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UNIT 14

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Asian Shipbuilding Technology



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UNIT 14

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UNIT 14

Author Charlotte Minh-Hà L. Pham

Asian Shipbuilding Technology

Core Knowledge of the Unit

This unit introduces students to shipbuilding technology around the world, with a particular focus on South-East Asia. The unit will explore boat traditions in the region (basic boat types, terminology and construction methods) and examine how they evolved over time.

On completion of Asian Shipbuilding Technology unit, students will:

- Be familiar with specific shipbuilding terminology
- Have knowledge of a variety of boat traditions around the globe, particularly in South-East Asia
- Be able to identify main features of specific boats, shipbuilding traditions or cultures
- Be able to understand a shipwreck or boat remains, interpret and relate its features to known traditions
- Appreciate the importance of preserving traditional boats and how much work is required to increase existing knowledge
- Be able to apply knowledge into a 'practicum' on traditional boat recording

Introduction to the Unit

The study of watercrafts, vessels or boats is part of the academic discipline of maritime archaeology. It is important to remember that such studies are not exclusively related to shipwrecks and are in fact based on various aspects of humanity's past activities on or near water (Muckelroy, 1978). Traditional crafts that take place along the coast, local boatyards, ports and harbours also form part of the study area for a maritime archaeologist. By exploring these key areas, we can gain a more complete understanding of past maritime activities, may they be as a result of trade, war, exploration or subsistence.

A boat is not constructed only according to its environment, but is also dependent on the materials available or functional factors that are at the heart of these maritime activities. The actual construction and use of a boat are essential components of a society's economic and social organization, and to understand the boat in its broader context is just as important as understanding the practical and technological aspects of it.

This unit, therefore, will examine technological aspects that will provide tools for describing and interpreting boat finds, as well as offering a broad overview of boat traditions in the region to provide context

and infer comparisons. Looking at or studying a boat goes further than only describing the number of masts or the types of fittings contained, nonetheless, a mastering of the diversity of different boat types and of the terminology and of regional traditions is essential to understand this technology in a broad setting. Acquiring knowledge of boat technology also helps to pinpoint data, such as cargo sizes, distances travelled, seaworthiness or speed that are elements only seldom used in building arguments in history.

Students should also refer to Appendix B: *Basic Terminology of Shipbuilding*, for a description of the basic components of watercraft referred to in the text.

1 General Boat Technology

Ancient seafaring, navigation methods, construction technologies, boat origins and evolution, ports, harbours and boatyards are all intimately related to our understanding of archaeological boat remains. By studying each of these different aspects we can build a clearer and more complete picture of the past. The boats that we can study, under or above the water, have a deeper meaning that 'is much broader than timbers and technology' (Adams, 2006, pp. 6) and are tightly intertwined with all of these different aspects.

Boats are mirrors of culture. They reflect a wide array of aspects of our maritime (and non-maritime) ancestors' daily lives. Nowadays, traditional boats and boat remains can not only be studied for what they can reveal about technological features, transfers and achievements, but also what they can reveal about social organization, material resources, ideology and traditional beliefs, symbolism (Crumlin-Pedersen and Munch-Thye, 1995; Ballard et al, 2003), political intentions or economical systems (Hasslöf et al, 1972; Adams, 2003; Blue, 2003).

Maritime archaeology, as Westerdahl states, '...includes the prominent interests of water transport technology, trade and exchange, waterborne industries, seafaring, coastal settlements, harbours and waterfronts, ritual and funerary deposits...and arguably, the whole entity forming the 'maritime cultural landscape' (Adams, 2002, pp. 328).

The breadth of maritime archaeology enables us to examine the different aspects, linkages and connections to other disciplines, and to stimulate interdisciplinary study in order to get a bigger, better and more precise image of the past. This also brings a unique insight into the realities of humanity's activities on the sea.

ADDITIONAL INFORMATION

1 The vocabulary and definitions included in this section are essentially compiled based on Steffy, 1994 and McGrail, 2001. Descriptions of the main South-East Asian boat traditions are based on McGrail, 2001 and Manguin, 1985 and 1993 (see Suggested Reading).

1.1 The Basics of Boats, Ships, Vessels and Watercraft

What is the difference between a boat and a ship? According to Richard Steffy (1994, pp. 7) a boat is a small, open vessel, whereas a ship is a large sailing vessel (with a bowsprit and three to five square-rigged masts). But it is more practical to classify boats as small vessels designed for operating in sheltered waters and ships as large vessels designed for deepwater navigation. Sometimes duty rather than size controls the designation.

Boats, ships and watercraft all float. Following the concept of Archimedes, they float because they are not as dense as water and displace an amount of water that is equal to (or greater than) their own weight. To summarize, Steffy (1994, pp. 9) states,

the weight of a ship and all it carries, pushed downward by a force known as gravity, is supported at all submerged parts of its hull by an equal force; buoyancy. But that is an ideal condition that exists only in still water! As soon as a wave or gust of wind causes the hull to list and thereby changes the area of distribution of water against its surface, the centres of buoyancy and gravity also change, and the hull becomes unstable.

How a ship is constructed and the different features incorporated into its design are meant to keep hulls stable in dynamic waters. A vessel not only has to be buoyant and steady, it also needs to be strong enough to withstand the worst weather it is likely to encounter.

Each feature of each type of boat is designed for a different purpose that do not just relate to functional or environmental factors. The design of a ship, its concept, overall purpose and construction sequence are dictated by the people who construct and use them, by the materials that are available and also the political, social and economical backdrop of the time.

1.2 Basic Boat Types

How different boatbuilding traditions developed and in what order in different parts of the world, is still an area of controversial debate, with many development models being presented by different archaeologists and historians. Although these models can not all be covered in this introductory unit, more information can be found by the books presented in the Suggested Reading at the end of this section.

For simplicity, this unit will use the model developed by Basil Greenhill. In proposing the 'roots of boatbuilding' (1995, pp. 74-101) he suggests that boat diversity originates from four main models from which all other kinds derived (the raft, the skin boat, the bark boat and the log boat) and that they evolved differently according to the properties of their construction material.

Although these types are at the basis of most of the large ships present in the contemporary record, most of these 'primitive' types still survive and can be found today in South-East Asia.

1.2.1 Bark Boat

In a bark boat or canoe, the bark is the main strength member that determines the shape of the boat. It is then supported by an internal framework. This type of construction is called 'shell first' and is particularly associated with Native Americans who are known to have built particularly sophisticated crafts. The ones used in Australia, South America and Africa were often simpler.

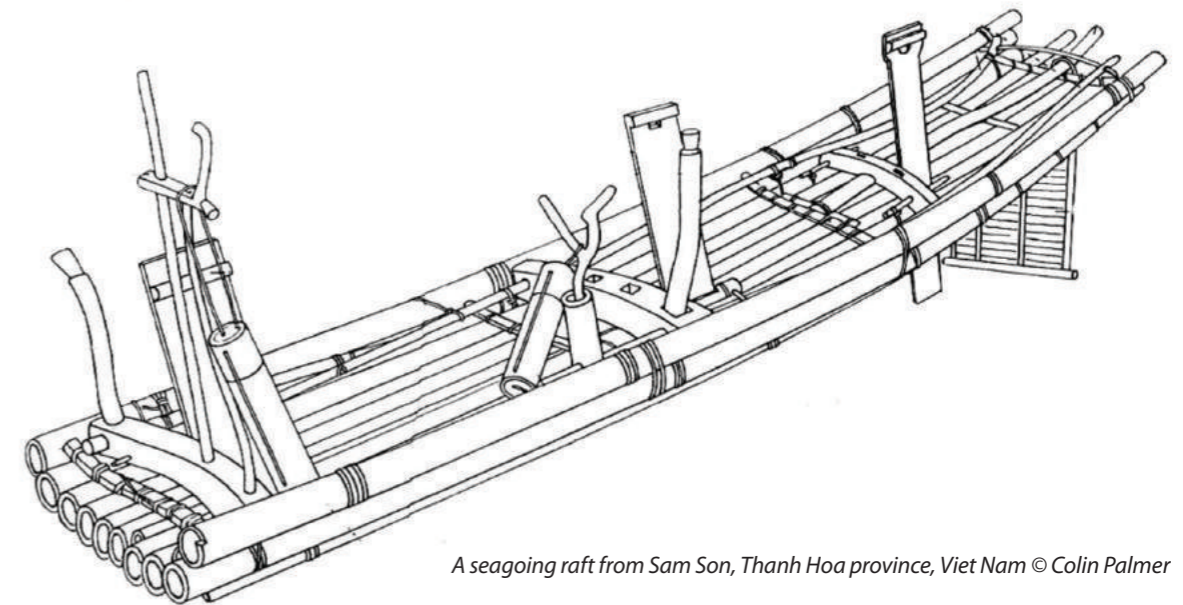
1.2.2 Raft

A raft is any structure with a flat hull that floats on water. It is one of the most basic types of boat design. Rafts can be made of logs, bamboo poles or reed bundles.

Usually, the bamboo poles or the logs are set in parallel, braced and lashed together with bamboo strips, rattan or husk. Rafts are quite flexible as their structure allows water to flow through the deck, which makes them relatively stable when navigating through swells and heavy waves.

Rafts are known to have existed since c. 3500 BC and although basic in terms of construction, they were developed for the sea, fitted with a mast, sails and centreboards (for controlling leeway). This type of seagoing raft still exists along the coast of the Thanh Hoa province in Viet Nam, but are quickly disappearing (Burningham, 1994).

These Vietnamese rafts appear to be similar to the rafts of Formosa as described by Needham in 1971. If following the proposal that an Austronesian speaking group crossed from China to Taiwan aboard such a kind of raft, and that North Annam is its initial point of distribution (Paris, 1942, pp. 423), then these rafts may relate to the earliest Austronesian speaking groups who dwelled between central and northern Annam.



A seagoing raft from Sam Son, Thanh Hoa province, Viet Nam © Colin Palmer

In 1994, Tim Severin explored the legend of the Chinese general Xu Fu, who is said to have crossed from Asia to America on a huge bamboo raft between 219-210 BC. As part of his study, Severin reconstructed a very large oceangoing sailing raft to demonstrate that it is possible that such a vessel could have physically sustained a voyage of 5000 miles in the open sea (Severin, 1996).

In China, where the earliest boats were riverine and later evolved in seagoing junks, Greenhill (1995, pp. 80) suggests that many of the complex patterns of boats on the coasts and rivers of China may have evolved from plank-built copies of rafts of the Formosan type, formerly used on the coasts of China and from where they were probably introduced in Formosa. This highly developed form of raft with its drop keel, rudder and sail was one of the most sophisticated in the world; it was built of bamboo poles lashed together illustrating in rudimentary form several characteristics of some Chinese boats and big plank-built Chinese vessels.

1.2.3 Skin Boats/Basket Boats

Skin or basket boats involve the concept of tying a skin or woven mat around a frame. In the skin boat, an animal skin forms a watertight cover. The construction is usually 'skeleton built' (based on the framing) and derives its shape from the frame around which it is built. On a basket boat, a woven bamboo mat is covered with resin to produce a watertight shell and is set inside a bamboo framing.

The Eskimo culture, being largely dependent on what could be won from the sea, perfected the skin boat to perhaps its finest form in modern times. As a maritime hunting people that existed in a very hostile environment, lacking in timber, but rich in skins (with driftwood and whalebone also available), they developed one of the most specialized boat types; the kayak. Skin boats are also found in Bronze Age Europe, such as coracles in Wales, or currachs or curach in Ireland. In India, coracles were described by Herodote (480-420 AD) and the shells of the Irakian kuffahs are also made of woven reed.

Basket boats in Viet Nam are not thought to have developed from the skin boat or the woven reed kuffah. Vietnamese basket boats are from a very specific tradition of their own and are nowadays found all along the coast, from north to south. There are many different kinds of basket boats that differ from one another in terms of size, shape and use. They can be seagoing, riverine, found in the rice fields, used as small floating shops or even as a dinghy to a larger boat.

From the small round *thuyền thúng chài* to the longer boat-shaped *thuyền nan*, bamboo boats are favoured for being cost effective, utilizing available materials, relatively quick to construct, easily adapted to fit family businesses and needs, and importantly, can be easily manoeuvred. All types can be fitted with a mast and a helm. In central Viet Nam, this type of craft evolved into larger seagoing fishing vessels (over 10 metres long), the hull being extended by planks and known as a 'mixed hull'.

The great advantage of using bamboo is that it is resilient to wood-boring organisms. The material contains a high level of silica, not favoured by *Xylophagidae* and *Teredinadae* (such as the shipworm *Teredo navalis* and *Bankia sp.*), as the bamboo laths are usually too thin to host them (Aubaile-Sallenave, 1987, pp. 81).

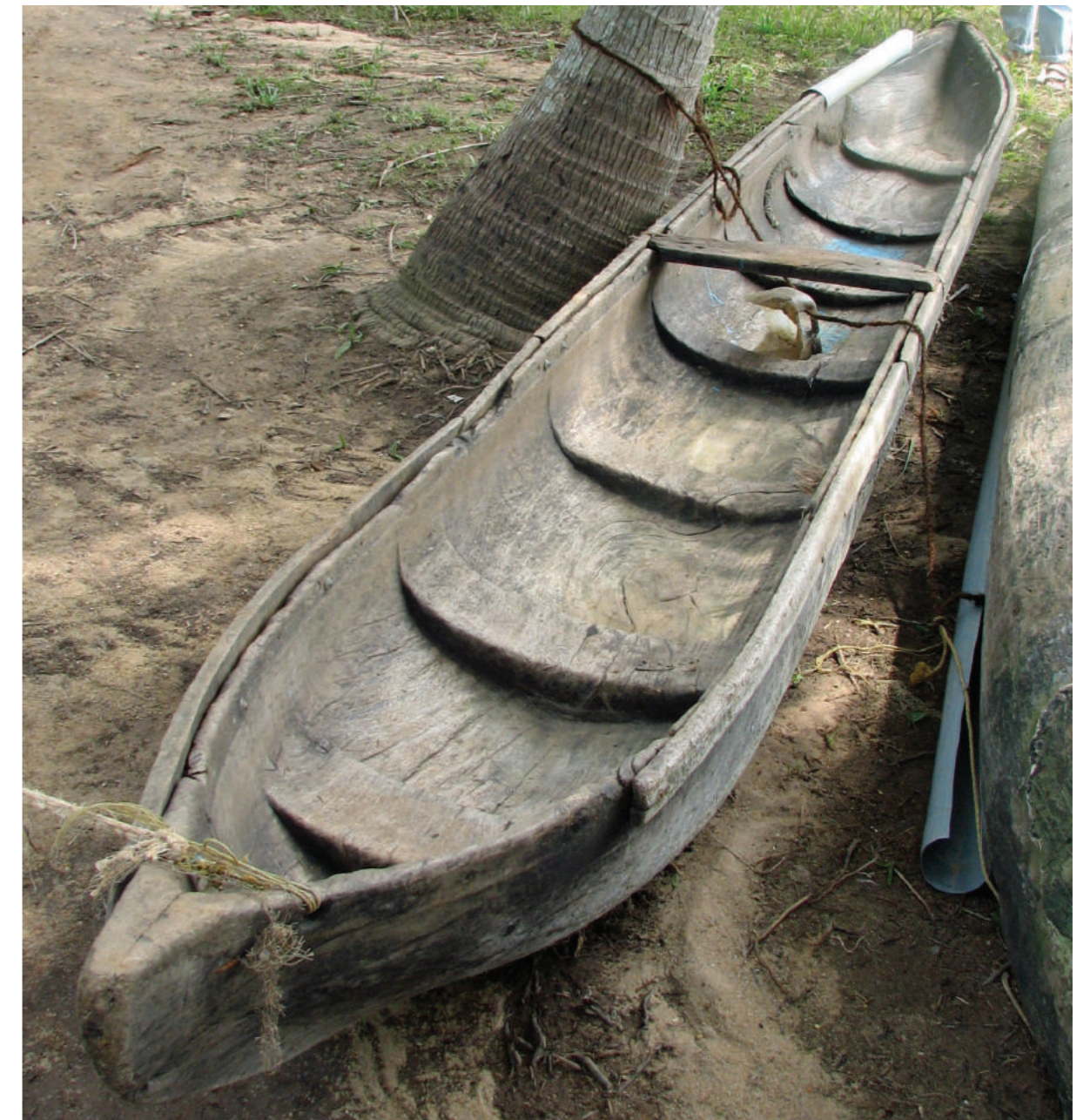


A small round basket boat known locally as a *Ghe Thung Chai*. © Colin Palmer

1.2.4 Log Boats, Dugouts and Monoxylons

Log boats, dugouts, dugout canoes (but be aware, the word canoe implies a way of moving forward with a paddle), or monoxylons (from the Greek word *mono*, meaning single and *xylon*, meaning tree) are essentially formed from a hollowed out tree trunk. The trunk is worked by hand tools, before being opened up and made larger by burning the interior of the trunk.

Several trunks can be assembled together, to form boats similar to those used for racing in Cambodia. The inside of these hollowed trunks can be fitted with floor timbers or benches to reinforce the structure. A well made log boat from a small log can be efficient, light and seaworthy. In the larger versions, because of the dimension of the tree from which it is made, the dugout is long and narrow. These boats derive their stability from their length and are suited for use on rivers and lakes. The efficiency of larger log boats was greatly improved by softening the sides with fire and water and then forcing them apart with wooden struts (Greenhill, 1995, pp. 102).



Log boat or *vallam* from Kerala. These are now very rare and no one knows why they have carved frames. © Colin Palmer

According to Greenhill (1995, pp. 104),

the undertaking of making a log boat is a considerable one. Suitable trees must be available near to the water, and the community concerned must have a great deal of time available for this kind of specialized work, for making a log boat, frequently takes more time than building houses or cattle pens or fencing fields. It is a kind of large scale capital investment requiring a sufficient surplus of food production to enable the log boat makers to give the considerable amount of time demanded by the work. They must have reasonably efficient tools. It follows that, to make such a big investment, the community must be a prosperous one in a certain stage of technical development

The dugout construction technique is universal and examples can be found throughout the world since the early times. In Egypt, images on temple walls depict how to make planked boats on a possible dugout base (Hornell, 1946, pp. 48). In terms of material evidence, the earliest dugout dates to 8000 cal. BP and was found in South-East China, in the region of Kuahuqiao. The site of the dugout also contained three paddles, pieces of bamboo or cane matting attached to a wooden frame and working tools, which suggests that the site was once associated with a workshop for making or repairing canoes (Leiping and Li, 2005).

The lines of the descendants of dugouts are very complex and the evolution towards plank-boats cannot be addressed in depth here, but put simply, by adding planks to the edges of the canoe it is most likely that the dugouts later evolved into a basic planked boat. First, the planks would have been sewn or lashed together and then fixed with tenon and mortises, then fully dowelled to form a watercraft. From this form of watercraft, many different types of boats later emerged.

Clear evidence of a probable origin of an expanded and extended log boat is provided when a boat type features solid or block ends to a planked hull, in the place of a stem and sternpost or transoms. These block ends represent the solid ends of almost all log boat structures.

The development from this rudimentary design to a craft of higher quality moved along two lines:

- By way of the extension of expanded log boats, which eventually became no more than bottom shells.
- By way of three part or five part bottom plank boats, which were shaped to closely resemble the form of the log boat. To solve the problem of the plank ends, hollowed out massive baulks of timber were used.

Dugouts can still be seen today along the Mekong River or on Inle Lake in Myanmar. Simple dugouts can be fitted with ribs, expanded with planks or elongated to form long canoes. In Cambodia, dugouts can reach as long as 30 metres (Walker-Vadillo 2010, pers. comm.).

1.2.5 Sewn Planks

In the times before the ready availability of iron fastening material, wooden plank boats have been fastened by wooden pegs or dowels. This method of fastening was also used in combination with binding and lashing, using locally available materials and techniques developed through experience. This practice is seen across the globe and has been followed from prehistory to classical times and through to the present day (Greenhill, 1995).

There are various techniques for fastening the planks together. Essentially, it is possible to either sew them in a continuous way, similar to the basic Indian Ocean tradition or else stitch them together in a discontinuous way, usually only visible from the inside, which represents the general South-East Asian tradition (Manguin, 1993, pp. 260). These differing techniques suggest they are independent, rather than culturally linked traditions.

The stitched tradition seems to be widespread throughout South-East Asia and homogenous across the whole Austronesian range. The hulls were built by raising planks on each side of a keel piece, which indicates having evolved from a dugout base (Manguin, 1993, pp. 258). The fastening technique is referred to as lash-lug, with lashing and protruding cleats (Horridge, 1982).

The earliest material evidence that exists for this type of sewn technology is the ship that dated back to 2500 BC and was found in a chamber in the pyramid of Cheops. First, the strakes (planking) were joined together by pegs and then lashed together forming the hull. Once complete, the internal strengthening structures were added.

In South-East Asia, there is material evidence from the third to fourteenth century, but it is thought that this tradition existed during at least the whole of the first millennium, producing ocean going vessels which were large enough to carry large cargoes. The evolved lash-lug technology (Horridge, 1982) is considered one of the strongest common South-East Asian traditions.

The series of the Butuan ships found in the Philippines also indicated an evolution in the technique, with boat remains dating from 320 until 1250 AD and moving from a lash-lug tradition to a fully dowelled fastening system (Green et al., 1995).

Boats with planking fastened by bamboo fibre cords were recorded from the seventeenth to the twentieth century in Malaysia, Borneo, Sarawak, Moluccas and the Philippines. This traditional technique can still be seen today in the form of small river crafts used in the region surrounding the ancient capital city of Hue in Central Viet Nam.



Indian Ocean tradition: a sewn boat of India, Orissa. © Colin Palmer

1.2.6 Planked Boats

Planked boats are essentially all types of craft (including sewn boats) that are not rafts, dugouts or skin/basket boats. Although the principles remain the same, changes in design, shapes, sizes and specific features will vary tremendously from regions and time periods.

Evolution can be quite slow and most of the time it is not well documented, due to a substantial lack of material evidence. However, some general traditions for South-East Asia have been identified and are discussed in this section.



Planked boat: a golekan also known as the 'Madura trader' originate from Madura. Distinctly different from boats in Java, the golekan have a shallow form and small capacity, but are striking crafts, with an intricately decorated stem and stern. © Kurt Stenross



A large janggolan with the sailing rig removed, laid up for the monsoon. In Madura, janggolans are dedicated to freight work, usually carrying a salt cargo. © Kurt Stenross



This lete-lete under construction in Gayam, Sapudi is a good example of a perahus. This contemporary design has been influenced by Dutch boat building in the Madura region. © Kurt Stenross

1.3 Specific Purposes and Categories

Any wooden ship or boat can be classified into one of four categories: transport, naval, fishing or utility. Each of these categories places specific demands on hull design (Steffy, 1994, pp. 10), for example, construction of transporters or carriers focuses on the hold and on the storage spaces, whereas war ship designs are conceptualized to accommodate new forms of aggression and defence; to support archers, catapults, guns or to contain the numerous rowers to propel the ship.

To more accurately describe ships and boats from South-East Asia, additional sub-categories can be added: troop transporters, merchant ships, coasters, fishing vessels, floating houses or floating markets, racing canoes, ceremonial and festival boats, and royal barges. They can also be distinguished according to their environment: coastal, inland (lakes) or riverine and high seas.

However, boats and ships can also be described according to their propulsion systems, to their sizes or purpose, for example:

- *Whalers are relatively narrow vessels that are pointed at both bow and stern. Their design enables them to move either forward or backwards easily. Originally developed for whaling, these vessels became popular for work along beaches since they manoeuvre easily and do not need to be turned around for beaching or refloating.*
- *Caravels are highly manoeuvrable sailing ship developed in the fifteenth century by the Portuguese to explore the West African coast and the Atlantic Ocean.*
- *Schooners are sailing ships characterized by the use of fore-and-aft sails on two or more masts, with the forward mast being no taller than the rear masts. Schooners were first used by the Dutch in the sixteenth or seventeenth century and further developed in North America from the early eighteenth century.*

In South-East Asia specific terminology is seldom used in this way. Terms, such as sampan, junk, praus/perahu are used often, but with little care for precision. As a result, it is even more important that the design and features of a vessel are examined when trying to identify boats or ships in the region.

2 Asian Shipbuilding Technology: Main Traditions

Each period of history produced vessels with distinctive hull designs in specific geographical areas. Some of these designs survived for centuries, even millennia where civilizations were stable. Certain features remained constant or were often adopted in other areas because of their practicality and function. Overall, each seagoing society throughout the world produced distinctive design and construction features that evolved as the society developed.

Greenhill (1995, pp. 20-21) states,

Boats have developed all over the world in different ways and at different speeds. Their development has been conditioned by the geography of the local waters, climate, purposes for which the boat was needed, availability of materials for their construction, tradition of craftsmanship which grew up among the boat builders and the general state and nature of the culture of the people building them. To appreciate a boat one must be aware of the factors that give rise to her building, the timber available, the general environment, the building traditions of the society which produced her, and above all, the purpose she was built for.

It is also noteworthy that evolution in ship technology is a relatively slow process. Steffy (1994, pp. 8) explains,

Water is not our natural environment; humans are instinctively uncomfortable with it. It is unstable, presenting structural problems. When water is combined with winds and tides, structural problems increase dramatically. Worse yet, when vessels sank in this unfriendly element there was no haven for their occupants; they could not walk away from a disabled ship as they could from a broken wagon, nor could they come back later and retrieve its payload. It is no wonder that shipbuilders were so cautious with new designs and that global travel evolved so slowly.



Bajau children and their small boats in Tawi-Tawi. The Tawi-Tawi Bajau have a great variety of boats. Islands, sometimes even villages, tend to be associated with certain boat types. Thus, a survey of the boats throughout the archipelago might reveal patterns of movement and diffusion. Such a survey is urgently needed since the widespread use of inboard and outboard motors in recent years is drastically altering traditional boat-building' (Nimmo, 1990). © Jo-Marie Acebes

2.1 A Continuity

There is no direct evidence for water transport until the Mesolithic period and it is not until the Bronze Age (c. 2000 BC) that vessels, other than log boats, appear. Nevertheless, there is sound evidence for their use in lakes and rivers and for overseas voyages from earlier times.

South-East Asia was the scene for one of the most crucial steps in human evolution, namely the completion of the first sea crossings. Mainland South-East Asia is considered as a stepping stone for early colonisations of South-East Asian islands that later extended to more remote destinations as far afield as Australia and Oceania.

Although archaeological evidence from Australia suggests that the world's earliest sea crossings occurred by *Homo sapiens* ca. 50-40,000 BP, little is known about their seafaring capacities or about the types of watercraft that existed. The sea level fluctuations during the Pleistocene are a radical taphonomic factor, which as a result, have eliminated most coastal archaeological evidence from that early period.

Ethnographical data of the area, as well as archaeological record from the mainland has, however, provided knowledge about the prehistoric shipbuilding traditions. In Sundaland (the continental shelf zone, that includes present day Malaya, Sumatra, Java, Borneo and Palawan), the earliest boats that have so far been discovered date back to the second century (McGrail, 2001, pp. 283).

As archaeological remains are scarce, it is the accounts from European travellers (sixteenth to seventeenth centuries onwards) and contemporary ethnographic studies that provide the most important sources of data. Evidence illustrates an increasing technological complexity, yet, also shows that many of the fundamental features of early boat types were never superseded and were still used in the region during recent times (McGrail, 2001, pp. 304).

2.2 Early Sea Crossings and the Austronesian Outrigger Boats

Very little is known about early seafaring, although taking the fluctuations of sea level into account, it is possible to estimate the distances which *Homo sapiens* would have had to have crossed. The lowering of sea level (ca. 60-53,000 BP) opened up routes and pathways (Borneo, Sumatra, Java or Palawan were undoubtedly settled through land bridges) and reduced distances between the Wallacean islands.

Later, rising sea levels (ca. 53-45,000) diminished Sundaland by a third and increased the isolation of some islands along the Wallacea line. During periods of lower sea level, it appears that a minimum of 90 km of sea travel had to be achieved, a distance which required travelling out of sight of land, keeping a heading at night, particular navigational skills, as well as seaworthy watercraft.

Moving forward in time (from ca. 4,500 BC), the dispersal of the Austronesian speaking groups and the introduction of their domesticated agricultural system in newly colonized islands indicates the existence of well-established and continuous maritime activity. There is also evidence to suggest that present day native populations of South-East Asia share ancestries with the ethno-linguistic group of the Austronesians in terms of culture, language and genotype.

There are different theories regarding how this Austronesian speaking group may have spread, with additional insight being provided by advances in linguistics and DNA analysis. Following Bellwood (1997), the most accounted theory is the suggestion that they originated from Fujian, China, then moved to Taiwan and then on to the Philippines. By doing so, they achieved the most widespread dispersal of their time; over 4,000 years, they spread over 7,000 km, reaching as far as Polynesia and Easter Island to the east and Madagascar to the west.

These journeys would have primarily been conducted over small distances, but on a great scale. To achieve this, the group would have had to have utilized seaworthy crafts, capable of carrying cargo, viable units of males and females and possibly domesticated animals and crops.

During the early Austronesian period it is suggested that the vessels would have comprised of seagoing rafts or sewn-planked crafts while later, outrigger canoes were adopted as their emblematic vessel. Ethnographical observations of this period confirm their wide range distribution use and support, as well the common tradition of lash-lug planked boats (Finney, 1996; Horridge, 2006).

The early period occurred ca. 4500-3000 BC, when their diffusion expanded from China to Taiwan (160 km), then to the Philippines (480 km) and eventually west, towards the Malay Peninsula. The very early Austronesian tool kit included ground stone adzes, stone mortars and pestles, stone pads, slate spear points, slate-reaping knives and baked spindle whorls (Bellwood et al., 2006, pp. 107) made out of basalt or clamshell, with drills fashioned from shark's teeth or shell.

Bamboo rafts are the most likely option, as bamboo is found in abundance over South-East Asia and can be easily cut with stone tools (Birdsell, 1977; Horridge, 2006). Lightweight and strong enough to support multiple people, bamboo also does not become waterlogged due to its high silica content. By observing the simple tools used by *Homo sapiens*, bamboo could have easily been prepared and lashed together with vegetable fibres. Ethnographical data also reveals that bamboo rafts are still traditional in Indonesia, Philippines, Melanesia and in the area of Sam Son in Viet Nam (McGrail, 2001; Horridge, 2006).

The later period occurred from approximately 1500 BC onwards, when Austronesian speaking peoples crossed very important stretches of water; from the Bismarck Islands to Melanesia, Polynesia and finally Oceania. To try to identify the type of watercraft used during this expansion, linguistic study offers some clues (Blust, 1995; Pawley and Ross, 2006). Amongst the words that have been reconstructed are those for sail, mast, outrigger and outrigger boom. Linguistics specialists claim that these words and the artefacts they describe could be 5,000 years old (McGrail, 2001, pp. 317).

Before reaching eastern Melanesia, this migrant group must have known that there were further islands beyond the horizon. Given this, watercraft technology would have to have been advanced enough to build boats which were not only capable of longer voyages, but were also able to carry plants and animals (Irwin 1990, 1992; Finney, 1988)

The band of islands stretching from mainland South-East Asia to the Solomon Islands was in a relatively sheltered equatorial position between cyclonic areas, with predictable seasonal reversals of winds and currents. This formed a 'voyaging corridor' (Irwin, 1992, pp. 4), from where most of the islands remained in sight of land. This vast archipelago was thus well placed to become a springboard for exploratory journeys to the north and the east, with the island network from Western Melanesia to the Solomons acting as a safety net on return (McGrail, 2001, pp. 314).

Although the evidence for watercraft from c. 1500 BC to 1300 AD is negligible (McGrail, 2001, pp. 338), linguistics suggests that Proto-Polynesians began their oceanic voyaging abroad outrigger boats with sails. Otherwise, it is on European accounts, starting with the travel logs of Magellan and Del Cano's circumnavigation voyage of 1520 that an image can be formed, completed with ethnographic data relative to much later periods. The late eighteenth century and the nineteenth century are golden ages for pre-ethnographic studies done by captains, seamen and intellectuals who accurately recorded the boats they encountered on their travels. The work of Admiral Pâris (1843), the father of nautical ethnography, is an excellent example of the interesting descriptions compiled on traditional crafts of the region.



Modern example of an outrigger boat, known as a banca in the Philippines. Batangas Bay, Saint Bernardino Strait. © Robert Whitehurst

Suggestions on early watercraft and on the boats potentially used by Austronesian speaking groups are, therefore, essentially based on contemporary data. Contemporary records show the use in the wide regions of Oceania of floats, bundle boats or rafts, as well as log boats around the islands which had suitable trees for boat building or driftwood logs.

Early oceanic voyaging boats could also have been log based boats, extended by sewn planks with treenails (McGrail, 2001, pp. 339). This Neolithic boatbuilding tradition was based upon lashings, protruding pierced lugs and a hollowed base for the hull with added planks, sewn to the sides (Horridge, 2006, pp. 144). Ethnographically, the distribution of sewn plank boats over Europe, Asia and Oceania indicates that this type of boat may have persisted since the Austronesian speaking peoples (Manguin, 1984; Horridge, 2006).

In summary, the Europeans identified four essential types of seafaring vessels:

- *Oceangoing rafts*
- *The single hull planked boat*
- *The planked boat with outrigger*
- *The double hulled or paired plank boat*

These boats share some construction characteristics as they are all shell first, with planks sewn together and framing lashed to the planking (lash-lug tradition). Under the waterline, the hulls are usually double-ended, while above the waterline they are unequal-ended. All are probably log boat based, although the sizes and shapes of planks would have depended on the availability of timber.

Boats with two outriggers have been used in western Melanesia and in Indonesia from at least the eighth to the ninth century, as witnessed on the Borobudur relief in Java (Manguin, 1980; Jahan, 2006). Yet, from eastern Melanesia eastwards, there is no evidence for such crafts. Instead, in all European accounts for the region, boats with only one outrigger are recorded.



A double outrigger banca on the beach. Batangas Bay. © Robert Whitehurst

Their hulls are usually slender, sometimes double-ended (either end being usable as the bow) or sometimes showing a clear distinction between both ends and with the outrigger on port side. The dissimilar ended, have their mast stepped towards the bow and the position of the mast determines how the boat is handled when changing direction relative to the wind.

Some boats with dissimilar ends sometimes have balance boards, which jut out from the boat on the side opposite the outrigger. When the float is to leeward, the boat can be brought more upright by stationing crew on the balance board. Ethnographically, the distribution of outrigger canoes corresponds to the distribution of Austronesian people and they are still used in present day Polynesia, which is located at the tips of the eastern migration.

Outrigger boats and paired boats are the most advanced crafts, clearly capable of ocean voyages when Europeans encountered them. Both types may have been used for ocean voyages during the settlement of Oceania, however, for reasons of speed, manoeuvrability and capacity, it may have been that outrigger boats were preferred for exploratory voyages and paired boats for colonization.



A modern outrigger boat in Mindanao, Sarangani Bay, Philippines.
© Jo-Marie Acebes

2.3 Stitched Boats: the Early South-East Asian Tradition

The technique of sewing planks together to make a watercraft is considered as the earliest common South-East Asian tradition. There is also ethnographical evidence to show the pattern of distribution of the stitched boats and to support their common traits across the region. Associated with most of these vessels is also the complimentary lashed-lug technique that features protruding cleats or lugs carved out on the inner side of the planks, with hollowed out holes in them.

Both traditions have survived under a variety of forms and were found in all areas from Hainan and Viet Nam to the Philippines and Eastern Indonesia, well into the 20th century. (Horridge, 1982; Manguin, 1985; McCarthy, 2005).

The first evidence of this technique came in the form of the Pontian boat which was found in Malaysia in 1926. The boat was dated to 260-430 AD (Evans, 1927; Gibson-Hill, 1952) and featured flush-laid planking sewn together and fastened with occasional dowels, as well as carved out lugs to which framing timbers were lashed. The ties pass through paired L-shaped holes (Manguin 1985b, pp. 333), the

treenails protrude from the edges of the planking and the stitching is discontinuous. In this design the treenails are clearly auxiliary and supporting the lashings of the sewn boat. It is the earliest example of fastening technology recorded for South-East Asia.

The planks of the Khuan Luk Pat boat of Kolam Pinsi were found in Palembang and dated to the fifth to seventh century. The planks clearly appeared to have belonged to a sturdy hull that had been stitched together and fastened to the frames by way of lashed-lugs (Manguin, 1993, pp. 261).



Lash-lug boats displayed at the Bujang Valley Archaeological Museum.
© Noel Tan



One of the Butuan boats, Philippines National Museum. © Noel Tan



The Jewel of Muscat, a stitched boat replica based on the Belitung shipwreck.
© Noel Tan

Little remains of the hull of the early tenth century Intan shipwreck, that was found in the Java Sea, but structural details indicate that the ship was a lashed-lug craft. It is thought that the ship was probably bound to Central or Eastern Java from Palembang. Her cargo 'provides a unique insight into the nature of cosmopolitan trade in the tenth century Western Indonesian, at the height of the Srivijayan power, and enhances our understanding of the ceramic models circulating in South-East Asia, including Cambodia' (Flecker, 2001a; Guy, 2007).

The Cirebon shipwreck, found in the Java Sea and dated to the late tenth century, also belongs to the lashed-lug tradition. Investigated in 2004, the ship's cargo was found to consist of 75 per cent Chinese ceramics and an array of valuable trade goods from Indonesia, Thailand, Viet Nam and Persia. Artefacts included pearls, rubies, sapphires, garnets, gold jewellery, lapis lazuli, Fatimid rock crystal, Iranian glassware, Chinese bronze mirrors and Indonesian bronze statues. See: cirebon.mariemont.museum/home-6.htm?lng=en (Accessed March 2012.)

In the Philippines, the Butuan boat remains, which range from the third to the thirteenth century, illustrate an evolution in technology. Recovered artefacts show a clear transition from lashed-lugs boats to a fully dowelled fastening system (Green et al., 1995).

From the eighth century onwards, shipbuilding technology evolved towards treenails as a primary fastening technique. This is best demonstrated by the remains of three boats found in Sambijero, Indonesia (one of which dated to 610-775 AD) which features not only lashings between the planks, but also treenails as the essential fastening method (McGrail, 2001 pp. 298).

Boat remains found in Paya Pasir, Butuan (dated from the twelfth to thirteenth century) demonstrate this technique, while the technique was also still described in the sixteenth and seventeenth century by European authors (Horridge, 1982) and can still be seen present day in Bali and Madura.

2.4 Kunlun Ships

Even if during the first millennium China was already highly involved in maritime trade, the principal long distance carriers belonged to the 'South Sea people' (also known as Kunlun), or the Malay people. The term Kunlan was 'probably originally used for the maritime peoples of Indochina and later extended to the Indonesian population' (Nguyễn Thê Anh, 1996, pp. 108) or to the Malay people.

There is evidence to show that during this time the main shippers were essentially from Srivijaya and that between the eighth and twelfth centuries, it was these foreign shippers that transported most of the Chinese cargos (Flecker, 2007, pp. 83). In Chinese sources, there are descriptions dating to the third and eighth century of large Kunlun oceangoing vessels called Bo (Needham, 1971, pp. 459). These are understood to be very large ships (measuring up to 50 metres in length) with a capacity of between 500 to 1,000 tons, holding about 1,000 passengers.

These ships were said to be lashed together, featuring multiple masts and a deep V-shaped multi-sheathed hull with a keel that made them sturdy in the open sea (Manguin, 1993, pp. 262). The fact that these vessels were made without the use of a single piece of iron and that their rudders were lateral rather than axial, make them easily differentiable from the Chinese tradition.

Unfortunately, there is no material evidence for these ships. However, their existence suggests a long technological evolution that resulted in the Chinese developing a seagoing fleet during the Song Dynasty, which retained some of these distinctive features.

2.5 From Srivijaya to Majapahit, Javanese Jong: the South-East Asia Tradition

After the evidence which attests to the South-East Asian stitched tradition, the textual and archaeological data related to vessels from the thirteenth and fourteenth centuries indicates a radical shift to fully dowelled ships. There is little data to document this progressive evolution (Manguin, 1993, pp. 265), but data relative to South-East Asian ships from the sixteenth century onwards, is relatively complete and allows us to form a firm image of the technology used at that time.

From the fifteenth century onwards, European textual evidence provides descriptions of large seagoing ships called 'jong' in Malay (or Javanese) or 'junco' in Portuguese and makes it possible to understand the design of the trading shippers of the region.

Following the earlier stitched plank tradition, jongs were assembled only using wooden dowels and without iron. Related to their Kunlun ancestor's bo, the jongs were very large vessels, capable of carrying up to 500 tons with a large capacity for passengers. Their V-shaped hull was formed on a keel piece and consisted of a multiple sheathing of hard wood, probably constructed near the teak forests of North Java and South Borneo (Manguin, 1980). Jongs were fitted with multiple masts (and a bowsprit), rigged with canted or lug sails and steered with two lateral rudders.

As these boats are classic examples of South-East Asian tradition, from the sixteenth century the words junco, jonque and junk are terms commonly used to describe all kinds of large ships encountered in the region (McGrail, 2001, pp. 308), as well as Chinese ships.



A late sixteenth century drawing of double outriggers and a Javanese jong in the Banda Sea. © De Bry 1629, plate 28

2.6 The Chinese Junks

Prior to the Song Dynasty, the Chinese vessels were essentially fluvial (Manguin, 1980, pp. 276) and it is only since then that the Middle Kingdom started to build powerful oceangoing fleets. By the thirteenth century, the Yuan Dynasty took control of the seas (and later shipbuilding technology) and seafaring culminated during the Ming Dynasty with the voyages of the General Zeng He.

The earliest material evidence of Chinese river boats that date back earlier than the tenth century, consists of three planked river boats (Peng, 1988, pp. 32) and of the remains of the Tang Dynasty Rugao river boat (Green, 1986). Additional information provided by the Qing Ming scroll (1085-1145 AD) gives a more accurate idea of what the fluvial junks looked like. From here, it is possible to identify the basic characteristics of the Chinese fluvial junks that were retained until later periods.



A nanjing or sand ship has a flat bottom that allows it to theoretically be beached or to travel in river channels. On this Chinese merchant ship depicted on the eighteenth century picture scroll 'Tosen no Zu' (Matsura Historical Museum), it is possible to clearly see the flat transom and the leeboards. This type of ship belongs to a Northern type of Chinese boat building tradition.
© Matsura Historical Museum/Jun Kimura



A fuzhou ship is typically a Southern Chinese shipbuilding tradition. It is possible to recognize the bamboo battened sails, a clear hanging axial rudder and a keel. This ship also figures on the eighteenth century picture scroll 'Tosen no Zu' (Matsura Historical Museum).
© Matsura Historical Museum/Jun Kimura

The Chinese junks were constructed shell first with a single layer of carvel planking and fastened with iron nails and clamps. They have a flat bottom design to suit their riverine environment, an overhanging flat transom and the stern is typically the largest part of the vessel.

Another important construction feature of the boats in China is the conception of bulkheads or wooden partitions that provide the transversal strength (instead of frames) and creates watertight compartments within the ship. There is evidence of bulkheads since before the Tang Dynasty, as illustrated by the Rugao boat.

In terms of propulsion and steering systems, there is little information available to identify the poles or steering oars that could have been used, yet, it is possible that the yuloh (a sculling oar over the stern) appeared during the Han Dynasty (McGrail, 2001, pp. 356). It is also quite plausible that in early times, the boats were towed from the river banks. From at least the second century onwards, the axial suspended rudder was commonly used (Manguin, 2010, pp. 336). The Chinese use of sails (most likely the square sail) appears to have begun in the Han Dynasty, followed by the introduction of lug sails somewhere around the time of the twelfth century.

As a result of cross-cultural influences and the presence of foreign ships in Chinese harbours, by the late tenth century the Chinese started developing what became a great oceangoing navy. By the thirteenth century, the Yuan Dynasty (the Mongols) under Kublai Khan followed in their ancestor's footsteps and set about expanding their territory.

In 1274 and 1281 AD, enormous fleets were sent to invade Japan, but both times a 'divine wind' called Kamikaze destroyed the fleets. The Yuan also had views on northern Viet Nam, but there, the fleet was destroyed at the famous naval battle site of Bach Dang, where the Vietnamese planted wooden stakes in the river, so that when the river ebbed, the fleet was impaled in a forest of stakes and finally annihilated.

Later, in 1293 AD, a large invasion fleet was sent to Java to punish King Kertanegara for having refused to pay tribute. So it is possible that at this time, the South-East Asian shipbuilders adopted the Chinese feature of transverse bulkheads. The defeats of Kublai Khan's navy in Japan, Viet Nam and Java paved the way for the downfall of the Yuan Dynasty (Delgado, 2009, pp. 168). Unfortunately in terms

of material evidence, there is little remaining about the boats that existed during that time period (Kimura 2006; Sasaki, 2006).



Boat building in Northern Viet Nam, demonstrating the Chinese tradition of using iron nails.
© Colin Palmer

The Yuan Dynasty (1279-1368) was followed by the Ming Dynasty. It is during this period that the famous treasure fleet of General Zeng He was constructed in Nanjing for world exploration. It is said that these ships could reach 120 metres long, had nine masts, a beam of 50 metres (more or less the size of a football field) and a capacity of 1,500 tons. Between 1405 and 1433 AD, the General made thirteen voyages. However, the fleet was destroyed along with all the documents related to these voyages in 1465 AD, when the successors of Emperor Yonle shifted China's foreign policy inwards. The Haijin laws, which enacted a strict ban on private maritime activity until they were abolished in 1567 AD, included restrictions on ships sizes in shipbuilding, banned overseas trade (apart official tribute missions), shut coastal facilities and overall, limited foreign contact.

These events consequently had a great influence on the rest of the trade and shipbuilding in the region and potentially lead to the conception of the 'hybrid' tradition of the South China Sea.

2.7 The South China Sea 'Hybrid' Tradition

From the fifteenth century onwards, both Chinese and South-East Asian vessels sailed the seas, the respective features of each, appearing on ships around the region. These features can be clearly identified on multiple shipwrecks dating from the late fourteenth to the late sixteenth century, and suggests a hybrid tradition that Manguin proposed to term 'South China Sea tradition' (1984: 199). This term is used to define this group, which still allows individual traits and distinctive characteristics, but demonstrates a common international trend in shipbuilding.

This tradition is closely linked to the context of economic changes along the South China Sea and is the result of maritime trade and cultural, political and commercial interactions of the time. For example, when the Ming issued their edict on the ban of private overseas trade it triggered the rise of new production centres, such as the ceramics from Thailand and Dai Viet's kilns. The predominance of shipwrecked hybrid ships in the Gulf of Thailand and along the Malaysian coast reflects this surge in Thai production (Flecker, 2007, pp. 81). Certainly, by restricting the commercial activities, shipbuilding declined and this had a specific impact on boat designs in the region.

By this point in history, a new maritime power had risen in Java, the Majapahit. They sailed jongs and increased the presence of South-East Asian ships on the seas. South-East Asian shipyards also provided ships to the Chinese diaspora when they settled in local harbours and commercial centres (Manguin, 1993, pp. 274). Manguin (2010, pp. 348) wrote,

as a consequence, the hybrid Sino/South-East Asian shipbuilding tradition, that had come into being in earlier times, appears to have expanded under the Ming, and to have grown into a regular configuration for ships regularly plying South China Sea waters. It coexisted with the still lively indigenous traditions of both China and Insular South-East Asia, as a legitimate offspring of various degrees of interaction between sea-oriented ethnic groups living on the shores of the Asian 'Mediterranean'.

Shipwreck remains show vessels from this period are a blend of designs; the V-shaped hull, the keel and a thin pointed bow of the South-East Asian tradition, with the partitioning of the hull in compartments following the Chinese tradition. Yet, these 'bulkheads' are not watertight and frames share the structural strength. Additionally, shipwreck remains show the use of iron nails similar to those used by the Chinese, alongside wooden dowels. In some instances, the ships included either Chinese steering systems with an axial rudder or South-East Asian with a lateral rudder (MgGrail, 2001, pp. 299-301, Flecker, 2007).



Boat building in Southern Viet Nam, demonstrating the South-East Asian tradition of using wooden pegs. © Colin Palmer



There are still so many maritime traditions that have yet to be documented, such as the fascinating single leg rowers of Inle Lake, Myanmar. © Charlotte Pham

3 Various Shipbuilding Traditions in the Region

3.1 The Malay Archipelago

The Malay Archipelago encompasses the Philippines, Singapore, Brunei Darussalam, East Malaysia, Timor-Leste and the islands of Indonesia. It is a region rich with maritime tradition and considered the cradle of great ancient seafaring nations, such as Srivijaya, the Majapahit or the secular Bajau. In this region, maritime trade and boat construction are usually connected to particular groups of people, including the Bugis, the Madurese, the 'Sea Gypsies' Bajau, the Mandar or the Butungese. As each of the independent cultural traditions of these groups are difficult to isolate, it is important to gain knowledge of the islands, their interactions and cross-cultural contexts to better understand boat building and boat use in the region.

Outrigger boats and perahu are commonly considered the most representative types of boat of the archipelago, but the boat traditions in the region are much more diverse. Prau or perahu is actually a generic term that varies in time and according to geographic location. There are multiple ways to spell the word, including prau, prauwe, proa, perahu, or prau. According to Hawkins (1982, pp. 7) the spelling 'prau' is the most accurate to those who built and sailed such vessels. However, that name is narrow in scope as Indonesian linguistic groups have specific names for various watercrafts, which can range in size from canoes to multi-masted sailing traders (May et al., 2009, pp. 3). Liebner, Burningham and Stenross, who are specialists in boat traditions in Indonesia, tend to use the word 'perahu', to describe wooden vessels that are particularly used for transportation work. As Stenross (2007, pp. 2) explains,

it can refer to any sort of small vessel. However, in maritime transport circles it refers to substantial wooden craft of traditional or semi-traditional style, intended for cargo work. In Madura, small open vessels of up to 10m in length which may be used for either fishing or short haul transport are referred to as 'sampan' a word borrowed from Chinese, although the boats bear no resemblance to the various small Chinese vessels known by this name – while the term perahu (in Madurese, parao) is reserved for larger vessels, usually decked over. A ship is referred to as kapal. Some large perahu are effectively small ships and indeed nowadays designated so for official purposes but they are nevertheless referred to in common parlance among those who used them as 'perahu'.

It is impossible to address here in depth the myriad of boat traditions of the region or even to name them all. Therefore, for each country, only some main references (in English language) are listed, with a brief summary on boat types and/or the archaeological evidence or relevant excavation, investigation or project.

3.2 Malaysia

3.2.1 Boats Types

The sailboats of Malaysia (or perahu besar) come in two types, the bedar and the pinas. Similar to broad South-East Asian traditions, boats in Malaysia are built without a plan, constructing the hull first and fitting the frames later. The planks are fire bent and joined edge on edge using ironwood dowels. Before the new plank is hammered on, a strip of the bark of a tree is placed over the dowels. The planks are usually separated by a 1 to 2 mm layer of a natural material which contains sealing properties. This is an ancient and unique building technique, the origin of which might date back to the Proto-Malay migrations that colonized the archipelago thousands of years ago.

There are several types of fishing boats around the Malay Peninsula, such as kolek, payang, bedar and sekoci, alongside four types of perahu besar, such as the dogol, pinis dogol, pinis gobel and anak bedar. The perahu besar vessels plied the trade routes around what is modern day Viet Nam and Indonesia.

3.2.2 Archaeological Evidence: Log Boats

In Sarawak, graves dated to the mid-second millennium BCE to the mid-first millennium BCE include log coffins with plank lids, or coffins made of stitched bamboo strips. Such burial coffins are also found elsewhere in Malaya and Viet Nam (Dong Son log boat coffins).

Three log boats used for burial purposes were found in a site in Malaya (Kuala Selinsing), yet only one was excavated and was dated to the second to third century. The excavated log boat provided the earliest evidence for the feature which has become a diagnostic characteristic of the South-East Asian tradition of plank boats; series of integral pierced rectangular cleats with spacing between series, which suggests that one or more strakes had been added to give a greater freeboard. In more recent plank boats traditions, flexible ribs were lashed to such cleats (McGrail, 2001, pp. 294).

There is also evidence of a treenailed boat, on a fragment of planking found south of Kuala Lumpur and dated to 465-655 AD (Manguin, 1996), and the previously mentioned Pontian boat remains, dated to 260-430 AD and belonging to the lash-lug tradition.

3.2.3 Naga Pelangi Projects

Christoph Swoboda, reconstructed a 14 metre perahu bedar, named the *Naga Pelangi*. Once complete, this traditionally rigged vessel was sailed around the world and became the first contemporary indigenous Malay sailing boat to finish a circumnavigation, thus proving the seaworthiness of this type of craft. In 2003, Christoph started the construction of a second boat, this time of a pinas type with a length of over 20 metres, named the *Naga Pelangi II*.

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3.3 Indonesia

3.3.1 Boat Types

There are several types of boats found in Indonesia, including:

- *Padewakang of South Sulawesi* (Liebner, 2004)
- *Pinisiq (variously spelled pinissi, pinisi, or phinisi)/lamba/palari* (Liebner, 2004)
- *Perahu jukung, the traditional Balinese boat* (Spoehr, 1980; Herron, 1993, 1994)
- *Tena of Lembata, used for traditional whale fishing* (Barnes 1985, 1996; Butcher, 2004)
- *The kora kora of the Moluccas* (Hornell, 1946; Horridge, 1979a, 1982).
- *Perahu mayang of Java* (Stenross, 2007)
- *Madurese boats: golekkan, janggolan and lete-lete* (Stenross, 2007)

3.3.2. Iconographical Evidence: the Borobudur Ships (Java)

The carvings on a relief at Borobudur are the earliest depictions of South-East Asian vessels, with or without outriggers, yet their true origin is still debated as they are not considered as being typically Javanese sailing crafts (Manguin, 1980; Burningham, 2004; Jahan, 2006).

3.3.3 Archaeological Evidence

In the region of Palembang (South Sumatra), the ancient capital of Srivijaya, twenty-four discovered planks seem to be related to the stitched tradition. The planks have stitched fastenings and cleats to which ribs were lashed and appear to belong to a large and sturdy hull. The calibrated date of the wood sample gives 434-631 AD (Manguin, 1993, pp. 257).

Other remains of a boat found near Sambirejo elucidate the evolution of the lash-lug to the treenailed tradition. Dated to the 610-775 AD, the remains show stitches that supplement the unlocked treenails, ensuring that the planking was held fast. It may be classified as a treenail fastened boat (McGrail, 2001, pp. 198); the framing timbers are lashed to cleats integral with the planking.

Remains of large sewn-plank ships at Paya Pasir (North Sumatra) found with Chinese ceramics and hence dated to the twelfth to fourteenth century, show treenails, cleats and a lashing system. This was not a flexible framing, but a reinforcing framing for a relatively large vessel, possibly up to 30 metres in length (Manguin 1996).



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3.4 Brunei Darussalam

3.4.1 Boat Types

Brunei Darussalam was also an essential fraction of the Malay Peninsula, a maritime empire who, during the sixteenth century, controlled the entire island of Borneo, as well as parts of the Southern Philippines and Northern Java and traded with all the countries in the region.

During an exhibition in 2006 and as part of the collection of the Malay Technology Museum in Kota Batu, several boat types were described including the tongkang, pengabat, pelauk, bagong, pedayong, kumpit and bidar temuai.

3.4.2 Archaeological Evidence

In this region there are two primary sites of interest, the Limau Manis River archaeological site and the Kota Batu site. Investigations at Kota Batu revealed that boat building industries have existed in Brunei Darussalam for a long time, as ceramics found in the area dated back to the fourteenth to seventeenth centuries and were mainly from the Ming Dynasty. The site of Kampung Limau Manis is older. More than tens of thousands of ceramic shards ranging from the Song to the Yuan Dynasties (tenth to fourteenth centuries) were found on the site, alongside the remains of small boats, believed to be have been built during the same era (Rozaan, 2010).

3.4.3 The Brunei Shipwreck

Lost during the reign of the Sultan Bolkiah (1485-1524), the commonly called 'Brunei shipwreck' was transporting Chinese and Thai products when it sank 40 km off the coast of Brunei Darussalam. In 1998, French maritime archaeologists (Association for the Development of Maritime Archaeological Research) conducted an excavation and a survey.

Identified as belonging to the Chinese tradition, some 13,000 artefacts recovered originated from Thailand, Viet Nam and China illustrate the flourishing trade belonging to Brunei Darussalam some 500 years ago.

The ships from Brunei Darussalam were exporting local products to the Philippines, Siam or the Moluccas, yet little is known of their return journeys, so this shipwreck provides a unique insight into Brunei Darussalam's consumption of foreign goods and the ship's voyage back home. China at that time was isolating itself and had banned all forms of seafaring trade, so most foreign merchants who wanted to deal directly with China came bearing tributes to the Chinese Emperor. Local traders were forced to smuggle exported goods if they wanted to take part in international trade, which in turn lead them to contribute to the hybridisation of naval technology (L'Hour, 2001; Pirazzoli-t'Serstevens, 2011).



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3.5 Philippines

3.5.1 Boat Types

Banca or bangka: is the most commonly used term to refer to boats in the Philippines, such as non-houseboats, with or without outriggers. The Bajau do not have a general term comparable to the English word 'boat' that applies to all watercraft, but rather have a term for each boat type. These terms are often used casually, for example, two Bajau may use different names for the same boat, and similarly the names used for the parts of the boats may vary from person to person (Nimmo, 1990, pp. 60).

The balangay: (balangai) or Butuan boat is considered as the oldest means of transportation by which the Filipinos or people of Samar migrated to the country. The earliest boat finds (the Butuan boats) were all balangays; a name that originates from the Austronesian word for 'sailboat'.

The birau: is similar to a boggo. The only difference is that the Birau is designed so that the bow and stern both slope inward, whereas those of the boggo drop perpendicularly or outward.

The bitok: features a wider beam and a shallower hull than that of either the boggo or birau. It also rarely has outriggers or added planks.

The junkun: typically consists of a simple dugout hull, although a plank is frequently added to either side. It occasionally features outriggers. Typically 2.5 to 8 metres in length, this type of boat is used for fishing or short distance travel.

The tonda'an: is a fishing boat which is essentially a smaller version of the pilang, shorter, with fewer planks and usually lacking elaborate carving. The outrigger attachment is also typically much simpler.

Other notable boat types include:

- *Vinta of Mindanao* (Doran, 1973; Doran, 1981)
- *Pilang/Lipa* (double outrigger)
- *Lipa and pidlas of Tawi Tawi* (Nimmo, 1990, pp. 61)
- *Tawi-Tawi bajau boats*
- *Bettu* (lightwood rivercraft)
- *Pedda* (flat hardwood dug-out)
- *Birok* (rough-hewn dugout for fishing)
- *Bog-goh* (sailboat for transport)
- *Boggo* (a simple dugout, 1.5 to 4.5 metres in length)

3.5.2 Archaeological Evidence

Only three of the nine 'Butuan boats' were excavated, out of which one is dated to 320 AD, one to 1250 AD, while one is still undergoing preservation treatment (the remainder are preserved *in situ*). The planking of the Butuan finds is edge-joined with treenails, and cleat blocks (lugs) integral to the framing had pairs of holes through which the framing was lashed to the planking (Clark et al., 1993;

Green et al., 1995). The planks, which were made from a type of hardwood called doongon in the Philippines (*Heritiera littoralis*), were fastened together every 12 centimetres, where holes were driven on the edge of each plank. On the inner side of the boat the planks were provided, at regular intervals, with raised rectangular lugs, carved from the same plank, through which holes were bored diagonally from the sides to the surface (Casal et al., 2003). The National Museum of the Philippines is expected to conduct further research on the remaining Butuan boats in 2012.

3.5.3 The Balangay Replica

In the summer of 2009, the National Museum in cooperation with Bajaus carpenters from Sibutu and Sitangkai carpenters from Tawi-Tawi, built under the driving force of Art Valdez, a replica of a balangay, called *Ngandahig*. The result was not an exact copy of the ancient boat, but one that incorporated the design and construction methods of the Samar people. The main aim of the project is to sail on the routes used by the Filipino Ancestors during the waves of Austronesian settlement that spread throughout the Malay region and the Pacific. In 2009, the project covered seven legs around the Philippines, covering 2,108 nautical miles before culminating at the tip of Sulu. In 2010, South-East Asian waters were sailed, while in 2011, the Balangay retraced the voyages to Micronesia and Madagascar. In 2012, the balangay will sail across the Pacific onward to the Atlantic, all the way around the world, before heading back home to the Philippines in 2013.



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3.6 Viet Nam

Located at a crossroads along the trade routes of South-East Asia, the long coast of Viet Nam enjoys incredible boat diversity. There are two main trends in boatbuilding are clearly related to the two main groups who controlled the region; the Dai Viet and the Champa. Each trend reflects their own cultural, political and economical ties and connections; the Dai Viet linked to its Chinese heritage and influence and the Champa sharing common traits with South-East Asian traditions. A blend of these two main influences can be seen in the features of the planked boats of Viet Nam, but other types of crafts are also still seen along the beaches and lagunas that demonstrate how 'primitive' traditions may have evolved. The great diversity of boats in Viet Nam can be categorized in six groups if looking only at the hull construction: bamboo rafts, basket boats, mixed hulls (basket and planking), stitched boats, planked boats, and log boats (Pham et al., 2010).

3.6.1 Shipwrecks Found in Vietnamese Waters

Several underwater investigations occurred between 1992 and 2002, before a law that prevents illegal treasure hunting and underwater investigations was issued in July 2005 (The Decree No. 86/2005/ND-CP on Management and Protection of Underwater Cultural Heritage).

These explorations produced significant information, maybe not for the archaeological understanding of the shipwrecks themselves, but for the improved knowledge of the different regional trade patterns through the recovered ceramic cargoes. Five wrecks were officially excavated in Vietnamese waters (Nguyen Dinh Chien and Pham Quoc Quan, 2008). None originate from Viet Nam or belong to a Vietnamese tradition, yet, they still add knowledge of the main boat building traditions in South-East Asia and their cargo happened to be very significant in terms of art history (Guy, 2001; Flecker, 2002; Guy, 2005, 2007). The excavations were officially conducted by Vietnamese experts, but were initiated by foreigners and supported by international investments.

1. Hon Cau wreck (1620), also called the 'Vung Tau' wreck, was investigated in 1990 to 1991. The work was conducted by Viet Nam National Salvage Agency (VISAL), Hallstrom Holdings Oceanic and Michael Flecker (Flecker, 1992; Jörg and Flecker, 2001).
2. The Phu Quoc wreck, also called the 'Hon Dam wreck' was dated to the fifteenth century. The ship remains yielded about 16,000 artefacts comprising of celadon and brown porcelain from Sawankhalok's kiln in Thailand (Flecker, 1994; Brown, 1997). The wreck lay at a depth of 40 metres and the investigation was mainly conducted by VISAL, Michael Flecker and Warren Blake.

3. The Cu Lao Cham wreck was investigated in 1997 and considered to be the biggest and most costly salvage conducted in Viet Nam. The wreck lay at a depth of 72 metres, so required an array of advanced technology to recover some 200,000 ceramic artefacts. Various bodies were involved in the investigation and recovery, including VISAL, Mensun Bound, Saga Horizon (Malaysia) and the National Museum of Vietnamese History of Hanoi.
4. The Ca Mau wreck (1723-1735) was discovered 36 metres beneath the surface and was investigated between 1998 and 1999. The project recovered a large cargo of about 60,000 blue and white porcelains from China. The work was conducted by VISAL, the National Museum of Vietnamese History and the Museum of Cau Mau.
5. The Binh Thuan wreck (1573-1620) was investigated between 2001 and 2002 by Michael Flecker with the collaboration of VISAL and the Museum of Vietnamese History (Nguyen Dinh Chien and Flecker, 2003; Flecker, 2004).

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3.7 Cambodia

Boat traditions in Cambodia have not been extensively studied, although there is an interesting diversity in the three main bodies of water that belong to Cambodia, namely the coast of the Gulf of Thailand, the Mekong River and the great Ton Le Sap Lake.

3.7.1 Boat Types

Dugouts: various kinds of dugouts can still be found, such as palm boats which are found in flood plains, or the long racing boats that are constructed to compete in dragon boat races during the annual Khmer water festival (Groslier, 1921; Walker-Vadillo, 2010, pers. comm.).

Plank boats: there are also different types of plank boats. For example, on the Mekong near Stung Treng, there is a narrow-shaped flush-laid plank boat that features a raised, pointed bow, thus exhibiting a strong Laotian influence (Nugent, 2009). Most of the river boats are narrow and long, essentially evolving from a dugout base with added planking. These long canoes are present all along the river from south to north of Cambodia. Some long boats are so elongated that they are referred to as 'needle boats' (Ken Preston, 2010, pers. comm.). In addition, there is the typical Khmer 'pirogue' which is found throughout the country and has a very distinctive hull shape, being sat very low to the water. There are a few variations regionally to propulsion and steering.

Additional boat types include the tuk chaleum (from the Mekong delta), the tuk prabel and tuk chap ky.

3.7.2 Iconographical Evidence

The twelfth century bas reliefs from the Bayon and Banteay Chmar temples feature incredibly detailed depictions of the boats used in times of leisure or war. An interpretation of their nautical features can be found as part of research conducted by Walker-Vadillo in 2008.

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3.8. Laos

There is very little English language knowledge of boat traditions in Laos. At this stage it is only possible to note that the transition between the upper and lower Mekong, which is located at the border between Laos and Cambodia, implies changes in boat traditions. The boats on the Mekong in Laos are long, narrow, flat bottomed and made with just a few thin planks, in comparison to the heavier Cambodian hulls (Ken Preston, 2010, pers. comm.)

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3.9 Thailand

3.9.1. Boat Types

'The boats of the Siamese are innumerable. They are of many sizes and styles, but always beautifully, if simply, constructed from teak. No people in the world, indeed, have such variety of craft, or craft with lines so invariably graceful' (Whitney, 1900, pp. 628-630).

- The majority of boat types are based on the rudimentary lines of the Rua Chang
- Dugouts used on the canals
- Royal racing canoes
- Royal barges

3.9.2 Archaeological Evidence

In terms of archaeological remains, various shipwrecks belonging to the South-East Asian tradition or to the South China Sea tradition (with treenailed planking) have been found in the Gulf of Thailand.

The Pattaya was found off the east coast of Thailand and dated to fourteenth or fifteenth century. This boat features a keel, a round hull and Chinese bulkheads, but is also constructed according to the South-East Asian tradition of treenailed planking (three layers).

The Ko Si Chang 3 was a trading vessel of over 20 metres in length and dated to the fifteenth or sixteenth century. The elements excavated included a keel, six strakes of inner planking, some outer planking and possible sheathing, nine bulkheads, frames and a mast step timber (McGrail, 2001, pp. 301). The inner planking is fastened edge to edge with treenails.

The Ko Kradat shipwreck also featured edge to edge planking, fastened with treenails. The pottery artefacts recovered from the site dated to the sixteenth century.

The Ko Si Chang I also has bulkheads, planking fastened edge-to edge, a keel and may have been measured approximately 25 metres in length.



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3.10 Myanmar

3.10.1 The One Legged Rowers of Inle Lake

Most transportation on Inle Lake is traditionally conducted by either small boats or by somewhat larger very long and shallow draft boats, fitted with outboard motors. One of the most distinctive sights on the Inle Lake, however, is the local fishermen and their unique rowing style which involves standing at the stern on one leg and wrapping the other leg around the oar to manoeuvre.

This rowing style probably evolved because of the natural conditions on the lake as it is quite shallow and covered with reeds and floating plants, which make it difficult to see beyond while sitting. Standing provides the rower with a clearer view and easier steering. To fish, the local fishermen push conical traps down vertically with one hand, while their other hand and leg manoeuvre the boat.

3.10.2 The Kabang of the Moken Sea-Gypsies of the Andaman Sea

The Moken or Sea Gypsies spend almost half of their life in a kabang, travelling in fleets of ten to forty boats. In the Moken culture, people and boat are almost inseparable and to understand their boat technology, one needs to understand their cultural and symbolic context (Ivanoff et al. 1997, 1999). The kabang are used for cooking, sleeping and as a work space throughout most of the year. When the monsoon rains started to fall, the Moken would go ashore and build shelters on small islands to wait out the rainy season.



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3.11 Bay of Bengal

3.11.1 Eastern Coast of India: the Andhra Pradesh Coast

In India, the diversity of boats is as overwhelming as the diversity of its population and history. Each region and location has its own distinctive traditional boats and boat building technology. For example, the Andhra Pradesh coast is known for four types of traditional boats constructed for cargo transport, fishing and ferrying purposes: catamarans (teppa), dugout canoes, stitched-planks built boats and nailed-planks built boats. Teppas are simple floating devices, but are the predominant traditional sea craft along the Andhra Pradesh. Some keeled planked boats that are locally called padavas are also common vessels along the Andhra coastline (Thivakaran and Rajamanickam, 1993; Tripathi, 2006).

Orissa is famed for its maritime trade and vast network of maritime contacts that were established during the Early Historic period. Notable shipbuilding traditions include the Boitas (or Voitas) that were built in during the heyday of the Kalinga Empire, and the Patia. The Patia demonstrates a specific boat tradition, as it is constructed with the reverse clinker technique (in the planking, the lower strakes lap each other in the opposite manner to that used in the Northern European tradition of clinker planking). Visually stunning with its sweeping strakes, the patia is one of the most complex traditional boat constructions in the world.

Frame-first vessels of Tamil Nadu include the vattai and the vallam. These boats are interesting because they are built frame-first (unlike all other traditional plank boats observed on the east coast of India) and they are generally similar in structure and form. Furthermore, they are designed using variants of a standard technique which was probably brought to India by Europeans, possibly by the Portuguese in the sixteenth century. Vallam are either extended log boats with a rounded bottom and flared or narrow 'carvel-built' plank boats. The Vattai, in comparison, is an open fishing boat that features three, sometimes two masts, balance boards and leeboards (Blue et al. 1998; Kentley et al., 2000)

3.11.2 Boat Types of Bangladesh

Basil Greenhill (1957, 1966 and 1971) provided one of the earliest analysis and system of classification of the boats from Bangladesh.

As a result of the inconsistencies in boat names, Greenhill classifies them based on their features, as follows:

- Round hulled, smooth skinned (*binekata* in Bangla)
- Round hulled clinker (*digekata*)
- Clinker boats of the Upper Ganges
- Chine built, smooth skinned of Dhaka region
- Flat bottomed boats (*koshas*)
- Dugouts (*log boats*)

3.11.3 The Oru of Sri Lanka

The oru, an outrigger boat with a dugout hull from the south and west coasts of Sri Lanka, is probably the most representative type of boat for the region. Thirty-five types of this vessel were extensively documented by Kapitan (2009) in his beautiful collection of scale drawings and photographs.

Based on types of fishing and environment, Kapitan identified five different kinds of watercraft in Sri Lanka; the raft, vallam, oru, angula and ma-del-paru.

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3.12. West Indian Coast and Goa

3.12.1. Boat Types of Goa

Goa is a former Portuguese colony on the west coast of India. Here, the fishing boats are named after saints, and the owners and crew of the vessels make offerings to the relevant saint on his or her feast day.

Different kinds of boats can still be seen along the Goan coast, including dugouts, plank boats of different sizes and shapes (with or without outrigger), sewn-planked boats and motorized fishing boats.

3.12.2. Some Boat Types of the West Indian Coast

On the Kerala coast, there are different kinds of rafts, dugouts and plank built boats (stitched and nailed). The smallest craft of the Karnataka region is a canoe, known as a hudi, which is scooped out of a single tree trunk. Here, mid-sized crafts are known as doni (boat) while the largest crafts are known as machchwa (ship). (Gaur, 1993; Sundaresh, 1993).

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3.13 The Arabian Sea/Oman/Pakistan

Arabia and Persia were two distinct and independent trading nations, but from historical evidence alone it is impossible to distinguish clearly between Arabian and Persian ships, as the interaction and inter-influence across the Arabian Sea was so great (Flecker, 2001b).

Stitched hull construction was the only technique used by both Indians and Arabs, until iron nails were introduced by the Portuguese (Hourani, 1995, pp. 93). Evidence on this early tradition is presented in the chapters of the *Periplus of the Erythraean Sea* (first century) and continues to be mentioned in descriptions of this region from the sixth century to the present (Hornell, 1942; McGrail, 1996).

3.13.1 The Dhow

A dhow is a traditional Arab sailing vessel, easily recognisable with its triangular lateen sails, pointed overhanging bow, sheer rising to a high poop and a raked transom. It is primarily used to carry heavy items, such as fruit, along the coasts of the Arabian Peninsula, Pakistan, India and East Africa to China, through the Straits of Malacca. Larger dhows have crews of approximately thirty people, while smaller dhows typically have crews of around twelve. Dhows are much larger than feluccas, another type of Arab boat usually used in fresh water in Egypt, Sudan and Iraq (Hawkins, 1977).

3.13.2 Boat types of Oman

Some of the traditional boat of Oman recorded by Vosmer and his team (1992; 1997; 2000) are as follows:

Badan: there are two basic types of badan, the fishing badan and the larger cargo badan, both known locally as a uwaissiyah.

Baggarah: a long, narrow vessel with long raking stem and radically upswept stem sections.

Baghlah: large cargo vessel distinguished by its elaborately decorated high poop and quarter galleries.

Battil: a type of double-ended vessel with club shaped stem head and stem profile, in the shape of a stylized dog's head. The end of the stems of these vessels are usually covered in goat skin.

Boom: a double ended vessel which features a sharply raking stem and less sharply raked stempost. The stem is normally painted with a black and white motif and bears one or two masts.

Ghanjan: very similar to the baghlah, but less elaborately decorated. Its stemhead features a distinctive decoration of concentric circles surmounted by a trefoil crest.

Houri: dugout canoe or extended dugout.

Jalibut: a transom-sterned vessel with vertical stem.

Karib: large fibreglass dinghy that is powered by an outboard motor and used for fishing.

Shashah: a small one or two person vessel made from the spines of date palm fronds.

Shu'l: a transom-sterned vessel with straight stem that ends in an ogee curve. Commonly used for fishing.

3.13.3 The Belitung Wreck

Located near the island of Belitung (Indonesia), the Belitung wreck (also known as the Tang wreck) is an Arabian or Indian ship dated to the ninth century whose cargo includes ceramics from the Tang Dynasty (618-906 AD). The wreck provided the first evidence that clearly demonstrated direct trade between the Indian Ocean and China during the latter part of the first millennium.

The analysis of its construction method, hull form and timber species shows similarities with both traditions. Wood analysis could have helped determine the origin of the ship, but the analysis was inconclusive due to the poor state of the wooden samples (Flecker, 2001b, pp. 347).

3.13.4 Jewel of Muscat

The *Jewel of Muscat* is a replica of a ninth century sailing ship whose reconstruction was based on a range of historical sources, including the findings of the Belitung wreck. The 18 metre ship was built without nails and the planks were sewn together with coconut fibre. Her voyage started in February 2010, in Oman, with stops in India, Sri Lanka and Malaysia, before ending in Singapore four months later. The journey retraced part of the historic maritime trade route between Arabia and the Far East.

The project was funded and supported by the governments of Oman and Singapore. Every stage of the *Jewel of Muscat's* construction and voyage was documented and can be seen at: www.jewelofmuscat.tv (Accessed March 2012.)

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Unit Summary

This unit explores the terminology, building techniques and boat types of Asia and even further a field. Having been introduced to different construction methods, students have the basic interpretation tools required to identify future underwater finds.

By exploring the traditions of the region, we can clearly illustrate how each feature of each type of boat is designed for a different purpose that do not just relate to functional or environmental factors. The design of a ship, its concept, overall purpose and construction sequence are dictated by the people who construct and use them, by the materials that are available and also the political, social and economical context of the period. Boats reflect a region's history and help archaeologists and historians to place local traditions in a wider maritime historical landscape.

It is important to remember, however, that although this unit introduces numerous boat types and building traditions, knowledge is still lacking in countries, such as Myanmar and Cambodia. Even in areas where we appear to have a great understanding, documentation and data is often hard to access (particularly in the English language) and much of the information presented has not been collected during archaeological excavations.

Unfortunately, through events such as the Tsunami in 2004, these traditions are disappearing much faster than is anticipated and further research is required to preserve maritime cultural heritage and craft traditions. It is hoped that in the next few years new archaeological excavations, that incorporate a holistic approach, will increase the knowledge of past Asian shipbuilding technology.



Small traditional boats are still used, but are fast disappearing along with traditional crafts and ways of life. Inle Lake, Myanmar. © Charlotte Pham

Suggested Timetable

| | |
|----------|--|
| 15 mins | Introduction to Asian Shipbuilding Technology |
| | Break |
| 60 mins | General Boat Technology - <i>The Basics of Boats, Ships, Vessels and Watercraft</i> - <i>Basic Boat Types</i> - <i>Specific Purposes and Categories</i> |
| | Break |
| 120 mins | Practical Session: Boat Terminology |
| | Break |
| 60 mins | Asian Shipbuilding Technology: Main Traditions |
| | Break |
| 60 mins | Practical Session: on Each Country: Part I |
| | Break |
| 60 mins | Practical Session on Each Country: Part II |
| | Break |
| 60 mins | Present 5 Minute Description of One Specific Boat Type per Country - <i>Complete reference list on boat traditions</i> - <i>Exchange documents</i> |
| 10 mins | Concluding Remarks and Closure |

Teaching Suggestions

Trainers should present the various aspects of Asian shipbuilding technology through a series of lectures and practical exercises. The practical sessions will help students put the appropriate terminology to use and help them become more familiar with boat diversity in the region.

The lecture can be split into three parts: a short lecture on general boat technology, one that covers boat terminology (combined with a practical exercise) and finally a lecture and long practical exercise on Asian and South-East Asian shipbuilding traditions.

Practical Session: Terminology

The aim of the first practical session is to help students familiarize themselves with boat terminology. To begin the practical session it is recommended that trainers introduce students to the different names for each component of a boat. Students should be encouraged to take notes and request translations and further explanation where needed.

The practical session gives students a chance to test their knowledge and reflect on each of the terms. Trainers should prepare and provide each student with a folder that contains pictures of different types of boats from around the region. The pictures can either be discussed as part of the lecture to illustrate the theoretical material and/or used as part of a group exercise.

In small groups, students should be asked to think about how each of the boats can be categorized e.g. boat types, rudder types, construction types, etc. This not only allows students to practice identifying specific characteristics, but also highlights the great technological diversity to be found in the region.

Alternatively (or in addition), if the training centre is in the proximity of a small harbour, trainers could take the students and discuss the types of boats encountered.

The lecture introducing the main traditions of Asian shipbuilding technology provides students with a basic list of boat types found in the region. This is meant to form a foundation, from which to develop further knowledge. The aim is to then encourage students to share the knowledge they have on their countries respective boat types, by selecting one representative boat for each country and presenting the main features and characteristics of that boat to their fellow students.

It is important that the list of boat types in each country evolves and that additional references and boat types are added to create more comprehensive and up-to-date information. As it is not possible to browse through all the regions and boat types collectively in one lecture, it is recommended that a practical session be conducted. Students should be divided into small groups, e.g. by region or by sea or river network. In their groups, students should begin by assessing the existing reference list and adding more references or boat types as appropriate. The students also need to assess how much knowledge is available and what more research needs to be undertaken.

Next, each group needs to select one representative boat that they want to share with the rest of the classroom. Students need to accurately identify the different features, characteristics and most essential terminology belonging to that boat. It is useful if students can also include anecdotal, historical, or environmental information that will help other students remember the craft. Students must select a picture and prepare a short presentation (maximum of 5 minutes) for the rest of the class.

All of the documents, articles and essays related to the groups selected boat should be saved in a central database (CD or USB) and circulated to the other students. The aim is for each student to create a reference folder of information (including pictures and reference documents and articles) with which to build on after the Foundation Course is complete.

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