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Shipbuilding Tools in Antiquity in the Mediterranean: An Archaeological and Ethnographic Approach

A Master Thesis submitted as a partial fulfilment of the requirements for an MA in Maritime Archaeology

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ABBREVIATIONS

IJNA   International Journal of Nautical Archaeology
IEASM  Institute of Underwater Archaeology.
INA    Institute of Nautical Archaeology.
MSUH   Maritime Studies of the University of Haifa.
RIMS   Leon Recanati Institute for Maritime Studies at the University of Haifa.
DECLARATION

I hereby declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.
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ABSTRACT


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This thesis is concerned with the development of shipbuilding tools of ancient ships and the techniques of using them, since it's essential for a firm comprehension of water transport in Antiquity. The study extends from circa 3000 B.C. to the 7th century A.D; date of Yassi Ada I shipwreck. This particular time frame is chosen since it shows the most important step of transition of shipbuilding techniques from shell-first to frame-first. It focuses on shipbuilding tools around the Mediterranean.

The ancient Mediterranean remains a place of great culture complexity and its recreation in the hands of historians has become even more challenge as a mass of new evidence emerges to displace the primacy of the major classical texts.

Furthermore, the appearance of similar shipbuilding techniques in different geographical areas could be a result of past contact between people of those regions, either during trade or even in a direct way—in exchanging technological “knowhow”, which could be simply a manifestation of the human life evolution nature.

The data of this study includes archaeological evidence from excavated material, iconographic evidence, and resources for creating comparative analysis. In addition to Ethnographic field work.
INTRODUCTION

This research is intended for investigating diverse tools used in the shipbuilding process, as well as to trace the development of these tools through different civilizations.

There are a lot of different definitions for the tool. The simple one is any hand-held instrument used for cutting, shearing, striking, rubbing, grinding, squeezing, etc.

The Ancient peoples have invented tools in-order to adapt with the surrounded environment. Through centuries, they have worked on developing more different tools, which are now matter of conjecture, as the only voice from the past, which can convey their technological achievements in creating tools.

The most important example in investigating the development of shipbuilding traditions is to trace development of tools, and how the craftsmen succeeded in building a seaworthy vessel to transport them from one place to another through the aquatic medium. However, a wide range of tools was used in carpentering ships for different purposes, including cutting, fastening, hollowing, and measuring, etc. Creating a comparative analysis between both ancient woodworking and their achieved technology by that time with the technology nowadays can provide a better understanding for the obstacles that the carpenters have gone through including time and effort needed to build a ship and the efficiency in building techniques. However, it does not matter how efficient the tool is, than how skilful the carpenters are to adapt with the available technology.

Research Objectives

The purpose of this study was to:

1. Investigate shipbuilding tools in the ancient Mediterranean discovered, shipwrecks, as well as their iconographic and text evidence during the period 3000 B.C to the 7th century A.D.
2. Trace the development of the selected tools intended in this study over the time.

3. Compare and evaluate the difference between the selected tools through ages.

Research Methodology

Selection criteria of the Research

a. The Geographical Frame:

The research will deal with shipbuilding tools in the area of the Mediterranean (Egypt, the Greek world including Asia Minor, Greek mainland, Cyprus and finally the Roman and Byzantine world), due to its historic role in the development of maritime technology.

b. The Time-frame:

The time-frame for this study includes the period from circa 3000 B.C. –date of the burying of Abydos fleet discovered in Sohag in 1991-to the 7th century A.D – date of Yassi Ada I shipwreck, that shows the most important step of transition in the shipbuilding techniques from shell-first to frame-first.

Analysis and Interpretation of Data:

This is a meta-analysis method by virtue of which data is surveyed, examined, and made best usage for the purpose of coming up with a comprehensive and insightful understanding of the topic. The data is assembled from the following sources:

a. Excavated Materials:

Excavation in and around the Mediterranean waters have provided valuable information about methods of manufacture of shipbuilding tools in Antiquity. For instance, the excavations and research done by Petrie on Egypt (Kahun, Gurob and other places) published in 1917 had preserved important archives for ancient Egyptian tools. Also, the lack of resources through the Greek period have represented difficulties through the research, but different examples for measuring tools and tool marks that were discovered in Ma'agan
Mikhael Greek shipwreck provided vast information with regards ship building tools that were of concern during the Greek period.

b. Written Sources:

Written sources are another source for gathering information about ship carpenter’s tools. Ancient sources include Thophrastus, Pliny the Elder, and Ovidius. In addition to other sources like Odysseus’ this is the most famous description of ship construction in literature.

c. Iconographic Evidence:

The iconographic evidence is an important source of information about ship carpenter’s tools created by artists in Antiquity, and it primarily exists in wall painting in the pilgrimages sites, coins, pottery and stone inscriptions (grave relief or marble relief). Through this research, studies have been done using various iconographic evidences. It is including relief paintings displayed on tomb walls in the Ancient Egyptian period, the marvellous Greek painted pottery examples, and gravestones through the Roman period.

d. Ethnographic Evidence:

Ethnography is a research methodology specific to social sciences, used by ethnographers and anthropologists to obtain an in-depth understanding of the history, practices, values, and traditions of individuals and groups. Accordingly, visiting shipyards in Egypt were for evaluating and linking between usage of ancient and modern tools. Moreover, fieldwork was essential for gaining more understanding of evidence from shipyards. The reason for selecting a shipyard at Rashid through this study goes back to their background experience in using ancient Egyptian shipbuilding designs, tools, and ship navigation techniques from the time of the Egyptian queen Hatshepsut side by side with modern ones during the construction of “Min of the Desert”. A discussion conducted with the Patrice
Pome\textsuperscript{1} for clarifying the variety of tools used in building “Gyptis”\textsuperscript{2} the sailing replica of an archaic Greek wreck which dating from the 6th century BC. Moreover study models Cavalière Roman shipwreck dated around 100 B.C and Comacchio goes back to the last quarter of the 1st century.

**Conclusion**

This study will tackle with different types of tools used in shipbuilding in different centuries from ancient time. In addition to point out how such tools developed through the time. Not only studying how the tools developed but also, it will figure out development of techniques used by the ship maker or crafts men while using such tools. In the light of what researchers achieved from previous studies on shipbuilding tools, as well as their comments written on each specific tool which categorize as cutting, bouncing, measuring and smoothing tools.

\textsuperscript{1} Director of Research Emeritus at CNRS, Center Camille Jullian.

\textsuperscript{2} Detailed information with regards to the “Gyptis” project at the following link (\texttt{protis.hypotheses.org/}).
CHAPTER ONE

SHIPBUILDING TOOLS IN EGYPT
CHAPTER ONE

SHIPBUILDING TOOLS IN EGYPT

What define the ancient Egyptian civilization is its cultural unity, economic prosperity, and political stability. Water craft also played a salient role in the creation, development as well as the expansion of Ancient Egypt. The river Nile served as a natural highway that connected Egypt together, bridging the gaps among the different cities. Transportation via the Nile had to be made accessible creating the need for shipbuilding. Therefore, water craft as well as the ship building industry constituted a corner stone in Ancient Egyptian civilization.

According to Monroe, the shipbuilders were mainly men, women, and even children, responsible for organized tasks to work on ship construction in an area near Memphis. Moreover, he stated that their socio-economic class was the low-class level. (Monroe 1990:iii).

The earliest Egyptian tools were mainly made of stones. Later, during the Late Period, the extensive production of metal tools was introduced and mainly manufacture of copper and bronze metals. The fact that the stone blades could easily be re-sharpened, less expensive and don’t require specialized craftsmanship allowed the continuation of using stone tools side by side with the metal tools which varied in type, weight and size according to the intended function needed (Haldane 1993: 47- 48).

Through the ages, Egyptian shipbuilding tools could be traced through models, carpentry scenes and artefacts that were represented in true Egyptian style inside discovered tombs. Shipwright tool kit consisted of adzes, axes, chisels, and saws as cutting tools; drills and awls for perforation; hammers and mallets for percussion; and plumb bob as measurement tools, all of which were displayed on the tomb walls.
Although, the resources related to the models discovered inside Ancient Egyptian tombs were useful material for reflecting a clear image of the carpentry tools used by that time. Another key point, the carpenter’s shop model of Meket-Re provides a perfect representation of the woodworking process; as Winlock mentioned “one can almost hear the rasping of the ripsaw as its teeth cut through a timber, the chopping of the adzes, the tapping of mallet on chisel handles, and the grinding of sandstone planning blocks” (Winlock 1955:33) (see section 1.1.3. Adze -Fig 1.19).

The following section will illustrate the shipbuilding tools ordered by ship manufacturers. This could be categorized through intended task as: Cutting, Fastening, Shaping, Bouncing, Measuring and finally Smoothening.

1.1. Cutting tools:

1.1.1. Axe: minb

The Ancient Egyptians have associated the axe, "minb", ( Hammad 2009: 96) usage with chopping down, processing of trees and roughly splitting logs and shaping of planks (Roger 1996: 16). The axe was used to cut in either parallel manner or across the grain of the wood. To cut down trees, the woodcutter's axe had to have a long handle and was held with both hands (Scheel, 1989: 48) (Figure1.1) Over the course of axe development, it seems that axe have the same form it was the blade that witnessed the evolution Although, the axe handles and blades were attached together using varied materials (leather lashing for example). Over the time, ancient Egyptians have developed a new method for tightening the axe blade to the handle by adding holes on the blade to tight it with the handle as well as using leather thongs. In addition to axe importance as a woodworking tool used through-out the shipbuilding process, it also had a ceremonial purpose. This type of axes was usually
decorated and found with encryptions (Figure 1.2). The below figure illustrates different types of axe blades which include: (Figure 1.3, 1.4).

1. Rounded blade (Early of the 1st Dynasty).
2. Square blade (Middle of the 1st Dynasty).
3. Fully deep axe blade with lugs (Middle Kingdom).

Figure 1.1 Woodcutter at work the blade, of his axe is semicircular (Scheel, 1989:48 fig 52).

Figure 1.2 : Decorated copper alloy round blade axe, with two perforations for hafting to handle 12th dynasty ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
Figure 1. 3 Several types of axe blades (Scheel, 1989:48, fig. 51).

Figure 1. 4 Different types of axe blades a) Copper alloy round blade axe with one hole drilled through for hafting to handle, and lugs turned down to hold the lashing 6th dynasty, b) Copper alloy plain blade axe attached to handle by leather thong 90 degrees to the handle Early Dynastic Period, c) Copper alloy round blade axe 12th dynasty by leather thongs d) Copper alloy round blade axe with broad lugs through which leather thongs get attached to the lugs 18th dynasty "Petrie Museum, UCL Petrie Collection Online Catalogue", 2002.
Examples for the polished axes were found in Nubia that date back to the early pre-dynastic period. However, different examples for axe have been displayed in tombs scenes such as tomb of Abba at Deir el Gabrawi, (Figure 1.5) and Ty tomb reliefs (Figure 1.6) (Haldane 1993: 49). Dockyard records from Senwosert I region have shown that a standard axe weighed from 50 to 40 Deben$^3$ and their blade varied from 0.15 to 0.7 cm in thickness (Haldane 1993: 49; Ward 2000: 27).

![Figure 1.5 Using axe in the Tomb of Abba at Deir el Gebrawi (Wachsmann, 1998:234, fig. 10).](image)

![Figure 1.6 Using axe with worker number1, 3to process a log (Roger, 1996:17, fig. 3).](image)

$^3$ Approximately 700 to 560 grams
1.1.2. Saw: $t\theta$

Saw "$t\theta"$ (Hammad 2009:112) is a vital tool kit used in the earlier stages of ships construction for chop up the wood into blocks and planks. Also, it was used in the final construction stages in order to finish up or clear off any undesired excess wood of the hull of the ship (Figure 1.7). The teeth extend along the blade without reaching the tip facing down the handle (Ward 2000:27).

Ancient Egyptians developed two shapes of saw push and pull saw (Figure 1.8). Saw shape modification can be traced over time through scenes and discoveries. Going back to the Pre-dynastic period, Badarian Period 4500 to 4000 BC, a flint saw was discovered (Figure 1.9). Moreover, at Saqqara in tomb 3471, Emery had discovered copper saws side by side with other wood working tools (Figure 1.10). It was suggested that they were dated back to the 1st Dynasty. The Tombs scenes of 5th Dynasty show the saws with a distinct straight back with a set of teeth along a curved cutting edge. The handle was molded to fit the carpenter's hands giving it a more comfortable and controlled grip (Killen, 1994: 18-19, 33-34). Until the 6th Dynasty, there were many scenes of sawing illustrating two types of saws one of them with a handle and a clear blade at one piece and the other with an added handle attached to the saw (Petrie, 1917 43). The sawing process tool consist of two wood branches consist the legs set vertically into the ground roped together with a cord and a stick with a heavy weight stone wedged between them. The process of lifting the stone allows the movements of the blade through the sawn object (see also Figure 1.7).
Figure 1. 7: Using of saw fifth dynasty (Monroe 1990:52, fig 21).

Figure 1. 8: Carpenters using a 'pull' saw and adze (missing). Deir-El-Bersha, tomb of Djehutinakht. Late Eleventh or early Twelfth Dynasty (Boston Museum of Fine Arts).

Figure 1. 9: Flint saw ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
The earliest example that goes back to the 1st dynasty of copper saw shape and profile are similar to slightly curved edge with round blunt nose, edge were beaten to increase the metal's hardness, at the same time reducing the thickness of the edge ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).

1.1.3. Adze: ʿnt

Egyptian woodworkers depended on using the Adze ʿnt (Hammad 2009: 99) in many purposes such as rough shaping, finishing of timbers and taking off a thin slip of unneeded wooden parts. The adze blade was fastened at the top of its shaft with leather thongs, strips of linen or cord (Killen 1994: 40). According to Egyptian tomb scenes and archeological finds, the development of adze handle and blades took several stages depending on the technology of each time and the available materials. Roger has categorized adze handle by their shapes into two types of handles; a swan neck and candy cane shapes (Figure 1.11 - 1.12) (Roger 1996: 27).
Monroe, in his turn, divided them into smaller and larger forms according to their sizes. During the Old Kingdom and Middle Kingdom, the small form hand adze tends to have a blade to handle with acute angle closer to 45 degrees. The larger form was illustrated in the boatbuilding scenes long enough to be controlled using both hands. Although, this type has a wider blade angle to the haft that reaches 90 degrees, such right angle will support the shipwright in accelerating removing layers quickly. Later, during the New Kingdom, the longer type of adze only appeared in hieroglyphs and ceremonial scenes (Figure 1.13-1.14) (Monroe 1990: 41-42).
On the other hand, adze blade with parallel sides has been known and its development could be traced from Pre-dynastic times to the Third Intermediate Period. Going back to the Pre-dynastic period, long, narrow copper blades were discovered. Blades became broader concave at the sides and broader at the lower end during the early dynasty. From the 2nd dynasty, the upper end of the blade was developed taking a rounded curve. By the 3rd dynasty and until reaching the 4th and 5th dynasties the blades with a marked notch in the upper end were used and developed through this period to a clearly formed head (Figure 1.15).
Moreover, there are collections of old kingdom finds of copper-alloy model tool shapes in the tombs of the sons of Vizier Qar at Abusir South (Figure 1.16). Through the 18th dynasty, this type was not used any more. However, during the 12th dynasty, bronze blades were used side by side with the copper ones (Figure 1.17) (Scheel 1989: 49-50). Thus, by considering all of the above classifications, it is obvious that the development of both handle (size, form and material) and blade (size and form) have their influence on the way of attaching, the angle degree, breadth formation and shape which facilitates the task needed to be achieved in the first place.

Figure 1.15: Adze blades form (Scheel, 1989: 49, fig 53).

Figure 1.16: Collection of different types of adze blade from the Old Kingdom Fifth Dynasty burials equipment (Odler, 2017).
Furthermore, shipbuilding tools did not affect only the life of Ancient Egyptians, but also their beliefs about death and as a result it was used as a death ceremonial tool. This usage could be viewed from Deir el Bahri, where there are eleven bronze adzes bound with leather to a wooden handle and one of them has inscription with the name of Queen Hatshepsut (Figure 1.18). Representation of the carpenter’s shop in which men with adzes worked on dressing timbers and smoothing planks sitting on the floor, while others worked on sanding a timber, which is equivalent to planes and sand papers, represented by a block of wood (Figure 1.19) (Winlock 1955:33). In Ty relief, Adze was the most frequently illustrated tool which always associated with Egyptian boat construction (Figure 1.20), moreover it appeared in text of tomb which means carpentering using adze (Hammad 2009:350). Another example highlighted in (Figure 1.21) that shows an Adze marker from the Red boat, Dahshur.

Figure 1.18: Bronze adze inscribed with the name of Hatshepsut ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
Figure 1.19: The carpenter shop from tomb of Noble Meket-Re. (Winlock 1995:156, fig. 28).

Figure 1.20 Adze marks on a deck beam from the Red boat, Dahshur (Creasman, 2010: 88).

Figure 1.21 The work of the underside of the keel to the adze represented in the tomb of Ti in Saqqara Fifth dynasty of the Old Kingdom (Belov, 2014:110, fig. 54).
1.1.4. Chisel: *mgbt*

The Chisel’s, *mgbt* (Hammad 2009: 106) main use was for small cuts and removing wood along or across the grain during hull construction. In other words, it was used mainly to cut mortises or channels for joining purposes, also, to sculpt and decorate stem and stern finals and creating position for oars (Figure 1.22) (Roger 1996: 35-121).

Chisel was among the tools listed in funerary inscription; of which thousands of chisels were included for tomb owner’s use in the afterlife. Accordingly, during the 4th Dynasty chisels were requested by Ka-em-ankh from four different types, to be encompassed in his tomb (Ward 2000:28). Also, many scenes have demonstrated chisel usage such as that of Rahotep tomb during the 4th Dynasty, Prince Khuenre in the Giza tombs during the 5th Dynasty, the Abba tomb at Deir el Gebrawi in the 6th Dynasty (Figure 1.23) and also in Ti tomb 5th Dynasty (Figure 1.24) although, the word “mnkh” in hieroglyph was interpreted by Lallemand to mean "to mortise", Montet and Petrie have simply translated it as "using the Chisel" in its general meaning. It also appeared in the Ti relief in hieroglyph form(Figure1.25) (Roger 1996: 68-69).

![Figure 1.22: Mortising a plank: Two workers, using mallets and mortising chisels to cut mortises into the top surface of a plank (Wachsmann 1998:231, fig .10.15).](image)
In the light of scenes from tombs it's fair to mention that chisel had different types that can be divided into:

a. **The bare metal chisel**: the simplest form as seen in figure where the butt as well as the tip are sharpened and handheld from the middle without adding wooden handle. This kind was found even in the period of prehistoric Egypt as handy graver (Figure1.26) (Petrie 1917:19).
b. **Graving Chisel:** by the 1\textsuperscript{st} Dynasty round handles were added to graver blades (Ward 2000: 28-29).

c. **Square Chisel:** used during the 3\textsuperscript{rd} Dynasty and continued up to the 19\textsuperscript{th} Dynasty. They were found in Khosekemui, Nefermato at Meydum, located at El Amarna (Figure 1.27) (Petrie 1917:20).

d. **Mortising Chisel:** this type was unique in its form; it was wide and thin, with two equal curves sloping to the edge. Furthermore, its usage duration through Dynasties was identical with the square chisel (Petrie1917:63). Mortising chisel consists of two forms:
a. The square-bar mortising chisel.

b. The rectangular-bar mortising chisel.

It is suggested that, the first form was to be used accompanied with mallet for digging out of hole, followed by scaring and praying with the heavier rectangular-bar chisel to clean the mortise out and finish it. Generally, both were similar to modern chisel tools, except for the metal head and the edge which is mono facial on a genuine modern chisel. While both bifacial and mono facial edges were used in the New Kingdom (Monroe 1990: 47-48).

e. **The Tang Chisel:** was designed in a way to fit into a handle. It was barely found in Egypt before Roman times (Figure 1.28) (Petrie 1719: 20).

![Figure 1.28: Tang chisel (Petrie 1719: XXI, fig. 90-95).](image)

f. **Bare and Tanged:** The use of end pressure became common, whereby a mere pad of wood was put at the end of the tool forming a flat plank as it was in the 1st dynasty chisels (Petrie 1719: 18).

g. **Firmer Chisel:** The Firmer Chisel, in contrast, had a handle with a round top, which would fit comfortably into the palm of the carpenter's hand, suggesting it was used for handwork and carving. It had a rectangular blade and was shorter in length than a mortise chisel (Figure 1.29) (Killen 1994: 22).
In Ancient Egyptian history, there are clear evidences for chisel usage. In Saqqara tomb 3471, 51 mortise chisel, short chisel, and chisel with round-ended handles for hand work were discovered. On Dashur boat and Lisht planks chisel blade marks were showed on mortise. (Ward 2000:28). Moreover, in 1888, Petrie had discovered a workmen’s town at Kahun back to the Middle Kingdom. A number of chisel and adze blades were found in varies materials (bronze, tin, and alloy of copper) inside the temple complex of this town (Killen 1994, 41). According to Belove (2014) in his study of the Egyptian naval architecture of the Late Period on vessel 17 (11th to 1st century B.C) which is based on excavations carried out by the Institute of Underwater Archeology (IEASM) in (Thonis-Heracleion) allowed to discover more than sixty boats. (Figure 1.30).
1.1.5. Bow drill: *wnt*

The Bow drill, *wnt* (Hammad 2009:104) in most cases was best used for cutting through wood forming a line of small and round holes on the vertical surface of the bulwark for inserting pegs (Roger 1996:36). This tool consists of a bow made of wood, wrapped with cord of a single turn, arrow and a cap. The arrow is then wrapped with the chord of the bow and set upon the area they wish to drill. A cap is then fitted over the top of the wooden drill or arrow as a means of centring and inflicting pressure (Figure1.31, 32, 33) (Gorelick 1981:25). Because normally the ancient Egyptian boat builder avoid making holes in the hull to prevent the penetration of water. Unlike the axe and the adze, the drill role was not essential through ship construction process (Roger 1996:36).

![Figure1. 31: Bow-Drill from a Carpenter's Shop Thebes, Southern Asasif, Tomb of Meketre copper wood 12th dynasty](http://www.metmuseum.org/).

a) ![Figure132 a) Unfinished drill stock wood](7084)

b) ![Figure132 b) bow made of wood not found together](7085)

Figure 132. a) Unfinished drill stock wood, b) bow made of wood not found together ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
Although the bow drill was well known since the Early Dynastic era, but drill was never portrayed in a known shipbuilding scene up until the Late New Kingdom showed at Qaha tomb (Figure 1.34). However, the Mataria vessel of c.500 BC provides physical evidence for drilled peg holes (Ward 2000: 29). Also, the Lisht frame as well as the only peg tenon found in one of the blanks of Wadi Gwasis (Figure 1.35) (Ward, Zazzaro, & Abd El-Maguid 2010:388).

Figure 1.34: Qaha at Deir el- Medinah (Ramses II) (Wachsmann 1998:236, fig. 10.25).
1.2. Bouncing Tools

1.2.1. Hammer

The hammer was to ensure that all hull parts were fitted together by bouncing the planks. The Egyptians have used different kinds of hammer: small cylinder stone (Figure 1.36); two-handled (Figure 1.37); cubic shape (Figure 1.38, 1.39), a smooth stones that functioned as a hammer, two scenes that illustrates the workers retaining stone handled hammer during hull construction process.

Figure 1. 35: Pegd tenon at Wadi Gwasis out board edge 1 (Ward, Zazzaro, & Abd El-Maguid, 2010:388, fig. 1).

Figure 1. 36: Ty relief hull 2 using stone hammer (Wachsmann, 1998, fig. 10.18 : 233).

Figure 1. 37: Stone hammer, Old Kingdom ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
1.2.2. Mallet: *ḥrw*  

The mallet, *ḥrw* (Hammad 2009: 109) is a large wooden hammer cut from the stem or branch of a tree with a short handle and a cylinder wooden head. (Steffy 1994:275). Mallets were used for pounding chisels (Figure 1.40 and 1.41); nevertheless, they were also used in various stages of construction, such as the driving of planks into place. At Deshasheh, during the 5th Dynasty, there were various forms of mallet. One was formed of a piece of branch thinned down at one end allowing for a better grip its shape similarly word "hm" in hieroglyphic (Figure 1.42). The second one was shaped of a long handle with a cross-head (Figure 1.43). The third
one was a heavy mallet most of the time was cut from one block of wood with a large head was usually conical (Figure 1.44), bulbous (Figure 1.45) oblong or cylindrical, which were used till the 19\textsuperscript{TH} Dynasty (Petrie 1917:40).

Figure 1.40: Use of mallet and chisel (Lucas, 1934 unnumbered page).

Figure 1.41: Use of light and heavy mallets in carpentry New Kingdom scenes (Monroe 1990:49, fig. 19).
Figure 1. 42: Wooden mallet made of a piece of a branch, thinned down at one end to give a hold Dynasty 5 ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).

Figure 1. 43: Wooden mallet with a cross-head ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).

Figure 1. 44: Wooden mallet New kingdom ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).

Figure 1. 45: Wooden bulbous head mallet ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
1.2.3. Maul

A stone dressing tool used during the Old Kingdom to the Middle Kingdom as a sledge-hammer. In the tomb of Ti at Saqqara a heavy maul with wooden handle had been discovered. Moreover, evidence for a limestone maul usage from Beni Hassan tombs (Figure 1.46) Giza, another example with different shape that is two-lugged axe head inscribed in hieroglyphics with name of the UAB-priest SEKHENU (Stocks 2003: 23) (Figure 1.47).

Figure 1.46: Limestone maul Beni Hasan Dynasty 12 ("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).

Figure 1.47: Stone hammer maul, New Kingdom("Petrie museum, UCL Petrie Collection Online Catalogue", 2002).
1.3. Measuring Tools

1.3.1. Plumb bob: \( \text{th} \)

A plumb bob "\( \text{th} \)" (Hammad 2009:122), also called plumb line, used as a vertical reference line that employs the law of gravity. It has been an important tool used during hull design construction for affirming hull symmetry, elevations and dimensions (Figure 1.48). By the end of the Old Kingdom the plumb bob was no longer demonstrated in reliefs related to boat construction or the carpenter’s shop scenes. However, the relief’s discoveries in the tomb of Ty, chapel of Khuenre and tomb of Ra’sphepeses have illustrated various shapes and sizes of plumb bob. Petrie’s excavation allowed us to clearly identify different materials such as wood, alabaster, limestone and copper alloy and they were found in varies shapes of the plumbs including pyramidal, oblong, and trapezoidal shape (Figure 1.49, 50).

Figure 1.48: Use of plumb bob on Mastaba of Mereruka (Roger 1996:47, fig. 3).
1.3.2. Builders’ Squares:

Along the Mediterranean, the carpenter’s square is one of the oldest and most used technical instruments used by the Egyptian builders and masons in order to lay off or check out right angles elevations either in building or in dressing blocks. The square tool in its simple form consists of two arms that are perpendicular to each other and connected at their intersection point with pegs, tongue or groove. In certain instances, a footboard is added at one of the two arms so that the square could stand in upright position. Sometimes, an additional piece of wood is added to the squares connecting the two legs and forming “A”
shape. There are good examples of discovered tools inside tombs for carpenter’s workshop that illustrated square usage. For example, the modern replica of builder’s square from the Theban tomb of Mektira (Figure 1.51). Furthermore, found in the tomb of the Egyptian architect Sennedjem at Deir el-Medina square level along with other tools dating back to the 20th dynasty (Figure 1.52) (Cuomo 2007:135).

1.4. Summary

Ancient Egyptian civilization had provided us with the most sufficient materials about tools in all fields of life and we still have a lot to explore. Researchers highlighted the most common tools used, it is clear that they had a numerous number of tomb scenes that gave us a clear picture of how tools looked like and what are the most common tools used.

All archaeological sources pointed to the adze as the most important tool in the ancient Egyptian shipwright’s tool kit then the mallet and the chisel. This could be explained in the light of the principles, methods and tradition of shipbuilding in ancient Egypt. The assemblage methods in a hull constructed with shell first principles were lashing or tenon and
mortaise. The ancient Egyptian tradition used the floatability rules with the displacement to float a boat. In addition, it used -in general- the unpegged single or double tenon and mortaise system method and sometimes the sewing by straps in rectangular channels that open in the side of the plank and not in the outer face. In order to execute this needs the shipwright opted to use thick planks for his shell. The builder could not bend these thick planks by force or by charring so he had to carve and to curve the planking (Abd el-Maguid 2009:305-307). The best tool for this operation is the adze. This tool will appear again in finishing and planning the surface of the planking. This importance would explain the choice of Ankhwah, the boat builder from the third dynasty, to be portrayed in a statue holding an adze (Figure 1.53). The mallet and chisel are used in cutting mortaises for tenons or channels for ropes. The mallet, also, is used in bouncing planking to be assembled one to another with the thick tenons in between (Figure 1.54).

Figure 1.53 A statue of the third dynasty boat builder Ankhwah is showing him holding an adze (British museum).
Figure 1. 54 Kneeling man with left using adze during construction also right using mallet and chisel late period (Brooklyn Museum, 2017).
CHAPTER TWO
SHIPBUILDING TOOLS IN ANCIENT GREECE
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SHIPBUILDING TOOLS IN ANCIENT GREECE

The Greek period lasted for three millennia, from the beginning of Minoan civilization in Bronze Age Greece around 3000 B.C. until Roman took of the last of the Greek territories around 30 B.C. (Adkins & Adkins 1997: 50).

The geographical nature of Greek country, with its long coastline, numerous scattered islands, and above them all favourable climate, formed a very fertile place for trade whether internally or externally. Thus, investing and developing in shipbuilding tools and techniques were important aspects of Greece's economic activity and prosperity (Delgado 1997: 180).

Consequently, ancient Greece advanced its shipbuilding industry and used diverse types of ships, among which was the cargo ship and warship (Apel 2004: 22). Good timber was scarce in Greece, and most timber, especially for shipbuilding, was important. Wood working skills were highly developed and specific types of wood were deliberately selected for different purposes (Adkins & Adkins 1997: 51). Nevertheless, Ancient Greek carpentry is not well known because of the lack of the preservation of wooden objects that are permanently dry or permanently waterlogged. However, the underwater excavations of the wrecks of cargo ships have provided important information about what manner the Ancient Greek shipbuilding was complex and sophisticated (Wilson 2006: 733).

On the other hand, the migrations of the Greeks and Phoenicians, whether to colonize or to trade, then saw these two groups interact both in the eastern and the western Mediterranean. The single best example of the transmission of ideas - opposed to products - by skilled personnel is the diffusion of the Phoenician alphabet to the Greeks. In the realm of shipbuilding and seamanship, Greek historical sources refer to the impact of
Phoenician navigational skills, while the evidence recovered by marine archaeologists suggests such close affinities in the details of shipbuilding that it presupposes independent free craftsmen were at work in the construction of merchantmen in diverse localities (Linder 2001: 397). The skilled craftsman who is responsible for the construction and repair of ships is called Shipwright and their job included a wide array of tools and efficient techniques that allow sailing in rough sea. The shipwright tool kit consisted of axe, adze, chisel, saw, drill, auger, hammer, mallet and plane (Maragoudaki & Kavouras 2012:199).

As for the materials used, we have no reason to doubt the validity of the detailed references in the Homeric epic for Mycenaean shipbuilding. They have been documented from many verses in the "Iliad" and the "Odyssey", they were available in Mycenaean times and were used in the Greek world in antiquity as written and archaeological evidence shows. The social structure of the Mycenaean civilization, which is characterized by a high degree of specialization in labor and skills and a well-organized society, could have permitted the application of sophisticated and demanding in time and skills methods of shipbuilding, such as mortise and tenons joints (Beltrame 2003: 25).

The following section will illustrate the shipbuilding tools which are categorized as cutting, bouncing, measuring and finally smoothing tools.

2.1. Cutting tools:

2.1.1 Axe: Πέλεκυς
The word Πέλεκυς is a Greek word means axe as (Beltrame 2003:27) said previously, the axe is a hand tool used for chopping, splitting, and piercing; it has been mentioned in several numbers of historical sources. As for example, Homer, in his fifth book of the Odyssey,
provided us with a comprehensive description of the axes' shape and its usage in ancient times.

“She gave him a great axe, well fitted to his hands, an axe of bronze, sharpened on both sides; and in it was a beautiful handle of olive wood, securely fastened; and thereafter she gave him a polished adze. Then she led the way to the borders of the island where tall trees were standing, alder and poplar and fir, reaching to the skies, long dry and well-seasoned, which would float for him lightly. But when she had shown him where the tall trees grew, Calypso, the beautiful goddess, returned homewards, but he fell to cutting timbers, and his work went forward apace. Twenty trees in all did he fell, and trimmed them with the axe; then he cunningly smoothed them all and made them straight to the line”

(Homer, Odyssey 5.252- 234)

Furthermore, Homer in his Iliad used the axe as a symbol to represent how violent and powerful the battle between Asius and Idomeneus was.

"And he fell as an oak falls, or a poplar, or a tall pine that among the mountains shipwrights fell with whetted axes to be a ship's timber; even so before his horses and chariot Asius lay out-stretched, moaning aloud and clutching at the bloody dust"

(Homer, Iliad 13. 389-393)

In the same token, another verse in the Iliad describes the usage of axes in cutting trees.

"Agamemnon send their man to cut woods and they went forth bearing in their hands axes for the cutting of wood and well-woven ropes, and before them went the mules: and ever upward, downward, sideward, and aslant they fared"

(Homer, Iliad 23. 114-115)

Also, Theophrastus pointed out the axe in his book “Enquiry into plants Historia Plantarum”.

“What is the right season for cutting tree and how square logs can be cut after the time of peeling, since trimming with the axe removes the uncomeliness”

(Theophrastus, Enquiry into plants: 5.1)

“Theophrastus some trees is' four-cleft ' sometime 'two-cleft ' in that case the blows of the axe follow these lines in cases where the hewing stopped short on either side of heart wood”

(Theophrastus, Enquiry into plants: 5.9)

Although, the single bladed axe was commonly used, the double axes were also a prominent tool used in this period of time and part of the ancient tool kit employed by carpenter, masons and shipbuilders. In Ancient Greece, the word labrys means double axe (Dubin, 2015: 273).

The double axe/double head axe appeared as builders’ marks on the walls of Minoan palaces, such as carved lime stone walls from Zacro. This representation was prevalent as indication of
Hittite civilizations and as a symbol of Hurritic god (the god of thunder). However, the double blades axe was popular in Crete due to its significance as religious symbol, like a Minoan vase where the body is decorated by paintings of double axe (Figure 2.1). Moreover it was in use as pottery ornament on Greek pottery (Montelius 1910:66). (Figure 2.2) As well as a gold ring recovered from the Acropolis of Mycena, picturing the double axe in the middle (Figure 2.3) (Vermeule 1959: 9).

Figure 2.1 : Minoan vase with double axe motif (Dubin 2015:274).

Figure 2.2: A double axes depicted as a symbol or an ornament on Greek pottery datable to the latter part of the second millennium B.C (Montelius 1910, fig 11: plate II).
At the Kızılburun shipwreck\(^4\) a double axe head was found in a poor condition where it deteriorated badly and the hardest parts remained, the blade was made of iron and remains of the handle indicating it was made of wood fastened to the blade (Figure 2.4) (Rash 2012: 98).

\(^4\) In 2005, the Institute of Nautical Archaeology (INA) at Texas A&M University began the excavation of an ancient cargo ship, which was wrecked off the rocky coastline of western Turkey, near the present-day city of Izmir. The promontory where the ship sank is called Kızılburun, Turkish for 'Crimson Cape.' The location has proven to be a dangerous point for ships, as there are at least five wrecks clustered around the promontory, all from different time periods. One of the earliest wrecks lies at a depth of 45 meters (Rash 2012:1)
2.1.2 Saw: πρίων

It is called and known as πρίων in Greek. In Ancient Greece, the saw was one of the most essential tools from the Bronze Age to the Iron Age (Smith 1842:1029; Adkins & Adkins 2005:34).

Theophrastus mentioned how the carpenter selects a specific type of wood suitable for each purpose. For instance, as long as the wood is moist it is considered easier to be split or sawed and it is fair to say that the level of wood moisture determines which type of tools should be used.

“For example, wood which is very green closes up again when sawn and the saw dust catch in the saw teeth and clogs them and also the teeth of the saw are set alternate ways, to get rid of the sawdust….. On the other hand, wood which is over dry is hard to saw because of its hardness: for it is like sawing through earthenware…..

(Theophrastus, Enquiry into plants: 5.3)

Adkins (1997) mentioned that Neve (1989) states a clear evidence for the use of saws and their use in Hittite culture and mentions that the largest collection of bronze saws came from Crete. Furthermore, Neve notices the wide spread of drills and saws which have been used in stones cutting, planks cutting and carving. Also, according to Deger-Jalkotzy & Lemos (2006) the pendulum saw was the most advanced technology and have been used extensively and widely.

Numbers of evidences indicate the usage of the saw in shipbuilding, like the marks of the saw teeth which have been identified at some of the Ma'agan Michael ship wreck planks, close to the stern. These marks identified that the saw was of a huge size, which requires two or more people to use it.

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5 Ma'agan Michael ship wreck: In autumn of 1985 the ship wreck of Ma 'agan Mikhael was found by Ami Eshel at about 70 m offshore at Kibbutz at (occupied Palestine) This ship goes back to the 5th century BC among the archaeological finds was a carpenter tools' example (ruler ,square and plumbob) ,also tool marks were found ( Kahanov 1999: 155 -160)
On *Ma'agan Michael* ship, wreck saw marks appeared on the tenons as well as the corner of the limber hole of the left side of the ship moreover marks had no pattern with no adjusted distance between them sometimes appearing on the forward side of the nail (Mor 2004:166-169). Unfortunately, there is no clear picture/illustration to these marks. Furthermore, tool marks at Pabuç *Burnu* ship wreck, provided that the saw as tool was used those saw tooth marks, about 2.5 mm apart and angled approximately 47 degrees to the run of the grain are visible (Figure 2.5). (Polzer 2009:45-46; Polzer M. E 2010: 24).

![Saw marks preserved on the inboard face of one of the ship's plank](https://example.com/saw_marks.jpg)

Figure 2.5: Saw marks preserved on the inboard face of one of the ship's plank

(Stephanos 2009:46, fig. 2.12).

### 2.1.3 Adze: εκεπαρνος

The adze was a multipurpose tool, it is called and known as εκεπαρνος (Smith 1842: 141). According to Mark (2005) when Homer used to build his ship he "used adze to accomplish

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6Pabuç Burnu ship wreck: In 2002 and 2003, the Institute of Nautical Archaeology excavated the remains of an East Greek ship that sank off the coast of Pabuç Burnu, Turkey, this ship goes back to the second quarter of the sixth century B.C. The remains of the vessel’s hull have provided the first shipbuilding in the Aegean. (Polzer M. E 2009: iii)
final form finishing the surface of his timber "adze used in different sizes with large handle as
on a red-figure pottery from Greece Attica illustrates a Greek carpenter working with long
handle adze, on a timber (Figure 2.6) (Mark 2005: 83). Moreover carved gem, shows Argos
while using the adze with short handle which had been used in shipbuilding (Figure 2.7).

Furthermore, tool mark at Pabuç Burnu ship wreck, dedicated tool marks along with
the wood analyses provided us that the planks were first sawn then curved to shape using the
adze (Polzer M. E 2010: 24).

Figure 2.6: Greek carpenter using an adze to shape a timber (The British Museum).

Figure 2.7: Argos used an adze in shipbuilding on gem, United Kingdom, Cambridge
show Argos (iconiclimc).
Two different blade marks its widths 2-5 centimetres, were identified at *Ma’agam Mikhail* shipwreck (Figure 2.8) (Mor 2004: 32). Furthermore, adze’s marks were found at the *Pabuç Burnu* shipwreck (Figure 2.9) (Polzer 2009: 55).

**Figure 2.8**: adze marker on frame 14 Ma’agam Mikhail shipwreck (Mor 2004:32, fig .3).

**Figure 2.9**: Adzed edge of plank (Polzer M. E 2009:55, fig .2.15).

### 2.1.4 Chisel: σμίλη

Chisel known in Greek as σμίλη (Smith 1842:420). It is used for carving, cutting and shaping wood, as Theophrastus mentioned
"It is easier to use the chisel with green wood because the chisel gets a better hold and doesn't slip off" (Theophrastus, Enquiry into plants:5.6.4)

In Ma'agan Mikhael shipwreck chisel marks were identified in the mast step groove (Figure 2.10) and also different types of chisels marks were found on it.

Figure 2.10: Chisel marks in the mast-step groove in the Ma’agan Mikhael shipwreck (Mor 2004:31, fig.1).

The following section represents the different types of chisels according to the shape of the chisels’ edges:

a. Socketed chisel.

b. Tanged chisel.

c. Flat chisel.

d. Bar chisel.

a. **Socketed chisel:**

The socketed Chisel (Figure 2.11) is a pointed edge handle, cylindrical bar roughly shaven point with peak cut off and flat end showing signs of being struck with a dull object. Another example one end of handle is pointed, but a symmetrical; the bottom is rounded with minor offset between the shaft and point of the handle. (Figure 2.12) (Udell 2003: 204-205).
b. **Tanged chisel:**

There are two shapes of Tanged Chisel which are:

a. Handle with remains of iron tang in mortise: According to Udell (2003) tanged chisel had a bar handle with a mortised flat face and the bottom is slightly mushroomed, showing signs of being struck with a dull object (Figure 2.13).

b. Handle with rectangular socket and collar: bar handle with a mortised flat face, the bottom is round (Figure 2.14) (Udell 2003: 205).
c. Flat Chisel:

Such chisel was found at the Kizilburun shipwreck it is considered as a multi-purpose tool due to its blade fragment where it could be used in carving and finishing of fine detailed work (Figure 2.15) (Rash 2012: 81-84).

![Figure 2.13 : Tanged chisel (Udell 2003:205, fig. 6 a-b)](image)

![Figure 2.14: Tanged chisel (Udell 2003:205, fig. 5).](image)

d. Bar chisel:

The Bar chisel was found also in Kizilburun shipwreck showing a flat blade chisel with thin tip and a semi-rectangular handle attached (Figure 2.16) (Rash 2012: 87).

![Figure 2.15 : flat chisel at Kizilburun shipwreck three components handle, bar and blade from left to right (Rash 2012 :81, fig. 3.1).](image)
2.1.5 Bow Drill: Τρπανον

Beltrame (2003) mentioned that it is called Τρπανο in Greek. Bow drill used at Ma'agan Michel ship wreck to drill holes into knees. In (Figure 2.17), this scene from a vase showing a carpenter drilling holes in a chest, the carpenter drills a hole in the side of the lid with a bow drill (Mark 2005:85).

Bow drill found in Ma'agan Michel ship wreck had a nave made of heartwood, split along the grain and hollowed to attach permanently to the spindle (Figure 2.18) (Udell 2003: 206).
2.1.6 Strap drill:

The strap drill was recognized in two occasions where it is clearly showing its existence in Greek era in both. The first is Homer epic, "The mutilation of the Cyclops's single eye with a stake of olivewood is compared to the bidirectional rotation of a strap drill: "just as a man bores a ship's timber with a drill while those below him twirl it with a strap they hold at either end, so the bit spins continuously" (Homer, Odyssey : 9. 383-390; Homer 1919 ; Humphrey1998: 333), while the second one was depicated on a gem showing a man called Tydeus who is known in the Greek mythology of being mortal , using it as a weapon participating in the clash that is narrated in the story of seven against Thebes (Figure 2.19) (Tydeus, n.d.) .
2.1.7 Auger
As for the Auger as a tool it was known from the narrative of Homer, Odyssey where the story showed a goddess known as Calypso gave odyssey Augers to make holes to put the pegs such description is clearly showing the exisitence of Auger in such era, as well as the usage of such tool in shipbuilding. "Meanwhile Calypso, the beautiful goddess, brought him augers; and he bored all the pieces and fitted them one to another, for fastening and did he hammer it together. Wide as a man well-skilled in carpentry marks but the curve of the hull of a freight-ship, broad of beam, even so wide did Odysseus make his raft" (Homer, Odyssey 5.270-275).

2.2. Bouncing tools

2.2.1 Hammer: σφυρα

It is called in Greek σφυρα (Smith 1842: 726). The hammer was used in conjunction with the chisel for the same purposes in ancient as in modern times. The below terracotta relief in (Figure 2.20) represents Athena while supervising the building of one of ships called Argo, by Argos who hold hammer and chisel (Redford 1886 : 12) As mentioned in Enquiry into plants
that Best hammers are made of wild olive wood (Theophrastus, Enquiry into plants: 5.7.7-8).

As evidence for using it in carpentry, Leontichus mentions the hammer in his tool list where he put his tools for the god's benefit (Leonidas of Tarentum: 6. 204-205).

Figure 2.20: Terracotta relief 1st century, found near Porta Latina in an old wall of a vineyard, Rome. British Museum (British Museum).

2.2.2 Mallet: σφύρα

According to smith (1842), it is called in Greek σφύρα such term is also given to the hammer because they are used for same purpose. It is used to force timbers into place, drive planks into position, and set treenails, tenons and wooden plugs, it also could have been used to strike chisels. Thophrastus came to mention the large wooden mallet without mentioning other size “Large mallets are made of Aleppo pine wood” (Theophrastus, Enquiry into plants: 5.7.4).

Wooden mallets recovered from Maga’an Mikhael ship wreck had heads and long handles to absorb the shock when used while the head is tightened each time it is swung due to centrifugal force. As an example, from Maga’an Mikhael ship (Figure 2.21) mallet had a Balanced head; round eye, and of force-fit handle (Udell 2003: 209-210)
2.3. Measuring Tools

Shipwrights have utilized such tools of measuring in the construction of boat and ship, accordingly needed certain instrument to check and test their work for accurate length and angles. Based on Herodotus in (*Historiae* Pheidon), Phedion, who made his city an important power in the Peloponnese (Greece) invented the system of standard measures, where it remained in effect in the Peloponnese long after his death; the system was also employed in Athens before the reforms of Solon (6th century BC) (Pheidon: 2016). On the other hand, according to Pliny the Elder in (*The Natural History*), Theodorus of Samos invented certain tools used in wood working, for example the set square (Hand Tools around the World: 2016).

2.3.1 Plumb bob: έταθμη

Based on Beltrame, 2003 plumb bob called έταθμη and it is used to test the vertical or to find a point directly above or below another point. For example plumb bob that was found in Ma'agan *Mikhael* Shipwreck it was made from galena artifact where it had a round top and horizontal base (Figure 2.22) (Udell 2003: 212).
2.3.2 **Ruler: κανών**

It is called in Greek κανών (Smith 1842: 985-986). It is considered the earliest preserved classical Greek measuring instrument where it is found at *Ma'agan Mikhael* shipwreck. The units represented on the ruler are known as a Pheidonian and a Solonian foot, whose ratio may be correlated precisely to a statement by Aristotle about the metrological reform of Solon. Furthermore, the builder's ruler had been developed through slightly shortening one of its two edges to create a dual-standard rule; the tool was smooth with round corner, indicating heavy usage. On the upper edge, a bit to the right of center, a mark was incised termed a "complex mark X.". The sign, known as the Greek letter alpha, probably indicates the owner's initial or maybe to indicate the upper measure from the low (Figure 2.23) (Stieglitz 2006: 195- 196).

2.3.3 **Square: γνώμων**

It is called in Greek γνώμων (Smith1842:806). It consists of a blade (the vertical arm), a tongue (the horizontal arm), and a footboard (base) (Figure 2.24).
This handmade tool was used for drawing or testing right angles. "The square used a shorter unit, identical to a measure known from Hellenistic and Roman times as the Italic foot, whose length was five-sixths of a Pheidonian foot" The main architectural use of the square is to determine the right angle (Stieglitz 2006: 200).

![Carpenter square at Ma'agan Mikhael Shipwreck](https://example.com/image1)

**Figure 2.24:** Carpenter square at Ma'agan Mikhael Shipwreck (Stieglitz 2006:201, fig. 5).

### 2.3.4 Caliper:

The caliper is a tool used to measure the distance between two opposite sides of an object and to measure the thicknesses. For example, a pair of wooden carpenter’s calipers of Greek manufacture is one of the most remarkable artifacts found at the *Giglio* ship wreck\(^7\) (Figure 2.25) (Bound 1995:100).

![Caliper Giglio ship wreck](https://example.com/image2)

**Figure 2.25:** Caliper Giglio ship wreck (Bound 1995: fig. 11-13: 109).

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\(^7\) For four years beginning in 1982 Oxford University MARE in strict collaboration with the Superintendence of Archaeology for Tuscany, excavated the remains of the pre-Classical wreck off the Island of Giglio in the Tuscan Archipelago, was found in The remains of the vessel, which can be dated to c. 600 BC (or soon after), were situated in 45 to 55m of water at the base of an off-shore reef known as Secca i Pignocchi in Campese Bay on the north west side of the island. (Bound 1995: 99)
The Caliper consists of four parts, as the following:

a. The beam: The beam passes right through the center of the rectangle head. As for the purpose of tighten the head in position while the measurement is being taken.

b. The fixed head is fixed permanently to the beam with the four wooden pins (Figure 2.26) its function concentrated on moving the beam up and down, while measuring the object between the jaw.

c. Sliding head: is the moving head which used for adjusting the measurements

d. The lip: The lip is a piece of wood situated in the sliding head. The purpose of lip is to provide a surface which can rub against the pins and to freeze the sliding head by means of friction (figure 2.27) (Bound 1995: 100-101).

Figure 2.26: Fixed head of caliper (Bound 1995:110, fig. 13-14).

Figure 2.27: Lips (Bound 1995:110, fig. 20-21).
2.4. Smoothening tools

2.4.1 Plane

Leontichus the carpenter dedicated his tools to the gods Athena. These tools are the plane, hammer, axe, saw with curved handle, ruler, bow-drill, heavy axe with handle, auger and double edge adze (Leonidas of Tarentum: 6, 204-205; Humphrey 1998: 344).

2.5. Summary

The researcher was able to collect a great amount of information about tools from Ancient Greek writers like Homer: (Odyssey, Iliad), alongside Theophrastus (Enquiry into plants). Ma'agan Michael shipwreck provided a clear data of how tools looked like due to the discovery of such tools in a good condition. In the light of such resources, new tools like strap drill, caliper and plane appeared but the auger was the present tool in Greeks tool kit. Ancient Greek shipbuilders used shell first principles that were achieved by two methods of assemblage. The first one is sewing. Sewing ships was accomplished with the opening of holes using auger along the planks, lashing them together with some sort of chord and then secured in place with pegs hammered in the holes to stop the chord. The second method was more recent and started probably at the beginning of the classical period. The fastening of the ship relied mainly on a dense net of pegged tenons and mortaises. Furthermore, fastening frames to planking, if it is not made by lashing, is executed by drilling holes in the frames in order to receive treenails or metal nails in treenails. (Abd el-Maguid 2009: 309-311). Here, chisel and mallet or/and hammer is used to open mortises at the side of the boards. Then a piercing tool is used to perforate holes in the tenons and mortaises extremities to host the securing pegs.
CHAPTER THREE

SHIPBUILDING TOOLS IN THE

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Roman Empire, the ancient empire, centred on the city of Rome, that was established in 27 BC following the deterioration of the Roman Republic and continuing to the final chapter of the Empire of the West in the 5th century BCE. Rome was the dominant power in the entire Mediterranean Sea, most of western Europe, and large areas of northern Africa. The Romans possessed a powerful army and were gifted in the applied arts of law, government, city planning, and statecraft, but they also acknowledged and adopted contributions of other ancient peoples—most notably, those of the Greeks. Moreover The Byzantine Empire was the successor of the Roman Empire in the East. Byzantines considered themselves Romans, but they had a few major differences from their Roman predecessors: most importantly, they were Christians and spoke mainly Greek instead of Latin. In AD 300 Constantine the Great changed the capital of the Roman Empire from Rome to a new city named after himself, Constantinople, planted on the site of the ancient Greek Byzantium. Constantine wanted the seat of his rule to be in the east, where he stood a greater chance of restoring order and stability. After his death the split between the eastern and the western part deepened until, in AD 395, the empire was officially divided in two, each half with its own rule. The eastern was the Byzantine Empire (Casson 1994:96).
Ancient representations of shipbuilding tools produce an invaluable perspective about how tools were held and in what applications they were used. As symbols of their profession, their pride, and their very identity. According to Ulrich, Wolfgang Gaitzsch\(^8\) who recently published the most comprehensive and detailed study of all Roman iron tools, suggests that the forms of such tools were fully developed in Roman time and did not change until the machine age (Ulrich 2007:15).

The following section will illustrate the shipbuilding tools in Roman empire as well as the Byzantine empire which is categorized as cutting, bouncing, measuring and finally smoothing tools.

### 3.1 Cutting tools:

#### 3.1.1 Axe: securis

In Latin, the Axe was named *securis* (smith 1842:1014). The roman used it for tree felling and initial preparation of timber. They used double blades axes but the most common use was the single blade (Figure 3.1). Double-bladed axes may have employed one sharper blade for cutting and a second duller blade for splitting (The most common form of Roman axe is a flat poll, with the entire blade is often cast with a gentle curve. Even that the blade is not curved, one or both sides of the front face sweep to provide a broader cutting edge. Axes are usually triangular in horizontal section. Additionally, the wooden handle was fitted into the metal blade through a socket, eye, or lug, and occasionally secured by iron nail acting as a wedge. The eye is oval or, more rarely, round(Ulrich2007:22).

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\(^8\) Eiserne römische Werkzeuge (1980)
Trajan's Column⁹ has a number of representation of legionaries cutting down tree. For this, they used special axe, the *upupa* which has a cutting edge for felling and chopping on one side and on the other a pick-type head for sticking in the ground and for moving logs (figure3.2) (Adam1994:88-89).

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⁹ Founded at Saint-Ambroix (cher) goes back to Rome, A.D. 113.
Inscription on a roman coin stored at the Museum of Cartage a ship depicted with an axe and an adze upon it (Figure 3.3)

At the Byzantine shipwreck *Yassi Ada*¹⁰, a double axe was excavated; the top plane was concave, the blade tapered to curved cutting edge one of which was slightly sharped than the other the eye was round over eyes there as a nail acting as a wedge to hold the handle tightly in the eye (figure3.4) (Bass1982:237).

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¹⁰*Yassi ada*, is a small coastal island that caused many ships to wreck in antiquity. *Yassi ada I* dates back to the 7th century A.D and was the first excavated shipwreck at this site between the years 1961-1964. It lay about 32-39 m deep and had a basket of carpentry tools among its cargo. for more information visit (INA)website: http://nauticalarch.org/projects/yassida-byzantine-shipwreck-excavation/
3.1.2 Saw: *serra*

Saws or *serra* in Latin (Smith 1875:1029). Was prominently used at every level of woodworking, from the initial cutting and preparation of timber to fine veneering and jointing. Roman saw blades and their frames were made in various sizes depending upon the type and the fineness of the cut desired while, the sharpest saw blades were made of thin iron sheets.

As Ovid mention in the legend of Daedalus and Icarus that is the saw was invented when Daedalus’s nephew observed the backbone of fish

“AS he was consigning the body of his ill-fated son to the tomb, a chattering partridge looked out from a muddy ditch and clapped her wings uttering a joyful note. She was at that time a strange bird of a kind never seen before, and but lately made a bird; a lasting reproach to you, Daedalus. For the man’s sister, ignorant of the fates, had sent him her son to be trained, a lad of teachable mind, who had now passed his twelfth birthday. This boy moreover, observed the backbone of a fish and talking it as model, cut a row of teeth in a thin strip of iron and thus invented the saw” (Ovid. Metamorphoses : 8.246)

Wolfgang Gaitzsch (1985) distinguishes five categories of Roman saws: bow saws, small frame saws, large frame saws for ripping logs, crosscut saws for cutting heavy timbers and logs, and small handsaws. (Figure3.5 (Adam 1994: 92; Ulrich 2007: 46).
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<tr>
<td><img src="image1" alt="A) Bow saw from Fayum in the Petrie Museum, London" /></td>
<td><img src="image2" alt="B) Small frame saw on marble relief of carpenters at their workshop (I Viaggi di Raffaella)" /></td>
<td><img src="image3" alt="C) Two men ripping a plank with a frame-saw in fresco known as the Procession of Carpenters, 79 A.D (lost art press)." /></td>
<td><img src="image4" alt="E) Iron handsaw blade from Verulamium (Ulrich 2007:51, fig 3.40)." /></td>
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Roman-period depictions of craftsmen using their saws appear frequently in painted scenes of daily life. On the mosaic of Rotande from the roman 2nd century AD, which found at baths of Thayna (ancient Thaenae) Tunisia frigidarium in 1904, a carpenter was represented with a frame saw, also a bow drill and an adze inside a box appeared between his leg (Figure3.6) (Gauckler1910: 11-18).

At the Dor Byzantine shipwreck, saw marks were found on the wood, timbers were sawn. Several types of saw marks were identified on many frames which were made of hardwood.

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11 The Dor 2001 shipwreck was discovered in Dor/Tantura lagoon dated to the first third of the 6th century CE. The shipwreck was excavated over five seasons, from 2002 to 2006. The search was conducted by students of the Department of Maritime Civilizations, with the assistance of the Maritime Workshop of the Leon Recanati Institute for (MSUH) (Kahanov & Hadas, 2014)
In some timbers hundreds of parallel saw lines were visible. Furthermore, in some places the saw marks were at a diagonal angle to the plank itself, the saw marks were perpendicular (Figure 3.7) (Kahanov & Hadas, 2014:53).

![Figure 3.6: Saw marks at the section which take singe (C9)](image)

(Kahanov & Hadas 2014:54, fig.23).

3.1.3 Adze: *ascia*

Roman Adze or *ascia* as in Latin (smith 1843: 141) had sharp blade attached so that the cutting edge is oriented to the handle like the blade of hoe, and were operated by one or both hands. Adzes used for appropriate shaping the curved structural timbers, and smoothing work. (Ulrich 2007:16-18).

Adzes’ metal blades can be classified in two major groups:

1- Simple blade: looks like thin metal wedges or even broad chisel. These socketed blades were attached to a bent wood handle and secured with a wooden wedge or metal collar (Figure 3.8 A). This simple form was known throughout the ancient
Mediterranean and is documented from Sicilian context dating back to Copper Age (Ulrich2007:16).

![Figure 3.7](image1.png)

**Figure 3.7:** A- Simple flat blade held in place by an iron collar wedge. B- head is rectangular with doomed face, eye is oval with a long rectangular sleeve below, C – blade strongly splayed and has curved edge, face almost rectangular but is set at the end of a narrow head with long conical sleeve below (Ulrich2007:16, fig. 3.3).

2- Adze-hammer blades: Romans commonly combined the adze blade with a second tool counterfeit on the opposite side; a cutting edge on one side and a striking head on the other (Figure 3.8 B- C) (Ulrich2007:16), the British museum had a well preserved collection of adzes hammer from Romano-British (Figure 3.9-3.10).

![Figure 3.8](image2.png)

**Figure 3.8:** Iron adze-hammer, the adze-blade is strongly splayed and has a curved edge at (British museum).
Figure 3.9: Iron adze-hammer on display with reconstruction of handle. The adze-blade is turned through a sharp angle and has straight sides which splay out to give a relatively wide, slightly convex blade at the British Museum.

The grave relief of Pablius Longidienus from Ravenna from early first century A.D highlights how a shipwright works with his adze on a plank or hull of a boat under construction (figure 3.11) (Ulrich 2007:19).

Figure 3.10 Funerary monuments of the Western Roman Empire showed shipbuilder using an adze (Rougé 1981:26).
Roman period introduced form of small double-handled adze which has been identified by Gaitzsch as *ascia-hobel* or "adze-plane", he suggested that it was a hybrid tool used for close smoothing work (Figure 3.12,3.13) (Ulrich2007:18).

![Figure 3.11: Adze plane Funerary relief of P.Ferrarius Hermes at vicinity of Pisa (Ulrich2007: 17, fig 3.4).](image)

![Figure 3.12: An adze-plane, from stele of P. Beitenos Hermes Louvre (Ulrich2007: 18, fig. 3.6).](image)

Byzantine adze found at *Yassi Ada I* shipwreck the blade was set vertical to the handle chocked by a collar around the tongue (figure3.14) it is called a "slot adze".
3.1.4 Chisel: *scalp rum*

The chisel or as in Latine *scalp rum* for shaping wooden joints: cutting mortises, forming tenons and dovetails through using thick and heavy blade and applying pressure; therefore, it was indispensable tool for shipwrights. Standard chisel blades were flat, that tapper from the handle toward the blade (Ulrich2007:26-27). Chisels were made in various shapes and sizes according to their function:

**The paring chisel:** was used to make shallow cuts; its blade was often formed by the gradual tapering of the iron shaft (Ulrich2007:28). From the Roman town of Aquileia in northern Italy; a paring chisel was recovered with its wooden handle (Figure 3.15).
The mortising chisel: Its blade was thick, and heavy; was used for cutting deep mortises in wooden stock with mallet (Ulrich2007:28) From the House of the Vetti, Pompeii, at the Ixion Room, Icarus, the son of Daedalus, appeared sited at a workbench and cuts mortises with a mortising chisel and a mallet (Figure 3.16, Figure 3.17) (Ulrich2007:27).

The firmer chisel: refers to a general-use category that it was thicker and stronger than the paring chisel and could be struck with a hammer or a mallet. The handle and cutting edge were sometimes formed from a single piece of iron with tanged blade (Ulrich2007:28).

Figure 3.15 : Icarus, cuts mortises with a chisel and a mallet (Ulrich2008:443).
From the Byzantine shipwreck *Yassi Ada I* a chisel with round flat head was found. The blade’s body is round until it began to taper, then it formed two flat faces and splayed very slightly near the tip, ending in a straight cutting edge (figure 3.18) (Bass, H, & Jr 1982:246).

**Figure 3.16** Carpenter using mallet and chisel (By Mirime Mastoury).

**Figure 3.17** : Chisel with round head (Bass, H, & Jr, 1982: 247, fig. 23).

**Chisel with a rectangle blade:** Head is formed in a circular form blade is rectangular and thinned from the end to form the cutting edge (Figure 3.19) (Bass, H, & Jr, 1982: 246).
The gouge is considered one of chisel types: Its blade is characterized by curved edges; it is used in making scooping cuts, and small objects with hollowed interiors or architectural mouldings with concave profiles. A group of iron socketed gouges found at Silchester (U.K.) (Figure 3.20).

Figure 3.18: Iron rectangle blade chisels at yassi ada shipwreck (Bass, H, & Jr, 1982:247, fig 24).

Figure 3.19: Gouges found at Silchester (Ulrich2007:30, fig3.18).
3.1.5 Bow Drill: *terebra*

Bow drill named in Latin *terebra* used for the initial hollowing out of mortises (Figure 3.21) it has been suggested according to Goodman 1964 that the Romans were the first to attach the thong to a bowed (not straight) stick. In its simplest form drill has at the top a sort of bearing, a hollowed piece on which the hand presses and in which the actual instrument rotates, then a cylindrical spindle around which is wound the cord of the bow, and finally a sharpened drill-bit which through fast rotation bores through the wood. Example at Stele of a carter which depicted on the side face bow drill (Figure 3.22) Furthermore, Marble relief found at the Villa Muti in the environs of Frascati which portraits faces and sculpture tools (Figure 3.23).

![Figure 3.20 Used of bow drill (Adam1994:99, fig 229).](image-url)
Figure 3.21: On the side face of stele, a bow drill, a compass and a rule other carpenter tools depicted, museum of Syracuse (Adam 1994:99, fig 228).

Figure 3.22: Marble relief on the right tools of carpenter as bow drill, Villa Muti (The British museum, 2015).
3.1.6 Strap Drill
At the Byzantine Shipwreck *Tantura E*\textsuperscript{12} drilled holes in timbers were well preserved tool marks. Bolts for securing these timbers were driven through these holes. A drilled hole, 15 mm in diameter, was found in ceiling plank under the name (C6) (Figure3.24) (Israeli & Kahanov2014:379).

![Figure3.23: The ceiling planks in situ drill hole fond at C6 plank.](image)

3.1.7 Auger: *terebra*
The auger or *terebra* as in Latin It is the only boring tool that can be turned in one direction continuously, Moreover it is a T-shaped boring and reaming tool; a vertical iron rod terminates in the bit, which is shaped like an arrow spoon, with an upturned tip hence a spoon bit which can help to know different between auger. The boring action of the auger is powered by the principle of leverage; great force can be applied when along handle is employed (Figure3.25) (Ulrich2007:18).

\textsuperscript{12} The *Tantura E* shipwreck dated between the end of the 7th and the beginning of the 9th century which was discovered in 1995 during a survey by (INA),(RIMS).Tantura Lagoon is natural harbours' along (occupied Palestine) (Israeli & Kahanov, 2014)
3.2 Bouncing tools

3.2.1 Hammers:
By Roman times the hammer was developed to a point where it was an example of the modern tool, with an iron head and in some cases a claw for the extraction of nails. Shipwrights used hammers for all striking or prying tool propose, with its different shapes it provided shipwrights with an extensively choice to do a variety of jobs. Hammers with metal heads were used to drive nails and spikes of bronze or iron into wooden planks, the heaviest iron hammers, or sledge hammers, were used when great force was necessary (Ulrich2007:51).

A hammer was found at the 4th-century-BC Roman shipwreck *Mateille A* in Gruissan, with two broken ends; nevertheless, it is possible to see the departure of ends that are section rectangular, the wooden handle is not preserved but the opening provided to its location east (Figure3.26) (Postiaux 2015:135).

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13 *Mateille A* shipwreck is located in the Narbonne region at the south west of France, date by century (Solier 1981: 176-177)
Figure 3.25: Hammer from Mateille A shipwreck (Postiaux2015:48, fig. 48.1).

Two hummers’ types were found at the Yassi Ada I shipwreck: the first with one head of hammer was round with a slight curved face. The poll was visually round section and narrowed slight towards the tool's socket. Socket was rectangular in section the eye through the socket was elliptic in the eyes a part of the wood handle is preserved (Bass, H, & Jr1982:245) (Figure 3.27A), in the second type; the hammer's poll was octagonal in section, ending in an elliptic head with a very slightly curved face, eye was elliptic a part of wood handle is preserved; at each end of it top end and bottom there were long, low rising lugs. From the socket, the peen of the hammer bent down slightly and was rectangular in section, near the end the peen divided into claws, which were angle down more sharply (Figure 3.27B) (Bass, H, & Jr1982:245).

Figure 3.26 A- Iron hammer (Bass, H, & Jr1982:243, fig.20 ),
B-Claw hammer (Bass, H, & Jr1982:243, fig.22).
3.2.2 Mallets: malleus

Mallets or malleus as in Latin it is used to make the seams in wooden boats watertight by driving fibrous materials between wooden planks. Woodworking mallets were made of hardwood, beech has been the favorite, the simplest mallets were made from a single piece of wood. (Ulrich2007:51) An exceptional example of a mallet in use is found in the painting from Pompeii of Icarus cutting mortises (see figure3.16 section 3.1.4), Moreover a representation of mallet on mosaic was discovered in 1895 in Tunisia showed Roman vessel Representation of the complete profile of vessels that appear to be on the water with their name of the head of Ocean god and river god late third century A.D at Altiburos ( El M’DAINA ) (see figure3.17 section 3.1.4) (Duval, 1949) Furthermore, the remains of a Roman ship that discovered in 1962 discovered mallet that made from one piece of wood (Figure 3.28).

Figure3.27: Mallet made from one piece of wood (museum of London).

3.3 Measuring tools

Measuring was a process that utilized simple equipment, requiring the most of operational skills. Measuring instruments appear on a Roman funerary plaque. On the left side an upright
ruler (*regula*) and calipers with straight arms (*cicinus rectus*), while on the middle there are 

hanging plumb line (*perpendiculum*), square (*norma*) for 90 degrees angles; and a level with a 

small plumb line (*libella*) (Figure 3.29).

![Figure 3.28: Measuring tools ruler, caliper, plum bob and square, The Nelson - Atkins Museum of Art (COHON 2010 :19, fig. 1),](image1)

### 3.3.1 Plum Bob: *perpendiculum*

Plumb bob or *perpendiculum* as in Latin was used for establishing vertical lines, it was a 

metal weight with a pointed end to which a string was attached. While it was clearly 

represented on a relief in Rome (Figure 3.30) (Ulrich2007:53).

![Figure 3.29: Relief depicted Plumb bob, caliper other tools Late first -early second century, Aquileia Museum, inv.1231. (Ulrich2007:54,fig.3.43).](image2)
3.3.2  **Ruler: regula**

Roman ruler or *regula* as in Latin (smith 1875:985) was a straight strip usually of bronze, as far as we know, there were no numbers marked on Roman rulers, but there were lines or symbols to indicate segments. A well preserved funerary stele depicted a carpenter holding ruler is a great example for the regula (Figure 3.31) (Ulrich 2007:54).

![Funerary stele of a carpenter holding a ruler](flickr.com)

**Figure 3.30: Funerary stele of a carpenter holding in his left hand a rule, Bordeaux France (flickr.com).**

3.3.3  **Square: norma cacumen**

Square norma (Smith 1875: 806) or norma cacumen as in Latin were used to test right angled joints," Isidore describes how a simple square can be made from three wooden battens fixed to one another in the form of a triangle" (Translated from Isidore : Orig. 19.18.1). In other words, Smith (1875) also described the Square that it is made of wood consists of three flatten rules with the same thickness, but with different length.

Well preserved example found at Pompeii and now stored in the Naples Museum, consist of two arms forming a right angle.
3.3.4 Calipers: *circinus*

The caliper or *circinus* was used to transfer measurements between work pieces, moreover it consisted of two bowed legs joined at one end, there are two types of calipers first with straight legged, second with curved legged (see Figure 3.29, 3.30 section 3.3.1) (Ulrich 2007:52).

3.4 Smoothing tools

3.4.1 Plane: *runcina*

Roman plans or *runcina* as in Latin it existed in different shapes and sizes, and the shape of their blades indicates their functions. It used for smoothing wood as it is showed in funerary relief from Rome carpenter smoothed a plank with a plane (Figure 3.33) (Adam 1994:98).
According to Ulrich (2007) planes fall under three general categories:

First category all smoothing purposes which in general its blades had straight edges

a. jack plane for quickly removing large amounts of wood.

b. trying or truing plane but no clear evidence of using in shipbuilding.

c. long joining plane, which smoothes and levels long boards in preparation for gluing; and a variety of small smoothing planes for closer and finer work for extra.

The second category is

a. Molding planes, though Ulrich came to mention such plane but it was not used in ship building.

Third category is

a. The rabbeting planes: fitted with narrow blades, designed for cutting long grooves parallel to the grain of the work piece used in the keel (Figure 3.34).

Though it is important to note that those types are used in wood working for general. Goodmanham plane found in excavations at Goodmanham, East Yorkshire i 2000 this plane is the most complete Roman example known and the only known example with an ivory stock may date to the earlier Roman period (Figure 3.35).

Figure 3.33: Used of rabbeting planes to make garboard under keel (Bass 1982).
3.5 Summary

Sufficient information was found about carpenter tools during the Roman era as well as in Roman mythology legendary characters who mentioned who invented some tools. Moreover, in funerary Stella, coins and mosaic romans presented carpenter's tools in general which provided us with clear description about ship building tools in specific, while inscriptions contained different shipbuilding tools. Most of the tools like the saw - especially the frame saw-, the adze-hammer, Bow drill, strap drill, auger, and finally the plane are frequently present. Certainly, they were not all necessarily used in shipbuilding. We know that the Romans followed the same principles and methods of construction as the second Greek phase (Abd el-Maguid 2009: 309-311). So, the saw would be of great importance in cutting the less thick planking of the hull. The Adze-hammer, two tools in one, would be used in shaping frames and then hammering nails for fastening. One of the perforating tools for making holes for pegs or treenails and finally the plane.

The Byzantine era was characterized by the lack of important resources about carpenter tools "bow drill, strap drill, auger, mallet, plane and measuring tools"
The researcher based her work on finds in shipwrecks from this period. Yassi Ada I shipwreck offered clues that shipbuilding was adjusting to a different environment than that existing in the Classical Roman World, where Byzantine start switching the principles and methods of construction from shell-first to frame-first. In these new techniques, the builder relied on the transversal framing of the hull, which means dropping off the tenon and mortaise system for fastening. In the transition phase, the unpegged tenon and mortaise web became less dense and the intervals were widely spaced (Abd el-Maguid 2009:314-317). This is translated by the rarely presentation of chisel and auger.
CHAPTER FOUR
AN ETHNOGRAPHIC APPROACH TO
THE STUDY OF TRADITIONAL
SHIPBUILDING TOOLS
CHAPTER FOUR

AN ETHNOGRAPHIC APPROACH TO THE STUDY

OF TRADITIONAL SHIPBUILDING TOOLS

Ethnography was originally developed within the anthropological paradigm. It is a way to provide a detailed description of the social and daily behaviour of various cultures (Fuquen Gomez 2014: 2). It provides a holistic outlook in research to gain a complete structure of various societies and extract conclusions upon field searches within site extractions (Sorset2014:43). Researchers claim that the field of ethnography to describe other ways of life is an activity with roots in ancient history. They refer to the writings of Herodotus, the Greek traveller and historian of the 5th century BC describing 50 different people in different ways focusing on their laws, social customs, religions, and appearance. (Ethnography 2016)

Stuttgart Spradley (1979) emphasises the importance of choosing the right place and people and relates those choices to the research questions. He divided the process of giving an Ethnographic interview into various elements that may include giving ethnographic questions that explain projects and record explanations, in addition to asking descriptive and structural ethnographic questions. Researchers assure that field work is an essential part in the area of Maritime Ethnography where site search stands as the main activity in any case study. They explain this field work as involving many activities such as asking questions, eating strange food, learning a new language, attending ceremonies, taking field notes, interviewing informants, and hundreds of his things. (Stuttgart Spradley1979: 3- 67).

McGrail, the well-known maritime archaeologist, expressed the importance of Maritime Ethnography by saying: "It is evident that Ethnography stands as a key tool to archaeologists as one of the source to be used in the interpretation of excavated material and equipment" For
him, it has proved to be a key methodology for the maritime archaeology that gave a various range of solutions in different aspects. (McGrail 1984: 149-150).

Experimental Archaeology, a branch of archaeological studies, can come to help when archaeological evidences are scarce and when the information obtained from the ethnographic studies are not enough. It provides one way to investigate hypotheses about past technologies, artefacts and cultures. In Maritime Archaeology, such experiments can take the form of building, on full or reduced scale, models or making other simulations of ancient boats or ships, and testing them in repeatable sea trials, real or simulated (Coates, et al 1995: 293).

4.1 Methodological Approach:

Despite the fact that Egypt has many shipyards, researches on recent decades indicate that all those shipyards use the same shipbuilding tools. Therefore, collecting data from more than one shipyard will not add valuable information to this study. For the purpose of this study the researcher visited a shipyard at Rashid, specifically Ebad El-Rahman shipyard, where the replica of "Min of the desert" has been built.

Rosetta was specifically chosen for its rich and valuable sources about shipbuilding tools. In particular, "Ebad El-Rahman" shipyard is chosen for its well-known experiment of building "Min of the desert" boat which will be fully explained at section. The data of this study is collected through interviews with some of the "Min of the desert" boat builders, besides taking notes from a predesigned questionnaire to collect information.

Other valuable shipyards which are concerned with old shipbuilding tools and the way of using them along the Mediterranean are found outside Egypt. However, due to the

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14 Rashid or Rosetta is, actually, a fishing port city on the mouth of the western Nile branch and located 65 km north-east of Alexandria.
difficulty of travelling outside Egypt, the researcher gathered information from the archaeological experiments found in many researches made in the Mediterranean area.

4.2 **Case study:**

4.2.1 **Min of the desert:**

Discussions held by scholars led to the idea of reconstruction so, from 2006 to 2008 Cheryl Ward led a team that designed (Figure 4.1) , built and sailed the reconstructed ship based on the data collected from Gawasis as well as assembly line mentality of common dimensions, shapes and proportions. Min of the desert named after the ancient God of Kopotos it was built as an experiment to reconstruct one of the trading ships of the female pharaoh Hatshepsut nearly 3,500 years ago.

![Figure 4.1: Cheryl Ward with model (Abd el-Maguid, 2008)](image)

It was built using the same techniques and methods seen in the remains of ships 4000 years ago at Gawasis on voyages to Punt. The ship measures 20 x 4.89 x 1.7m deep under its beams and displaces 30 tons with a cargo capacity of about 17 tons. (Ward C. 2010:}
The building process relied on archaeological data for its design and internal structure. Thick planks interlocked along their edges and fastened by deep, unpegged mortise and tenon joints created its structurally sound hull. Min’s sailing performance proved that a rig copied directly from the Hatshepsut Punt reliefs was efficient, effective and conclusively demonstrates the feasibility of extended sea voyages in indigenous Egyptian craft (Ward 2012:225).

The study data was collected through the following questionnaire:

1. **What is the reason behind choosing to work at "Min of the desert" boat in specifically and when did they start working?**

Among the entire shipyards at Rosetta, the scientific team chose the shipyard of "Ebad El-Rahman" to share his experiment in building the Min of the Desert boat. His choice was based on two aspects. Firstly, the available shipbuilding tools found at that shipyard. Secondly, the skilled technicians working at that specific shipyard, that gain their experience from their ancestors who mastered the craft. Such aspects are highly valuable for the team to help in her project.

2. **How many people are working on the boat? Identifying them through name, age' if it is available to know '.**

The responsible team included six technicians; the oldest and most experienced one is called "Mosaad", 60 years old. The team also included some of Lahma's family members such as "Hamdi", 47 years old, "Mahroos", 42 years old, and "Hassan", 51 years and others but age is unknown like yoursry, waleed , Hassan , yoursry Rashad.

1. **What is the work duration?**

8 months
2. **What kind of wood was used?**

Douglas fir was used as its physical characteristics such as density, bending strength and ring size are closely comparable.

3. **The tools used in building?**

The building tools included adze, auger, pull saw, plumb bob, chisel, hammer, mallet, double saw and carpenter square. The technical ship builders, who are experienced in using those tools, wanted to re-enactment the ancient process of building by using tools that are similar to ancient Egyptian tools. The only difference was that the utilized tools were made out of iron and not from bronze like those of the ancient Egyptians. The tools usage is explained as follows;

**Adze**: used in cutting and curving planks (Figure 4.2).

**Pull saw**: used in trimming pegs and other works (Figure 4.3)

![Figure 4. 2: Adze is used for all kinds of shaping and finishing including the trimming of curved framing and planking (Abd el-Maguid, 2008)](image-url)
Chisel: used to make mortising moreover create special shape 'curved chisel ' to complete their work this type never depicted in scenes or in finds.

Auger: used for making holes, however, it was never used by the ancient Egyptian shipbuilder where the bow drill was used instead (Figure no.4.4).

Hammer: used with chisel to ensure that the mortises, tenons and other hull parts were well fitted together (Figure no.4.5).

Plumb bob: used checking hull symmetry and elevations were vital concepts of ship construction and helped to maintain control of the shape of the hull as it was constructed (Figure 4.6).

Carpenter's square: check right angles, in building as well as dressing blocks (Figure 4.7).
Figure 4. 4: Auger that used in ship construction of Min (Abd el-Maguid, 2008).

Figure 4. 5 Using of hammer in different purpose, hammer cutting mortise (Abd el-Maguid M. M., 2008).
Figure 4. 6: Using of plump bob (Abd el-Maguid M. M., 2008).

Figure 4. 7: Using of carpenter square (Abd el-Maguid M. M., 2008).
4. Are there any tools designed specifically for the building process? What was the reason for designing such tools?

In order to complete the building process, curved chisel was specifically designed to be used to remove rash from tenons then using modified mallet with a hummer to join the tenon with mortise (Figure 4.8).

In addition, the technicians also preferred to use electric tools for two months after using the traditional tools for about five months (starting from April 2008 till October 2008) to save time. For example: manual mortising takes almost 16 minutes while electric mortising takes only 5 minutes thus saving almost 11 minutes on such task (Figure 4.9). However, it should be noted that despite of utilizing modern equipment, the primary crew responsible for the ship building that consists of four men and two teenagers relied on iron hand tools made to ancient specifications for most of the work.

Figure 4. 8 : Using hammer for chopping tenon to mortise (Abd el-Maguid M. M 2008).
4.2.2 The project Prôtis sailing replica of an archaic Greek ship of the 6th century BC:

Going back to the 6th century BC Greek carvers used specific methods and principles in ship building, which could be seen from the archaeological remains, in the light of such information Archaeologists deployed these methods in reconstruction of the vessel (Projet Prôtis, 2010). Archaeologists were in fact motivated by the excavations made on Jules Vern 7, Jules Vern 9 ship wrecks in Marseille to reconstruct one of the two ships accordingly their decision to reconstruct Jules-Vern 9 came into action because of its smaller size.

The colony that was built in Marseille had a governor his name was Protis, that governor got married to the king daughter her name was Gyptis, in the light of such information the project got its name "Protis" in the same fashion the ship got its name "Gyptis" (Pomey & Poveda 2014: 43).
The originality of the experimental approach lies in its *ethnographic approach*. Indeed, "sewn" boats are still being built in a traditional way in several parts of the world: in the Indian Ocean, for example, where the systems and assembly techniques put into practice recall in their principles those which are found on ancient Greek ships.

When compared with archaeological sources, ethnographic sources contribute to the interpretation of the remains and allow a more sensitive approach to assemblage by ligatures. (Projet Prôtis, 2010) Team that participate on the project consists of 5 carpenters, 5 archaeologists, 25 volunteers supervised by Patrice Pomey, (Figure 4.10).

The project operations were executed in the shipyard "Borg" in Marseille", in cooperation with "Arkaeos" the ship got its first trip in April 2013. In order to achieve such construction they built the ship using 3D modelling to make sure they got every single detail of "Gyptis" (Pomey & Poveda 2014: 45) The ship measures 9.80 meter long, 1.88 meter cargo capacity 625 K.g (Goasguen 2014: 76).

Carpenter Nabil Merabet Phocaea used rudimentary tools were for shipbuilding (Comment les phocéens voguèrent jusqu’à Marseille 2014: 110) More over variety of tools used in building replica hammer, gouger, mallet and chisel It's so important to realize that they used electric tools to make work easy (Figure 4.11,4.12,4.13).
Figure 4. 10: The tools used to construct the JV9 study model (Projet Prótis, 2010).

Figure 4. 11: Part of team during their work (Comment les phocéen voguèrent jusqu'à Marseille 2014: 109).
Figure 4.13: Using mallet and chisel in the rebuilding process (Goasguen 2014:6, fig. 6).

Figure 4.12: hammering pegs during reconstruction process (Goasguen 2014:6, fig. 7).
4.2.3 Cavalière and Comacchio study models:

In her dissertation Sabrina Marlier decided to make specific section concerning the level of technology and principal function of each construction technique that existed in ancient Mediterranean shipbuilding. Both study models had been built in 25 days between June and November 2002 by R. Roman and S. Marlier.

The Cavalière is a Roman shipwreck dated around 100 B.C, that was found in 1972 under the Mediterranean French coast. The model of study carried out concerned about one meter of the central part of the hull and includes a keel section, a section of the first six strakes, two sections of frames and two half-frames (Marlier 2005: 516-517).

Comacchio is a part of this group of wrecks discovered in the Adriatic and still present by ligatures for the assembly of the shells in Roman times ship building, discovered in the region of the Po delta. It covers a portion of the Roman ship of Comacchio goes back to the last quarter of the 1st century. The model of study carried out concerns the central part of the hull and includes a section of the central strake (Marlier 2005: 531-532).

The traditional carpenter tools were used to construct both models, including small hand saw, a rabbit planer, a chisel, a mortising chisel, hammer, a gouge and steak. However, in order to facilitate the work, they used modern carpentry, an electric planer, planning-machine, electric mortiser and power drill (Figure 4.14,15,16,17 and 4.18) (Marlier 2005: 531-532;Marlier 2016: 45).
Figure 4. 14: Using chisel and hammer Comacchio (Marlier 2005, fig 135h:224).

Figure 4. 15: Digging with a gouge Cavalière (Marlier 2005: 215, fig .134 i).
Figure 4. 16: using drill to make channels Comacchio (Marlier 2005: 225, fig. 135j).

Figure 4. 17: wooden instrument used to tighten lashing at Comacchio (Marlier 2005: 233, fig. 135x).
4.3 Summary

It is important to realize that all replicas that were made used different ancient tools as well as modern ones. Through time, tools used in carpentry experienced no big change in shape and function but it witnesses the big transformation from man power to electricity and in material. Moreover, the case studies that researcher have chosen focused, at the end, on how to get to the final shape of the project without paying attention to how ancient tools were used in shipbuilding, except for Min of the desert ship reconstruction which used ancient tools- but made of iron not of bronze- during most of the time except the final stages where they have used electric tools to save time.
CONCLUSION
CONCLUSION

The early people have tamed every available resource to survive. They built ships for the sake of looking for food and safety, such ships showing remarkable resourcefulness even at times when life was materially poor. One of these resources that the nautical archaeology concerned with is the construction process of ships, which starting with cutting timbers, planning, shaping and ends up with fitting everything together forming the hull. However, shipyards were often temporary, being set up to exploit local timber supplies. It is through such chance archaeological finds, literary references, and artistic depictions that a complete picture of the ship building tools could be figured through time.

In this research, the diverse shipbuilding tools discovered along the Mediterranean which are including shipwrecks, iconography, texts and tool marks evidences have been investigated. However, the extents of woodworking tools have developed through different civilizations. Despite the similarity of the woodworking tools of the carpenter and the shipwright, the researcher managed to know those that used in shipbuilding except the square which was not clear with no evidence if it was used in shipbuilding or not. It was used in carpentry, but the researcher doesn't think that it was not used in shipbuilding because the 90 degrees angle is almost non-existent in a hull.

Tools that are used in shipbuilding are the same that are used in ship maintenance on board. Having the tools on board of the ship, as well as a crew knowledgeable in ship repairs, would result in saving time and money wasted during a commercial venture while waiting for a shipwright to make needed repairs at a nearby port. For instance, double blade instrument used in shipbuilding, cooking and stone cutting like the adze-hammer and the axe-adze.

Some general conclusions about the tools development through selected period in this study were analysed based on their form and usage. These observed changes in tools are believed to
indicate the social and ideological changes which interconnected with the ship usage importance in different societies and its construction principals, methods and traditions. The comparative analysis headed between tools development through Ancient Egyptian, Greek, Roman and Byzantine periods indicated to the following tools:

5.1. The cutting tools:

A. **Axe**: Ancient Egyptians created the axe for felling and trimming off trees as well as the roughly shaping of planks. It is fair to mention that the Egyptians created different types of axe blades, while Greeks created the idea of the double axe (sharp blades in both sides). The usage of the axes lasted until the Roman and byzantine periods.

B. **Saw**: It was well-known in ship construction in the Mediterranean area. There were two types for saw in ancient Egypt, which are the push saw and pull saw. It had different shapes and it was in use in the Roman and byzantine periods. Whilst during the Roman era, different shapes of saw were used. The most common type of saw used was the frame saw, also the double saw used in north Europe but it used in building of "Min of the desert".

C. **Adze**: Used in Egypt with different handles' shapes, as well as the short and long blades were developed through sequential dynasties. The small handle style was applied for the Greek adze, but there is no clue of further development occurred. The Roman and byzantine adze were characterized by being so much developed in a way that matches some of the Egyptian adze, who used it as a plane for different purposes.

D. **Chisel**: It is appropriate to say that the vessel's shipwright carried a variety of chisels in varying sizes, due to the need of cutting the planks in varied sizes. Consequently, whenever one of these tools is found with handles, there is certain likeliness that they are tools for lighter work. The same cannot be said of tools without handles, unless they hold clear signs of rough handling. If the top of a chisel has been hammered out, this could
serve as evidence for harder work. In ancient Egypt, different shapes were found and continued in use during the Greek era, but it became less important at the Roman and Byzantine era due to the changes in shipbuilding techniques. Gouges is considered as a type of chisel. However, it had various degrees of curved cutting edges.

E. **Bow Drill**: It is originated from weapon. In ancient Egypt, it had a straight handle where it got a cap made from stone to apply pressure from the top. The researcher believes that such invention "The Cap" was not used in any other civilization, while the handle was not straight but semi circled in ancient Greek and Roman era.

In Greek era, holes in the ship hull were made by bow drill, with their distinct drill bit diameters, each for its own purpose. The carpenter might have had one bow drill with changeable bit diameters, as in the modern drill of different bit diameters.

F. **Strap drill**: It began to be in use in the Roman period and continued in use at the Byzantine periods.

G. **Auger**: Never used in ancient Egypt because the bow drills were in use for boring holes.

In Greek era, it had been used for opening holes along the plank. However, there is no evidence for auger in the Roman period, but this does not mean that it did not existed and being in use in ancient times. Especially the marks of an auger were appeared on wooden planks of a shipwreck from Byzantine period. Consequently, in the making of "Min of The Desert" they used auger instead of bow drill that was originally used by ancient Egyptians.

5.2. **Bouncing Tools**

A. **Hammers**: The main function of the hammer was to strike on several types of tools. Ancient people tend to use light weight hammer. Even if it is made of stone, it is made to be easily used as the heavier types which tend to become tiring and awkward over time. Metal hammers are also used in woodworking for driving metal nails into wood. While
all constituents are made of wood, including the use of wooden nails, it is common to use in wooden mallets. As it developed in shape, ancient Egyptians used two shapes made of stone (cylindrical shape and cubic shape). While Greeks used wooden hammers but in the Roman and Byzantine periods the double blade adze hammer was in use.

B. **Mallet**: They are tools made entirely from hard or soft wood. It has two types, the first one is formed of a one mass of wood, while the second one is a cross headed mallet, which is formed of a handle with circular end attached to a blade.

### 5.3. Measuring Tools

**The Plumb bob**, **square** and **ruler** are measuring tools and remained unchanged during all ancient periods. The purpose of its usage remained without significant change.

**Calliper**: During the Greek and Roman era, callipers were used in different shapes, however, the ropes or ruler were used in Egypt.

### 5.4. Smoothing Tools

**The plane** was unknown in Egypt. They used stone or sand to smooth the wooden surfaces, but the adze was more than adequate substitute in the hands of skilled crafts men. In the ancient Greek culture, there was no planes found, but it was mentioned in text. While in Roman era different types of plane have been appeared.

While the handles of most of these tools were made of wood and remained until nowadays. Their blades developed from stone, mainly flint, to copper then bronze. These were weak blades that need to be changed or at least be sharpening often. A big step came with use of iron in the manufacture of these tools starting from the classical period. Ancient
Egyptians fitted together the handles and the blades with leather thongs soaked in water and left to dry over the blade. Sometimes they used different materials like cords or linen (Lucas, A 1962:222; Nicholson, P 200: 355). This method continued in a way or another in the next periods but a better fitting reigned starting from the Roman period.
BIBLIOGRAPHY


**List of Websites:**


### GALOSSARY OF SHIP AND BOAT TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adze</strong></td>
<td>Adze or sometimes spelt addes in old books on the art of shipbuilding, the principal tool of the old time ship builder in the day of wooden ship. It resembled a garden mattock but with long and sharper blade slightly curved inwards towards the handle, it was always considered a most difficult tool to use, but with it an experienced shipbuilder could smooth or 'dub', an Oak plank and leave it as smooth it is had been planned (Kemp 2005: 5).</td>
</tr>
<tr>
<td><strong>Axe</strong></td>
<td>The axe has a parallel sharp edge to the handle it was bound to. It was mounted into a handle or a handle into it. It was used to drive into wood with the aim to split it. The axe usually has a short body to allow for the pulling back or twisting it loses from the grip of the cloven wood (Petrie 1917: 5-6).</td>
</tr>
<tr>
<td><strong>Boat</strong></td>
<td>An open veseeel, usually small and without decks, intended for use in sheltered water. (Steffy 1994: 268).</td>
</tr>
<tr>
<td><strong>Bow drill</strong></td>
<td>A device with a hollowed handle in which a spindle rotates; the spindle is connected to a drum, around which a cord it wrapped and run back and forth by means of a bow to rotate the drill bit (Steffy 1994: 268).</td>
</tr>
<tr>
<td><strong>Calipers</strong></td>
<td>is used to transfer measurements between work pieces (Ulrich 2007:52).</td>
</tr>
<tr>
<td><strong>Caulk</strong></td>
<td>To ram fibrous material (caulking) hard into a seam to make it watertight and to prevent the planks of the hull from sliding upon each other when the hull is subjected to longitudinal bending stresses. (Gardiner, Christensen, &amp; eds 1996: 134).</td>
</tr>
<tr>
<td><strong>Chisel</strong></td>
<td>The chisel is an essential woodworking tool where deep, angled cuts are required. It is therefore indispensable for shaping wooden joints: cutting mortises, forming and dovetails, and removing stock for rabbets tenons and removing stock for rabbets (Ulrich 2007: 27).</td>
</tr>
</tbody>
</table>
### Cordage

A general term for ropes and cables (Steffy 1994: 269).

### Experimental archaeology

A method of deriving information about technology and energy consumption in the past by the study of reconstructed processes, based on primarily, but not exclusively archaeological source material (Delgado 1997: 146).

### Hammer stone

In flint working the block of hard stone used to detach flakes from a core. Typically, a conveniently shaped pebble or rounded stone is used battering and cracking on the end usually betray their use as hammer stones (Darvill 2008).

### Keel

Central backbone timber, of sufficient cross sectional area to offer significant longitudinal strength to the hull (Hocker F 2004:165).

### Lash

To fasten elements together by multiple passes of cord or strap through a set of holes either side of the joint line (Hocker & Ward, 2004: 165).

### Mallet

A large hammer with a short handle and a cylindrical wooden head, sometimes hooped with iron to prevent it from splitting, used for caulking (caulking mallet) and general shipwright (Steffy 1994 : 275).

### Maul

A heavy wood or iron hammer primarily used to drive large bolts (Steffy 1994: 275).

### Mortise

A cavity cut into a timber to receive a tenon (Steffy1994: 276).

### Mortises –and– tenon joint

A Union of planks or timbers by which a projecting piece (tenon) was fitted into one or more cavities (morises) of corresponding size (Steffy 1994: 276).

### Mortising chisel

A specialized chisel used for shaping narrow mortises (Steffy1994: 276).
<table>
<thead>
<tr>
<th><strong>Plane</strong></th>
<th>was used at the final stage of the construction in order to smooth the wood and remove tool marks (Mor 2003:32).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plank</strong></td>
<td>A wide, flat member, relatively thin but thicker than a board. Such pieces are used to cover the exterior and interior of the hull, the deck, and so on (Hocker F 2004: 165).</td>
</tr>
<tr>
<td><strong>Ruler</strong></td>
<td>straight piece of wood; a ruler, or straightedge for drawing or sighting lines (Ulrich 2007: 278).</td>
</tr>
<tr>
<td><strong>Sew</strong></td>
<td>To fasten the major elements of a hull together with cord or fibre such craft are normally called &quot;sewn boat “(Hocker F 2004: 166).</td>
</tr>
<tr>
<td><strong>Ship yard</strong></td>
<td>Ship yards are the prime locus of shipbuilding. They are the sites of production where a sizeable work-force constructs, assembles and outfits ships. (Özveren 2000: 584).</td>
</tr>
<tr>
<td><strong>Shipwright</strong></td>
<td>A master craftsman skilled in the construction and repair of ships. In many instances, the person in charge of a ship's construction, including the supervision of carpenters and other personnel, control of expenditures and schedules, and acquisition of materials. Probably in many more areas and periods that have been documented, the term designated a formal title, such as the shipwrights to the English monarchs, or a level of expertise qualifying admission to a guild or association. (Steffy 1994: 279).</td>
</tr>
<tr>
<td><strong>Shell</strong></td>
<td>The external planking of a vessel (Steffy 1994: 279).</td>
</tr>
<tr>
<td><strong>Shell-first</strong></td>
<td>A shell-first is a ship built as a watertight shell. The building process begins by erecting the outer shell of the hull, and any internal framing that may be needed is inserted later (McGrail 2001: 8).</td>
</tr>
<tr>
<td><strong>Strap drill</strong></td>
<td>a powerful two-man drill. The bit is twirled by wrapping a thong, perhaps of leather, around the shank (Ulrich 2007: 280).</td>
</tr>
<tr>
<td><strong>Reconstruction</strong></td>
<td>The reassembly or recreation of watercraft (Delgado 1997: 334).</td>
</tr>
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<td>-------------------</td>
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</tr>
<tr>
<td><strong>Tenon</strong></td>
<td>A wooden projection cut from the end of a timber or a separate wooden piece that was shaped to fit into a corresponding mortise (Steffy 1994: 281).</td>
</tr>
<tr>
<td><strong>Treenail</strong></td>
<td>A round or multi–sided piece of hard wood, driven through planks and timbers to connect them (Steffy 1994: 281).</td>
</tr>
<tr>
<td><strong>Wood work</strong></td>
<td>The skill or activity of making wooden objects (Longman, 2016).</td>
</tr>
<tr>
<td><strong>Frame-first</strong></td>
<td>A frame-first hull is built as a waterproofed frame in exactly the opposite order. The building process begins with the erection of a rigid structure of backbone and frames that is waterproofed by an outer skin of planking (McGrail 2001: 8).</td>
</tr>
<tr>
<td><strong>Peg</strong></td>
<td>A tapered wooden pin driven into a pre-drilled hole to fasten two members or lock a joint (Steffy1994: 277).</td>
</tr>
</tbody>
</table>
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قسم الآثار و الدراسات اليونانية و الرومانية

أدوات بناء السفن القديمة في البحر المتوسط - دراسة أثرية وإثنيوجرافية

بحث مقدم للحصول على درجة الماجستير في الآداب من قسم الآثار و الدراسات اليونانية و الرومانية - تخصص الآثار البحرية

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