried out on a Song-dynasty vessel found near Shanghai. In certain respects it resembles both the Quanzhou and Ningbo vessels, but only remotely. Unlike the other two vessels, this craft is flat-bottomed. The flush-laid, bottom planking assembly, made of pine, consists of three strakes: a keel plank and two additional strakes attached to either side of the keel plank. The edges of the two bottom strakes are chamfered to take the garboards. Nails driven from the outside attach the garboards to the bottom planking. The garboards and the second side strakes rise sharply at a 45 degree angle from the bottom of the hull. The turn of the bilge occurs at the sharp-angled juncture between the
second and third side strakes. The remaining side strakes (3 through 7) rise perpendicularly from the horizontal plane. The resulting shape of the hull is rather sharply angled in profile, producing five distinct surfaces from sheer to sheer.\textsuperscript{50}

The vessel is approximately 31 m long and 7.5 m wide. It is square-ended, and in the bow, near the forwardmost bulkhead, projects a box-like compartment which may have supported the anchor. Although it may have been sailed in open water, it was most likely intended for inland use. As in the case of the Quanzhou vessel, the planking is attached to the bulkheads. Frames, rather than half frames, however, were used; at least two were found in the bow. A mast step, spanning approximately five strakes, was positioned along the forward side of the third bulkhead near the bow.

On either side of the hull a wale, similar to those of the Ningbo vessel, was nailed to the planking. The wales of the Shanghai vessel, however, were not placed at the turn of the bilge, but rather higher up on the side of the hull, along the seam between strakes 5 and 6.

During the same year that the Shanghai vessel was discovered, another flat-bottomed inland craft was recovered near Jinghai in Hebei province.\textsuperscript{51} This vessel, dated to approximately the year 1111, has several
interesting design features. The vessel itself is about 12 m long and over 3 m wide. Its flat bottom assembly consists of a thick keel plank and a double layer of about six flush-laid planks on either side, all of which are fastened with iron nails (Fig. 55). On both sides of the bottom assembly is attached a chine plank, slightly thicker than the double layer of bottom planks. These chine planks are reminiscent of the chine girders found on other vessels previously discussed. Approximately 12 floor timbers, spanning the width of the hull, are attached to the bottom planking. Four waterways, two on either side of the centerline, are notched out of the bottom edge of each floor timber. Alternating between each floor timber are stick-like half frames that extend up the full height of the vessel's sides.

The sides of the hull are built up having the garboards nailed to the chine planks, followed by the flush-laid second and third side strakes. At this point a standing knee, atop either end of each of the floor timbers, was nailed to the floor timber and to the second and third side strakes.

The fourth side strake (approximately 10 cm thick) overlaps the upper edge of the third strake. A heavy sheer strake (15 cm thick) tops the fourth strake, and a caprail finishes the upper sides of the vessel. Along the
Fig. 55: The Song-dynasty vessel from Jinghai. This flat-bottomed northern Chinese craft has both flush-laid and lapstrake planking and is internally strengthened with both crossbeams and floor timbers. Of particular interest are the standing knees, not usually found on Chinese vessels, positioned along the sides atop the floors and crossbeams. (After Tianjin City Cultural Relics Administration, fig. 5)

Inboard surface of the fourth strake and sheer strake runs a much thinner (3 cm thick) run of planking. This planking is sandwiched between the bottom half of the fourth strake and a crossbeam. There are 12 of these crossbeams, positioned above the floor timbers. They are notched at either end to fit against the upper edge of the third side strake. Each crossbeam is supported by stanchions, positioned between the crossbeam and the floor timber. Further support is provided by stanchion-like uprights that are attached to the flat forward surface of the floors and the crossbeams. Standing knees, atop either end of each crossbeam, are nailed to the beam and to the inner side of the vessel. The nails attaching each
knee to the side of the vessel are driven into the upper arm of the knee, through the thin inner planking of the hull and into the fourth side strake and the sheer strake.52

This humble inland watercraft has many fascinating construction features. First of all, the use of knees in construction of any Chinese vessel is most unusual. Because so little is known about this, however, further analysis is not possible until more information becomes available. Aside from this, what we can determine is that the shape of the vessel's hull coincides with the notion of northern Chinese vessels typically having flat bottoms, square ends and a hard chine where the sides join the bottom. Although the use of beams and floor timbers to frame the hull may not fit the standard of northern vessel types, it does reflect what I believe to be the older method of framing used in China. I also believe that the chine planks on the vessel is an indication of an older method of building. Chine girders, more robust than the chine planks, may have been used in the past on similar vessels, but the strength derived from iron nails made it possible to fasten the sides to smaller chine planks. No wales were used on this craft because the keel plank and chine planks provided the necessary longitudinal strengthening along the bottom of the hull. The location
where a wale might have been attached along the side, such as on the Shanghai vessel, has overlapping strakes supported by crossbeams instead. The Quanzhou vessel, employing fully developed bulkheads, did not need crossbeams, but the strakes were overlapped at points along the hull where, on other vessels, wales may have been attached.

Without further archaeological evidence, we cannot accurately determine how much if any of this indicates evolutionary developments in ship construction or what the chronology of these developments might actually be. Because all of these vessels were constructed within a relatively close period in time, the best we can really state is that each represents a different class or type of vessel. Nevertheless, the Shanghai and Jinghai vessels can be classified as northern vessel types, and the Ningbo and Quanzhou vessels as southern vessel types. Also, the Quanzhou and Jinghai vessels provide evidence of lapstrake construction in China, a point that has been overlooked in the past.

Ship Illustrations on Silk Scrolls

In 1126 the Northern Song emperor Hui Zong commissioned the artist Zhang Zeduan to create "a pictorial record of the misty prospects of Pien River." Zhang's completed work, entitled Qingming Shang He Tu
(Traveling on the River during Spring Festival), provides a fascinating panoramic representation of events and activities occurring at what most scholars believe to be the capital of Kaifeng. Over the centuries the original scroll painting was stolen, recovered, bought, sold and copied many times. Its final fate is uncertain, but most authorities contend that the original painting is the one presently owned by the national museum in Beijing.

Of all the scenes depicted on the scroll, the most important to this study are the ones of ships. Barges, tenders, passenger boats and cargo boats of various sizes are amongst the many vessels shown along the bustling river. To the left of the illustration (Fig. 56) can be seen the stern of a flat-bottomed passenger boat that is being towed by trackers on shore.56 Beyond that, moored along the riverbank near the "Rainbow Bridge" (the bridge is not visible in the illustration), are several large, possibly ocean-going cargo vessels. The more prominent vessel in the center of the picture has a round-bottomed hull, and the hoisting mechanism for the axial rudder can
Fig. 56: A silk scroll painting of Song-dynasty watercraft. Note the lapstrake appearance of the planking on each of the vessels. (From Wu, p. 506, fig. 3)

be seen. The mast (or masts) of this vessel has been taken down. Of particular interest is the way the vessel's hull is planked. The sheer strakes appear to be pierced with through-beams, probably supporting a deck, and the side and bottom planking curve upwards into the transom. Roderick Whitfield, quoting from a Chinese text written just two years before the painting of the scroll, describes seagoing vessels as being constructed:⁵⁷
... entirely of whole timbers and great beams, built up in a mass. The upper part was level and horizontal; the lower part was angled like a blade, which was valuable to enable it to break the waves in sailing. Inside it was divided into three compartments. In the forward hold there was no decking, only at the bottom the galley and water tanks, being just between the two masts. Below this were sleeping quarters. The second hold was furnished as four rooms and the last one was known as the high room ... with windows in the four walls, and constructed like a house. On it there was a painted and decorated railing, additionally decorated with curtains. The envoys of official rank were all separately housed according to their standing. Overhead there was bamboo matting which was normally piled up, but which when it rained made a close cover. Now the crewmen greatly feared the height of the deckhouse because of the great wind, which made it ... inconvenient ... At the bows of the ship between two supporting posts there was a winch with cable wound on it, as thick as a column. Below this hang the anchor stone, held between two wooden books. When the ship has not yet entered the ocean, and approaches a hill to anchor, then the anchorstone is let down to the bottom of the water, as a kind of hawser, then the ship does not move. If wind and wave are strong then extra anchorstones are added: their use is like that of the great stone, but they are placed to either side of it. When sailing the winch is turned to haul them in. There is a main rudder of two sizes, large and small, which are changed according to the depth of water. It is behind the deckhouse and is inserted from the top. Two oars known as san-fu t'o ... are only used when the ship is at sea.

Although it describes a different type of vessel than the cargo boat in the painting, this account provides us with further written evidence of Chinese vessels with sharp-bottomed hulls. The boat in the painting may indicate a class or type of cargo boat that had a round, full (rather than flat or sharp) bottom, designed as such
to increase its carrying capacity, but still built up from a keel or keel plank.

Of particular interest is the line of dots along the bottom edge of each strake. A similar pattern is also found on the other vessels nearby. This dotted line looks very much like it is meant to depict nails or rivets fastening together lapstrake planking.

Two ships with similar markings are shown on an earlier scroll, entitled Sailing on the River after Snow, painted during the period of the Five Dynasties (Fig. 57). These two vessels, with their rather elaborate superstructure, have several interesting features. The masts, supported by multiple stays, are positioned atop an axle-like timber that, when rotated, allows the mast to be lowered. The vessel in the foreground has a small boat, or tender, floating along side, tied off with a painter. Also, a bundle of bamboo is lashed along side the ship, perhaps to provide the hull with extra buoyancy. The vessels appear to be flat-bottomed craft, with the upper two strakes of their hulls having a line of dots somewhat similar to those shown on the Song vessels. Whether or not this indicates at least two lapstrake planks is debatable, but that which is shown on the Song vessels is rather more convincing. Admittedly, however, the artist of the Song vessels may just as likely have been showing a
Fig. 57: A picture entitled *Sailing on the River after Snow*. This tenth-century Chinese silk painting illustrates two vessels that may have lapstrake construction. Note the bamboo bundle lashed to the hull's side, probably to add buoyancy to the ship. (From Anon, *Chinese Art Treasures*, p. 501)

hull with edge-joined planks fastened together with diagonally driven nails.

Over time, copies of the Song scroll were made, either by copying directly from the original scroll or by copying other copies made of the scroll. These later copies often either changed or simply left out many details of the original. As Whitfield complained, the
"painting progressively fails to be a living record of the toils of men and the fruits of their labor, to become a product of the genteel imagination, shunning actual contact with the unpleasant, or possibly unaware of its existence." 59

Thus caution must be used when interpreting the copies of later date. However, at least in some cases, what the copyist may be showing us are not the vessels of a more ancient period, but those of his own time of which he is more familiar. For example, a copy of the Song scroll made during the Ming dynasty depicts ships, moored near the Rainbow Bridge, that are of a completely different design than those of the Song depiction (Fig. 58). Although these vessels plainly were not painted with the same concern for technical accuracy as were those of the Song scroll, they may nevertheless shed at least some limited light on the change that occurred in vessel design between the Song and Ming periods. Ignoring the way the artist shows how the rudders are hung, and the rather extreme shape of the hulls, both of which may be due to ignorance and artistic license, we can see that these vessels are built up from a flat bottom assembly consisting of several planks, ending in a horizontally planked transom. 60 Their side planks are edge joined with no apparent line of nails. How accurately these vessels
Fig. 58: A Ming copy of a Song-dynasty painting. These vessels differ considerably from those on the Song painting, but they may indicate a general, perhaps generically represented, vessel type common to later periods. (From Priest, pl. 6)
represent any Ming vessel type is debatable. What we can say, however, is that at least to the artist and his intended audience, these vessels represented adequately enough Ming-period watercraft.

After the ban was placed on maritime ventures during the Ming dynasty, descriptions and representations of Chinese vessels were predominantly of craft with flat bottoms. With sailing activities kept largely within the coastal borders of China, flat-bottomed vessels may have been more adaptive to this environment and, thus, increasingly more common. A technical manuscript produced in 1553, entitled Long Jiang Chuan Chang Zhi (Record of the Dragon River Shipyard), indicates that all the vessels built during that period at the Dragon River shipyard were flat-bottomed. This is not to suggest, however, that the construction of southern vessel types ceased altogether. It may be that at least some, less careful observers, who assumed that all Chinese vessels were, by default, flat-bottomed, inaccurately described southern vessels as such. Nevertheless, considering the vessels shown on the Ming scroll painting, and even more accurate representations of later date, it is apparent that Chinese ships became predominantly flat-bottomed.61

As we have seen, however, archaeological evidence indicates that earlier Chinese vessels were certainly
built having sharp bottoms with a keel, and their sides were constructed in a lapstrake manner. This fact is further supported by the archaeological remains of a shipwreck found in Korea.

The Shinan Shipwreck

In 1975, off the coast of Shinan (or Sinan) in southwest Korea, the remains of a shipwreck were found after fishermen reported having their nets entangled with pieces of ceramics. Excavations, begun the following year, revealed that this was a trading vessel hauling a mixed cargo of pepper, bronze coins and a variety of ceramics. On one of the many wooden cargo boxes was hung a tag on which was written the year 1323, thus providing the closest date of when the vessel was sunk.62

The remains of the vessel, now undergoing conservation treatment at the Mokpo Conservation Center in Korea, consists of a keel, six port-side strakes, approximately 14 strakes of the starboard side, a small section of the stern transom and part of the transom bow.63 She had two masts, and the forward mast was set at an angle against a correspondingly angled bulkhead. Because of the way the vessel was constructed, she is believed to be Chinese in origin, and, from the cargo that was recovered, authorities think that she was lost,
probably during a storm, while trading along the coasts of Korea and Japan, perhaps en route to Okinawa.\textsuperscript{64}

The remains of the vessel are 28 m long by 6.8 m wide. The robust keel is approximately 50 cm square in section. As in the case of the Quanzhou vessel, the Shinan ship's hull is V-shaped in cross-section and is internally divided by bulkheads, seven altogether, creating eight compartments.

The available reports do not indicate how the rabbeted, lapstrake planking was fastened together (Fig. 59). Jeremy Green, however, explained that the bulkheads are notched to fit over the planking seams, and those forward of the main mast step are:\textsuperscript{65}

\ldots supported on the aft side with frames and on the forward side with stiffeners. The stiffeners are pointed wooden pegs that penetrate each strake from the outside of the hull planking, thus locking the opposite side of the bulkhead to the frames, and are attached to the face of the bulkhead. Aft of the main mast step, the reverse situation occurs. The strakes are butt-joined. In most cases the butt joint is a lap joint, but on the garboard strake and on at least one other place the joint is a mortise and tenon joint. On the internal face of the butt joints, there are butt plates which sit over the top of the joints and clamp them together. In some cases, these butt plates are set under a frame, indicating that the frames were put in place after the completion of the planking.

A Profile of East Asian Ship Construction

Authorities contend that the way the Shinan ship was constructed indicates that she was not of Korean origin.
Fig. 59: A profile diagram of the Shinan vessel. Note the rabbeted, lapstrake construction of the side planking. (After Green and Kim, fig. 5)

Zae Geun Kim, the excavation and research director of the Shinan wreck, argues that traditional Korean vessels had a flat bottom, the planks of which were "held together with long square-sectioned dowels running the whole width of the bottom". The dowels, in turn, were "held in place by round pegs driven through the planks to fix the square-sectioned dowels." Onto this flat bottom assembly were added rabbeted, lapstrake planks, such as on the Wando ship. In this case, however, the rabbet was cut on the upper edge of the strake, which is opposite to the way it was done on the Shinan vessel.
Kim believes that one of the most salient features indicating that the Shinan vessel is of Chinese build is the bulkheads. Drawing on evidence presented by Horace Underwood, Kim argues that Korean as well as Japanese ships were "held together by a series of cross timbers known by the Koreans as 'Mongeh' (yokes) and others called 'Changson'."67 As we have seen, however, Chinese vessels also used crossbeams. A seventeenth-century Chinese publication, entitled "Things Produced by the Works of Nature", states that vessels have "pillars" that are "erected on both sides from the bottom to reach the deck: partitions are built to divide the boat into separate hatches: beams are laid crosswise to the boat."68 There is no strong evidence to negate the idea that Korean vessels had a similar configuration of beams, which, on Korean vessels, may have later developed into only bulkheads. While there may be no strong evidence to negate this idea, there is no strong evidence to support it either. However, if it is true that many Korean vessels have a dugout ancestry, then not all of them would have been flat-bottomed, as Kim alluded.

As for the construction of Japanese vessels, unfortunately little more can be said here other than what has already been stated in previous chapters. Like Korean watercraft, however, many traditional Japanese vessels
have a dugout ancestry. Ships are built up from a keel-like hog, and their hulls have sharply ended bows.\textsuperscript{69}
Japanese manuscripts from the sixteenth and seventeenth centuries indicate that Japanese ocean vessels had sharp-bottomed hulls strengthened with heavy crossbeams, were equipped with multiple masts (hung with square lug sails made of matting or cloth), and were accompanied by as many as two to three tenders for each ship. These large ships could be as much as 36 m long and more than 9 m wide, and carried a crew of more than 400 people.\textsuperscript{70}

The Shinan vessel is indeed likely a Chinese-built craft, probably from southern China, but until we have further material evidence, we are limited in exactly what can or cannot be said about other East Asian watercraft, and the influence Chinese ships may or may not have had on them.\textsuperscript{71}

South Asia and Possible Chinese Influences in Southeast Asia

Pierre-Yves Manguin divides shipbuilding in the regions of the Indian Ocean into two major traditions: Arabo-Indian shipbuilding and Southeast Asian shipbuilding.\textsuperscript{72} The Arabo-Indian tradition is characterized by vessels with a dugout ancestry that are built up from a keel (or at least have sharp-bottomed hulls) and that have ligature-fastened planking.\textsuperscript{73} Vessels with flat-bottomed
hulls with ligature-fastened planks can be seen as constituting an additional class not mentioned by Manguin. Over time, for both flat- and sharp-bottomed vessels, these ligatures were replaced with dowels (occasionally the two were used together, possibly indicating a transitional stage), and dowels were eventually replaced by nails. Because all three methods of construction are still in use today, and because we have no physical remains to indicate when any transition may have occurred, we cannot succinctly establish a chronology for South Asian vessel development. Thus, information about these vessels other than what has been presented here and in Chapter III of this study remains to be discovered.

The relationship between Arabo-Indian and Southeast Asian shipbuilding traditions is uncertain. There does appear to be a distinction between the two in the way planks are joined together with ligature fastenings. In the Indian Ocean, builders characteristically use long, nearly continuous lines of coir to lace planks together; whereas in Southeast Asia short, separate lengths of lashing, usually of rattan, are used.

By the time Europeans were sailing the waters of Southeast Asia, some rather striking developments in ship construction had occurred. J. S. Stavorinus, travelling in Bira during the eighteenth century, wrote that the hull
of the perahu, paduakans, were made "very tight, by doweling the planks together, as coopers do the parts that form the head of a cask, and putting the bark of a certain tree between, which swells, and then fit timbers to the planks, as at Bombay, but do not rabbet, as it is called, the planks, as is done there. In Europe we build reversely; we set up the timbers first, and fit the planks to them afterwards."74 Dowels, rather than ligature fastenings, allowed builders to construct vessels of rather considerable tonnage. These ships could average between 400 to 500 tons, and an exceptionally large one, built in Java in 1513, reached 1,000 tons and carried upwards of 1,000 people on board.75 Manguin states that all sixteenth-century textual sources describe Southeast Asian ships as built entirely from wood without any nails to fasten their structural components together.76 Another characteristic is the way ships' hulls were planked with upwards of three layers of wood, as was done in East Asia.77 Interestingly, however, nearly all the dozen or so large, fourteenth- to seventeenth-century shipwrecks excavated so far have their planking fastened to frames with iron nails.78 Because little has been published on the actual structure of these vessels, only a brief description can be given here of two that fit the time-frame of this study.79
The Ko Si Chang 2 and Pattaya wrecks were both found in the Gulf of Thailand and date to the thirteenth and fourteenth centuries respectively. The hull structure of the Ko Si Chang 2 is unlike that of any known Southeast Asian vessel. Seventeen side strakes on one side (which side is uncertain) and both garboards are extant. The garboards, attached to a hog, form a "keel slot" that, if the excavation drawings are accurate, is identical in shape to the hog planking assembly found on Japanese ships. The side planking extends out from the keel slot at nearly a 90 degree angle, producing a rather flat hull bottom. The planking is fastened by diagonally driven iron nails, but the nails are driven from the inside of the hull rather than from the outside as on East Asian vessels. The planking may also have been attached to bulkheads and frames, but none were reported found. The Ko Si Chang 2 wreck is indeed an unusual craft, and its nationality has yet to be determined.\(^{80}\)

On the Pattaya wreck, the keel and a double (or possibly triple) layer of eight strakes on either side have survived. The planks are edge-joined with dowels, and the outer planking layers were likely fastened to the inner planking with nails. The hull was internally strengthened by at least six bulkheads that had frames nailed to them and to the planking. A large block of
wood, positioned atop the keel and against one of the bulkheads, is believed to be a mast step.81

Like the Ko Si Chang 2 wreck, the nationality of the Pattaya vessel remains uncertain. Manguin proposes that these, and other later examples like them, indicate a hybrid tradition of Southeast and East Asian shipbuilding that he calls the "South China Sea tradition".82

During the Song dynasty, as trade in and out of China increased, Chinese shipwrights were increasingly exposed to the techniques of Southeast Asian vessel construction; the shipwrights of Southeast Asia were increasingly exposed to Chinese methods of construction as well. Archaeological evidence does indeed suggest that a class of vessel was emerging that combined features found on both Southeast Asian and Chinese watercraft, such as sharp, V-shaped hulls with keels as well as bulkheads, nailed planking and, possibly, stern rudders. Although the vessels of insular Southeast Asia have predominantly retained their quarter rudders, evidence such as the Chinese-influenced ship depicted at Bayon in Cambodia may indicate that at least some of these "hybrid" vessels had stern rudders.83

The Ships of Zheng He

The development of more seaworthy ships in China, combining Chinese and Southeast Asian shipbuilding
methods, may have made possible the construction of the
great ships numbering amongst the expeditionary fleets of
the Chinese explorer, Zheng He (1371-1435?). Because so
much has already been written about this legendary
fifteenth-century admiral, only a brief mention of him and
his ships need be made here.

Although other Chinese expeditions before the time of
Zheng He had sailed the far western reaches of the Indian
Ocean, it was those of Zheng's that had the greatest, most
enduring impact on Asian history and legend. Zheng, who
had distinguished himself as a military officer in the
rebellion which placed the Emperor Yanglo (1403-1424) on
the throne, was commissioned to sail to the western
barbarian lands in 1407. One reason for the initial
expedition was possibly to search for and capture the
dethroned, renegade emperor, Jianwen, who had fled the
country. However, the real intent of the expeditions,
of which seven altogether were made, was to explore and
gain knowledge of foreign lands, to acquire valuable
products (medicines being one of the more important) and
to establish tributary links to the Chinese empire.

Records of the voyages were made by Ma Huan and Fei
Xin. From these documents, Huang Sheng Zeng later in
the fifteenth century wrote:

With 100 mighty ships they began their journey from
Fuhchow at the river mouth of the Five Tigers.
With rudders hoisted and sails unfurled they took their course where sea and sky are blended. Hence forth, amid the thundering billows and surges rearing mountains high, helped by their flying masts and labouring oars, now with their cordage tightly strained and now under loosened sails, they journeyed many myriads of li, and in their voyaging to and fro spent nigh on 30 years. And yet the lands they saw were but a score or so in number . . . . Beyond Sumatra . . . Cochin-China is the most remote and on again of the six or seven countries more, Arabia is the farthest.

Much speculation, and some of it rather fanciful, has been given about the size of the vessels in Zheng's fleet, especially those labeled as "treasure" ships. The available firsthand information about the ships, however, is limited. The official court record of the Ming dynasty merely states that "62 large ships were built, each with a length of 44 chang and a width of 18 chang." Information gleaned from Ma Huan's firsthand accounts, however, indicates that the expeditions were equipped with at least five different classes and sizes of vessels. The largest vessels were the nine-masted treasure ships (length: 44.4 chang; breadth: 18 chang), followed in size by the eight-masted horse transports (length: 37 chang; breadth: 15 chang), the seven-masted supply ships (length: 28 chang; breadth: 12 chang), the six-masted billet ships (length: 24 chang; breadth: 9.4 chang) and the five-masted combat ships (length: 18 chang; breadth: 6.8 chang). According to T. P. Pao, one chang is approximately 3.3 m. If the measurements given for
these vessels are correct, they were magnificent structures indeed. The length and width of the treasure ships would have been more than 145 m by 59 m respectively. C. D. Gibson calculated that the maximum length that a structurally safe wooden vessel can be built without iron or steel reinforcement is 90 m. André Sleeswyk further estimates that this maximum length applies only to inland watercraft; the safe length for seagoing vessels, without some kind of metal reinforcement, is no more than 75 m. Sleeswyk believes that the chang measurement was a mistake made by later chroniclers. Based on more realistic, historically documented measurements used for Chinese craft, Sleeswyk estimates that the largest of Zheng's ships had a length of no more than about 62.5 m.

Although these vessels may not have been the towering floating fortresses of mythical proportions as previously believed, nonetheless they were obviously exceptionally large ships, the construction of which is no less impressive. The shipwrights who built these legendary craft may very likely have benefited from the developing hybrid construction techniques combining Southeast Asian and Chinese construction methods. Considering this to be true, we may now have a better idea of how such large vessels were successfully built in ways other than the
"traditional" Chinese manner which, in and of itself, would probably not have been able to produce sound enough vessels of similar dimension.

During the mid-fifteenth century, China, yet again, was torn by political factionalism and continually weakened by the harassing threat of barbarian invasion along the northern borders. The treasure-fleet expeditions were terminated, and official Chinese support of maritime affairs declined such that by 1474 the Chinese navy was in tatters. By the time the Portuguese, and the other Europeans who were to follow, had made their presence known in Asia, China had fallen from the pinnacle of maritime prestige back to a state of landlocked isolationism and Sino-typical xenophobia. Of the ensuing contact between East and West, Joseph Needham wrote:96

So this was the confrontation. On the one hand there were the voyagers from the East, the Chinese, calm and pacific, not encumbered by heritage of enmities, generous (up to a point), menacing no man's livelihood, tolerant, if a shade patronizing, in panoply of arms yet conquering no colonies and setting up no strong points. On the other hand there were the voyagers from the West, the Portuguese, Crusader traders out to take hereditary enemies in the rear, wrest a mercantile foothold from unsympathetic soil, hostile to other faiths yet relatively free from racial prejudice, hot in the pursuit of economic power and heralds of the Renaissance. In all the maritime contacts between Europe and Asia in that dramatic age, our forefathers were quite sure who the 'heathen' were; today we suspect that these were not the less civilised of the two.
In a far less maudlin way than Needham, J. P. Lo summarizes for us China's position during the first half of the second millennium as:

Broadly speaking, the maritime expansion of China during the late Sung, Yuan and early Ming periods was the cumulative result of changing sociological conditions arising from climatic and geological disturbances, political unrest, and the pressure of alien invaders from the Northwest. The movement of the populations to the coastal regions and out to sea, the orientation of the nation towards the Southeast, the interest of the people, even the scholar-official class, in maritime affairs and technological development, and the attention which the government paid to commerce and to the development of the navy, all illustrate the inconstancy of social characteristics commonly attributed to the Chinese and the inconclusiveness of general statements made about them. Social characteristics change under the compelling forces of nature and general statements blur our view of the facts and dynamics of historical change. We cannot discern the zigzags in the course of the historical and cultural development of a people like the Chinese if we remain so close to the ground that we become preoccupied with ... "the episodical aspects of conventional historiography," but we can see them quite clearly if we stand upon an eminence where we can survey the wide sweep of each epoch of Chinese history.
Notes


2Ibid., p. 88.


4Fairbank, supra n. 1, p. 92.


10S. Lee, tran., The Travels of Ibn Battutah, p. 172.


13C. A. Buss, Asia in the Modern World: A History of China, Japan, South and Southeast Asia, p. 54.

14Ibid., pp. 54-55.


19Buss, supra n. 13, pp. 77-78.


21Buss, supra n. 13, p. 13.

22Fairbank, supra n. 1, p. 108.

23Buss, supra n. 13, p. 13.


27M. Hane, Premodern Japan: A Historical Survey, pp. 61-106.

29B Cumings, *Korea's Place in the Sun: A Modern History*, p. 44.

30Endicott-West, supra n. 24, p. 151.

31Buss, supra n. 13, p. 13.


34Shamen University Department of History, supra n. 33 p. 22; Quanzhou Research Group, "Song Dai de Tong Qian Chukou (The Exportation of Copper Coins During the Song Dynasty)," *HaijiaoShi Yanjiu* 1 (1978): 50-54.


36Green, supra n. 32, p. 253; Quanzhou Research Group, "Quanzhou Wan Song Dai Hai Chuan Fu Yuanchu Tan (Recent Recovery of a Song-Dynasty Ocean Vessel in Quanzhou Bay)," *Wen Wu* 10 (1975): 28-30.


38Keith, supra n. 35, p. 126, fig. 7; B. Yang, "Dui Quanzhou Wan Song Dai Hai Chuan Fuyuan de Jidian Kanfa (A Reply on the Original View of the Song-Period Oceangoing Ship from Quanzhou Bay)," *HaijiaoShi Yanjiu* 4 (1982): 35.
39J. Z. Ge, "Quanzhou Song Dai Gu Chuan (The Ancient Song-Period Quanzhou Ship)," Haijiaoshi Yanjiu 2 (1989): 84-86; Quanzhou Research Group, supra n. 36, pp. 29-35.

40Quanzhou Research Group, supra n. 36, pp. 29-35.

41Green, supra n. 32, p. 258.


44Green, supra n. 32, p. 256.

45Ibid., p. 258; Quanzhou Research Group, supra n. 36, fig. 7.


47Ibid., p. 305.

48Ibid., p. 305.

49Ibid., p. 306, 311.


51Tianjian City Cultural Relics Administration, "Tianjian Jinghai Yuan Menkou Song Chuan de Fajue (The Excavation of a Song Vessel at Jinghai Near Tianjin)," Wen Wu 7 (1983): 54.

52Ibid., pp. 57-58.


54C. Blunden and M. Elvin, Cultural Atlas of China, pp. 120-121; P. Ebrey, "The Golden Age of Tang and Song,"

55R. Whitfield, "Chang Tse-Tuan's *Ch'ing-Ming Shang-Ho T'u*," Ph.D. diss., Princeton University, p. 244.


57Whitfield, supra n. 55, pp. 126-127.

58Anon., *Chinese Art Treasures*, vol. 5, p. 44.

59Whitfield, supra n. 55, p. 77.

60A. Priest, *Ch'ing Ming Shang Ho Spring Festival on the River: A Scroll Painting (Ex. Coll. A. W. Bahr) of the Ming Dynasty after a Sung Dynasty Subject*, pl. 6.


64Youn, supra n. 62, p. 83.


74 J. S. Stavorinus, Voyages to the East Indies, p. 93.


76 Manguin, supra n. 72, p. 16; M. Y. Hashim, "Perdagangan dan Perkapalan Melayu: Rujukan Khusus Kepada Bentuk Perdagangan dan Perkapalan Melaka di Abad ke-15/16 (Malaysian Trade and Shipping: Sources Concerning the Particular Form of Trade and Shipping at Malacca During


78 Smaller vessel, however, have been found built in the traditional lash-dowel manner, as pointed out by A. H. Taha in "Masalah dan Persoalan Semasa Mengenai Arkeologi Maritime di Semenanjung Malaysia (Questions and Problems Concerning Malaysian Maritime Archaeology)," in Kapal dan Harta Karam (Ships and Sunken Treasure), ed. M. Y. Hashim, pp. 135-136.


85S. A. Huzayyin, Arabia and the Far East, p. 9.

86R. Baldwin, "The Interchange of European and Asian Navigational Information in the Far East Before 1620," in
500 Years of Nautical Science, 1400-1900, ed. C. D. House, p. 82.


90M. D. Lo, Xi Yang Ji (Record of the Western Ocean), pp. 3-4.

91Pao, supra n. 89, p. 2; see also, Z. X. Li, Long Chuan Chang Zhi (Record of the Dragon River Shipyard), part 2.


94Ibid., fig. 2; H. Ma, Ying-gai Shen-lan (The Overall Survey of the Ocean's Shores [1433]), tran. J. V. G. Mills, pp. 304-306.


CHAPTER VI

SUMMARY AND CONCLUSIONS

From the time of the fifteenth century, as Europeans ventured into Eastern seas, they bore witness to a maritime realm that was all too often beyond their full appreciation. These sailors, soldiers, merchants and missionaries; these conquerors of lands and souls -- the harbingers of the Great Age of Discovery -- were certainly not the first from the West to travel the passages of the eastern hemisphere. But they, and others later, would indeed have as great an impact on the Asian world than any before them -- an impact that is plainly apparent today.

An analysis of the changes that occurred in maritime Asia after the advent of European colonization would require a separate study altogether. We should not, however, overly assume the influence the West had on Asian maritime affairs. Certain vessels from certain regions adopted some Western features. But a great number of craft continued to be built in traditional ways. This remains true even today, but to a far lesser degree.

The beginning of Asian maritime history is linked to the movements and migrations of early humans and human population groups. Archaeological remains dated to the Upper Paleolithic period indicate that humans have roamed
the Asian continent for more than 50,000 years. In
Australia archaeological evidence may indicate that humans
arrived there sometime between 80,000 and 100,000 years
ago, which would further indicate that humans inhabited
the Asian continent far earlier than originally believed.\(^1\)
Early migration to what are now island areas, such as
Japan and Sri Lanka, was most likely possible because of
land bridges created by lower sea levels during the
Pleistocene. For humans to travel as far as Australia,
however, required some form of watercraft. Exactly what
type of vessel this was is debatable. Adrian Horridge
contends that Australoids migrated to Australia by raft.\(^2\)
This is a likely assumption, and, if true, it also implies
that those watercraft that predate the raft are older
still.

The earliest forms of watercraft were simple flota-
tion devices. From these were developed the raft and the
dugout, as well as a number of other vessel types such as
the skin boat, basket boat and bundle boat. The two
vessel types that had the most influence on the develop-
ment of Asian watercraft, however, were the raft and the
dugout, but which of these two appeared first is
uncertain. Written documentation indicates that as early
as the fourth millennium B.C., humans in China were
crossing streams and rivers on rafts and raft platforms
with gourds attached beneath them. In time rafts were developed into rather elaborate vessels, and the sailors of these craft ventured further away from inland waters and out into the open sea.

Whether or not the raft predates the development of the simple dugout is not known. Horridge contends that because the first Australoids who sailed to Australia were not equipped with the tools to create a dugout, these early mariners therefore must have used rafts. He does not elaborate, however, on precisely what tools he believes would have been required to build a vessel other than a raft. Unless the earliest rafts were made from material that could simply be collected, such as pieces of driftwood, fallen logs or similar objects, then timber for the raft would have to be cut, and any tool capable of cutting this timber could also likely be used to create a dugout. We know that builders have constructed dugouts using tools made from seemingly inappropriate material such as mollusk shells. Many might mistakenly assume that these types of tools were far too fragile to accomplish the task, whereas, in fact, they performed quite adequately. Therefore, if we are basing our evidence only on the tools available to prehistoric humans, then the dugout could very well have been developed as early as the raft. With no more material evidence than what we have
today, however, we must continue to rely on conjecture to answer this question.

Of particular importance is the development of vessels fitted with side strakes which, in turn, resulted in the creation of more diverse types of watercraft. The earliest evidence of a plank-built vessel in the Indian Ocean region may be from a representation painted on a piece of pottery dated to the fourth millennium B.C., but this is highly conjectural. Better evidence, dated roughly to the third millennium B.C., is found on Southeast Asian kettle drums depicting sizable, crescent-shaped craft, many of which obviously were used in warfare, and possibly constructed of a variety of materials. The design of these vessels was likely based on the built-up dugout, and the planks were probably attached with some type of ligature. The earliest material evidence available of a Southeast Asian vessel having ligature fastening is the Pontian boat from Malaysia. This vessel, dated to the third century A.D., has planks attached with dowels, lashed lugs and ligature fastenings along the planking seams. This form of construction was probably being developed in South and Southeast Asia at least 20,000 years ago. Before this, planks added to simple dugouts were perhaps attached with only ligature fastenings without dowels. Interestingly,
in South Asia, based on contemporary evidence, laced planking is common, whereas in Southeast Asia vessels were more often constructed having lashed planking. The difference between the two is that in laced construction a single, continuous line of ligature fastening is used, and in lashed construction, planks are joined by shorter, separate lengths of fastenings.  

Archaeological remains of the Butuan boats in the Philippines indicate that, between the fourth and thirteenth centuries A.D., a transition was occurring in Southeast Asian ship construction. Boatbuilders were relying more and more on lashed lug planks, fastened together with dowels. The lashing of planking seams, such as that on the Pontian boat, was no longer done.

The development of East Asian vessels has been a subject of some debate, particularly concerning Chinese craft. The conventional view that Chinese vessels have evolved from the raft has certain merit. Possible evidence of this can be seen in those craft with hulls that have no keel, are flat-bottomed, hard-chined and with square ends. This, however, does not apply to all Chinese vessels. Documentary evidence indicates that some types of Chinese watercraft originated from the dugout, and this evidence is further supported by the archaeological remains of vessels found in southern China.
The Song-dynasty Quanzhou and Ningbo vessels are both sharp-bottomed craft with keels. Whereas the Ningbo vessel was apparently built having only a single layer of planking, the Quanzhou vessel was built in a complex manner using both lapstrake and flush-laid planking. The reason for the Quanzhou vessel's rather unusual type of construction and the history behind it is uncertain. Likely, however, neither the Quanzhou nor the Ningbo vessel represent an evolutionary stage relative to one another. Instead, they probably are simply two different types of southern Chinese vessels that were constructed in different ways. What they do prove, however, is that at least during the early centuries of the second millennium A.D., some Chinese vessels were sharp-bottomed and had keels. This fact alone, however, does not necessarily indicate a dugout ancestry. Nevertheless, considering the documentary evidence indicating that Chinese vessels of the pre-Christian era were developed from the dugout, and what we know about the development of vessels elsewhere in the world, these southern-type vessels provide strong evidence that they too may have a dugout ancestry.

The Quanzhou and Shinan vessels further prove that at least during the Song and Yuan dynasties, some Chinese ships were built using lapstrake planking. Ship
representations painted on silk scrolls from the Song period may indicate this form of construction.

Apparently there has existed in China a southern and a northern shipbuilding tradition, geographically divided somewhere near Hangzhou. Vessels of the southern type characteristically have sharp bottoms, such as the Quanzhou, Ningbo and Shinan vessels. Those of the northern type are more like the watercraft that have been considered as traditionally Chinese, with flat, hard-chined bottoms, no keels and square ends. These craft may very well have been based on the raft rather than the dugout. Certain features associated with some vessels, however, indicate that even flat-bottomed craft may have some ancestral connection with the dugout. Among several of the interesting elements found on the flat-bottomed Jinghai vessel, such as knees and lapstrake planking, are the chine planks used in the bottom planking assembly. Evidence from Korea, India and Sri Lanka indicates that some flat-bottomed vessels were built having chine girders formed from either a pair of dugouts or a single dugout longitudinally split in two. The Jinghai vessel therefore may have at least some connection with the dugout, and it may also represent a development in construction in which chine planks replaced the more robust chine girders when iron fastenings became common.7
The Jinghai vessel, as well as two older watercraft dated to the Tang dynasty, rely on floors or half frames along with crossbeams to internally strengthen their hulls. In contrast, the Ningbo and Quanzhou vessels have bulkheads combined with frames. This, I believe, may indicate that the bulkhead, rather than emerging fully developed in antiquity, was developed from frames combined with crossbeams (or, in some cases, thwarts). Over time the number of crossbeams increased and, being placed one above the other, they eventually formed a single unit, thus evolving into the bulkhead. In Korea and Japan, however, shipwrights apparently continued to rely mostly on crossbeams, but the use of bulkheads cannot be ruled out.

Throughout Asia shell-first construction predominated and the most common vessels were those with a dugout ancestry. In both South and Southeast Asia, ligature fastenings predated dowels, and it appears that a transition occurred in which ligatures were replaced by dowels, and dowels were eventually replaced by nails. Particularly in South Asia, however, all three of these fastening methods still exist, indicating that whatever transition occurred was far from universal, thus we are yet unable to establish an accurate chronology for this aspect of vessel development.
In Southeast Asia archaeological evidence suggests that during the first half of the second millennium A.D., a hybrid type of oceangoing vessel was emerging that combined Chinese and Southeast Asian construction methods. By comparing the Ko Si Chang 2 and Pattaya wrecks with the Quanzhou, Ningbo and Shinan vessels, we can begin to see what this emerging hybrid type may have been. Each of these vessels have certain features in common such as sharp, V-shaped hulls with keels. These features are believed to be of Southeast Asian influence. Each vessel also has bulkheads, nailed planking and, at least in some instances, stern rudders, all of which may have been of Chinese influence. The vessels of this "South China Sea tradition" were seaworthy craft. Their design, which probably continued to develop into at least the seventeenth century, may have been followed by the shipwrights who built the legendary ships sailed by Zheng He.⁹

European colonization had a profound impact on many aspects of Asian economy, society and politics. In the realm of shipping, native shippers often altered their traditional trade routes in order to capitalize on the demand for goods at European trading factories, and those communities that, for whatever reason, did not or could not participate became increasingly isolated. Changes
also occurred in vessel construction whenever enterprising shipwrights adopted what they thought to be superior design elements from European vessels. Most often this resulted in the way shipwrights rigged their vessels, such as the pinisi schooner rig of Sulawesi, but occasionally hull design and the way planks were attached were altered to resemble Western counterparts. Many perahu throughout the Great Sunda Islands have schooner-like bows and planking attached with iron nails, and in China the vessels generically called "lorcha" were often rigged with Western-style topsails and sometimes a jib.¹⁰

Thus, there is no doubt that Western vessels had a certain amount of influence on the development of native Asian craft. The majority, however, continued to be built in traditional ways. On the islands of Bali and Madura, traditional craft continue to be used and can still be studied. This is rapidly changing, however, with the introduction of motorization, which is a modern example of Western influences altering the evolution of Asian vessels.

This study has provided only a brief overview of the development of Asian watercraft. The information currently available on the history of these important and often unique vessels is limited. We still understand very little about the development South Asian vessels, for
example, and our knowledge of Southeast and East Asian vessels is only slightly better. While there is always the exciting possibility that information may be gained from yet undiscovered artistic renderings or textual documentations, of more immediate concern, however, is the need for research on the actual traditional watercraft that still exist today. The ambition of shipwrights and sailors to modernize their vessels, especially in South and Southeast Asia, will likely cause the extinction of traditional watercraft within a decade or two. Documentation of these traditional craft will provide valuable information that can help us better understand the data that has been collected from the archaeological record as well as the data that, with luck, will be discovered in the future.

Although the study of existing watercraft is of vital importance, ultimately, however, the greatest amount of information about the development of Asian vessels will come through archaeological research. Important archaeological work has been done, and the potential for further important work is great, but presently this research is slow in coming. Politics and economics have always played, and probably will always play, a decisive role in the research that can and cannot be done, and where and when it will be conducted. Nevertheless, the
importance of this research outweighs whatever difficulties that may impede the way.

The history of maritime Asia constitutes a major portion of the history of the world. If we endeavor to understand the history of the world, we must therefore continue our endeavors to understand the developments of Asian ships and other nautical affairs that have been so vital to many of the Asian peoples and to the maritime history of Asia as a whole.
Notes


3. Ibid., pp. 95-96.


7. Tianjin City Cultural Relics Administration, "Tianjin Jinghai Yuan Menkou Song Chuan de Fajue (The Excavation of a Song Vessel at Jinghai Near Tianjin)," Wen Wu 7 (1983): 54.


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# APPENDIX I

## THE DYNASTIES OF CHINA

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<td><strong>Shang</strong></td>
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<td><strong>Zhou</strong></td>
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<td><strong>Ming</strong></td>
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<td>Southern Ming</td>
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<td><strong>Qing</strong></td>
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APPENDIX II

THE YICHANG DRAGON BOAT

The Spencer Model Collection

Ship models, like other works of art, have aesthetic appeal, attracting both the novice and expert alike. In fact, simple attraction, and a fascination with watercraft, was what lured the late Joseph E. Spencer, Professor of Geography at the University of California, Los Angeles, to purchase his first model of a Chinese river vessel.

In 1934, while studying native transportation systems, Spencer lived near the busy port of Yichang on the Yangzi River (Fig. 60). In daily contact with a multitude of Chinese watercraft, Spencer became increasingly interested in the numerous, and often unique, ships and boats plying the Yangzi and its tributaries. As a result, he began learning as much as he could about these craft, and eventually commissioned a Chinese model builder to construct, on an almost full-time basis, additional models representative of the native vessels of central China.

Chinese craftsmen, at the time, enjoyed a rather lucrative business producing ship models of native craft which they sold to Western tourists, often at exorbitant
Fig. 60: A map of central China's Yangzi River Basin. (Map author)
prices. A good percentage of these models, however, were wildly stylistic in design, little resembling the actual boats they were intending to depict. Even other, less fanciful examples were still often limited in their accuracy. Because of this, Spencer provided his commissioned model builder with photographs and a host of technical details so that each model in the collection depicted the actual vessel as accurately as possible. However, for various reasons, as Spencer pointed out, a few of the models in the collection, such as the crooked stern junk (Appendix III), do have some structural and stylistic inaccuracies. Nevertheless, the majority of the collection, totaling over 29 models, are exceptionally precise. Thus, these ship models have not only an aesthetic appeal, but also an important, singularly pragmatic value, in that they are among the few remaining representations of a once vital nautical culture.

Over the years tempting, lucrative offers were made for the purchase of individual models from the collection. Spencer, appreciating the importance of keeping the collection intact, wholeheartedly refused to consider any of these offers. Spencer did realize, however, that his collection would eventually require a permanent home with conditions better than the attic and living room of his own house, where the models could be properly displayed
and utilized by a future wider audience. Spencer agreed to donate his collection to the Department of Geography at Texas A&M University. Since 1974 the collection has remained intact there and is now temporarily in the possession of the Nautical Archaeology Program, which is providing conservation maintenance for a few of the models. Included in the collection is a model of an Yichang dragon boat which provides a fairly accurate artistic representation of a class of vessel considered to be rather atypical of traditional Chinese craft.

**The Chinese Dragon Boat and Its History**

The famous Dragon Boat Festival of China began as a commemorative event marking the tragic death of the poet and statesman, Qu Yuan. Qu, who lived during the Zhou Dynasty (fourth century B.C.), was noted for his literary criticisms concerning the rampant corruption of the government and its political officials. Qu's opponents were quick to find means to degrade and dishonor him. As reflected in his poetry, Qu was eventually beaten into emotional submission. Legend claims that on the fifth day of the fifth moon of the lunar calendar, a fisherman came upon Qu wandering along the banks of Lake Dongting in Hunan Province. When the fisherman asked how the great minister had fallen so low, Qu replied, "The world is foul, and I alone am clean. They are all drunk, and I
alone am sober. So I am dismissed." The fisherman, who seems to have possessed a singularly odd form of philosophy, replied: "The true sage does not quarrel with his environment, but adapts himself to it. If the world is foul, leap into the tide and make it clean; if all men are drunk, drink with them and avoid excess." 2 Soon after the fisherman had departed, Qu Yuan picked up a large stone, and flung himself into the depths of Lake Dongting, thus ending his life and, hopefully, his shame. Moved by the death of such an insightful statesman, Qu's fellow countrymen launched a fleet of boats and searched, in vain, for his body.

Over the years the search for Qu Yuan became an annual event and eventually a national holiday. The attendant boating events soon developed into colorful and raucous competitions, the competing vessels honoring Long Wang, the dragon king of the river gods.

Although there were a number of minor variations in the design and construction of dragon boats, certain primary features remained consistent from one geographical location to another that set these craft apart from the traditional manner of Chinese vessel construction. This has caused considerable speculation as to the possible origins of these vessels. The similarity in appearance to the vessels of the Dongsong and other Southeast Asian
cultures has given rise to the theory that the dragon boats of China may have originated with, or at least been influenced by, those of China's "barbarian" neighbors. Nevertheless one can just as easily argue that Chinese dragon boats represent an ancient vessel type, possibly some form of war canoe, developed independently in China and over time superseded by the more common type of keelless, flat-bottomed, hard-chined watercraft so frequently described in the literature.³

One of the characteristics that have caused such speculation concerning the origins of the dragon boat is the long, canoe-like shape of the vessel's hull (Fig. 61). Another is the use of a keelson. Traditionally the construction of a dragon boat began by shaping and laying down the keelson. Ideally the keelson was made from a single piece of wood, but since the size of a boat could reach lengths of anywhere from 16.5 m to over 33 m, timber of suitable size was often unavailable or too expensive to obtain. When this was the case, several pieces of wood, scarfed together, were used to create this important strengthening member. After the finished keelson was set in place, two hardwood planks, joined edgewise, were positioned beneath it. Next, 12 to 18 bulkheads, depending on the vessel's length, were shaped and slotted into position over the keelson.
Fig. 61: The Yichang long quan. This model of a "dragon boat" of Yichang, from the Spencer collection of Chinese junks, represents the type of craft that was raced during the clamorous Dragon Boat Festivals held annually in China. The hull, painted in bright and gaudy colors of red, green, yellow and gold, depicts the body of the dragon, with its intricately carved head and tail attached to the bow and stern. On the blade of each paddle and on the flag, held by the flag bearer in the stern, Chinese characters boldly proclaim that this is the Taoge Shao Lao Hong Long ("Old Red Dragon from Little River Bend"). (Photo author)
Interestingly, the side planks (numbering three to a side) were not built up one after another from the bottom of the hull, as is generally customary in boat construction. Instead these strakes were shaped and then nailed together, forming two side units of three strakes each, before being muscled into position and attached to the bottom planking. These boats, with only a few exceptions, were usually dismantled after the festivities and used for firewood. This explains why there was little concern for long-term durability, and perhaps why builders apparently made no attempt to fasten any of the bottom or side planking to the internal framing members. G. R. G. Worcester explained that once the side strakes were fastened to the bottom planking, ropes were passed at intervals beneath the hull and then hove down with a Spanish windless, whereby the planking was forced against the sides of the bulkheads, "and thus the boat [was] shaped."  

A stringer, running along the top of the bulkheads, provided some internal strength, but mainly served as a platform for the gangway planking. Of more importance was the heavily woven bamboo rope that ran along the length of the hull, atop the bulkheads. One end of the rope was looped over the stern and the other over the bow.
Tourniquet-like tension was produced by inserting small poles through the rope's strands and twisting the poles, thus creating a hogging truss to support the hull's ends.

Some observers have argued that the hogging truss of the Chinese dragon boat indicates a Mediterranean source of influence because of its assumed similarity to the hypozomata used on ancient Grecian triremes. Here again, regardless of the similarities, it is just as likely, in fact more likely, that the Chinese developed this technology independently. Also, keels (longqumen, or "dragon spines") and keelsons were not foreign concepts to the Chinese boatbuilder. As for the long, canoe-like design of the dragon boat, it is possible that it originated in Southeast Asia. On the other hand, this design may very well indicate a dugout origin for at least one type of vessel developed in China.

The dragon boat in the Spencer Collection represents those that were built near the town of Yichang during the 1930s. The crew, typical of most dragon boats, consisted of a flag bearer in the stern, a coxswain at the helm, a drummer and the shou_shao in the bows commanding the paddlers (Fig. 62). The number of paddlers, however, is only symbolically represented by the model. The average boat of 16.5 m (beam of 1 m 15 cm) would carry 36 paddlers seated in pairs on 18 bulkheads. Here only nine pairs of
Fig. 62: The shou shao stands in the bow of the dragon boat. His job was to direct the energetic efforts of the paddlers. After the race, and before the boat was dismantled for firewood, the ornately carved head and tail of the dragon were removed and stored until the next year’s festivities. (Photo author)

paddlers are represented. Nevertheless, the head and tail of the dragon, attached to the ends of the keelson, are accurately depicted. If this were an actual vessel, these spiritually important ornamental features would be removed, before the vessel was dismantled, and stored for use on the next year’s dragon boat.
Notes


5J. E. Spencer, Junks of Central China: The Spencer Collection of Models at Texas A&M University, pp. 74-75.
APPENDIX III

THE CROOKED STERN JUNK

Created by the runoff waters from the Dalou Mountains in Sichuan Province, the Gongtan He (Gong Rapids River), a tributary of the Yangzi River, is infamous for its rough and turbulent currents that shoot through the deep, vertical gorges just above the town of Fuling. In order to navigate this dangerous section of the Gongtan He (more commonly known today as the Wu River), a type of vessel classified as the "crooked stern junk" was developed which, from a Western viewpoint, was one of the strangest, most intriguing vessel types unique to China (Fig. 63).

The origin of these vessels is uncertain. According to legend, an ancient dragon, recently retired and desiring a less stressful life-style in his old age, decided that controlling a river would be an easy and relaxing way to make a living. After careful consideration, the dragon took up residence along the Wu River because he believed the rapids of this infamous waterway could not be navigated, thus alleviating him of the troublesome responsibilities of dealing with shipping traffic. Irked by the smug assuredness of this old worm, Lu Ban, the carpenter god, decided to shake up the dragon's life a little by building a junk that, having a specifically designed crooked stern, could navigate the
Fig. 63: The crooked stern junk from the Spencer Model Collection. Known as the waipi qu or houban quan, the crooked stern junk was built specifically to sail the turbulent waters of the Wu River in Sichuan Province. This unique craft usually carried a cargo of salt and occasionally other commodities. Since she carried no sail (the mast shown here was for trackers' lines), three large steering sweeps, one forward and two aft, and four side sweeps were used to steer and control her. (Photo author)
turbulent river. The dragon, flabbergasted by this invasive new development, which threatened to increase his otherwise nonexistent work load, besought Lu Ban to build no more crooked stern junks. After some deliberation, and considerable finagling by the dragon, Lu Ban finally agreed to the dragon's wager that no such watercraft would ever be built again provided that he, the carpenter god, failed in constructing a pagoda without nails. In very little time, and much to the dragon's chagrin, Lu Ban succeeded in performing this miraculous feat. As a result, the dragon was required to look after the welfare of the mariners on the Wu River, especially those who sailed crooked stern junks.¹

Lu Ban and the Dragon of Wu River notwithstanding, the reason behind the design of theseparticularly unusual river craft has caused considerable speculation. Although salt was the most common cargo carried by crooked stern junks, other items were occasionally shipped beyond the rapids. Transferring this cargo to and from a crooked stern junk was usually done directly from ship to ship. This led some early nineteenth-century observers to speculate that these vessels' twisted form created a lower freeboard on the starboard side which facilitated the loading and unloading of cargo. Considering that the forward starboard side was no lower than the port, however, it is unlikely that cargo handling had any
influence on the development of such a drastic design. Another explanation claims that a junk, after being constructed by a certain respected master builder, unintentionally warped into a peculiar, crooked stern shape. Out of respect, other builders thereafter deliberately designed their vessels to have a crooked stern so the master would not lose face. A third and somewhat more plausible speculation on the vessel's design was that the crooked stern permitted these craft to navigate the sharply angled, right-handed bends encountered while sailing the river downstream. This alone, however, does not account for the fact that the crooked stern junk sailed up river as well as down, and had to negotiate both right- and left-handed bends. Nevertheless, the real reason behind the design of these vessels does concern the manner in which they were steered. To appreciate this more fully, however, we need to look at least briefly at how these vessels were constructed.²

Many firsthand accounts of the crooked stern junk's construction were less than flattering. Some Western observers disparagingly characterized these craft as being merely Oriental oddities, while others vehemently declared they were dangerous, rickety deathtraps, indicative of the Chinese inability to appreciate the science of nautics. Even the standard Chinese name for the crooked stern junk,
waipi qu, does not have a particularly adulatory connotation -- "crooked, flatulent buttocks". In reality, however, the crooked stern junk, or houban quan ("thick-planked boat", the name given these vessels by native sailors and carpenters), was the result of long and ingeniously conceived planning and design.\(^3\)

To construct a crooked stern junk, the builder first laid down five or more planks, often of various lengths, and joined them together edgewise with large, square clincher nails. These maple or cedrela planks, constituting the bottom of the junk, were then hoisted up a few feet at one end and onto a crutch. The top of the planking at this end was soaked with water; the underside was smeared with mud. A large fire was then kindled beneath the planking, and heavy stones were used as weights to bend and twist the wood into the desired crooked stern shape (Fig. 64).

After the wood cooled, the structure was flipped over, and to it were clamped the horizontal, edge-joined planks that, when built up, formed the vessel's bulkheads, the primary lateral strength of the hull. Next, beginning with the bilge strakes attached to the bottom planking, the flush-laid side strakes and wales were then fastened by clenched iron nails to the bulkheads, to each other, and to nearly anything that would hold them. At this point, before the nails and other fasteners were
Fig. 64: Stern sweep configuration. The large main sweep of the crooked stern junk was hung by a cheek piece positioned over a boomkin on the port-side taffrail. The smaller auxiliary sweep was positioned on the lower starboard side and, working in a different plane, could be used simultaneously with the main sweep without interference. The helmsman worked the main sweep from a startlingly precarious flying bridge above the deckhouse. The two upper and lower foot planks of the bridge have been removed from their position to show the mortises used to attach them to the top of the stanchions. Large stones lashed to the looms helped balance the heavy steering sweeps. The stone on the auxiliary sweep of the model, however, has slipped so that now it incorrectly hangs below the loom; unfortunately, the control lines associated with the sweeps are inadequately depicted. (Photo author)

permanently driven home, the hull looked a little like an over-stressed pin-cushion.

The deckhouse, with its center usually positioned near but slightly aft of midships, was larger and higher than those of other types of junks and could accommodate upwards of four bunks. The galley, located outside the deckhouse, took up the compartment space formed by the
bulkheads that supported the loosely decked area near the stern. Forward of this, seven similar compartments served as cargo holds. The deck space forward of the cabin, contrary to what one might predict, was not used to stow cargo. The reason for this was because the vessel, carrying no sail, heavily relied on oarsmen, who (traditionally clad in only broad-brimmed, bamboo hats and simple loin thongs) worked the oars by walking the looms forward and back along the deck's length. It was therefore necessary that the deck space remain empty.4

Up river into the rapids, the current was too strong for rowing alone. At this point, the tracking mast, stowed in the deckhouse, was brought out and stepped in the second compartment aft the bow. This mast, extending approximately 2.4 m above deck, was mainly used as a Spanish windlass to heave a rapid. Occasionally, however, it served as a bollard to which trackers' lines were made fast. On shore harnessed men, hitched to the tracking line, would haul out and, by muscle power alone, literally heave the vessel over the rapids. But the tracking mast itself was really only sturdy enough to handle easy water, thus its function was largely auxiliary. When tracking in fast water, three lines each were secured to the first and, if necessary, second tracking beam. Both of these sturdy beams were located, one in front of the other, near the bow.5
The design of the crooked stern junk reflects an imaginative technology that provided propulsion and steering control in an otherwise nearly un-navigable environment. Conditions under which these vessels operated ranged from rock-strewn passages so shallow that it was hard to tell whether a vessel was sailing or sliding, to deep, narrow ravines where the rapids, slamming against one stone wall after another, created such deep, violent whirlpools that vessels were in constant threat of being capsized and crushed against the sides of the gorge. Because of these conditions, stern-mounted balance rudders, as used on other river craft, were useless. In less turbulent waters, the depth at which the blade of these rudders ran through the water could be adjusted, but on the Wu River, even the most expert helmsman and crew were unable to hoist a stern rudder quickly enough to avoid shattering it on a shallow river bottom. To avoid this eventuality on other rivers, boats were fitted with a rudder that had a blade surface more elongated horizontally. In this way, the majority of mechanical leverage of the blade against the water occurred fore and aft along the blade's width, or length, rather than its height. This allowed a shallower blade depth, thus minimizing the possibility of dragging the rudder. But even this was inadequate for the Wu River.
To obtain the proper steering leverage, the crew of a crooked stern junk relied on three large sweeps, usually used in tandem. These sweeps, constructed of two to three hardwood tree trunks lashed together, were often longer than the overall length of the vessel itself (large crooked stern junks were 21 m to 27 m in length with a beam of 4.8 m to 5.7 m and drew 1.5 m to 1.8 m of water fully loaded). The two most frequently used sweeps were the bow sweep, positioned in a thole-like projection on the forwardmost beam of the hull, and the large stern sweep, to which was attached, at its point of balance, a hook-like cheek-piece. The sweep was then hung by this cheek-piece from a taffrail boomkin, providing a fulcrum on which the sweep pivoted.

Authorities on Chinese vessels, such as G.R.G. Worcester and L. Audemard, have stressed the importance of the second, smaller stern sweep and its influence on the unusual design of the vessel. Both propounded that two stern sweeps were needed to adequately conn the junk. In order for these two sweeps to function without interfering with one another, however, they had to be operated from two vertically separate planes; thus, the ingenuity of the crooked stern design. By twisting the stern so one side terminated higher than the other, the sweeps could work in unison on different radii in separate planes. The large stern sweep was operated from the rickety flying bridge,
positioned above the deckhouse, and the smaller sweep was worked from the afterdeck.\textsuperscript{6}

J. E. Spencer, who actually travelled several times aboard crooked stern junka, convincingly argued, however, that the smaller stern sweep had little to do with the design of these vessels. He pointed out that it was merely an auxiliary feature, usually used only during extreme conditions, and was not important enough to warrant such an unusual development in boat design.\textsuperscript{7}

The primary means of steering control was provided by the large stern sweep, with the bow sweep following second in importance. The mechanical stress placed on the main sweep necessitated that its point of attachment to the hull be strong enough to support it. But the crooked stern junk had no keel or any structural feature robust enough in itself to fulfill this requirement. In answer, Chinese boatbuilders created a warped transom stern whose port side twisted far enough over to stand along the longitudinal centerline of the hull, providing a kind of keel-like strength, adequate enough to support the main sweep. The stern's height also made possible the efficient simultaneous operation of the two stern sweeps and, moreover, positioned the larger sweep at an angle sharp enough to increase leverage and steering control.

Another question concerning crooked stern junka has to do with why the twist in the vessels' stern was
apparently always oriented toward the starboard side? The few existing photographs, models, and other representations depicting these vessels all indicate that the stern's port side was higher than the starboard. Adherence to tradition, a strong factor in the history of ship design, may provide an answer, but not a very satisfying one. One armchair explanation, albeit a very poor one, suggested that the port-side positioning of the main stern sweep related to the handedness of the average helmsman. The main stern sweep, hung from the port taffrail, was more easily worked by standing on the left side of the sweep's loom; in other words, a position more readily taken by a right-handed person. Since, statistically, the majority of humans tend to be right-handed, this aspect of the design was developed to accommodate this phenomenon. This is an interesting idea, but certainly one that modern automobile manufacturers have failed to adhere to on an international basis. The real solution to this question may have to do with the physical conditions encountered on the Wu River.

As previously discussed, the stern design may be based on the navigational requirements to steer the vessels through many tight, right-handed river bends. While this fact alone may not be reason enough to justify the development of the crooked stern design, it may, however, indicate why the port side of the stern served as
the point of attachment for the main sweep and, consequently, was the higher of the two sides. Firsthand accounts repeatedly express how right-handed bends were the most severe and frequently encountered conditions while sailing downstream through the vertical-walled gorges of the river. Once the vessel rounded a bend, the helmsman had to work the loom of the sweep hard to starboard in order to negotiate the oncoming whirlpools and to prevent his vessel from slamming onto the rock wall off his starboard side. During this maneuver, the stress placed on the sweep, at its point of attachment on the taffrail, was transferred along the length of the vessel's port-side planking. If the main sweep were hung from the starboard side, much of the stress would be placed on the somewhat lightly constructed transom, thus endangering the structural integrity of the hull. To compensate for this, a stronger transom would be required which, as a result, would increase the cost of construction.8

In summary, the houban quan required sweeps, rather than a balanced stern rudder, to navigate the turbulent waters of the Wu River. In order to provide a point of attachment strong enough for the main stern sweep, and one that also placed the sweep in a position to maximize steering control, the ends of these vessels were intentionally twisted during construction so that one side of the stern terminated near the longitudinal center line
of the hull. This heightened point of attachment, resulting from this configuration, not only facilitated the simultaneous operation of two stern sweeps, but, more importantly, allowed for the large stern sweep to be worked at a more acute angle to the water, thus increasing the sweep's potential leverage. Finally, assuming that the descriptions of downstream conditions on the Wu River were accurate, the river is characterized by sharp, right-handed bends. Negotiating these frequently extreme, right-handed sailing conditions repeatedly placed considerable, single-directional mechanical stress on the main stern sweep. Because of this, the stern was designed so that the main sweep was hung from the port-side taffrail. In this way, the stress experienced at the point of attachment was mainly transferred along the length of the hull rather than across the transom. The conditions encountered while steering in the opposite direction, or while bearing away from the riverbank as trackers pulled the vessel upstream, obviously placed less stress on the structural integrity of the hull.

The crooked stern junk included in the Spencer Collection is of value because so few models of this type of vessel were made or remain in existence. There are a number of problems, however, concerning its accuracy. Spencer explained that it had been completed before he knew much about the design and construction of the houban
quan, and he never got the opportunity to purchase a more accurate replacement. One problem is that the bow is too heavy and low. Another is that both the deckhouse and tracking mast are positioned too far aft, and the mast is twice too high. Planking at the stern, rather than actually being twisted into a crooked configuration, has simply been angled and rounded off, thus merely alluding to the actual shape. The hull itself is built far too smoothly; actual vessels were characterized by their rough and rickety construction, especially the above-waterline planking. Finally, both the main and auxiliary stern sweeps are hung from the side of the taffrail boomkins in a manner opposite to what is usually depicted; and the boomkins are shown as simple, rather weak-looking posts attached to the taffrail, rather than as sturdy, limb-like projections.⁹
Notes


5J. E. Spencer, Junks of Central China: The Spencer Collection of Models at Texas A&M University, p. 31.


7Spencer, supra n. 5, pp. 31-33.

8Herron, supra n. 3, pp. 154-155.

9Spencer, supra n. 5, p. 94.
APPENDIX IV

GLOSSARY

ACTIVE FRAME: A frame or frames serving as a primary means of shaping and strengthening the hull such as in frame-first construction. See PASSIVE FRAME.

BACKSTAY: Any stay employed to support the mast in a fore-and-aft line from the stern. See STAY.

BAYUNGAN: The section of an outrigger boom secured laterally to the sheer of a canoe, particularly those from Bali, Java and Madura. See CEDIK and SENDANG.

BEAM: A transverse timber that supports the decks and provides lateral strength.

BOOMKIN: A small spar projecting from the side of a vessel.

BOWSPRIT: A spar projection forward over the bow of a vessel.

BULKHEAD: A vertical partition usually constructed of multiple flush-laid boards that transverse the internal width of the hull. In many Asian vessels bulkheads were the primary means of internal
strengthening. Watertight bulkheads, often having sealable limber holes (or "fairy gates"), prevented water from entering the rest of the hull.

BULWARK: A planked fence-like structure to prevent waves from coming on deck.

CAPRAIL: A timber atop the sheer strake or bulwarks that defines the upper edge of a vessel's sides.

CARVEL: Flush-laid planking joined edge-to-edge.

CEDIK: The section of an outrigger boom connected to the bayungan and the outrigger float.

CEILING: The interior planking of the hull usually positioned over the inboard surface of the frames.

CHEEK: A protuberance at the bow or stern against which the side planking is stopped.

CLAMP: A thick ceiling strake that adds longitudinal strength to the hull or helps support the deck beams.

CLEAT: A small block of wood fastened to the surface of a timber to attach another timber to it or to act as a stop. See LUG.
CLINKER CONSTRUCTION: See LAPSTRAKE CONSTRUCTION.

CORACLE: A small boat, typically round or oval in body plan, having a framework, made from either bone or wood, covered with animal skin or a woven fabric made from plant material. Some coracle-like craft are actually earthenware vessels, turned on a potter’s wheel, with enough capacity to carry at least a single person.

COURSE: The lowermost square sail. Also called a mainsail, foresail, main course or fore course, depending on the mast from which it is hung.

CURRAGH: A large, often elongated coracle occasionally constructed having a keel.

DEADRISE: The transverse angle the bottom of a vessel forms with the horizontal plane.

DOLOS: A flat, transverse board used to reinforce the sides of Indonesian canoes, particularly those of Bali and Madura. A kind of bulkhead is formed when a large dolos is used or a combination of smaller ones are joined one atop the other.
DOWEL: A cylindrical piece used to align two members. Additional fastenings are usually required to prevent separation of the joint.

EDGE-JOINED CONSTRUCTION: See FLUSH-LAID CONSTRUCTION.

FLOOR TIMBER: A transverse structural member, crossing the keel, that serves as the central piece of a compound frame.

FLUSH-LAID CONSTRUCTION: A method by which planks are positioned or joined edge-to-edge rather than overlapped as in lapstrake construction.

FRAME: A transverse reinforcement timber consisting of one or more components, to which the hull and ceiling planking are usually attached. See ACTIVE FRAME and PASSIVE FRAME.

FRAME-FIRST CONSTRUCTION: The method of ship construction in which hull frames are erected first, and side planking is subsequently attached to them. Vessels built in a frame-first manner are internally strengthened primarily by the frames, which also largely determine the final shape of the hull. See SHELL-FIRST CONSTRUCTION.
FRAMING MEMBER: One or more of the components used internally to strengthen the hull of a vessel. Floor timbers, futtocks, top timbers, bulkheads, dolos-dolos and sendang-sendang are all examples of framing members.

FREEBOARD: The distance between the waterline and the upper deck.

FUTTOCK: One or more of the pieces comprising the middle of a frame other than the floor timber, half frame or top timber.

GARBOARD STRAKE: The lowest strake of planking next to the keel or the lowest side strake of a flat-bottomed hull.

GUDGEON: The fittings down the sternpost into which the rudder pintles fit. See PINTLE.

GUNWALE: The upper edge of the side of a hull, not to be confused with sheer strake.

HALF FRAME: A frame, usually used in pairs, that begins at one side of the keel and spans most of the distance up that side of the hull.
HOG: A bottom, centerline strake that serves as a point of attachment for the garboards. See KEEL PLANK.

HOGGING: A vertical strain on the hull causing the ends to droop and, if sufficient enough, to break away.

HOGGING TRUSS: a fore-and-aft framework or post-supported cable used to prevent hogging.

JIB: The foremost sail set between the masthead and the bowsprit.

JOGGLE: Notches or steps cut into the surface or edge of timber to fit another, as used on some Asian and ancient Egyptian vessels.

KEEL: The main longitudinal timber, or "backbone", of a vessel, providing significant strength to the hull.

KEEL PLANK: A thick bottom plank used in lieu of a keel. See HOG.

KEELSON (Kelson): An internal strengthening timber positioned longitudinally atop the frames along the centerline of the keel.

KNEE: An angular piece of timber used to reinforce the junction of two surfaces. See STANDING KNEE.
LACED (Laced construction): A term referring to the method by which a ligature, formed from some variety of flexible material, is passed through corresponding holes, or similar openings, in order to join and bind together two planks, or similar structural members, creating an apparent, single-ligature, continuous fastening along the line of the resulting seam. This apparent continuous line of fastening passed through corresponding holes along a seam is what distinguishes laced from lashed. A seam joined by separate ligatures is classified as lashed, although these joints may extend along the entire length of the seam. The terms stitched and sewed differ from laced because they imply that a ligature is passed through a material having no previously formed hole or opening through which to do so.

LAPSTRAKE CONSTRUCTION: A method by which planks are positioned or joined such that the edge of one plank overlaps the edge of another. This method of construction is often referred to as "clinker built" which, more specifically, refers to planks joined in a lapstrake manner but fastened together with rivets.

LASHED: See LACED.
LATEEN SAIL: A triangular sail with a long inclined luff which is laced to a yard. The leech is vertical.

LAYANG-LAYANG: A flat, transverse board, positioned atop the hull of a canoe, through which passes the mast and the lashing for the forward bayungan.

LEEBOARD: An external board fitted to each side of a relatively shallow-draft hull to increase lateral resistance and thus decrease leeway.

LEECH: The after edge of a fore-and-aft sail. Both edges of a square sail designated as fore and after leech depending on which is to windward.

LIMBER (Limber hole): A channel or opening to allow the passage of bilge water.

LONGGUMEN (Dragon spines): The Chinese name for "keel" as used on some vessels, such as dragon boats, built in East Asia.

LOU CHUAN: Chinese ships, usually naval vessels, with multiple decks. Also known as "towered warships".

LUFF: The leading edge of a fore-and-aft sail.
LUG: A projection carved from the surface of a timber to act as a stop or to which other structural members are attached. See CLEAT.

MAST PARTNER: A timber used to steady the mast usually at deck level, but also used onundecked ships.

MAST STEP: A mortise cut to house the tenoned heel of a mast.

MIDSHIPS [Amidships]: The middle of the vessel or the broadest part of the hull.

MORTISE-AND-TENON JOINT (Mortise-and-tenon construction): A union of usually edge-to-edge planking by which a projecting piece (tenon), either loose or fixed, is fitted into one or more cavities (mortises) of corresponding size. The joint may be secured by driving a wooden pin perpendicularly through either end of the tenon positioned within the mortise or mortises. See TENON.

OCULUS: Eyes, often fanciful in design, usually decorating the bow of a vessel. Traditionally intended to provide the watercraft with sight, thus enabling it to avoid danger and navigate safely.
OUTRIGGER: A stabilizing unit, extending from one or both sides of a vessel, usually consisting of one or more constituent pieces and a float.

OUTRIGGER BOOM: Transverse members attached to the hull and the outrigger float.

OUTRIGGER FLOAT: A length of usually cylindrical wood, either solid or hollow, attached to the outrigger boom and positioned outboard, parallel to the side of the hull.

PAINTER: A line secured to the bow of a small boat used for towing or making fast.

PASSIVE FRAME: A frame or frames, usually placed in the hull after the erection of the side planking, such as in shell-first construction, serving as a secondary means of hull strengthening and may or may not be attached to the side planking. See ACTIVE FRAME.

PEG: A usually tapered projection or separate piece shaped to fit into a predrilled, round, corresponding hole. Used to fasten two members or lock a joint. See DOWEL, TENON.
PERAHU: The Bahasa Indonesia word for "boat", usually followed by a qualifying word that refers to the vessel's use or construction. English derivations include "prahu", "prau" and "proa".

PINTLE: A fitting by which the rudder hangs. See GUDGEON.

PORT [Larboard]: The left side of a vessel, looking forward.

SCANTLING: The measurements of structural timbers.

SENDANG: A transverse wooden bar positioned either beneath lugs, carved on the interior sides of a dugout canoe, or through holes cut through sides of the canoe's hull. Lashing is passed beneath the sendang and over structural members, such as the bayungan, dolos or layang-layang, in order to secure these members to the sheer of the hull. A sendang positioned beneath lugs, the older method of assembly, also helps strengthen the sides of the hull.

SHEER: The upward longitudinal sweep of the deck line or vessel's sides from midships to fore and aft.
SHEER STRAKE: The strake running continuous from stem to stern at the level of the upper deck that describes the sheer line of a vessel. Often the name used for the uppermost side strake.

SHELL-FIRST CONSTRUCTION: A relatively modern term used to describe the construction of a ship's hull by which the planking is either partially or completely erected before any framing members are attached to it. The planking, or "skin", of hulls built in a pure shell-first manner is self-supporting. The additional strength provided by the framing members is of secondary importance. See FRAME-FIRST CONSTRUCTION.

SHORE: A support, such as a pole, used to brace a vessel upright when not afloat.

SHUNTING: The technique of reversing the longitudinal position of a fore-and-aft sail, or by moving the entire mast-sail assembly from one end of the hull to the other, in order to maintain forward movement without reversing the windward side of the vessels itself.

SPRITSAIL: A four-sided, four-and-aft sail with a boom (sprit) set diagonally across it.
STANCHION: An upright supporting post.

STANDING KNEE: A knee mounted with its vertical arm pointed upward. See KNEE.

STANDING RIGGING: Rigging, employed in supporting the mast or spars, that does not move except by normal and acceptable strains.

STARBOARD: The right side of a vessel, looking forward.

STAY: That part of the rigging which prevents the masts from moving fore and aft. See STANDING RIGGING.

STEM: The upright or upward-curving timber, or combination of timbers, attached to the forward end of the keel, into which both sides of the bow are joined.

STERN: The rear of a vessel.

STERNPOST: The upright or upward-curving timber, or combination of timbers, attached to the aft end of the keel.

TABERNACLE: A deck-level assembly or housing used to support a mast or post.
TARFFRAIL: The timber rail around the stern deck of a vessel.

TENON: A projection or separate piece shaped to fit into a corresponding mortise.

TOPSAIL: A sail set above the mainsail in fore-and-aft rigs and above the course in square-rigged ships.

TOP SIDES: The sides of the hull between waterline and sheer.

TOP TIMBER: The uppermost component of a frame.

TRANSOM: A flat, transverse plane, often constructed of planks edge-joined one atop the other, forming the stern of the hull.

WALE: A thick strake of side planking, longitudinally split logs or whole logs left uncut used to strengthen the outer hull.

WASH STRAKE: The upper strake in a ship's topsides. Also called a "sheer strake".

YAOLU (Yuloh): A Chinese-invented oar (dated to at least the latter Han dynasty) consisting of a broad, hardwood blade joined to a shaft and a loom. To the
loom is made fast a fiber rope, or metal chain, attached to a ring-bolt on deck. Moved in a back-and-forth manner, the yaolu operates on the principle of a screw, and in skilled hands can be used to move even a large, heavily laden vessel with minimum effort.
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