AN ANALYSIS OF TOMB RELIEFS DEPICTING BOAT CONSTRUCTION FROM
THE OLD KINGDOM PERIOD IN EGYPT

A Thesis
by
EDWARD MORGAN ROGERS

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

May 1996

Major Subject: Anthropology
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Approved as to style and content by:

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May 1996

Major Subject: Anthropology
ABSTRACT

An Analysis of Tomb Reliefs Depicting Boat Construction

From the Old Kingdom Period in Egypt. (May 1996)

Edward Morgan Rogers, B.A., Georgia Southern University

Chair of Advisory Committee: Dr. George Bass

Among the aspects of daily life represented on the walls of private tombs during the Old Kingdom in Egypt are reliefs depicting the construction of boat hulls. Examination of the twenty known reliefs and relief fragments which date to this period provides numerous insights into the technology and methodology of wooden hull construction. These reliefs were created to be blueprints of boat construction procedures but rather to ensure that the owner of the tomb would have boats in his afterlife. The majority of the procedures relate to the final stages of construction prior to the hull being launched. The depiction of the tools necessary for hull construction and how they were used is of great relevance. Hull symmetry was checked with the aid of a plumb bob while adzes were kept ready to remove flatspots. The procedure of joining planks edge-to-edge with mortise-and-tenon joints is represented with great detail in the Ty relief. Joining planks in this manner required a team of men working together while being supervised. Reliefs which show hulls with a rope truss stretching from end to end were used to tighten internal traverse lashed joinery and are not the hogging trusses seen on seagoing ships and cargo vessels. Depictions of various steps required for this procedure in most reliefs suggests that its employment was pervasive.
DEDICATION

For my Parents
ACKNOWLEDGEMENTS

It has been one long exciting discovery since I picked up the December 1987 issue of National Geographic Magazine, read Dr. George Bass' article on the Uluburun shipwreck and decided to devote my career to Nautical Archaeology. It embodied everything I wanted in academia. To say this decision changed my life is a gross understatement. If I had been told ten years ago of all the things that I would see and do before I was thirty, I could not have possibly believed it. The most important that I have learned from this experience is the conviction that you can change your life if you are willing to take a chance and follow your dreams.

I will begin with thanking my thesis committee Drs. George Bass, J. Richard Steffy, and Charles White for spending their time and effort on making this a better piece of work. The following people patiently listened to my theories on Egyptian boat construction and offered constructive criticism: Fred Hocker, J. Richard Steffy, Michael Fitzgerald, Mark Smith, Dr. Fred van Doorninck, Cemal Pulak, and Dave Grant. Dr. Cheryl Haldane's publications on ancient Egyptian hull remains provided an important foundation for this study. Dr. Bass deserves a special meritorious award for his part in compiling such a thorough research collection at the Sterling Evans Library, which has made my work so much easier and productive. Bertha Porter's and Rosiland Moss' colossal work, Topographical Bibliography of Ancient Egyptian Hieroglyphic Texts, Reliefs and Paintings saved me untold hundreds of hours of searching for sources. James Coggleshall unhesitatingly allowed me to use his computer after mine crashed at the critical stage of final editing. Dr. Elynor Davis and Liz Baldwin selflessly provided translations of articles for me. John Darnell contributed several important interpretations of hieroglyphs. The staff of the Inter-Library Loan Services at the TAMU Library provided a steady stream of books. The Brooklyn museum supplied prints of the unpublished Khuenre' relief. A boat construction relief which had eluded me for the past two years was located for me by Diane Bergman.
at the Wilbour Library of Egyptology of the Brooklyn Museum.

A fellowship from the Leyland Jordan Institute for International Awareness at Texas A&M University made possible a research trip to Egypt in the fall of 1991. During my stay in Egypt several people went out of their way to assist me: Dr. Kent Weeks, John and Debbie Darnell, Dr. Zahi Hawass and Dr. Donald McDonald. The staffs of the libraries in the American Research Center in Cairo and the Oriental Institute at Luxor were very friendly and accommodating.

I have made many great friends since coming to the Nautical Archaeology program. It is these friendships which I will cherish the most when I leave here. They have fed me, given me a place to sleep, helped get my car started, and provided rides to the airport. Their help and hospitality should never be trivialized nor forgotten. These include Liz and Rob Baldwin, Roxani Margariti, Mark Smith, Dave Grant, Claire Peachey, Rich Wills, Rahilla and Don Shatto, Greg Cook, Kyra Bowling, Mason McDaniel, Tina Erwin, Stephen Paris, Peter van Alfin, Georgia Fox, Barbara Van Mier, and Claire Calcagno. A big "Thanks," goes out to David Robinson, Valerie Rivas, Joe "Coz" Cozzi, Bill Charlton, Dr. Wayne Smith, Dr. Shelley Wachsmann, Dr. Donny Hamilton, Faith Hentschel, Ursula Cuzzi, Veronica Zuniga, Alex West, Steve Vinson, Robin Piercy, Don Frey, Murat & Tulin & Hiyat at Merhaba Cafe, Nancy Lively, and Jackie Chan.

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responsibility on the spektakulären Uluburun shipwreck project during the past six years, placing me in
charge of recording many of these pieces of history, as well as letting me be Uluburun movie czar.
May we chase tiger beetles until we're a hundred! The philanthropy of the members of the Board of
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My parents have been unwavering in their support for me during the past six years. It has largely
been their deep pockets which has allowed me to devote so much uninterrupted time to my career. The
huge family library which they provided me at an early age spurred my interest in archaeology while I
was still just a wee lad. Without their faith I would still be wondering what it would be like to
excavate on the world's oldest known shipwreck or travel to Egypt to study the boatbuilders at
Saqqara.

"If I have seen farther, it is by standing on the shoulders of giants," Sir Issac Newton 1675.
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ABBREVIATIONS

ASAE - Annales du Service des Antiquités de l’Egypte
AJA - American Journal of Archaeology
AJSL - American Journal of Semitic Languages
BIFAO - Bulletin de l’Institut Français d’Archéologie Orientale
BMMA - Bulletin of the Metropolitan Museum of Art
CQ - Classics Quarterly
DETOK - Decoration in Egyptian Tombs of the Old Kingdom
EFJ - Empire Forestry Journal
GM - Göttinger Miscellen
JEAc - Journal of Egyptian Archaeology
JNES - Journal of Near Eastern Studies
MFAB - Museum of Fine Arts, Boston
MMAJ - Metropolitan Museum of Art Journal
ZÄS - Zeitschrift für Ägyptische Sprache und Altertumskunde
CHAPTER I
INTRODUCTION

During the Old Kingdom period (2770-2160 B.C.), Egyptian tombs were decorated with reliefs depicting daily activities in the belief that they would provide for their owners’ needs during the afterlife. A common theme was the representation of pilgrimages by the deceased, who traveled in wooden boats along the Nile river. Beginning in the IVth Dynasty, the depiction of the construction of the hulls for these boats was included in some tombs. The majority appear in mastabas at the necropolises of Giza¹ and Saqqâra. They vary from simple, stylistic portrayals to complex depictions of many of the steps involved in hull construction. The reliefs contain detailed examples of Egyptian tools, tool usage, and boat hulls. They provide a unique record of some of the construction techniques used by Egyptian boatwrights, information that is not available from other sources.

The original extent of these reliefs is unknown for several reasons. Some tombs, along with their reliefs, were destroyed in antiquity by succeeding kings, invaders, or people seeking building material. In the early 20th century A.D., some reliefs that had survived these ravages were removed from their tombs, broken up, and sold. The fragments are now scattered in museums and collections all over the world. Their integration into the archaeological record continues.² Others have been lost due to looting or changes in climate. While some of these depictions are known from the drawings of early explorers and archaeologists, many others are gone forever.

Beginning with the western discovery of ancient Egypt in the early nineteenth century A.D., tombs and mastabas were explored and their reliefs recorded and studied. This documentation increased at the

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This thesis follows American Journal of Archaeology style.

¹ For the sake of consistency, the spelling of Egyptian names and places was adopted from B. Porter and R. Moss, Topographical Bibliography of Ancient Egyptian Hieroglyphic Texts, Reliefs, and Paintings.

turn of the century with the first serious application of the discipline of archaeology. Among those transcribed are twenty-five reliefs and relief fragments depicting the construction of wooden boat hulls. Twenty of them date to the Old Kingdom period, the majority of which are unique in their composition.³

Status of Research

The degree and quality of the documentation of these reliefs varies. The most thoroughly recorded and frequently published depictions are from the large, magnificent tombs which survived intact at Saqqara. These have been recorded with black and white photographs as well as detailed line drawings and paintings. Many reliefs from the smaller, less well preserved tombs are known only from single drawings or sets of photographs. It is this record which forms the basis for this thesis.

The first extensive study of these representations of Egyptian boat construction was in 1925 with *Études de nautique égyptienne* by M. Charles Boreux.⁴ Franz Moll provided a fairly complete record of reliefs in 1929 as part of *Das Schiff in der bildenden Kunst*.⁵ The most thorough study to date was made by Vandier in 1969, as part of his *Manuel d’archéologie égyptienne*.⁶ Much of this early research was based upon comparisons with Indo-European and contemporaneous shipbuilding practices.

The past thirty years has seen the emergence and development of the fields of nautical

---

³ A catalog of these is provided in Appendix 1.
⁴ M.C. Boreux, *Études de nautique égyptienne* (Cairo 1925).
archaeology and ship reconstruction. Consequently, a great deal of new information about the technology of ancient shipbuilding has been revealed. Additionally, the excavated remains of Egyptian funerary barges and boat timbers have been examined again and their construction features reinterpreted. This knowledge requires that most previous understandings about these reliefs be reevaluated.

Publications relating to nautical archaeology or ancient vessel construction usually include at least one example of these boat construction reliefs and provided some new interpretations. Cheryl Haldane’s dissertation, *Ancient Egyptian Hull Construction*, is the first study to utilize the new information derived from the study of the timbers of Egyptian vessels, much of which she pioneered, and apply it to an analysis of some of these depictions. However, a comprehensive, detailed study of the reliefs has not been undertaken.

New information provided by nautical archaeologists, Egyptologists, and epigraphers now permit a thorough analysis of representations of wooden boat hull construction. This study will analyze construction techniques portrayed in the four most informative reliefs from the Old Kingdom, while including the remainder as supporting evidence.

**Methodology**

All known examples of these reliefs, published and unpublished, were located and examined for

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8 J.R. Steffy, *Wooden Ship Building and The Interpretation of Shipwrecks* (College Station 1994).


this study. A comparative analysis made it possible to differentiate between unique features and standardized scenes. Examination of multiple photographs and drawings of each relief was attempted in order to make a complete and accurate investigation. A trip to Saqqâra and Giza in 1991 permitted a firsthand look at some of the reliefs in the context of their tombs.\textsuperscript{11} Damage sustained by the majority of the reliefs leaves us with incomplete records. While it is often impossible to know what they may have depicted originally, repetition of scenes and activities allows for some projection of the intact sections. Additional information was obtained by studying reliefs which portrayed outfitted boats.

History of Boat Construction Reliefs

The majority of known reliefs depicting boat construction are from the decorated tombs of court officials and priests of the Old Kingdom. However, most depictions included in these private tombs were developed between the IVth and early Vth Dynasty for the tombs, mastabas, and chapels of the royal family at Giza and Maidûm.\textsuperscript{12} Reliefs in the funerary temples of the kings were frequently very detailed and the sculpture of the best quality. Unfortunately, many of these temples have been pillaged or destroyed, and as a result there are no known examples of reliefs depicting wooden hull construction that can be firmly associated with these royal temples. Three fragments of a relief, found with a large group of architectural blocks used as fill for the XIIth Dynasty pyramid of Amenemḥet I at Lisht, may represent one of them. A depiction of the building of papyrus rafts, a subject common to many private tombs, is found in the sun temple of King Nywoserre\textsuperscript{13}.

\textsuperscript{11} E. Rogers, "Boat Reliefs in the Tomb of Ti and Mastaba of Mereruka," \textit{INA Quarterly} 19 no. 3 (1992) 8-11, 13.

\textsuperscript{12} Y. Harpur, \textit{Decoration in Egyptian Tombs of the Old Kingdom} (London 1987) 230.

\textsuperscript{13} H. Goedicke, \textit{Re-used Blocks from the Pyramid of Amenemhet I at Lisht} (Metropolitan Museum of Art 1971) 120.
The oldest known depictions of wooden boat construction are from the tombs of sons of IVth Dynasty kings. The earliest two occur at Maidûm (fig. 1) in the tombs of Rē 'hotp, and Itet and her husband Neferma'et, both sons of King Snefru.\(^{14}\) They portray small, papyriform hulls being finished by men with adzes and chisels. Despite their resemblance to papyrus rafts in shape and relative size, the presence of the woodworking tools indicates that the hulls were built of wood. The reliefs are notable for their portrayal of a worker pulling a line which leads into the hull, a probable indication of lashed joinery. The similarity of this action to another seen in reliefs depicting the fabrication of papyrus rafts may have led several scholars to identify these as also being made of papyrus.\(^{15}\) The Re 'hotp relief\(^{16}\) is identical to part of the more elaborate, but less well preserved, Itet relief. Whether these two reliefs were the work of the same artists or this duplication is a early example of copying is unknown.

Later in the IVth Dynasty, the availability of greater amounts of wall space for decoration permitted the expansion of craft scenes.\(^{17}\) This practice first appears at Gîza in the funerary chapel of Prince Khuenrē', son of King Menkaurē' (Mycerinus).\(^{18}\) The reliefs within the rectangular chapel include the detailed portrayal of the construction of four boat hulls. The hulls are now much larger in comparison to the workers and the activity around each of them is composed individually. Specific construction phases, some requiring gangs of men, are depicted. Evidence of the loss of reliefs at Gîza


\(^{15}\) Goedicke (supra n. 13) 119.

\(^{16}\) Henceforth, relief(s) = Egyptian tomb relief(s) depicting the construction of wooden boat hulls.


\(^{18}\) W.S. Smith, *A History of Egyptian Sculpture and Painting in the Old Kingdom* (New York 1978) pl. 49b; Y. Harpur (supra n. 12) 84.
Fig. 1. Funerary sites of Lower Egypt
is shown by fragments found in the mastabas of Duaenre,\textsuperscript{19} Hemyunu\textsuperscript{20} as well as an unprovenanced fragment, no. 944.\textsuperscript{21}

Following the reign of King Menkaur\'\textsuperscript{e} the location of the royal necropolis was moved from Giza to Saqq\ara (fig. 2).\textsuperscript{22} As at Giza, officials who had served the Kings were permitted to build their own mastabas there. The artists who decorated these private tombs drew upon many of the same scenes found in the royal monuments.\textsuperscript{23} Late in the 5th Dynasty one of these private tombs was built for Ty, a court official who had served under three Pharaohs.\textsuperscript{24} The artists responsible for the sculpture did an exceptional job and the art is considered the apex of 5th Dynasty style.\textsuperscript{25} One of the compositions\textsuperscript{26} is the most detailed portrayal of Egyptian boat construction. It is the best known of these reliefs and is frequently cited in references dealing with ancient nautical history and vessel construction.\textsuperscript{27} It consists of three registers and depicts the final stage of assembly of five boat hulls

\textsuperscript{19} Reisner (supra n. 17) 350, n. 1.

\textsuperscript{20} W.S. Smith, "The Origin of Some Unidentified Old Kingdom Reliefs," AJA 46 (1942) 527-28, fig. 14.


\textsuperscript{22} Harpur (supra n. 12) 11.

\textsuperscript{23} Goedicke (supra n. 13) 117.

\textsuperscript{24} G. Steindorff, Das Grab des Ti (Leipzig 1913) 1-7.

\textsuperscript{25} C. Aldred, Egyptian Art in the Days of the Pharaohs (New York 1980) 88.


Fig. 2. Saqqara Necropolis
by fifty-three workers and boatwrights. Some workers who are depicted close to one another perform related tasks. It provides a wealth of unique information on mortise-and-tenon construction. Several of the hieroglyphic inscriptions associated with the relief describe the worker’s activities, while others represent their comments. Most of them provide clues to the construction methodology. The artists gave a symmetrical look to the relief, frequently depicting workers in pairs. At the center of the relief stands a boatwright with a staff and plumb bob. Ty himself is present and is unexpectedly portrayed at the same size as the workers. Due to his presence, the boatwright and a scribe hold their left shoulders with their right hands as a sign of respect.\textsuperscript{29}

The relief in the tomb of Khunes at Zâwyet el-Maiyitîn is the most comprehensive boatbuilding scene known.\textsuperscript{29} It depicts numerous stages of construction in a sequential order. These range from the chopping down of trees to a final stage of hull construction. The relief is also notable for the diverse portrayal of supports used to stabilize the hulls.

Other reliefs dating from the middle Vth to the early VIth Dynasty are known from tombs at Saqqâra and Deir el Gebrâwi. Most cover basic aspects of construction and depict only one or two hulls. The Mereruka relief provides an important depiction of the measuring of a boat hull with a rope and plumb bob.\textsuperscript{30}

After the Old Kingdom period only a handful of reliefs deal with the subject of wooden hull construction. While craft scenes continue to play a large role in the decoration of private tombs, the frequency of reliefs depicting wooden boat construction changes. Only one relief is known from the Middle Kingdom period.\textsuperscript{31} By the time of the New Kingdom, reliefs portray the construction of

\textsuperscript{29} A. Varille, *La tombe de Ni-ankh-Pepi à Zâwyet el-Mayetîn* (Cairo 1938) 15, fig. 5.

\textsuperscript{30} Duell et al., *The Mastaba of Mereruka* II (Chicago 1938) pl. 152.

\textsuperscript{31} P.E. Newberry, *Beni Hassan* I (London 1893) pl. 29.
single funerary barges.\textsuperscript{32} Two examples are known from the Archaic period, though one or possibly both are copies of Old Kingdom reliefs.\textsuperscript{33}

\textbf{Function of Reliefs}

While these reliefs provide us with much unique information about hull construction, they are not instructions on how to build Egyptian boats nor are they a frozen moment of activity from the boatyard. They were included to serve a function as part of the owner's tomb. Mastabas not only housed the dead but also provided for their daily needs in the afterlife.\textsuperscript{34} The reliefs contained within them were a collection of attributes that would permit the owners to continue to play the roles that had been assigned to them in life.\textsuperscript{35} They reflect the positions that the owners held, jobs that they performed, and the daily life of their estates. Boats were considered essential in the hereafter for making pilgrimages and visiting areas of the estates. As it was integral for the deceased to have them for travel in the afterlife, it was frequently deemed necessary to portray their construction. A description accompanying the relief from the mastaba of Mereruka reads, "(see) ...the shabet boats of ished wood by which he will be able to land in the excellent West, by the boatwrights of his kingdom".\textsuperscript{36}

The reliefs portray only assembled boat hulls. They probably had to depict objects that were

\textsuperscript{32} Vandier (supra n. 6) 683-86.


\textsuperscript{34} Duell et al., \textit{The Mastaba of Mereruka I} (Chicago 1938) 8.


\textsuperscript{36} P. Montet, \textit{Les Scènes de la vie privée dans les tombeaux égyptiens de l'Ancien Empire} (Strausborg 1925) 330; D. Jones, \textit{Egyptian Boats} (Austin 1995) 74.
recognizable in order for them to be effective in the magical recreation. Therefore, all of the portrayals of boat hulls depict them in the final stages of construction. The reliefs are an idealized representative for all the hulls built during the owner's life, not a particular one. The artists responsible for them portrayed a minimal statement of those attributes whose presence was felt to be essential to an Egyptian's clear perception of the subject. It was a balance struck between the ideal and the actual.37 Fortunately, Egyptian artistic conventions were flexible enough to allow the artists to include their own innovations and variations of these scenes.38 Thus, each relief provides a unique portrayal of boat construction from which nuggets of information can be mined.

Many of these reliefs include hieroglyphs which provide descriptions of the activity or colloquial expressions and comments by the workers. To the Egyptians, such inscriptions were considered essential to the continued welfare of the deceased.39 Weeks points out that the comments of the workers, which are sometimes seen as comical, may be socially prescribed utterances. Their purpose in the funerary context is not readily apparent from their wording.40

Tomb Relief Construction and Layout

During the Old Kingdom most of the tomb decoration in the Memphite area was executed in stone relief rather than simple painting. The prevalence of this medium was probably due to the availability and permanence of limestone41, which was quarried across the Nile, south of Cairo.42 Reliefs were

37 Weeks (supra n. 35) 61, 68-69.
40 Weeks (supra n. 35) 74.
41 Harpur (supra n. 12) 5.
42 Duell et al. (supra n. 34) 7.
made in three stages: laying out the design, carving of the reliefs, and painting. The painter or painter draftsman probably made the original layout. This outline served as a preliminary sketch which was gone over by the master paintsman or draftsman, who modified and corrected the drawing. The reliefs were then carved with hand chisels.\textsuperscript{43} One of the earliest uses of relief sculpture was in the tomb of Re'hotp.\textsuperscript{44}

Most reliefs portray a composite of several stages of construction. The more elaborate ones also include several hulls at sequential stages of construction. This may begin with chopping down trees and end with the tightening of internal lashings. There is usually a discernable direction to the sequence. Determining it is valuable for analyzing the order of construction. A standard pattern for these does not exist. One relief may move from the top to bottom, left to right, while another may go from bottom to the top, right to left. An indication of the beginning of the sequence is the presence of preliminary stages of construction such as chopping down a tree, processing a log, and sawing planks.

Depictions in other parts of the tomb portray the same boat hulls outfitted and manned. They are either under sail or propelled by teams of rowers or paddlers. It is clear from the number of rowers or paddlers depicted that these identical hulls are much larger than they appear in the construction reliefs. The hulls in the boat construction reliefs are obviously not drawn in proportion to the workers who build them. While the size of workers and carpenters in craft scenes remains fairly uniform throughout the tomb, the size of the hulls in the boat construction reliefs varies. Their proportions were dependent on the amount of space relegated. Egyptian artists were not always careful about proportions and rarely drew objects to scale.\textsuperscript{45} An estimation of the size of some of these hulls based on the number

\textsuperscript{43} Duell et al. (supra n. 34) 12-13.

\textsuperscript{44} Y. Harpur, "The Identity and Positions of Relief Fragments in Museums and Private Collections: The Reliefs of R'-htp and Nfrt from Meydum," JEA 72 (1986) 24.

\textsuperscript{45} H.E. Winlock, "The Egyptian Expedition 1921," BMMA (1922) 26.
of rowers is provided in appendix 2.
CHAPTER II
THE TOOLS

All of the metal tools depicted in these reliefs are certainly made of copper since it was the only metal available for such use during the Old Kingdom.46 Though the Bronze Age began for Egypt in the Middle Kingdom, tools were still being made of copper into the New Kingdom.47 The rarity of metal caused copper tools, especially those of carpenter's, to be melted down and reused by succeeding generations. Further evidence of the value of copper in ancient Egypt can be seen in the records of transactions of a 12th Dynasty royal dockyard workshop of Seawosret I. Each tool that is issued to a craftsman has a weight recorded by it, indicating careful monitoring over the amount of wear for each tool.48

During the Old Kingdom period copper tools were cast in one-piece open mold. Tool edges were hardened significantly by cold hammering. Any traces of arsenic in the ore would have hardened the copper even more, producing an edge harder than bronze.49 The handles of Egyptian axes in the British Museum collection usually consist of native woods such as acacia, tamarisk or siddar.50 Green leather thongs were used to lash the axe and adze blades to their wooden handles. Upon drying the green leather contracted and formed a very hard, tight binding.51 A figure amongst the scenes of metallurgy in a relief fragment from the Causeway of King Unis portrays the final stage of tool

46 A. Lucas, "Woodworking in Ancient Egypt," EFJ 13 (1913) 213.
48 W.K. Simpson, Papyris Reisner II (Boston 1965) 16, 17, 36.
51 Hayes (supra n. 39) 289.
fabrication, the sharpening of the blade with a stone.\textsuperscript{52}

**Axes**

Axes appear in the majority of reliefs, usually in association with chopping down and processing trees. The round, thin-bladed axe is a type that is unique to Egypt, originating as early as the 1st Dynasty.\textsuperscript{53} It is interesting to note that the Egyptian hieroglyph for "boatbuilder" incorporates the ideogram of an axe and not an adze.\textsuperscript{54}

Two standing workers are shown processing a log in the Ty relief (fig. 3). Stumps of branches are visible along its length and one end is wider than the other. Beside each of the men hieroglyphs read "to do carpentry with the axe."\textsuperscript{55} The intensity of their work is emphasized by the manner in which they have rearranged their kilts so as to allow greater freedom of movement.\textsuperscript{56} Like all of the tools portrayed in this relief the two axes are very detailed. Each axe handle is slightly curved, providing a more comfortable hand-to-tool edge orientation.\textsuperscript{57} An examination of the axe heads reveals a cross hatching at the base which represents the leather binding used to hold the axe head into the handle slot. Another fastening detail is represented in the relief from the Vth Dynasty tomb of Ni`ankh-khnum and Khnemhotep which includes a single large hole in each axe blade (fig. 4). Axes which employed this method of attachment date to the IIInd Dynasty.\textsuperscript{58} This suggests that the artists responsible for the

\textsuperscript{51} S. Hassan, "Excavations at Saqqara 1937-38," *ASAE* (1938) pl. 96.

\textsuperscript{52} Petrie (supra n. 49) 7.


\textsuperscript{54} Montet (supra n. 35) 299.

\textsuperscript{55} Harpur (supra n. 12) 170.

\textsuperscript{56} Personal communication, Fred Hocker, May 1990.

\textsuperscript{57} Davies (supra n. 50) 27-29, pls. 1, 2.
Fig. 3. Three workers in the Ty relief using axes and an adze to process a log. (Wild [1953] pl. 129)

Fig. 4 Axes with holes in the centers of the blades, through which the fastenings would have passed. Tomb of Ni’ankh-khnum and Khnemhotp. (Moussa and Altenmüller [1977] fig. 8)
composition of the relief may have been influenced by an earlier depiction.

The two workers in the Ty relief are probably removing the bark and sapwood of the log in preparation for it being sawn into planks or other hull components. The presence of an adze being used by worker no. 2 indicates that the timber will be smoothed and squared by the end of this step. While it may at first appear significantly larger than other adzes in the relief, it is simply drawn in proportion to worker no. 2. The end result of this stage would be a smooth piece of timber, clear of bark and limbs. Portrayals of log splitting are limited to a single relief from the tomb of Ibi which depicts workers using a large maul and unhafted chisels.

The axes in the Ty relief vary in size. The axe of worker no. 1 has a blade that is about 20% larger and a handle that is 30% shorter than the one used by worker no. 3. The one with the smaller head is shown being used at the narrow end of the log. While inconsistencies in the depictions of tools could be due to the amount of space available to the artist, different sizes of axe heads are also evident from surviving examples. Variations in size as great as 20% are apparent from finds dating to the Old Kingdom. This evidence taken together with the detail displayed by the artists makes it seem unlikely that the difference in size was an arbitrary decision. While this variation could simply illustrate an inconsistency in the production of axes, it could also demonstrate that lighter axes were used for a separate step of log processing. The portrayal of different sizes and varieties of other tools is discussed below.

The Khuenre relief portrays three workers wielding axes while standing in the assembled boat hulls (fig. 5). Men with adzes work alongside them. Because these reliefs depict the final stages of

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59 Due to the numerous workers and hulls in the Ty relief each man has been assigned a number, 1 - 55, and the hulls roman numerals I-V, which corresponds to the designation in the figures.

60 Haldane (supra n. 10) 15, 53.

61 Davies (supra n. 50) 28-32, pls. 1-4.
Fig. 5. Workers using axes to shave surfaces of hull planks. Chapel of Khuenrë¹. (After MFAB, neg. no. A1061, A5475)
hull construction, it is unlikely that the workers are actually chopping or fashioning elements of the hull. They are using their axes to carefully shave the surfaces of the side planking. A similar depiction appears in the Middle Kingdom tomb of Khnemhotp III at Beni Hasan. Parallels for this practice by other cultures can be seen on the inboard faces of hull planks of medieval boats from northern Europe. Trimming the ends of a hull with axes appears in two reliefs from private tombs at Deir el Gebrāwi which date to the VIth Dynasty. The only mention of possible axe marks on Egyptian hull remains is from a report on the boat timbers from el-Lisht. These depictions illustrate the employment of axes for fine reduction work as well as for felling and processing trees. An almost identical portrayal of these varied tasks is found on a much later, but equally well known depiction which includes boat building: the Bayeux tapestry.

Saws

Saws are rarely portrayed in reliefs dating to the Old Kingdom, appearing in only four depictions. The Ty relief contains the most examples and depicts all of them being utilized. Most surviving examples of pull saws have roughly notched, uncanted teeth along one side of the thin blade. True saws, having alternate teeth bent in opposite directions, do not appear in Egypt until the New Kingdom. A surviving example of the blade of a two-handed pull saw, dating to the Eighteenth

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62 Newberry (supra n. 31)


64 N. de G. Davies, *The Rock Tombs of Deir el Gebrāwi* Pts. 1, 2 (London 1902) pls. 16, 10.


Dynasty, has a length of 56.7 cm. Its tip is narrow, unlike the wide, rounded tips of the saws depicted in Old Kingdom reliefs.  

Worker no. 14 uses a two-handed pull saw to cut planks from a vertically positioned piece of wood (fig. 6). His stance, the position of his arms, the vertical positioning of the wood, and the upward tilt of the saw indicates that he is pulling the saw towards himself. If the worker was attempting a modern push stroke the copper blade would have buckled. The handle has a downward turned knob, important for using a pull stroke. The hieroglyphs above him translate simply "to saw."

Near the top of the piece of wood that is being sown is a tourniquet, tightened with a stick and a rock, which serves two functions. It securely holds the piece of wood to the post and prevents the section that has already been cut from vibrating. As the work progresses the sawyer would have inserted a piece of wood in the gap to prevent the saw from binding. A model of a carpenter's shop from the XIth Dynasty tomb of Mekhetre provides a perfect representation of the arrangement of the saw, saw post, and timber, a parallel noticed by numerous scholars.

Overall, the depiction of using the two-handed saw is fairly simple considering that some planks on

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64 G. Killen, Ancient Egyptian Furniture I (Warminster 1980) 20, pl. 20.


71 Montet (supra n. 36) 302.

72 Lane (supra n. 69) 56.

Fig. 6. Sawyer using a two-handed pull saw to cut a vertically positioned piece of wood. Tomb of Ty. (Wild [1953] pl. 129)

Fig. 7. Sawyer in Ni’ankh-khnum and Khnemhotp relief. (Moussa and Altenmüller [1977] fig. 8)
The small funerary barges from Dashur were more than four meters in length. Most complex arrangements may have been necessary to saw the immense 7 - 23 m. long planks used for the construction of the Khufu I barge. The knot and end grain patterns on pairs of sawn planks from the Carnegie Dashur boat suggest to Haldane that they may have been cut from a single log.

The depiction of sawing in the Ty relief is different in one aspect from all other Egyptian portrayals. No differentiation has been made between the sawing post and the log being cut. It seems that the worker has sawn half-way through a beam that is apparently buried in the ground. This appearance may be due to the artist or sculptor unintentionally leaving out some detail. If it is to be taken as accurate, then the traditional sawing post was not used and the end of the timber being cut would have to be buried in order for it to be secured. The Sawyer would eventually have to remove it from the ground and start sawing from the other end in order to complete the cut. Perhaps it was easier to saw planks from large pieces of wood by this method. However, the distinction between the saw post and the log is clear in the only other boat construction relief that includes a two-handed saw (fig. 7), as well as the relief depicting Ty's carpentry shop. Since the example in the Ty relief is the exception to all other representations, and due to the difficulties in completing a cut for a log buried in the ground, the absence of this detail should be viewed as probably an accidental omission by the artists.

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74 Haldane (supra n. 10) 208, table 10-2.
75 Haldane (supra n. 10) 108.
76 Haldane (supra n. 10) 226.
77 Sliwa (supra n. 67) fig. 13, provides a compilation of these depictions.
78 The damaged relief in the tomb of Ra'shepses includes the lower torso of a worker who, judging from his posture, is probably cutting planks with a two-handed saw. C.R. Lepsius, Denkmäler aus Aegypten und Aethiopien III ii (Berlin 1849-1859) pl. 61.
Workers no. 43 and 48 are shown using smaller one-handed saws for finishing hull IV in the upper left register of the Ty relief (fig. 8). Seated in the hull, worker no. 43 uses his saw to rip a shaft of wood. A saw from the 18th Dynasty, which is similar in appearance, measures 38 cm in length. The tip of the saw is pointed up indicating that he is using a downward sawing motion. He lacks the vice which is employed with the saw post and simply holds the cut ends together with his left hand to keep them from vibrating. The probability that he is making battens for the plank seams will be discussed below in chapter V which deals with tightening trusses and lashed joinery. Another part of the hull that he could be fabricating are the attachment points for mounting the steering oars. These semi-circular components can be seen on the stern of the outfitted papyriform boat (fig. 9) and the Khufu I funerary barge. A similar scene is found in the relief from the tomb of Ra’shepses.

Worker no. 48 uses a saw near the bow of papyriform shaped hull IV (fig. 8). The teeth extend all the way down to the handle. Like the other one-handed saw, the handle has a downward turned knob. It is a very intriguing that a saw would be needed on an almost completed hull. Unfortunately, part of the scene is missing and it is not possible to discern what exactly the sawyer may have been doing, though it appears that the worker below him is about to become the victim of a very grisly industrial accident. A possible parallel for this activity can be found in a relief from the New Kingdom tomb of Ipuy, which depicts a worker using a saw around the papyrus flower end of a hull. An examination of the bow of the completed papyriform boat shows that it is also shaped like a papyrus flower (fig. 9). Worker no. 48 is probably using his saw to make divisions for the petals of the papyrus flower on the bow. Another example of a one-handed saw in a relief dating to the Old Kingdom period is seen on a

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80 Killen (supra n. 68) 19, pl. 19.


82 Lepsius (supra n. 78).

83 N. de G. Davies, Two Ramesside Tombs at Thebes (New York 1927) pl 34.
Fig. 8. Workers using one-handed pull saws. Tomb of Ty. (Wild [1953] pl. 128)
Fig. 9. Papyriform shaped wooden boat. Note end of bow which is decorated to look like a papyrus flower. Tomb of Ty. (Épron and Daumas [1939] pl. 49)

Fig 10. Worker standing in a hull with a one-handed saw. Fragment of a relief, possibly from a royal monument. (Goedicke [1971] 121)
unprovenanced relief fragment, which may be associated with a royal tomb. The worker holds the saw while simply standing in a hull (fig. 10).

The portrayal of the use of one-handed saws for cutting shafts of wood and decorating the hull illustrates their versatility for boat construction. They were employed for numerous other tasks that are not depicted such as cutting tenons and shaping and fitting the joggled edges of hull planks,\textsuperscript{84} jobs where the large two-handed saw would have been unwieldy. Some cuts may have required their use in conjunction with the vice and saw post.

While evidence from the remains of Dynastic Egyptian vessels shows that saws were used in fashioning all of the planks and hull components,\textsuperscript{85} they appear in only four reliefs during the Old Kingdom period. Certainly saws played a much greater role in hull construction than depicted in these reliefs. Two-handed saws were essential for cutting most of the planks and hull components. Their frequent absence suggests that cutting planks may have taken place outside the immediate vicinity of the boatyard. It seems more likely that the lack of saws is due to the reliefs depicting hulls which have most or all of their planking assembled. By this stage the majority of the hull planks would have been cut. Conversely, depictions of carpenter’s shops always include at least one saw.\textsuperscript{86}

Adzes

The adze appears in the majority of Old Kingdom reliefs. It is the most frequently depicted tool in the Ty relief, being used by twenty-two of the fifty-four workers. Due to its ubiquitous presence in these reliefs it is the tool that is often associated with Egyptian boat construction.

\textsuperscript{84} Haldane mentions the presence of saw marks on the ends of tenons and the faces and bases of scarfs on the Lisht timbers. Haldane (supra n. 65) 105.

\textsuperscript{85} Haldane notes “...saw marks (are present) on all timber faces from ancient Egyptian hulls I have recorded.” Haldane (supra n. 10) 15.

\textsuperscript{86} Sliwa (supra n. 67) 73-74, figs. 16, 20, 22.
The introduction of the adze in Egypt long preceded that of the axe, appearing as early as Pre-Dynastic times.\textsuperscript{87} It consists of a flat blade hafted to a wooden handle. The angle of the blade to the handle varies from perpendicular to almost parallel, depending on the type. Adze blades of the Vth and VIth Dynasties had narrow rounded heads with a ridge below, which aided in their attachment to the handles.\textsuperscript{88} The blade widens significantly to a broad cutting edge. Adzes could be used with or across the grain of the plank to remove wood. The hieroglyphic inscriptions which appears above workers no. 13 and 20 in the Ty relief (see worker no. 20 in fig. 11) translates as "to shape."\textsuperscript{89} Adzes are depicted with two different types of handles, one shaped like a swan's neck and the other like a candy cane. The handle length and angle of the blade to the handle is different for each type. Depictions of swan's neck adzes are limited to reliefs depicting boat construction\textsuperscript{90} and a scene of the preparation of a large beam.\textsuperscript{91} The candy cane or surfacing adze is the type that is commonly portrayed in depictions of carpenters' shops. The terms boatwright's adze and carpenter's adze will be used for the rest of this thesis. Boatwright's adzes have longer handles and larger blades than the carpenter's adzes. The blade is perpendicular to the handle while the carpenter's adze is almost parallel. The reduction of different areas of the hull required different adzes, whichever could be used most efficiently.

Four of the workers, no. 17, 29, 31, 50, wield boatwright's adzes exclusively on the underside of the hulls (see worker no. 17 in fig. 11). They sit or squat to use them in this confined space. The blades are flush against the hull. Their angles to their handles facilitate work at this location.

\textsuperscript{87} Petrie (supra n. 49) 5.

\textsuperscript{88} Petrie (supra n. 49) 16, pl. 17.

\textsuperscript{89} Montet (supra n. 36) 344.

\textsuperscript{90} Petrie notes their use "by shipbuilders." Petrie (supra n. 49) 18.

\textsuperscript{91} A.M. Moussa and H. Altenmüller, \textit{The Tomb of Nefer and Ka-hay} (Mainz 1971) pls. 19, 20.
Fig. 11. Use of the boatwright's and carpenter's adzes. Tomb of Ty. (Wild [1953] pl. 129)

Fig. 12. Use of the boatwright's adze. Chapel of Khuenrê'. (After MFAB neg. no. A1061, A5475)
Conversely, working on horizontal surfaces and in confined areas with this adze would not have been as efficient. Despite the perspective of the relief, these workers could either be adzing with or across the grain of the wood. The manner in which the adze is held suggests that the workers swung it with their left hand, while keeping their right hand fixed, allowing it to pivot at their hip. This swinging motion would permit a great deal of control with the large tool, necessary for finishing work. The weight of the boatbuilding adze and the size of its blade would permit the removal of larger shavings of wood than the carpenter’s adze. These workers are probably adzing down the seam areas of the underside of the hull, which was a necessary procedure in ancient shell-first hull construction.92

Scenes in six reliefs show the boatwright’s adze being used by workers exclusively on the topside of the hulls. From this location they could adze the plank centers for the interior of the hull.93 The only other relief that portrays the boatwright’s adze being used on the underside of a hull is from the tomb of Khuenre’, which also depicts it being used on the topside of the hull (fig. 12). The differences in these representations raises the question of the accuracy of each relief and the familiarity of the artists with boat construction. An explanation for this discrepancy can be found by noting the size of the hulls relative to the workers and the amount of space under the boats. The hulls in the Ty relief are the largest in relation to the size of the workers. This ratio is much less in most of the other reliefs. The size of the hulls in the Khuenre’, Ty, and Nûfer and Kaha reliefs permitted the artists to fit workers underneath the ends. The ratio in other reliefs only permitted the portrayal of this activity on the topsides. The boatwright’s adze was used at locations, both inside and underneath the hull, that were best accessible to the angle of its blade. Its appearance in the more elaborate reliefs and its absence from reliefs portraying carpentry shows that it was a tool strictly associated with wooden hull construction or for squaring large timbers. Different sizes of boatbuilding adzes are used by two men


93 Steffy (supra n. 92)
who work on the same hull in the Khunes relief (fig. 13).

The carpenter’s adze is depicted being used on all five hulls in the Ty relief. The workers wield these adzes with their right hands. They usually place their left hand in contact with some part of the hull, probably to help them maintain balance while squatting and to help gauge the distance to the boat while adzing (fig. 14). They work on the hulls from every angle in a variety of postures. Six workers squat under the hulls, two stand, while the rest sit on top of the hulls. While capable of performing a number of tasks, by this late stage of construction they are probably removing tool marks and smoothing planks and beams. Worker no. 51 draws his arm back over his shoulder in a rarely seen pose as if he is preparing to strike a heavy blow with his adze (fig. 15). The section of the relief which portrays the area of the hull that he is working on has been lost. He could be carving the decorative end of the hull. The placement of worker no. 4 at the square end of hull I makes it appear that he is adzing across the grain of the wood (fig. 16). This perception is due to the artistic convention of the ancient Egyptians. The worker should simply be viewed as working at the end of the hull and not adzing in a specific direction.

The relief in the tomb of Ni’ankh-khnum and Khnemhotep depicts a worker adzing a curved piece of wood (fig. 17). The hieroglyphs above him, ndr sht jn mdh, read “fabrication of the sht ship parts by the carpenter”. His placement between the hull and the sawyer suggests his task is an intermediary step. He is shaping a freshly sawn piece of wood that will later be joined to the hull. Its contour matches the space in the center of the upperstrake. The carving of hull components into their final shape is another characteristic of shell-first construction.

Considering the stage of construction that these reliefs represent, it is logical that so many adzes are depicted. Since the planking was cut by coarse saws, adzes were important for giving the planks

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94 A.M. Moussa and H. Altenmüller, Das Grab des Nianchchnum und Chnumhotep (Mainz 1977) 75.
Fig. 13. Workers using two sizes of boatwright's adzes. Tomb of Khunes. (After Varille [1938] 15, fig. 5)

Fig. 14. Workers no. 26 and 28 using carpenter's adzes. Tomb of Ty. (Wild [1953] pl. 129)
Fig. 15. Worker no. 51 with adze drawn back over his shoulder. Tomb of Ty. (Wild [1953] pl. 128)

Fig. 16. Worker adzing at the end of the hull. Tomb of Ty. (Wild [1953] pl. 129)
Fig. 17. Shaping a hull plank with a carpenter’s adze. Tomb of Ni’ankh-khnum and Khemhotp. (Moussa and Altenmüller [1977] fig. 8)
their final shape and obtaining a smooth, even hull.

Another important clue to understanding the reason so many adzes are depicted may be the presence of the hieroglyph rd-\(m\)dr in four of the reliefs. It has been translated by Darnell as "remove the red". He believes that ancient Egyptians boatwrights used red ochre to mark lines on boats in a manner similar to Egyptian and Sudanese boatwrights of the early twentieth century A.D. as observed by Clarke and Hornell. Clarke watched Egyptian boatbuilders use red ochre for several tasks: to divide a log for sawing into planks, to make a centerline along the keel, and to mark the positions for nails. Boatbuilders in Sudan used blue paint to mark the curvature needed by the plank edge so that it would join flush with the previously affixed plank. Darnell believes that an assembled hull of the Old Kingdom was marked by numerous red lines from similar construction techniques. The removal of these red lines with adzes was one of the final stages of construction of ancient Egyptian vessels. Evidence for the use of paint to mark construction features is found on the funerary barges from Dashûr. It consists of charcoal paint that was used to mark the inboard positions of mortises on planks. Haldane further suggests that ancient Egyptians used red ochre to mark plank curvature.

If these theories are correct, evidence for these construction marks no longer exist on completed hulls. However, an examination of construction procedures suggests that any visible markings would

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95 J. Darnell, "The Annotation \( \text{\underline{T}} \text{\underline{A}} \text{\underline{E}} \),", in GM 83 (1984) 17-26. This article came to my notice from reading C. Haldane's Ancient Egyptian Hull Construction, p. 56.

96 S. Clarke, "Nile Boats and Other Matters," Ancient Egypt and the East (1920) 47-49.

97 Hornell (supra n. 27) 217.

98 Darnell (supra n. 95)

99 Haldane (supra n. 10) 218-20.

100 Haldane (supra n. 10) 56.
have been minimal. Remnants of red lines that may have been used to divide a log prior to sawing, which were not obliterated by the saw, would be on the plank’s interior edges and would not be visible. Other marks would be destroyed as the plank was adzed to shape. Furthermore, why could not any remaining marks simply be washed off instead of having to be removed with an adze?\(^\text{101}\) Why go to all the trouble of adzing away so many marks might have resulted in little divots along the hull? An alternate theory on the meaning of “remove the red” will be presented below in the chapter III on plumb bobs and measuring.

Chisels

The chisel was indispensable to Egyptian woodworkers, since they relied on different varieties of mortises, dovetails, and other joints for joinery purposes; metal fasteners were rarely used.\(^\text{102}\) Considering the importance of mortises for the edge-to-edge joinery of planks, the use of the chisel was fundamental for hull construction. During mortise cutting it was utilized for levering out the pieces of wood cut from the mortise.\(^\text{103}\) All of the workers using chisels also hold long, slender wooden mallets, a type common in the Old Kingdom.\(^\text{104}\) The Middle Kingdom saw the appearance of the shorter, bell-shaped mallet\(^\text{105}\) that is always depicted in reliefs dating to the New Kingdom.\(^\text{106}\)

The chisels of workers no. 21, 22, 25 are depicted in the center of several notches along the

\(^{101}\) A question posed to me by Jeff Royal in Dr. Shelley Wachsmann’s “Pre-classical Seafaring” class. February 20, 1995.

\(^{102}\) Sliwa (supra n. 67) 29.

\(^{103}\) Petrie (supra n. 49) 20; Haldane (supra n. 10) 176; Haldane (supra n. 65) 217.

\(^{104}\) Petrie (supra n. 49) 40, pl. 45 (nos. 54, 55) pl. 46 (no. 60).


\(^{106}\) Vandier (supra n. 6) 683-86.
bulwark of hull II in the Ty relief (fig. 18). Since this uppermost plank is in place it would seem unlikely that they are cutting mortises to join another plank. To the left of each notch is a small round hole. Loops of rope will be attached through these holes to hold the boat’s oars. The notches are the pivot points for the oars.

Workers no. 40, 53, and 54 are chiseling around the bands at the ends of the two papyriform vessels (fig. 19). This activity is included in most reliefs, especially those which depict papyriform hulls. Whether or not these bands represent actual lashings will be addressed in the chapter VI on hulls. Chisels were also used to sculpt the ends of other types of hulls. A worker in the Khuenrê relief uses one to carve the characteristic animal head on the bow of a hull (fig. 20).

Missing Tools

The bow drill is not represented in any reliefs from the Old Kingdom period but does appear in one dating to the New Kingdom. Evidence from Dynastic Egyptian vessels for the use of the drill is limited to the Lisht frame and the pegged mortise-and-tenon joints from the deck house of the Khufu I barge. It was already being used by other Egyptian woodworkers during the Old Kingdom as can be seen in the relief depicting Ty’s carpenter’s shop. Further evidence for the use of a drill in hull construction is visible on hull II in the Ty relief (fig. 18). A drill would be the best tool for cutting the line of small, round holes on the vertical surface of the bulwark. The absence of the drill from these reliefs indicates that its use was limited and not considered an essential activity for hull construction. It is also possible that the holes were drilled after the completion of the hull.

107 B. Bruyère, Rapport sur les fouilles de Deir el Médineh (Cairo 1930) pl. 26.
108 Haldane (supra n. 65) 106, pl. 133.
109 Lipke (supra n. 81) 120; Haldane (supra n. 10) 54.
110 Wild (supra n. 79)
Fig. 18. Use of chisels to fabricate pivot points for the oars. (Wild [1953] pl. 129)
Fig. 19. Using chisels to carve the end of the hull. Tomb of Ty. (Wild [1953] pl. 129)

Fig. 20. Using chisel to sculpt animal head. Chapel of Khuenrê'. (After MFAB neg. no. A1062, A5478)
when the boat's oars were mounted.

Haldane has suggested that a worker in the fragmentary relief from the tomb of Tepem'ankh may be rubbing the end of the hull with a small tool in order to remove toolmarks. There is no indication of a tool in his hand. While the upper half of the worker is destroyed, the posture of his intact half is identical to that of workers shown adzing at the ends of the hull. He probably is simply holding onto the end of the hull while adzing. See workers no. 13 and 28 in the Ty relief for comparison (fig. 14, p. 31).

111 Haldane (supra n. 10) 54.
CHAPTER III
PLUMB BOBS AND MEASURING

Plumb bobs are visible in eight of the seventeen reliefs and relief fragments dating to the Old Kingdom that were examined in this study. All of the more elaborate reliefs include them as part of their assemblage of tools. Two\textsuperscript{112} of these, the Khuenré' and Mereruka reliefs, portray stages of construction which required their use. These depictions provide crucial information about how Egyptian boatwrights used measurement for hull construction.

The plumb bob (also called a plumb line or simply a plumb) consists of a metal or stone weight suspended by a length of line. It provides a vertical line of reference and is traditionally used during construction while building walls. It is the type of tool that would not wear out from use and was therefore unlikely to be discarded. But like many artifacts found in the archaeological record some were eventually lost. Petrie describes numerous examples, dating from the IIIrd Dynasty to the Roman period. In ancient Egypt it is usually associated with terrestrial architecture.\textsuperscript{113} Architects used a version that was mounted on a sideboard and it was also part of the ubiquitous square level.\textsuperscript{114}

Representations of the plumb bob in reliefs from the chapel of Khuenré', tomb of Ty, and tomb of Ra'sphepses depict a short sphendonoidal shape, pointed at the lower end. Other portrayals show a much more elongated plumb bob with a thin, fine point (figs. 21-25). While one of Petrie's examples is similar to the early representations, none have the long, thin shape of the other examples.\textsuperscript{115}

\textsuperscript{112} Besides the depiction in the mastaba of Mereruka, Haldane mentions another "shipwright checking hull measurements," in the VIth Dynasty tomb of Ibi but does not specify the procedure. Haldane (supra n. 10) 15.

\textsuperscript{113} Petrie (supra n. 49) 42, pls. 47, 48.

\textsuperscript{114} Arnold (supra n. 105) 253-55.

\textsuperscript{115} Petrie (supra n. 49) pl. 48.
Fig. 21. "Boatwright" with adze and plumb bob. Chapel of Khuenrê. (After MFAB neg. no. A1062, A5478)

Fig. 22. "Elder of the Dockyard," tomb of Ty. (Wild [1953] pl. 129)
Fig. 23. Boatwright from Khunes relief. (After Varille [1938] 15, fig. 5)

Fig. 24. Boatwright from Ra'shepses relief. Note unique shape of plumb bob. (After Lepsius [1849-1859], pl. 61)

Fig. 25. Boatwright from Ni'ankh-khnum and Khnemhotp relief (Moussa and Altenmüller [1977] fig. 8)
Boatwrights

Seven of the eight reliefs that include plumb bobs depict only single examples (figs. 21-25). Each always appears attached to a length of cord which is usually kept coiled in the hand of the worker. The artist depicts these men standing passively while everyone else is engaged in some activity. A staff is usually shown carried with the plumb bob (figs. 22, 23, 24, 25, 26, 27). Its association with the plumb bob suggests that it had a utilitarian function, rather than a symbolic one, and that the two tools may have been used together. The staff in the Ty relief is longer than the 'Imyt-r stave held by Ty (worker no. 23, fig. 18, p. 37) and lacks the characteristic knob at the top (fig. 20).\textsuperscript{116} The men who carry the staff and plumb bob are usually shown as being bald, an indication of their advanced age and experience.

The hieroglyphs above the worker in the Ty relief describe him as "Elder of the Dockyard"\textsuperscript{117} or "Master Shipwright."\textsuperscript{118} The usual singularity of the plumb bob's appearance and its association with someone who is a master boatwright may suggest that its use was limited to him alone during construction. However, in the Khuenrê' relief plumb bobs are held or used by three or possibly four workers, two of whom work in the same hull (figs. 28, 29). The hieroglyphic inscription $mdhw\ wi\ h\ dp\ h$ "boatwright,"\textsuperscript{119} appears to the right of the three who carry carpenter's adzes. The portrayal of multiple plumb bobs in this relief indicates that its use was not restricted to a single boatwright.

Information about the use of the plumb bob is provided by two reliefs. The Khuenrê' relief

\textsuperscript{116} H.G. Fischer, "Notes on Sticks and Staves in Ancient Egypt," \textit{MMAJ} 13 (1979) 5.

\textsuperscript{117} Jones (supra n. 54) 122. In a recent book he uses the title "Elder of the Workshop." Jones (supra n. 35) 74.

\textsuperscript{118} Montet (supra n. 36) 334.

\textsuperscript{119} Jones translates it to mean "shipwright" or "boatbuilder." Jones (supra n. 54) 119 entry I.d.4. The first sign reads carpenter/woodworker and the second means ship or boat. Letter from John Darnell, May 12, 1994. The term boatwright will be used for this study.
Fig. 26. Boatwright from Sekhemkârê' relief. The line in his hand is probably remnant of a plumb bob. (After Hassan [1943] 110)

Fig. 27. Boatwright from Tepem'ankh relief. (After Borchardt [1907] pl. 103b)
Fig. 28. Boatwrights with carpenter's adzes and plumb bobs. Note the hieroglyphs "Boatwright" to the right of both of them. Chapel of Khuenré'. (After MFAB neg. no. A1062, A5478)

Fig. 29. Damaged section of relief depicting boatwright. Incomplete worker with carpenter's adze (lower left) may have originally been depicted holding a plumb bob. Compare to the squatting boatwright in fig. 25. Chapel of Khuenré'. (After MFAB neg. no. A1061, A5475)
depicts the plumb bob being used for two different tasks. The worker standing in the lower right hull holds one in his right hand while gesturing with his left (fig. 28). A carpenter's adze hangs from his shoulder. Another worker, kneeling at the stern of the same hull, holds a plumb bob while adzing. The worker at the left end of the lower left hull, who also uses an adze, may have been originally depicted holding a plumb bob (fig. 29). His left hand and anything that it may have held is obscured due to damage sustained to the relief. The presence of the hieroglyphs for "boatwright" and the similarity of his activity and posture to the other two workers who carry plumb bobs and carpenter's adzes suggests that he may have originally held one as well. The fourth of these workers holds a partially coiled plumb bob and line against an upright staff or pole at the center of the upper left hull (fig. 29). This activity is probably connected with the use of the tightening truss and will be discussed below in chapter V on tightening trusses and lashed joinery.

Hull Symmetry

The right half of the Mereruka relief provides a unique depiction of the use of a plumb bob and line for hull construction (fig. 30). The entire scene is centered around one activity. Two workers hold a line over the ends of a stylized, papyriform hull while a third places an uncoiled plumb bob against it. A fourth worker leans over and appears to use a small stick to mark the spot adjacent to where the plumb bob touches the hull. Another worker grasps the stretched line with one hand. The only tool in this scene besides the plumb bob and line is the carpenter's adze which is carried by three of the six workers. The staff is not depicted. Despite the appearance of the hull as thin and papyriform, it is made of wood. Any hieroglyphs which may have described this activity probably ran along the top edge of the register and have been lost. Standing there inside the mastaba of Mereruka in 1991, the moment that I first saw this relief I knew it was important.
A key to understanding what is being portrayed in the Mereruka relief was found in the Khufu I funerary barge. The repeated use of the symbol "<->," painted in red along the centerline of the hull caused Lipke to speculate that these were reference marks, made with the use of a plumb bob and a centering line that was stretched bow to stern. This was done for the purpose of keeping the hull symmetrical during construction.120 Haldane noted the similarity between his theory and the Mereruka relief. She believes the scene may depict either the establishment of this centerline or an inspection of the hull's dimensions.121 The establishment of the centerline would have taken place early in the construction of the hull, possibly prior to the erection of any of the side planking. Such an initial step would not be an appropriate subject for boat construction reliefs. Stretching a line between the ends of the hull was also used during the construction of clinker hulls in Scandinavia.122

The solution to what is being portrayed is related to Darnell's translation "remove the red."123 The scene from the Mereruka relief portrays the marking of irregularities and flatspots in the hull's shape with red ochre. The hieroglyphic "remove the red" is the instruction for the workers with adzes to finish the hull by adzing away these red highlighted asymmetries. Might this hieroglyph have originally been included above the relief? In keeping with the subject matter of these reliefs, this is a final stage of construction.

The hull is depicted without the standard bulwark. Whether this was intentionally left out or was simply not included in this very basic portrayal of the hull cannot be determined. If the bulwark has not been added than perhaps the beams have not been installed either. An inspection of the interior of

120 Lipke (supra n. 81) 82, fig. 56.
121 Haldane (supra n. 10) 55.
123 Darnell (supra n. 95)
the hull with the plumb bob and line would have been easier prior to their addition.

Not surprisingly, the use of the plumb bob by Egyptian boatwrights continued into the twentieth century A.D. Observing the construction of a *naggr* in 1911 along the banks of the Nile, Clarke noted the unchanging nature of Egyptian boat construction procedures. One of the first steps was for the workers to make a red line on the midline of the upper surface of the keel by plucking a string soaked with red ochre against it. The next step involved setting up the end posts.

"By eye the stern post and rib for the bow"\(^{124}\) are set up, a string is stretched from the top of the one to the top of the other, and by means of plumb bob made of a heavy nail and a piece of string, the centre line or axis of the hull is established."\(^{125}\)

The only example that I have found of a depiction of the plumb bob, outside a relief depicting boat construction, is from the representation of the carpenter’s shop from the tomb of Ni’ankh-khnum and Khemhopt. A worker watching over the construction of a bed holds a plumb bob in his left hand and has an adze resting on his shoulder (fig. 31). The manner in which he carries his tools is similar to the standing boatwright in the Khuenrê’ relief (fig. 21, p. 41). Why the plumb bob is portrayed here and nowhere else is puzzling. After the Old Kingdom plumb bobs no longer appear in reliefs depicting either boat construction or the carpenter’s shop.

The need for control over the shape of the hull was a common problem faced by boatbuilders. The plumb bob provided some of the control that was needed by the Egyptian boatwrights. It was used by other cultures to aid them in hull construction as opposed to building strictly by eye. Late in the Medieval period it was utilized in vessel construction in Northern Europe.\(^{126}\) The use of control levels and measuring devices is well documented in Norway, where clinker hull construction is the

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\(^{124}\) I assume that the hull component Clarke is referring to is the curved stem.

\(^{125}\) Clarke (supra n. 96) 47.

Fig. 31. Scene from the carpenter's shop in the tomb of Ni'ankh-khem and Khnemhotp (After Moussa and Altenmüller [1977] pl. 63)
predominant form of boat building. Like Egyptian hull construction, clinker construction is a shell-first
construction method, the skin of the hull provided the major structural strength and was built without
the aid of frames or molds acting as guides.

One measuring device from Norway was the boat-ell, a type of measuring stick which was marked
with a number of measurements important for the construction of the boat such as the width of the boat
at the first strake amidships. Did Egyptian boatwrights also record important information on their
staffs? While there is no evidence of this, the use of symbols on the hull of the Khufu I barge
demonstrates that they were sometimes employed in hull construction.

Another norse tool was the Båtvater (boatlevel), which was also used in other parts of Scandinavia.
It consists of a wooden board on which hangs a plumb bob and line. It was employed during
construction to make both sides of the hull even. The board was placed on the planking and the spot
where the plumb fell was noted. It was then moved to the opposite side of the boat and the plank
adjusted until the plumb bob was at the same point on the board. A similar tool is the loddfjøl, which
was placed on a finished boat and was marked where the plumb-line fell on the board. A duplicate of
the hull could then be made by matching the angles of the planks of the new hull with the markings on
the board of the loddfjøl. Perhaps the Egyptian boatwright, bound by tradition to replicate
ceremonial boats, measured existing hulls with line and plumb bob and thereby knew where the plumb
bob should fall as he built a new hull.

Conclusions

Checking hull symmetry and dimensions were the typical jobs for which the boatwright used the
plumb bob. This helped him to maintain control of the shape of the hull as it was constructed. Most

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127 Christensen (supra n. 122) 238-40.
128 Christensen (supra n. 122) 241-46.
reliefs depict only a single plumb carried by the boatwright; this is related to its use during the end of construction and will be examined in the chapter on tightening trusses and lashed joinery. The Khuenrê' relief portrays three plumb bobs within the same relief, suggesting that checking hull symmetry was done by several individuals, working independently of each other. A final overall inspection of the entire hull was made during the latter stages and any mistakes or asymmetries that were found were marked with red ochre and then corrected with adzes. The plumb bob's use may have been critical for the boatwright to reproduce certain traditional Egyptian hull designs. An association between the use of the plumb bob and the carpenter's adze is clear. The adze was kept ready as the shape of the hull was checked and used to remove any uneven areas which were detected. This task was done both individually by a worker with a adze and his own plumb bob or by a crew checking the entire length of the hull.

The inclusion of the plumb bob in these reliefs indicates that during the Old Kingdom its use was considered essential for the proper construction of Egyptian hulls. While only present in eight reliefs, doubtless, additional examples existed in some of the other reliefs while they were intact. Clarke's observation of the use of a plumb bob and line by Egyptian boatwrights to establish the centerline of a hull indicates that this tradition continued to be used into the twentieth century, long after its disappearance from the walls of these tombs.
CHAPTER IV
"THE TEETH OF OSIRIS": MORTISE-AND-TENON JOINERY

Most of the information about mortise-and-tenon joinery is obtained from the Ty relief. It is the predominant subject of the relief, portraying several sequential stages. These include tenon fabrication, mortise cutting, and plank attachment and seating. Since mortise-and-tenon joinery was the primary form of edge-to-edge joinery used in vessel construction in ancient Egypt, this relief is indispensable for an analysis of the methodology. As the earliest representation of this important innovation in wooden hull construction, it is also extremely valuable as a comparative source for the use of mortise-and-tenon joinery during the next 3000 years of Mediterranean shipbuilding.

Mortise Cutting

Workers no. 15 and 16 are shown chiseling on a rectangular plank which sits on two forked posts (fig. 32). Each uses a hafted chisel and a long, slender mallet. The plank appears to be drawn in ratio to the workers rather than to the hulls. It lacks any of the curvature of the planks which are shown being joined to hulls I and III. This portrayal is understandable since the plank is simply representative of all the planks on which mortises are cut. The hieroglyphs above them are more complex than the word menkh which is usually associated with chiseling. Montet translates them as "to make a hole (in) the hull."\(^{130}\)

An interesting detail is a rectangular hole beneath the point of each chisel. There are two possible interpretations for the purpose of illustrating these holes. The workers may be cutting a second mortise perpendicular to the one shown in order to produce a 90-degree channel. This type of rectangular

\(^{130}\) Montet (supra n. 36) 337.
Fig. 32. Two workers cutting mortises in the edge of a plank. (Wild [1953] pl. 129)
mortise occurs in the boat timbers from Lisht where it was used for lashing planks edge-to-edge.\textsuperscript{131} The importance of transverse lashing for Egyptian boat construction may have required the inclusion of this step in the relief. Considering the prevalence of depictions of mortise-and-tenon joinery in the Ty relief it is more likely that these holes represent mortises for the mortise-and-tenon joints. The artist has placed them there in order to illustrate exactly what the workers are doing. This was a traditional Egyptian artistic convention that was employed in order to show contents of containers and horizontal surfaces that were not visible from this perspective.\textsuperscript{132} This specific convention is not duplicated in other reliefs or in the relief portraying Ty’s carpenter’s shop.\textsuperscript{133} Proof of the identity of the rectangular holes as mortises for mortise-and-tenon joints is the corresponding size of the tenons, visible between the two strakes on hull I (fig. 33).

Attaching Planking

The subsequent stage of mortise-and-tenon joinery is portrayed to the left of the mortise cutting scene. It is the central activity around hull I (fig. 33). Four men work together to attach a section of planking while being directed by an overseer who stands in the center. Comparison of hull I with the completed, outfitted example of this boat reveals that this is the bulwark upon which the oars will later be mounted (fig. 34). The space between the bulwark and the sheerstrake contains three rectangular objects which are certainly tenons. Landström and Sliwa have been mistaken by the jumble of the worker’s legs, which also appear between the strakes, into believing that seven tenons are represented.\textsuperscript{134} The distinction is especially clear when the line drawings of the relief are examined.

\textsuperscript{131} Haldane (supra n. 65) 105, fig. 2.

\textsuperscript{132} Montet (supra n. 36) 337.

\textsuperscript{133} Wild (supra n. 79)

\textsuperscript{134} Landström (supra n. 27) 103; Sliwa (supra n. 67) 57.
Fig. 33. The attachment of hull I's bulwark using mortise-and-tenon joinery. Tomb of Ty. (Wild [1953] pl. 129)
Fig. 34. Boat of same hull type as hull I (fig. 29). Tomb of Ty. (Épron and Daumas [1938] pl. 49)
The attachment of the bulwark is not a simple procedure and requires coordinated efforts and the application of a variety of tools. Workers nos. 8 and 11 hold stone hammers poised while their other hands are placed on the plank. Smooth stones were frequently used as hammers in ancient Egypt without the aid of attached handles. The only other clear example of a stone hammer in a relief occurs in the tomb of Nüfer and Kaha where it is probably used to pound lashing. Worker no. 9 holds a stick in between the center of the plank and boat hull. Worker no. 12 grasps the ends of a piece of rope which goes under the right end of the plank. Wachsmann believes a worker in the relief from the Middle Kingdom tomb of Khnemhotp III at Beni Hasan is also performing this task. His interpretation is based on a coarse drawing of the relief found in Newberry’s report on the tomb. The portrayal of only a single worker to represent a procedure which is depicted requiring five workers in the Ty relief is inconsistent with representations from all other known boat construction reliefs. Examination of an earlier, more detailed rendition of the Khnemhotp relief shows the worker striking a plank with a large mallet. The position of his arms and shoulder indicate that he is using a great amount of force. I feel this action conforms with the activities of the rest of the relief.

Three hieroglyphic inscriptions provide us with some insight into the attachment procedure. One is a technical description while the other two are comments by the men concerning their task. The technical one, s nkh s ‘Ε translates as “to adjust the bulwark.” The first comment can presumably be

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135 Petrie (supra n. 49) 40.

136 Moussa and Altenmüller (supra n. 91) pl. 19.

137 S. Wachsmann, Seagoing Ships and Seamanship in the Late Bronze Age (Unpublished Diss. Hebrew Univ. 1989) 199.

138 Newberry (supra n. 31)

attributed to the supervisor as he commands the men to "descend to the foundation." This is probably an order for them to hammer the bulwark all the way down to the sheer strake.

Information obtained through the excavation and analysis of shipwrecks and from the use of mortise-and-tenon joinery in the construction of replicas provides us with clues to the actions of the workers in the Ty relief. The bulwark is being attached as a single unit. Based on depictions of the outfitted boats, the estimated length of the actual bulwark is 10 m. The lack of long lengths of native wood in ancient Egypt suggests that the bulwark was probably made up of several planks. By attaching it as a complete piece instead of single planks the boatbuilders reduced the likelihood of twisting and bending which made the seating process a little easier. 

The initial step of this procedure would be to place the bulwark so that all its mortises had been placed onto their corresponding tenons which projected from the sheer strake. The two workers with the stone hammers then started hitting the strake simultaneously to force the mortises down onto the tenons. It was important for them to strike together so that both ends of the bulwark went down together. If one end was forced ahead of the other the tenons could twist and bind in their mortises, halting the process. Straightening these cocked tenons would be necessary before the seating could continue. Worker no. 9 may be using a stick to accomplish this. A similar technique was occasionally required during the construction of the sectional replica of the Kyrenia ship and the Kyrenia II. While the application of sheep's fat as a lubricant prevented most tenon jams when the strakes of the Kyrenia II were joined, the use of a small, flat stick to straighten tenons was sometimes necessary.

Worker no. 9 may also be helping to guide the plank down by limiting how far it dropped with

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140 Montet (supra n. 36) 341.

141 See Appendix 2 for calculations of the length.

142 Personal communication, J.R. Steffy, March 1995.

143 Personal communication, J.R. Steffy, February 1995.
each blow of the stone hammers. The wide spread of his legs suggests that he has braced himself, a
stance which would not be required if he was only straightening tenons. He could also use the stick to
pry up on the bulwark in case of tenon jams. If his task is related to the setting of the bulwark he had
to be careful the stick did not damage the edges of the planks. In the event that the bulwark had to be
removed for additional trimming the stick would have been useful for extricating it.\textsuperscript{144}

Worker no. 12 holds the end of the bulwark with a rope instead of his fingers so that there will be
no danger of them being crushed. The last hieroglyphs form a warning for him from worker no. 11.
"That I would crush your hands--Under us!"\textsuperscript{145} His job was to put the brakes on the descending
plank when too much force was applied to one end. If the end was driven down ahead of the other
and binding occurred, he could also have used it to pull up on his end of the bulwark. Keeping the
plank seams parallel was important for proper seating of the plank. During the actual procedure it was
probably necessary to have another man with a rope at the other end of the bulwark.

Did workers no. 9 and 12 have a stick and length of rope exclusively for these tasks, or did they
just use scraps lying around the boatyard? The pervasive use of mortise-and-tenon joinery in Egyptian
hulls suggests that a stick of proper size and a piece of rope of suitable length were kept available for
these tasks.

Worker no. 7 has his chisel placed on the left end of the bulwark. This activity is incompatible
with that of the rest of the workers involved in attaching the bulwark. His task may be related to the
operation above him in hull II, which has its bulwark already seated. Workers nos. 21, 22, 25 use their
chisels to cut notches for the oars (fig. 18, p. 37). The hieroglyphs above worker no. 25 are the same
as those to the left of worker no. 7. It is not repeated anywhere else in the relief. I believe that the
artist placed worker no. 7 there to indicate that his job, cutting notches on the bulwark for the oars, is

\textsuperscript{144} Personal communication, J.R. Steffy, March 1995.

\textsuperscript{145} Montet (supra n. 36) 341-42.
the next task for this part of the hull. This provides an image of continuity between hull I in the bottom register and hull II in the 2nd register. In addition, the placement of worker no. 7 at the end of the plank opposite worker no. 12 provides balance to the scene, a common theme in this relief.

The second depiction of the attachment of planking is portrayed on hull III in the 2nd register. Three workers labor to seat a section of hull planking into its final position (fig. 35). A gap remains between the hull and the left end. Unlike the previous scene no tenons are visible, but the similarity of the activity to the scene below indicates that mortise-and-tenon joinery is being used to attach the section of planking. The hull in the Ni’ankh-khnum and Khnemhotp relief (fig. 17, p. 33) and the left hull in the Tepem’ankh relief146 (fig. 27, p. 44) are portrayed without this section of the strake.

Workers no. 33 and 35 grasp large hourglass-shaped pounders of wood by handles located on each side. Their size and the workers extended height indicates they are exerting great force in their work. Arnold believes these pounders were made of stone, similar to two preserved examples.147 If they had been made of stone, their use would have certainly crushed or split the edge of the plank. The danger of splitting planking during the attachment process was always a concern during the construction of the Kyrenia II.148 In a manner similar to worker no. 9, worker no. 34 helps the seating procedure continue, though now he only needs one hand to do this. The limited space between the planks will only permit the insertion of a chisel blade instead of the stick. He bends down possibly to check the remaining space. It seems doubtful that there was any chance that the tenons were liable to twist this far along in the attachment of the planking. Therefore, it is unlikely that his job is straightening tenons. The absence of the rope at the end of the planking suggests its use is no longer

146 L. Borchardt, *Das Grabdenkmal des Königs Ne-user-Re* (Leipzig 1907) pl. 103b.

147 Arnold (supra n. 105) 262-63.

required.

Two hieroglyphic inscriptions, one a technical description and the other a comment by one of the workers, are associated with this scene. The first, *smn* *hr-ib*, reads "to adjust the central piece."

The second one has never been fully translated. One suggestion is that it may be a song for establishing the rhythm of the work. Darnell provides a possible translation: "It is good if you act without taking thought for the chisel in between." Annotations like this between workers are frequently comical or sarcastic. Darnell suggests that this phrase can be interpreted as meaning that one of the two workers with the pounders may be a bit tentative in his work so the other one is telling him to get going and not to worry about the chisel. This would suggest that the job of worker no. 34 occurs simultaneously with the other two workers. Therefore he is probably not straightening cocked tenons, which would certainly have required an abatement of the pounding on the planking.

As in the previous scene the artist has added a worker with a mallet and chisel at the end of the plank. Again, his action is not related to the seating of the strake. The end of the plank on which he sits is flush with the strake beneath it. He is placed there because his task is the next step of construction for this area of the hull. His activity is discussed below in the section on fasteners.

While these two scenes contain some similar elements, Montet suggests the attachment of these two parts of the hull required separate procedures. The two sections of planking have distinct names and represent distinct sections of the hull. He believes that the type of the hammer used was dependent on the thickness of each plank and the amount of resistance that each strake exerted. The bulwark (\(s\' \text{E}\)) was thinner than the central piece (\(hr-ib\)) and only required the use of the stone hammers instead

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149蒙特 ( supra n. 36) 341.

150 A. Erman, *Reden, Ruhe und Lieder auf Gräberbildern des alten Reiches* (Berlin 1919) 34, n. 2. This reference was shown to me by John Darnell.

151 Letter from J. Darnell, May 12, 1994.
of the pounders. He also states that use of the large pounders on the thinner bulwark would have
damaged it.\footnote{Montet (supra n. 36) 340-41} Montet does not realize that the amount of resistance in this procedure is dependent
on the number of mortise-and-tenon joints and the tightness of their fit rather than the size of the plank.
If the bulwark exerts less resistance during its attachment than the central piece this is only because it
may have had fewer M&T joints. The only available information on the spacing of mortise-and-tenon
joints for the bulwark and the sheer strake is from the funerary barges from Dashûr, for which the
intervals are very similar.\footnote{Haldane (supra n. 10) 206, fig. 10-2.}

These two scenes probably represent sequential steps. The stone hammers were used for the initial
seating when more control was needed. As the fitting of the tenons proceeded over their corresponding
mortises and the chances of tenon binding lessened the workers then switched to the large wooden
pounders to give the plank its final setting. An attempt to use the heavier, wooden pounders at an
early stage would have probably resulted in an uneven setting and frequent tenon jams. As the tenons
seated into their mortises and the space between the strakes was reduced, the worker guiding the plank
down would switch from the stick to the chisel blade, which provided a narrower lever. Moving from
hull I to hull III corresponds with the Ty relief’s bottom-to-top sequence direction.

The hammering that was needed to force the plank’s mortises on top of the tenons required the
hulls to be securely braced. Beams are depicted supporting the hulls in most of the reliefs. Hull II in
the Ty relief is supported by eight of them along its entire length (fig. 18, p. 37). Despite the
appearance of only bracing the central line of the hull, beams were undoubtedly also used along the
sides of the hull. Evidence for the pegging of braces is found on the hull of the Kyrenia ship.\footnote{Steffy (supra n. 92) 89.}

There is no indication of this on known Egyptian hulls.
The strenuous work required of workers no. 33 and 35 to seat the section of planking suggests that the tenons did much more than align plank edges prior to the completion of the lashings. Little information is available concerning the fit of the hundreds of free standing tenons used in the hull planking of the contemporaneous Khufu I funerary barge. Abubakr and Mustafa noted that the fit of the "rectangular wooden lugs" was very tight. 155 A sectional drawing of one of the joints however, shows a wide margin of space between the tenon and its surrounding mortise. There is also mention of an adhesive paste that was used to fix the "flat dowels of wood" into position. 156 Lipke notes that the tenons were made of siddar, a hardwood indigenous to Egypt, but makes no other comments about them. 157 By the Middle Kingdom the use of tight fitting mortise-and-tenon joints is evident on the funerary barges from Dashûr. The mortises are more than twice the depth of the ones used on the Khufu I barge. 158 New information about the fit of mortise-and-tenon joinery of Old Kingdom vessels may have to wait for the proposed excavation of the Khufu II funerary barge. 159

As discussed earlier the hulls are not drawn in proportion to the workers. Therefore, it is unlikely that the number of workers depicted is representative of the actual total needed to build these hulls. Their number was limited by the amount of space allotted for the relief. The attachment of a 10-meter-long bulwark would have required a larger gang of workers than the five portrayed. The depiction of only three, unevenly spaced tenons for a plank this size is not important to the function of the relief. It is merely representative of the procedure and is not an accurate portrayal of the actual number of


156 M.Z. Nour et al., The Cheops Boats (Cairo 1960) 48, 55, fig. 21.

157 Lipke (supra n. 81) 25.

158 Haldane (supra n. 10) 217.

159 Haldane (supra n. 10) 129-30.
tenons required for this part of the hull.

The similarities of two workers in the Mereruka relief to the workers in the two plank attachment scenes in the Ty relief suggest that elements of the Ty relief may have been copied. The left half of the Mereruka relief depicts an extremely simplified papyriform hull under construction by six workers (fig. 36). The two standing workers hold rectangular objects of similar size above their heads. The worker on the right holds his tool on both sides in a pose identical to workers no. 33 and 35 in the Ty relief who wield the large wooden pounders. The tool does not appear to have handles like those in the Ty relief, though the upper part of it is missing. The posture of the standing worker on the left is similar to worker no. 8 who holds a stone hammer, but his tool has sharp corners like those of his co-worker’s as well as a trace of a handle. His posture suggests one activity but the tool appears more like the wooden pounder. This ambiguity may be due to an unfamiliarity with the subject by the artists. The inclusion of these two workers on the same hull suggests a composite depiction of the activities in the Ty relief related to the attachment of planking. The Mereruka relief is the only one which duplicates these tools and activities. The similarity of these workers and the proximity of the tomb of Ty to Mereruka’s suggests that some copying occurred. Both of these tombs are located at Saqqāra (fig 2, p. 8) where the strongest similarities in style and scene content are found in tombs situated close to one another.160 The mastaba of Ty also predates Mereruka. Another possibility is that the artists simply used the same source material which was later destroyed.

Identifiable depictions of mortising are not evident from other reliefs. While the majority of representations of workers with chisels places them at the ends of the hull, some include them at or near the center of a hull which does not have its bulwark attached. While it is possible that they are cutting mortises in preparation for the attachment of the bulwark, they also may be cutting holes for treenails as will be discussed in the section below.

160 Harpur (supra n. 12) 231.
Fig. 36. Attaching planking. Mastaba of Mereruka. (After Duell [1938] pl. 152)
Fasteners

A hieroglyph common to many boat construction reliefs is *menkh* which Lallemand interprets as "to mortise"164 while Montet162 and Petrie163 have simply translated it as "using the chisel". The only place that it appears in the Ty relief is above worker no. 40, who is apparently sculpting the end of the hull (fig. 37). The one scene that probably does depict mortising includes a hieroglyph that is more elaborate than *menkh* (fig. 32, p. 54). This and other versions of *menkh* suggest different tasks which required the use of the chisel.

A unique version of *menkh* appears above workers no. 32 and 36 in the Ty relief. It includes a circle below the ideogram of the chisel (fig 35, p. 62). Montet believes that this detail was added to distinguish between the chiseling of round holes necessary for treenails and the rectangular holes needed for tenons.164 However, a chisel blade is an unsuitable tool for cutting a circular hole. The easiest and quickest way to make a round hole to receive a round treenail is with a drill. Round treenails were not used as fasteners on either the Khufu I barge or the Dashur boats. The frame timber from Lisht has three round holes on the bottom surface,165 suggesting to Haldane that round treenails were used to fasten it to the hull planking. She notes that there is no conclusive evidence that these holes were made with a drill.166

Square treenails were used on the Dashur boats for attaching the beams to the upper edge of the

161 H. Lallemand, "Les assemblages dans la technique égyptienne et le sens originel du mot *menkh,*," *BIFAO* 22 (1923) 77-98.

162 Montet (supra n. 36) 304.

163 Petrie (supra n. 49) 37.

164 Montet (supra n. 36) 338.

165 Haldane (supra n. 36) pl. 133; Haldane (supra n. 10) 185, fig. 8-14.

166 Haldane (supra n. 10) 54.
Fig. 37. Worker chiseling at the stern of boat. Note hieroglyphic inscription *menkh* in upper left corner. Tomb of Ty. (Wild [1953] pl. 128)

Fig. 38. Fabrication of wooden fasteners. Tomb of Ty. (Wild [1953] pl. 129.)
planking. These beams were added and joined prior to the addition of bulwark. The stage of
combination around hull III in the Ty relief would be the appropriate phase to insert the
beams and to cut holes for treenails to fasten them. The final strake is completed and the bulwark has
yet to be added. Cutting holes to receive square treenails would require a chisel. The possibility that
workers no. 32 and 36 are cutting square holes for the treenails must be considered. If treenails were
used, which tool was used to drive them? While beams were probably ubiquitous to all Egyptian
hulls, those on the Khufu I barge are not fastened with treenails and simply fit into notches on the
sheerstrake.

The task of workers no. 32 and 36 may be related to what worker no. 37 is making beside them.
He squats at the right end of hull III, adzing a stick (fig. 38). Montet translates the hieroglyph above
him as "to shape the rolls of wood." He is not certain if these rolls of wood are tenons or
treenails. A portrayal of the manufacture of tenons would be in keeping with the Ty relief's
central theme of mortise-and-tenon joinery. The width of the stick is almost the same as the tenons
between the strakes on hull I (fig. 33, p. 56). Conversely, if worker no. 36 is indeed cutting holes for
treenails his proximity to worker no. 37 suggests that their tasks may be related.

At the opposite end of the second register worker no. 19 is depicted adzing a stick which is shorter
and narrower than the one worker no. 37 holds (fig. 39). His small size and compactness compared to
the other workers suggest that he was inserted there by the artist rather hastily, perhaps to provide
balance to worker no. 37. Sticks of two different thicknesses are also portrayed being adzed in the

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167 Haldane describes the fasteners as pegs (3.0 x 2.5 cm). True pegs taper, a characteristic which
she does not mention. Haldane (supra n. 10) 211, fig. 10-3; Square treenails seems a more appropriate
term. Steffy (supra n. 8) 35.

168 P. Lipke, "Retrospective on the Royal Ship of Cheops," in S. McGrail and E. Kentley eds., Sewn

169 Montet (supra n. 36) 339.
Fig. 39. An apparently compacted worker no. 19 adzes a stick. Tomb of Ty. (Wild [1953] pl. 129)

Fig. 40. Fabrication of two sizes of wooden sticks. Tomb of Khunes. (After Varille [1938] 15)
Khunes relief (fig. 40). This variation in size may represent the manufacture of both tenons and treenails.

The other two examples of workers adzing shafts of wood occur in the Khuenré' relief (fig. 41) and the Ni’ankh-khnum and Khnemhotp relief (fig. 42). The worker in the Khuenré' relief is located on a hull which lacks a bulwark, adjacent to a boatbuilder with a chisel and mallet. Above him is a hieroglyph similar to menkh, the only appearance of that hieroglyph in the relief. Again, the men could be at work on joining either the beams or the bulwarks.

Conclusions

The Ty reliefs contain the only identifiable depictions of mortise-and-tenon joinery. While other reliefs depict hulls at the same stage of construction as those in the Ty relief, they do not include scenes of attaching planking or cutting mortises. Why this important aspect of construction, so prominent in the Ty relief, is absent everywhere else is puzzling, a good example of the eccentric nature of the composition of these reliefs. Fortunately, the artists made it a prominent part of the detail-rich Ty relief.

The Ty relief provides a crucial record of several stages of the methodology of mortise-and-tenon construction used by Egyptian boatwrights. Hull planking was joined in long sections made up of several planks. Its attachment and seating required a large crew of men using a variety of tools. To force the mortises onto the tenons the planking was struck by stone hammers, which were later exchanged for large wooden pounders for the final seating. This was undertaken by pairs of men who had to synchronize the timing of their blows to minimize the binding of the tenons in the mortises. Other workers, placed at the ends and the center of the planking, helped keep the seams of the planks parallel, which was critical for uninterrupted attachment of the planking. All of these efforts suggest that the fit of the tenons in the mortises was fairly tight.
Fig. 41. Worker adzing stick. Chapel of Khuenrê’. (After MFAB neg. no. A1062, A5478)

Fig. 42. Worker using foot to hold stick while he adzes it. Tomb of Ni’ankh-khnum and Khnemhotp. (Moussa and Altenmüller [1977] fig. 8)
Evidence for mortising is also very limited. The Ty relief provides the clearest example of cutting a row of mortises. Other evidence for joinery is the placement of workers with chisels on hulls which lack bulwarks. They could either be cutting joints necessary for attaching beams or the bulwarks. The adzing of sticks represents the manufacture of wooden fasteners. These probably represent tenons but may depict square treenails.
CHAPTER V
ROPE TRUSSES AND LASHED JOINERY

A boat construction scene that has initiated numerous interpretations is the portrayal of a rope truss attached to the ends of an unlaunched, assembled boat hull. Depictions of this scene are known from four Old Kingdom tombs: those of Khuenrê, Khunes, Feteka, and Nüfer and Kaha, as well as an unprovenanced relief fragment, Brooklyn 51.14. The truss is never portrayed in the representations of the outfitted boats depicted in these same tombs. Similar cables of rope appear on three known depictions of seagoing ships, a large obelisk barge, and an assemblage of New Kingdom cargo ships. The ropes on these operating vessels have long been believed to help prevent the hogging of the long, overhanging ends of the hull. The function of the trusses seen in the boat construction reliefs and their relationship to the hogging trusses has never been clear.

170 Museum of Fine Arts, Boston, unpublished black and white prints, Neg. no. A1061, A1062, A5461, A5478.

171 Varille (supra n. 29)

172 C. R. Lepsius, Denkmäler aus Aegypten und Aethiopien. Ergänzungsband. (Leipzig 1913) pl. 40c.

173 Moussa and Altenmüller (supra n. 91)

174 R. Fazzini, Miscellanea Wilbournia (Brooklyn 1972) 61.


177 Nina de G. Davies, The Tomb of Huy (London 1926) pls. 18, 32.

178 Steffy (supra n. 8) 28, fig. 3-6.
The Function of Rope Trusses

Explanations of the truss tightening scene usually relate to the shaping of the hull. Boreux, Moussa and Altenmüller, and Wachsmann believe that the truss was used after construction to bend the hull into a curved shape.\textsuperscript{179} However, analysis of Egyptian hull remains shows that hull planks were carved, not bent to shape.\textsuperscript{180} This was the usual practice in ancient shell-first construction.\textsuperscript{181} Landström and Sliwa suggest the truss was used to obtain the curvature of the bottom planks during the initial phase of building. Subsequent pieces of the hull would have been added until the hull was finished, at which point the truss was removed.\textsuperscript{182} However, trusses are only depicted on hulls which have all of their planking assembled, never on partially built ones. Furthermore, an attempt to insert planks under the ends of a tightened truss would have been quite awkward if not impossible.

Moussa and Altenmüller classify the hull in the Nüfer and Kaha relief as a "seagoing ship,"\textsuperscript{183} presumably associating the truss with the hogging trusses of Shaurê's ships. Another relief on the same wall of the tomb chapel depicts the same boat at sail, but without the truss.\textsuperscript{184} Petrie presents the plausible idea that the truss was employed to support the hull during launching until the boat was supported by the water.\textsuperscript{185}

Haldane, who has conducted studies of all the known remains of Egyptian boats, provides us with

\begin{itemize}
\item \textsuperscript{179} Boreux (supra n. 4) 249-50; Moussa and Altenmüller, (supra n. 91) 27; Wachsmann (supra n. 137) 195.
\item \textsuperscript{180} Haldane (supra n. 10) 226.
\item \textsuperscript{181} Steffy (supra n. 8) 23-85.
\item \textsuperscript{182} Sliwa (supra n. 67) 58; Landström (supra n. 27) 39.
\item \textsuperscript{183} Moussa and Altenmüller (supra n. 91) pl. 19.
\item \textsuperscript{184} Moussa and Altenmüller (supra n. 91) pl. 16.
\item \textsuperscript{185} W.M.F. Petrie, "Egyptian Shipping," \textit{Ancient Egypt and the East} (1933) 3, 66.
\end{itemize}
an insightful interpretation. She suggests that the purpose of the truss was to force the planks tightly together so that the transverse hull lashing, used in the construction of all known Dynastic Egyptian vessels, could be tightened over seam battens.\textsuperscript{184} This theory provides the most reasonable explanation for these scenes. It takes into account the evidence about the shaping of planks, the prevalence of transverse lashings in the remains of Egyptian vessels, and the structural problems that Egyptian boatwrights had to deal with. Vinson also proposed this idea, adding that the truss put the hull under tension. By using it prior to tightening the lashing, the lashed joints remained taut afterward.\textsuperscript{187}

The earliest known depiction of a hull with a rope truss appears in an unpublished section of a relief from the IVth Dynasty tomb of Khuenrê\textsuperscript{\textasciitilde} (fig. 43). It is a very lively representation with all eight of the men in the scene focused on this one task. The truss cable runs over three forked stanchions, with the center stanchion taller than the other two. The forks of the stanchions are higher than the ends of the hull. Sections of the relief are poorly preserved and some parts of this scene have been lost, including any detail which may have shown the number of ropes which make up the truss. A section of rope, which is perpendicular to the sheer, is visible passing around the bow.

Five workers labor to turn poles which have been inserted through the cable. Two pull on each of the sticks closest to the central stanchion. One of them, straining to complete a revolution, also pushes on the pole with his foot. Workers squatting next to each of them push against the stick with their shoulders. Each pair appear to be turning the sticks in opposing directions, which would be counter productive. Adjacent to the left pair, a single worker pulls unassisted on a third stick. His position and lack of a co-worker gives the whole operation an unbalanced look. The reason for his placement by the artist could simply be to fill in a gap. This extra space may have been due to the central stanchion

\textsuperscript{184} Haldane (supra n. 10) 17, 55.

\textsuperscript{187} S. Vinson, \textit{Egyptian Boats and Ships} (Shire Egyptology Series, Buckinghamshire 1994) 22.
Fig. 43. Tightening the truss cable. Chapel of Khuenrê'. (After MFAB neg. no. A1062, A5478)
being placed off center. Whether the placement of the central stanchion is accurate or it is supposed to be located at the center is unknown. The asymmetry of the hull ends makes determination of a central point difficult.

An overseer, standing at the right end, appears to strike the worker closest to him on the head with a curved stick, probably exhorting him to pull harder. At the other end of the hull a worker, whose left foot rests on the cable, places his right hand to his mouth to shout to the men. The pressure of his foot on the ropes would allow him to measure its tautness in order to help determine when the truss was sufficiently tightened. Underneath him a worker braces his back on the underside of the hull, perhaps using his legs to push up the end of the hull. Whether or not his efforts contribute much with the overseer sitting on the end is unknown. Overall, the scene indicates that tightening the truss was a very arduous task which required a team of men working together.

The sequential relief from the tomb of Khunes portrays in its bottom register the tightening of the truss (fig. 44) and perhaps a subsequent stage (fig. 45). The truss is depicted as a single, band, thickest at the center with two lines spiralling around it, giving the impression that the cable is twisted. Further evidence that the truss is twisted is the fact that it is arced, unlike the example in the Khuenré relief. It runs over a single stanchion located in the center, which is higher than the ends of the hull. Six standing workers are depicted pushing and pulling on two poles. The four closest to the stanchion place the rods across their chests. While the poles do not appear to be inserted through the truss cable, their angle and location relative to the truss, as well as the similarity of the men's stances to the workers in the Khuenré relief, confirm that they are indeed tightening the truss cable.

A similar depiction appears on the hull to the left (fig. 45). It shows two pairs of workers, one pushing and the other pulling on long poles which cross and then disappear into the hull. The rods are the same width as those used for tightening the truss. Though the truss cable appears as only a wide band, its lack of detail is probably due to the deterioration of the surface of the relief.

While the scene is similar in composition to the truss tightening scene, it may represent a
Fig. 44. Tightening the truss cable. Tomb of Khunes. (After Varille [1938] 15, fig. 5)

Fig. 45. Tightening the transverse lashing. Tomb of Khunes. (After Varille [1938] 15, fig. 5)
different operation. Depicting two versions of the same scene is inconsistent with representations of distinctive tasks in other boat construction reliefs. The portrayal of specific activities which require a team of men, such as attaching a strake with mortise-and-tenon joinery or measuring a hull with a plumb bob and line, are not repeated in reliefs that depict multiple hulls. I suggest that this scene represents the following phase of construction after the raising of the ends of the hull has forced the planking together sufficiently. The workers are now using poles to pull and tighten the transverse lashings on the inside of the hull, like on the Khufu I barge (fig. 46). The long poles would have provided the necessary leverage.

Severin describes the use of a wooden lever for tightening the lashings of the sewn hull ship Sohar.188 Among a group of miscellaneous wooden objects from the excavation of Khufu I barge is a pointed stick which Lipke labels as a "marline spike for tightening lashings."189 Wachsmann has noted the role of forked sticks for tightening the cordage on Egyptian chariot wheels and canoes of Oceania. He also suggests that a relief depicting papyrus raft construction from the Vth Dynasty tomb of Ptahhotp includes the portrayal of a forked stick that is being used to tighten lashings. His observation is based on a coarse drawing of the original relief.190 Close examination of a photograph of the relief reveals that the worker is not using a forked stick but actually holds one end of a piece of rope and a flint knife or stone hammer.191

Depictions of some of the preparatory steps necessary for setting up the truss are represented in several reliefs. The Khuenre relief provides a unique portrayal of one of the first phases of the

189 Lipke (supra n. 81) 23, fig. 13.
190 Wachsmann (supra n. 137) 202-203, pl. 140.
191 Hornell (supra n. 27) pl. 6B. The details of the relief are more discernable in this photograph than the example in the complete publication of the chapel.
Fig. 46. Section of the hull of the Khufu I funerary barge showing transverse lashing. (Lipke [1984] 74-75 fig. 43)
procedure (fig. 47). At the center of the hull a worker places a partially coiled plumb bob against an upright pole. The tools he uses and his sparse hair suggests he is a senior boatwright. The pole could represent several things but is probably a staff. Since these reliefs represent the construction of only the boat's hulls, the pole cannot be part of the canopy or mast support. The upper end is not forked so it is not a truss stanchion. Its size relative to the worker suggests that it is the staff that is frequently depicted being held by the same worker who carries the plumb bob (figs. 21-27, pp. 41-44).

Under either end of the hull a man works to adjust the position of the hull. The worker on the right has both of his hands on the top end of the outermost support. Unlike the other struts which are angled towards the center of each hull, this one is inclined outward, conveying that the worker is pulling on it. By doing this he is lowering the left end of the hull, which will consequently cause the right end to rise. The worker on the left end is pushing a domed object, probably a piece of wood, in order to chock the bottom of the hull. The activities of the man with the plumb bob and the two workers under the ends of the hull are connected. They are working together to adjust the position of the hull in preparation for erecting the truss stanchions. The supervisor has set his staff at the location of the central truss stanchion and is measuring the position of the hull relative to the plumb bob. The end of his staff may have been squared off, as the staff in the Ty relief is portrayed (fig. 22, p. 41), so that it would sit flush against the hull. In order for the tightening truss to be effectively used it was necessary for the stanchion(s) to be perpendicular to the longitudinal and transverse axes of the boat hull (figs. 48, 49). Unless the stanchion was plumb to the hull's axis, it might not be able to support the force of the truss as it is tightened and would consequently collapse.

The angle of the hull relative to the plumb bob was not acceptable to the supervisor and he instructs the two workers under the ends of the hull to adjust its position. The left end is lowered and the right end raised while the supervisor keeps his eye on the staff and plumb bob. This use of the

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192 This association was suggested by Mark Smith, April 1994.
Fig. 47. Depiction of leveling the hull. Chapel of Khuenre*. (After MFAB neg. no. A1061, A5475)
Fig. 48. Longitudinal Direction

Fig. 49. Transverse Direction
plumb bob demonstrates the accuracy required for the effective operation of the tightening truss.

Other reliefs may depict hulls that have already been leveled. A small, round object is seen under the left end of a hull in the Itet relief. The right hull in the Tepem'ankh relief includes a similar object under the right end of the hull (fig. 50). The likelihood that these hulls have been leveled is strengthened by the presence of a boatwright holding a plumb bob and staff at the center of the hull in the Tepem'ankh relief. Conversely, two of the hulls in the Khunes relief have wedge shaped supports under both ends of the hull (fig. 44, p. 80).

A good example of the next precursory step for setting up the truss is illustrated in the tomb of Ty where worker no. 44 adzes a forked stanchion positioned in the center of the hull (fig. 51). The height of the stanchion is slightly less than the length of the staff carried by the boatwright (fig. 22, p. 41). Like the stanchions seen in the truss tightening scenes the fork is higher than the ends of the hull. Another example of this step is depicted in the relief from the tomb of Ni'ankh-kham and Khnemhotp which shows a worker, squatting in the center of the hull, holding a stanchion and the handle of a tool (fig. 25, p. 42). The forked tip of the stanchion and most of the adze are missing due to damage sustained by the relief. The boatwright stands next to the worker, holding his plumb bob in his right hand with his staff situated parallel to the stanchion. This is a good example of the association of tasks of two adjacent workers. Four of eight reliefs that depict a worker holding a staff and plumb bob place him in the center of the hull. As seen in the Khuenrē' relief, this is the location from which the level of the hull is checked with the aid of the staff and plumb bob. The repetition emphasizes that this was a standard precursory step and that the use of the tightening truss was prevalent.

A third instance of this activity may be seen in the Tomb of Za'u at Deir el Gebrāwi. A worker, squatting in the center of the hull, adzes an upright piece of wood which has a wide upper end. Davies

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193 Petrie (supra n. 49) pl. 25.
Fig. 50. Tomb of Tepem'ankh. Note round object under right end of hull and stacked supports on left end. (After Borchardt [1907] pl. 103b)

Fig. 51. Worker no. 44 fabricating stanchion for tightening truss. (Wild [1953] pl. 129)
translates corresponding hieroglyphs as "shaping(?) a paddle". The absence of paddles and oars from all other boat construction reliefs and the similarity of the worker's activity, posture, and position in the hull to the other examples suggests that he is also shaping a truss stanchion. The portrayal of a worker finishing a paddle in the relief depicting Mereruka's carpenter's shop indicates that oars and other pieces of the boat's equipment were probably manufactured there and not in the boatyard.

The proximity of worker no. 43 in the Ty relief to the truss stanchion being shaped by worker no. 44 may offer an explanation for his activity (fig. 51). He is using his saw apparently to bisect a shaft of wood, an operation which would produce seam battens like those found on the Khufu I barge. The manufacturing of numerous battens would be necessary prior to the insertion of the transverse lashings. The Khufu I barge required 300. This depiction of batten manufacturing after the hull has been assembled indicates that at least some of the seam battens were inserted at the end of the hull construction process. The unique construction of the internal support system of the hull of the Khufu I barge and its construction sequence make comparisons difficult. What is evident is that the construction of the hulls portrayed in the Ty relief required the use of transverse lashings and seam battens.

The fragmentary relief from the tomb of Fetekta includes a section of a truss that is being tightened by three workers who stand on top of it (fig. 52). The size of the workers relative to the truss is much smaller than is usually depicted. Two forked stanchions are portrayed to the left of the cable, through which two crossed ropes pass through. Pairs of poles are also depicted at both ends of the hulls in the Ra'shepse relief (fig. 53). They may represent a simple crane which helped the workers to adjust the

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194 Davies (supra n. 64) 11, pl. 10.
195 Duell et al. (supra n. 34) pl. 30.
196 Haldane (supra n. 10) 15.
197 Lipke (supra n. 81) 79.
Fig. 52. Fetecka relief (after Lepsius [1913] pl. 40c)

Fig. 53. Ra'shepses relief (After Lepsius [1849-1859] pl. 61.)
position of the hull. This was probably essential for moving large boats during both leveling and launching. Such an arrangement could have assisted with raising the ends of the hull just prior to the tightening the truss cable. The inclusion of the use of this apparatus in only the Hetekta relief is puzzling.

The relief from the tomb of Nüfer and Kaha depicts a single hull installed with a truss\(^{198}\), which is curved like the cable in the Khunes relief (fig. 44, p. 80). This is the best preserved of the three intact truss scenes (fig. 54). Activities are centered around the truss cable, tightening the internal lashings, and launching the hull. It has long been believed that the artist has decided to show a composite of different stages of hull construction.\(^{199}\)

Two workers are occupied with the lashing. The one on the left grasps a rope which he has wrapped around his shoulder to gain a better purchase. The worker has placed his left foot on the bulwark to pull up on the line, which leads into the hull. His companion uses an oblong stone apparently to pound the lashing. Identical portrayals of both these techniques are seen in a relief from the Vth Dynasty Chapel of Ptahhotp which depicts the tying of papyrus reeds to fabricate rafts. Three of the workers in the Ptahhotp relief pull on ropes which they have wrapped around their shoulder or passed behind their backs. Another worker is shown using a rock to beat the cords while he pulls it tight around the bundles of papyrus.\(^{200}\) Tim Severin’s description of the construction of the sewn dhow Sohar again provides us with a parallel. The cords used to join the Sohar’s hull planks were

\(^{198}\) Moussa and Altenmüller (supra n. 91)

\(^{199}\) Sliwa (supra n. 67) 58; Landström (supra n. 27) 39.

\(^{200}\) N. de G. Davies, The Mastaba of Ptahhetep and Akheetep at Saqqarah, Pt. 1 (London 1900) pls. 21, 25.
Fig. 54. Removing the tightening truss. (After Moussa and Alteimüller [1974] pls. 18, 19)
pounded with a mallet while the stitching remained under tension.201 Presumably this was done to help make the lashings as tight as possible. These parallels and the context of the relief indicate that the two workers are tightening part of the hull’s transverse lashings. Another reported parallel is an identification by Edgerton202 and Landström203 of a rope being held by a worker in the Khnemhotp III relief. Like Wachsmann, these two scholars are basing their observation on a rough illustration of the relief from Newberry’s depictions of the tomb. An examination of an earlier and much more detailed rendering of the relief reveals the worker striking a plank with a large club.204

The worker in the center of the hull in the Niffer and Kaha relief places one hand on the truss while keeping his left foot and right arm on the stanchion. Beside him stands a supervisor who holds a scepter-like baton.205 The truss is represented by three to four strands of rope which appear to go around both the bow and stern. The activity of the next worker is usually assumed to be tightening the truss.206 He uses both hands to turn a short stick that is inserted through the truss cable. His stance does not convey that his work is very strenuous. He would have to be fantastically strong to do a job by himself for which artists of the other two reliefs have allocated crews of five or six. It is unlikely that he is representative of the team needed to tighten the cable since the artist has provided a group of four workers to launch the hull (fig. 55). It is more plausible that he is loosening the truss in preparation for its removal. Once all or most of the internal hull lashings had been tightened, the

201 Severin, (supra n. 188). It should be noted that the holes for the lacing cords on the Sohar penetrate the plank through to the exterior. This method of sewn construction is different than the technique used by Egyptian boatwrights where the exterior of the hull was never pierced.


203 Landström (supra n. 27) 91.

204 Champollion (supra n. 139)

205 Fischer (supra n. 116) 16.

206 P. Johnstone, The Archaeology of Ships (London 1974) 14; C. Haldane (supra n. 10) 17.
weight of the hull against the truss would be reduced, permitting the careful unwinding of the cable by a single person. The worker holding the stanchion is preparing to use his foot to dislodge it once the truss is loosened sufficiently. The scene is not a composite of activities so much as a depiction of the final moments prior to launching the hull.

A team of men hold a rope attached to the midships in preparation for moving the hull (fig. 55). The two nearest to the hull brace themselves as they make ready to heave. The imminent nature of their job is indicated by a worker who pours water in the hull’s path,²⁰⁷ a procedure also used during the moving of large statues on sleds.²⁰⁸ Another worker reaches under the hull to remove the stern support. While his activity appears similar to the task of the man in the Khuenrê’ relief (fig. 47, p. 84) his context within this relief indicates that he is helping with the preparations for launching the hull.

Brooklyn 51.14 is an unprovenanced relief fragment that has been associated with the late XXV or early XXVI Dynasty tomb of Montuemhêt at Thebes because of its similarity in style.²⁰⁹ It is regrettably a mere portion of a unique depiction of a hull outfitted with a truss (fig. 56). Two workers and portions of four others are visible. The truss appears taught and is comprised of seven cords, twice the number of other depictions. The ropes appear to continue and pass around the end and under a strake which may be the bulwark or caprail. The cords around the hull are actually a separate section of ropes to which the truss cable is attached (fig. 57). These cords do not encircle the bulwarks.²¹⁰ Not only are they the attachment point for the truss cable but they also help hold the ends together during the truss tightening procedure.

²⁰⁷ Moussa and Altenmüller (supra n. 91) 27.
²¹⁰ Personal communication, Cemal Pulak, March 1996.
Fig. 56. Relief fragment Brooklyn 51.14. (After Fazzini [1972] fig. 28)

Fig. 57. Cross section of hull showing the attachment of the truss cable to the end of the hull
One worker places his chisel along the bottom edge of the hull, an irrational action not seen in any other boat construction relief. Another worker has his hand between the hull and one of the truss ropes, a difficult feat if the truss is actually tightened. He draws back with his adze much farther than is normal, as if about to strike a mighty blow to the truss ropes. It seems unreasonable that the removal of the truss would require that it be severed. His action is similar to that of worker no. 51 in the Ty relief (fig. 15, p. 32) and he may be simply sculpting the end of the hull. The unconventional placement of these two workers suggests that the artist responsible for the layout was not familiar with boat construction methodology.

Portions of four other workers remain on Brooklyn 51.14, three of whom stand at deck level. The two workers whose arms are visible pass a length of rope, one end of which disappears into the hull. The direction in which the rope is being moved is unclear. They may be transferring it into the hull where it will be used for the lashed joinery. This would indicate that some rope for the lashings was not inserted until after the truss had been tightened. The addition of much of the transverse lashings was one of the final steps of construction of the Khufu I barge.\textsuperscript{211} If they are preparing to use the rope to launch the hull as seen in the Nüfer and Kaha relief, it would probably not lead into the hull. Despite the need for large amounts of rope for this procedure there are no depictions of rope either being manufactured or being brought into the hulls as seen in reliefs depicting the fabrication of papyrus rafts.\textsuperscript{212}

Brooklyn 51.14 postdates by at least 1800 years the other three boat construction reliefs known to depict the tightening truss, all of which date to the Old Kingdom at sites in Saqqâra and Giza! There are no other representations of this activity in any of the known reliefs carved during the long span between these periods. The reason for this absence may be associated with the practices of artists of

\textsuperscript{211} Lipke (supra n. 168) 30; Haldane (supra n. 10) 111; Steffy (supra n. 8) 26.

\textsuperscript{212} Davies (supra n. 200)
the Archaic period. Some Theban tombs of the late Archaic period contain reliefs which reflect the art of earlier tombs dating back as far as the Old Kingdom. Occasionally, artists blatantly borrowed directly from other tombs. A relief depicting boat construction from the Archaic period tomb of Ibi at Thebes was copied almost exactly from an Old Kingdom tomb at Deir el Gebráwi belonging to an official of the same name.

Several details in Brooklyn 51.14 suggest that it may have originated from an Old Kingdom relief. The large size of the hull compared to the workers is characteristic of the most elaborate reliefs dating to the Old Kingdom. The hulls depicted in all known reliefs post dating the Old Kingdom are so small in relation to the workers that it would not be possible to portray someone working under the end of the hull. Brooklyn 51.14 is the sole exception to this pattern. The shape of the end of the hull is more comparable to boats depicted in reliefs from the Old Kingdom. Finally, the inclusion of the tightening truss itself is a feature limited to boat construction reliefs of the Old Kingdom. Considering these factors, Brooklyn 51.14 is probably a copy of an Old Kingdom relief, that was later lost or destroyed.

The Reasons Which Required the Use of the Tightening Truss

The use of the papyriform shape by the Egyptians for boat hulls often resulted in long overhanging ends which could not be supported by the buoyant forces of the water. Their weight exaggerated the hull’s natural tendency to hog, causing the planking seams to open and endangering its integrity (fig. 58). This was especially pronounced at the upper portions of the hull. One way to reduce this was to pre-load or pre-stress the hull prior to its launching. Egyptian boatwrights achieved this by attaching a rope cable to loops of rope which were wound around the bow and stern. The cable was then inserted through one or three forked stanchions set into the hull. A simple hoist may have been used to help

213 Fazzini, (supra n. 174) 61.

214 Davies (supra n. 64) 36-37; Wachsmann (supra n. 33)
Fig. 58. Forces exerted on an Egyptian boat hull after launching.

Fig. 59. Forces of tension and compression
raise the ends of the hull at the beginning of the procedure. As the truss was tightened the ends of the hull were slightly raised, forcing the ends of the planks together. The truss was highest in the center of the hull in order to for this particular arrangement to be most effective. The procedure can be likened to drawing back the string of a bow.

The upper half of the hull is subject to forces of tension and the lower half is subject to forces of compression. The point where these forces intersect in the hull is the neutral axis (fig. 59). By pre-loading the hull with the tightening truss (fig. 60), these forces were reversed. The half of the hull above the neutral axis is now under forces of compression (fig. 61). The transverse lashings which edge-joined the planks could now be tightened to a degree that was not possible without the truss. The lashings along the bottom of the hull may have been tightened prior to the use of the tightening truss while the area was still under compression. After the lashing was tightened the truss was removed, reverting the forces back into their original directions. The tightened transverse lashings kept the hull pre-loaded, reducing hogging of the ends and helping the boat keep its shape.

There are two possible reasons to level the hull. The placement and arrangement of the truss stanchions required a great deal of precision. The position of the hull at the time of completion of the assembly was never adequate for setting up the truss. Therefore, every hull had to be leveled prior to placing the stanchions. It also may be possible that the construction of the hull required that it be built in position A, but the use of the tightening truss needed it to be changed to position B.

A Suggested Sequence for the Operation of the Tightening Truss

After all of the planks and hull elements had been assembled the preparations for setting up the tightening truss could begin. The level of the hull was checked by a master boatwright with a plumb bob and staff. The staff that he used was slightly taller than the tip of the tallest stanchion. His

\[215\] Personal communication, J. R. Steffy, May 1995.
Fig. 60. Pre-loading the hull.

Fig. 61. Reversal of forces.
ultimate goal was to make sure that the longitudinal and transverse axes of the hull would be perpendicular to the vertical axis of the stanchion(s). The endpoints of the longitudinal axis would be the points where the truss is tied. The transverse axis would be perpendicular to the same point near or at the middle of the hull.

It was not necessary that the truss stanchion be perpendicular to the ground, only to the longitudinal and transverse axes of the hull. However, the Egyptian boatwrights chose to use the plumb bob to level the staff and adjusted the position of the hull. Consequently, the axes of the hull were made parallel to the center of gravity. A portrayal of leveling the hull in the transverse direction is not depicted and would be difficult to show due to the conventions of Egyptian art.

If any adjustments of the hull were needed, they were probably minor. One method of altering the position of the hull was by moving the struts which support one end of the hull while adjusting the position of the chock at the other end. The boatwright would direct this while continuing to monitor his staff and plumb bob.

One or three forked stanchions were set up along the centerline of the hull and adzed into shape. Their forks were always higher than the ends of the hull. If more than one stanchion was used the tallest one would be placed in the center between the other two. After being inserted their positions may have been checked to insure that they were plumb. Dislodgement of the base of the stanchions had to be prevented, once the tightening of the truss began. They were probably fitted into mortises to keep them securely in place. The force of the tightened truss pushing down on the stanchion probably required that it rest on a component to help distribute the pressure. A piece similar to the frames on the Khufu I barge (fig. 46, p. 82) or something comparable to a mast-step could serve this purpose.

Several strands of rope were fabricated into a large loop to make the truss cable. It should be noted that it is not possible to be certain about the number of ropes in the cable based on these reliefs. To assume that the artists have represented the correct number of ropes which make up the truss would be just as erroneous a presumption as it would be to accept that the tenons visible between the planks
of hull I in the Ty relief (fig. 33) is the actual number used to join the bulwark to the hull.

The cable was attached to ropes which were wound around the ends of the hull and then placed into the forks of the stanchions to keep them in place. The forks may have been lubricated to reduce the friction of the ropes pulling across them. Poles were then inserted through the cable and teams of men worked strenuously to turn them, tightening the truss. A hoist may have been used to help raise the ends of the hull, especially for large boats. A worker shouted commands to help the men pull and push in unison. As the cable was twisted and shortened the ends of the hull were raised. This forced the ends of the planks above the neutral axis tightly together, closing spaces between plank ends. The mortise-and-tenon joinery which connected the plank edges restricted most longitudinal movement of the planks. The positions of the struts which supported the hull were probably adjusted as the ends were raised. The outermost strut in the right hull of the Tep'emankh relief has a block between it and the hull (fig. 50, p. 87), suggesting that it may have been chocked after the tightening of the truss raised the ends of the hull. A supervisor observing the tautness of the cable instructed the men when to cease. The poles were then secured to maintain the tension, perhaps being tied to the stanchions as was done on the tightened hogging trusses of seagoing ships. Whether or not some of the rope for the transverse lashings had been added prior to this stage is unknown. The lashing for the lower half of the hull was probably tightened prior to the use of the truss, while the area was still under forces of compression. Brooklyn 51.14 indicates that additional rope was added after the truss was tightened. The lashings were drawn tight by teams of men using long poles and by others simply pulling with their hands. Additional workers pounded the lashing with a stone to enable them to be drawn tight. Once the lashings had been tightened and tied off, the truss was loosened and removed. The now pre-stressed hull was then ready to be launched.


217 Borchardt (supra n. 175)
Seagoing Ships with Hogging Trusses

Hogging trusses appear on Old and New Kingdom representations of seagoing vessels, an immense obelisk barge, and on cargo boats transporting cattle. While some scholars have associated these trusses with examples seen in the reliefs from private tombs they actually serve a different function. Hogging trusses were a permanent part of the ship’s equipment. Whereas its function probably overlapped those of the tightening truss, it also provided additional longitudinal support for the ship when traveling over the troughs and waves of the sea or when carrying heavy cargos.

The first known appearance of a true hogging truss occurs in reliefs from the funerary temple of Sahurē at Abuṣīr, which depicts a fleet of seagoing ships. Its introduction must surely be related to the development and use of the tightening truss. At some point prior to the Vth Dynasty, Egyptian shipwrights realized that if a truss was made a permanent part of the hull’s equipment, it would add significantly to the ship’s longitudinal support and hull integrity. Perhaps a hull was launched without the tightening truss being removed. The addition of the hogging truss along with a rope girdle, depicted extending along the upper planking of Sahurē’s ships, reduced hogging and helped the ship maintain its shape as it traveled over the sea. These innovations permitted safer voyages and undoubtedly contributed to an expansion in seafaring by Egypt and helped in the transportation of stone needed for building Egypt’s monuments. Whether or not the hogging truss was used as a tightening truss during construction is unknown. The hogging truss was adopted by boatwrights throughout the world and continued to be used well into the 20th century A.D.

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218 Borchardt (supra n. 175)

219 Personal Communication, F. van Doorninck, April 1993.

The Disappearance of the Tightening Truss

With the possible exception of fragment Brooklyn 51.14, none of the known reliefs depicting boat construction made after the Old Kingdom depict any stage of using the tightening truss. While representations of carpenter’s shops and other crafts continue to be part of the decoration of tombs, the frequency of depictions of boat construction sequences are reduced and their composition simplified. Gone are the portrayals of multiple hulls, gangs of workers, and construction details. The four reliefs dating to the New Kingdom portray the construction of funerary barges. The disappearance of the tightening truss from these reliefs may be linked to the changing function of tomb reliefs. Compositions for the tombs of the New Kingdom are devoted to chronicling specific events and achievements in the owner’s life rather than providing for his needs in the afterlife. The size and function of the vessels which are depicted change from large boats, propelled by sails and large teams of rowers to smaller, funerary barges which were towed. The construction of these smaller, funerary barges may not have required the use of the tightening truss.

By the Middle Kingdom deep mortise-and-tenon joints were being used in the hull construction of funerary barges. Haldane suggests that the shallow transverse lashings on the funerary barges from Dashur may be relatively unimportant for hull construction. Stronger mortise-and-tenon joints and the decreasing role of transverse lashings in these smaller barges may have eliminated the need for the tightening truss during the construction of these vessels. The continuing use of the tightening truss for the construction of large vessels seems likely.

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221 Sliwa (supra n. 67) figs. 24-32.

222 Bruyère (supra n. 107); P. Virey, *Le tombeau de Khem* (Paris 1891) 366, fig. 2; Davies (supra n. 83) pl. 34; Metropolitan Museum of Art, unpublished photographs M.12.C 69-73, 78.

223 Haldane (supra n. 10) 229.
Conclusions

Depictions of the tightening truss are the most important contribution that boat construction reliefs make to the history of Egyptian hull construction. Except for these reliefs we have no record of this important construction procedure. Its inclusion in five reliefs as well as preparatory procedures in several other reliefs, indicate that its employment was a common sight in the boatyards along the Nile during the Old Kingdom. Preparations for setting up the truss stanchions required the use of a plumb bob, indicating the need for precision for this procedure. While only one relief depicts this technique, portrayals of other boatwrights with the staff and plumb bob, standing at the center of the hull, is evidence of this practice. The use of the tightening truss was probably essential for the construction of Egyptian vessels which utilized substantial transverse lashings for plank joinery. Evidence from relief fragment 51.14 and worker no. 43 in the Ty relief suggests that some of the rope for the transverse lashings and the seam battens were not inserted until after the truss was tightened. This technology probably led to the introduction and development of the hogging truss. The total absence of depictions of the tightening truss after the Old Kingdom suggests improvements in joinery techniques, eliminating the need for it in the construction of small vessels. It is hoped that a clearer understanding of this procedure will permit epigraphers to locate any existing references to this procedure or the equipment required for it.
CHAPTER VI

THE HULLS

The hulls depicted in the Ty relief are represented with a great amount of detail. An examination of their features and a comparison between them and the corresponding outfitted boats in the second corridor of the tomb provides additional information about construction technology.

Hull Lines

All but one of the hulls in the Ty relief retain traces of very intricate wood grain which was painted, not carved, onto the surface of the relief. Three of the hulls; II (fig. 8, p. 24), IV (fig. 18, p. 37), and V (fig. 19, p. 38) are divided by pairs of parallel lines along their entire length, separating them into three sections. There are no vertical lines. The grain pattern for each section is distinct from the adjacent area. Between the pairs of lines there is no detail and the color is a lighter shade of brown than the rest of the hull. What exactly these lines portray is unclear. The division between the bulwark and the rest of the hull is made with a single line, suggesting that the double lines do not represent plank lines. The hulls in the Khunes relief are also depicted with single lines (fig. 13, p. 31).

The configuration of the lines of hull III is unique, consisting mainly of single diagonals which divide the hull into six sections (fig. 62). The presence of S scarfs in the sheer strake indicates that the artist is showing some of the hull’s planking lines. The position and shape of the planking being joined is very similar to a plank on the Khufu I barge, which also has S scarfs, though in a pattern reverse of hull III’s.224 Diagonal scarfs may be represented in the depictions of Sahurê’s seagoing ships.225

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224 Lipke (supra n. 81) 66.

225 Borchardt (supra n. 175) pl. 12; Edgerton (supra n. 202) 131. Dr. Shelley Wachsmann originally pointed this out to me.
Fig. 62. Hull III. Note S scarfs on sheer strake. Tomb of Ty (Wild [1953] pl. 129).
Montet believes that the depiction of hull III can be taken as literal evidence that each side of the hull is made up of six pieces plus a seventh for the bulwark. Whether or not Montet refers to individual planks or not is unclear. He points out the use of names for different parts of the boat in the Egyptian Book of the Dead.\textsuperscript{226} An examination of complete Egyptian hulls shows that their sides were made up of more than seven planks. Each side of the Khufu I barge is made up of eleven planks\textsuperscript{227} while those of the funerary barges from Dashur consist of twelve.\textsuperscript{228} Therefore, it is unlikely that each side of hull III was made of only seven planks. It is more likely that the side of the hull was divided into seven sections, each of which consisted of several planks. The hulls of the outfitted boats in the tomb of Ty are devoid of any lines, except for an outline of the bulwark.

The Identity of Rectangular Features

Some of the outfitted boats in Ty's tomb display a rectangular feature at their ends, which is parallel to the vessels sheer. It appears at the stern of two boats (fig. 63) and at the bow of two others in different reliefs (fig. 64). This feature is always absent from reliefs depicting boat construction. Their appearance at both the bow and stern of a representation of a similar boat has led to their identification as massive through beams\textsuperscript{229} or fenders\textsuperscript{230}. While beams are an important structural element of all known intact Egyptian vessels, they are not visible on the exterior of the Khufu I barge, the only assembled vessel dating to the Old Kingdom. Beginning in the Middle Kingdom, rows of beam ends appear in depictions of boats along their sheer. The beam ends of the funerary barges

\textsuperscript{226} Montet (supra n. 36) 336, 341.

\textsuperscript{227} Lipke (supra n. 81) 66.

\textsuperscript{228} C. Haldane, The Dashur Boats (Unpublished M.A. Thesis Texas A&M University 1984) 49.

\textsuperscript{229} Landström (supra n. 27) 41; Goedicke (supra n. 13) 108.

\textsuperscript{230} H. Junker, Gita IV (Leipzig, 1940) 51.
Fig. 63. Rectangular feature at bow of boat. Tomb of Ty. (Épron and Daumas [1939] pl. 55)

Fig. 64. Rectangular feature at stern of boat. Tomb of Ty. (Épron and Daumas [1939] pl. 49).
from Dashûr are visible from the exterior of their hulls.\textsuperscript{231} If the rectangular features in these reliefs dating to the Old Kingdom are beams, why would something so conspicuous and structurally important be absent from boat construction reliefs, especially the detailed Ty relief?

A fragmentary relief dating to the IVth or Vth Dynasty provides a unique depiction of a pair of these rectangles on the bow of a boat under sail.\textsuperscript{232} Both are perpendicular, but at a slight angle to the sheer, and are staggered one above the other (fig. 65). The inclusion of certain details in some reliefs and their absence from others is symptomatic of Old Kingdom depictions of boats.\textsuperscript{233} Overall, the detail and quality of the art are outstanding, which seem to support the likelihood of its accuracy. This relief also depicts notches on the bulwark for the oars, a detail seen in only one other relief.\textsuperscript{234}

The Khufu I barge has rectangular pieces of wood at each end, which are perpendicular to the sheer of the hull (fig. 66). Lipke believes that they function as covers to protect structurally critical lashings which were exposed to the exterior.\textsuperscript{235} They are currently the only parallel from known hull remains for the feature depicted in the reliefs.

Intact reliefs show that black paint was used for the rectangles while brown and yellow was used for the rest of the hull.\textsuperscript{236} Black was also used to depict the rigging. It is not possible to say whether or not all boats used covers over these areas of lashings like those on the Khufu I barge. The different orientations of these rectangles suggests variations in hull construction during the IVth and

\textsuperscript{231} Landström (supra n. 27) fig. 275.

\textsuperscript{232} Goedicke (supra n. 13) 106-08.

\textsuperscript{233} D. Kessler, "Zur Bedeutung der Szenen des täglichen Lebens in den Privatgräbern (I): Die Szenen des Schiffbaues und der Schifffahrt," ZÄS 114 (1987) 66. I was led to this reference by reading Haldane’s report on the LIsht timbers. Haldane (supra n. 64) 103, n. 225.

\textsuperscript{234} Goedicke (supra n. 13) 111.

\textsuperscript{235} Lipke, (supra n. 168) 25.

\textsuperscript{236} Junker (supra n. 230) pl. 4.
Fig. 65. Boat under sail. Note unique arrangement of two rectangular features at the bow. (Goedicke [1971] 107)

Fig. 66. Stern of the Khufu I funerary barge. Rectangular lashing cover is perpendicular to the sheer. (After Lipke [1984] 83)
Vth Dynasties. Their absence from boat construction reliefs may be due to their not being finished until all the lashings were complete, a stage of construction not represented in boatbuilding reliefs. This area of the hull may have simply been covered by the ropes to which the truss cable is attached.

The Ends of Papyriform Boats

The objective of workers no. 53 and 54, who chisel at the bow of hull V in the Ty relief, is intriguing (fig. 67). An explanation for their task is dependent on the manner in which the bow is actually fastened together. If the ends of the planks at the bow are held together by external cords, similar to the technique used on papyrus vessels, the purpose of worker no. 53 may be to tighten the fastenings by driving them into mortises. The depiction of the entire blade of worker no. 54’s chisel suggests that he may be cutting channels for the ropes. If the thickness of the hull decreased towards the end, grooves would be needed to prevent the cords from slipping out of place.237 But cutting these grooves after the lashings are in place does not seem to be a logical sequence of construction. Portrayals of the tying or actual placement of these lashings are never depicted in any reliefs. The papyriform hull from the Khunes relief shows a papyriform hull which has its bow apparently tied to the ground (fig. 68).

Bands similar to those on hull IV and V are carved in relief on the sternpost and stem of the Khufu I barge (fig. 66). Based on this, it is unlikely that the bands depicted in the reliefs represent actual lashings. Using chisels to sculpt the ends of papyriform hulls is one of the most common scenes in construction reliefs. The portrayal of the creation of these bands was obviously of great importance for the proper construction of these papyriform wooden boats.

237 Personal communication, J.R. Steffy, April 1992.
Fig. 67. Worker using a chisel to sculpt papyriform end of hull. Tomb of Ty. (Wild [1953] pl. 128)

Fig. 68. Bow of papyriform hull tied to the ground. Tomb of Khunes. (After Varille [1938] 15, fig. 5)
Hull Shapes

Four different hull shapes are represented in the Ty relief. All of them are represented by corresponding boats in a procession on which Ty travels.\textsuperscript{238} With the exception of the papyriform hull, they are the same basic shape except for their ends. Hull I has square ends (fig. 69). Hull II is similar but has a pointed stern (fig. 70). Hull III has rounded ends (fig. 71). Hulls IV and V in the Ty relief are both the same papyriform shape (fig. 72). The stern curves up slightly and the bow curls downward at the end. The shape is a large, wooden imitation of a papyrus boat. A fifth type, which has the carving of the animal's head on the bow is depicted among the group of outfitted boats (fig. 73). Cargo boats, which are depicted in some of the same reliefs also have square ends, though appear shorter than hull I (fig. 74). An estimation of the length of hull I, based on the number of rowers, is around 16 m.\textsuperscript{239} The same five types of boats are portrayed in the tomb of Ni’ankh-khnum and Khnumhotep.\textsuperscript{240} The number of the boat pits associated with the pyramids of Khufu and Chephren is also five.\textsuperscript{241} The purpose for each of these different shapes has never been determined. By the beginning of the VIth Dynasty the diversity of hull shapes represented in tomb reliefs is reduced. The mastaba of Mereruka only depicts papyriform hulls and boats with rounded ends.\textsuperscript{242}

Why are a pair of the papyriform hulls represented in the Ty boat construction relief and but a single example of the others? Two papyriform hulls are the only ones portrayed in the Mereruka boat construction relief. Reisner notes that boat models left in tombs usually occur in pairs, one equipped

\textsuperscript{238} L. Épron and F. Daumas, \textit{Le tombeau de Ti I} (Cairo 1939) pl. 49.

\textsuperscript{239} Appendix 2.

\textsuperscript{240} Moussa and Altenmüller (supra n. 94) pls. 22, 25, 30.

\textsuperscript{241} J. Černý, "A Note on the Recently Discovered Boat of Cheops," \textit{JEA} 41 (1955) 75.

\textsuperscript{242} Duell et al. (supra n. 30) pls. 140-45, 152.
Fig. 69. Square ended boat. Tomb of Ty. (Épron and Daumas [1939] pl. 49)

Fig. 70. Boat with pointed stern. Tomb of Ty. (Épron and Daumas [1939] pl. 49)
Fig. 71. Boat with rounded ends. Tomb of Ty. (Épron and Daumas [1939] pl. 49)

Fig. 72. Boat with papyriform hull. Tomb of Ty. (Épron and Daumas [1939] pl. 49)
Fig. 73. Boat with animal head bow being rowed. Tomb of Ty. (Épron and Daumas [1939] pl. 49)

Fig. 74. Square ended cargo boat. Tomb of Ty. (Épron and Daumas [1939] pl. 27)
for sailing upstream and one for rowing downstream.⁴¹ Other reliefs depict a single example of the papyriform hull. This hull shape is the only one of the five types absent from a scene depicting a census of Ty's herds of antelopes, gazelles, and pigeons.⁴² Apparently, the boats in this scene were used to transport the animals. Are the papyriform boats used strictly for pilgrimages during the afterlife? Hieroglyphs referring to traveling to the "Perfect West", which is the hereafter, occur in reliefs which include all of the boats.⁴³⁵

The only boat portrayed in Ty's tomb which is not represented by a like hull in the boat construction relief is the animal head boat (fig. 73). Examples of this hull appear in boat construction reliefs in the tombs of Khuenrê² (fig. 20, p. 38) and Nêfer and Kaha (fig. 54, p. 91). There is a great amount of variation in the depictions of this animal and consequently there is little consensus as to what kind of animal it represents. It is most frequently identified as a hedgehog due to its resemblance to Egyptian depictions of the animal.⁴⁴⁶ Other comparisons include calf,²⁴⁷ sheep or it is simply referred to as an animal.²⁴⁸ Petrie believes some examples represent a pig's head, pointing out the association of the pig with the god Set. Set was important to the dead since he guarded the ladder to the sky.²⁵⁰ In a later article he notes a transition among the reliefs from a pig's to a sheep's

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243 G.A. Reisner, *Models of Ships and Boats* (Cairo 1913) iii.

244 Éprons and Daumas (supra n. 238) pls. 21, 22, 26.

245 Hayes (supra n. 39) 99.

246 H. Junker, *Giza V* (Leipzig 1941) 72; Harpur, (supra n. 11) 200; A detailed portrayal of the animal occurs in the chapel of Ptah-hotep. Davies (supra n. 200) pl. 22.

247 Boreux (supra n. 4) 277-78.

248 Vandier (supra n. 6) 697.

249 Hayes (supra n. 39) 100.

head. $^{251}$

$^{251}$ Petrie (supra n. 185) 7.
CHAPTER VII

CONCLUSIONS

Before an attempt can be made to analyze what is being portrayed in these reliefs, one must first understand their purpose and function. They depict the construction of the hulls for the boats which will be used by the owner of the tomb in his afterlife. It was necessary that the hulls be portrayed at a late stage of assembly. Some are represented with all of their planking, others lack the bulwark or the central span of planks along the sheer. Depictions of an initial stage of hull assembly, such as a central plank sitting on stocks, would not convey the desired image of a boat hull. Accordingly, most of the activity of the workers is related to finishing the hulls. Scenes depicted are simply representative of construction procedures and are not meant to be illustrative.

The content of the reliefs was limited by what the artists could see and what they could portray within the limitations of the artistic conventions. The degree to which they understood what they depicted is unknown. The variety of scenes and the degree of detail portrayed indicate that some of them were at least familiar with construction methodology and technology. They may have visited actual boatyards along the Nile or were advised by boatwrights when developing their compositions. While all reliefs contain some standardized scenes, most have one or two unique elements. It is because of this eclectic nature and variation in the composition of the reliefs that so much information exists. As these reliefs were made by artists, considerations such as balance and symmetry were important, while proportion was not. A correlation between the quality and detail of the sculpture of a relief and the accuracy of its subject seems apparent. Their composition was not in the least bit arbitrary. This is evident to such a degree on the Ty relief that every part of it should be scrutinized.

Reliefs which include portrayals of multiple hulls often depict them at sequential stages of construction. These sequences rarely include the same type of hull twice. Workers are usually grouped into each hull according to the order of their task. The key to determining the direction of the stage of construction of a hull relative to its neighbor is the presence or absence of planking such as
the bulwark. Other reliefs which include only one or two hulls depict a composite of the final stages of construction. Artists utilized all of the available space, so hulls are always filled with workers whether or not they are involved in common tasks. Close proximity of pairs of workers sometimes indicates that their jobs are related. This is especially evident in the Ty relief.

Common activities depicted include shaving planks with axes and adzes, sculpting decorative ends with chisels, fabricating fasteners, creating positions for oars, and tightening internal lashings. Clues to deducing the activity of each worker can be usually found in their stance and the position of their arms.

While preliminary stages of construction are not portrayed, preparatory steps which were essential for the creation of the hull were represented. Many reliefs include the chopping down of trees, moving the trunks to the boatyard, processing them with axes and adzes, and rarely, sawing the processed logs into planks. As the tomb owner needed hulls for his boats, he also needed the wood to build them. Pieces of wood which are being chopped or sawn alongside the hulls are merely representative of the wood that is cut and cannot be identified as a specific part of the hull based on its size compared to the workers or the boats. In other tombs these scenes of timber preparation are included adjacent to both the carpentry shop and the boatyard and not strictly associated with either. The boat’s gear, such as oars, masts, and paddles are not included in boat construction reliefs. They were probably manufactured in the carpenter’s shop.

The appearance and frequency of the tools was dependent on the stage of construction that the reliefs represent. Axes were not only important for chopping down trees and processing logs but were also used with the adze for the much finer work of shaving and finishing hull planks. While essential for cutting planks, the saw was rarely included in these reliefs since the hull was mostly assembled by this stage. Adzes were important for finishing the shape and surface of the hull-and were frequently depicted. Representations of them included two separate types. Variations in depictions of axes, adzes, and saws illustrate a breakdown of tasks. While chisels were indispensable for cutting mortises they were usually depicted being employed to sculpt the ends of the hull. Tool methodology does not
appear to have been very different from techniques used by shipwrights throughout history.

Some tools are characteristic of Egyptian depictions of boatyards. The identification of boatbuilding scenes among fragments of reliefs dating to the Old Kingdom, which continue to turn up in excavations, museums and in private collections, can usually be determined by the presence of either the boatwright’s adze or plumb bob.

While prominently represented in the Ty relief, the joining of planks with mortise-and-tenon joinery was not portrayed in other reliefs. Their attachment was a complex task requiring coordinated efforts and a variety of tools. The fit of these mortise-and-tenon joints was tight. Other depictions of joinery fabrication which occur in a few reliefs, included men cutting holes with chisels and the shaping of sticks with adzes. Though these probably represent steps of mortise-and-tenon joinery, they also could depict cutting square holes for attaching the beams and the manufacture of treenails.

Depictions of lashing were not included in the Ty relief. The inclusion of a stanchion for the tightening truss indicates that these hulls utilized internal transverse lashings for the edge-to-edge joinery of their planks. Internal lashing was a joinery technique that was not easily visible to the artist standing along side a hull. Occasionally, artists tried to convey the presence of this stage by representing activities which were visible from the outside of the hull. These usually consisted of a length of line held in a raised hand of a worker as seen in the Maidûm reliefs and the Nûfer and Kaha relief. Based on these reliefs and the archaeological remains of Egyptian hulls, internal transverse lashing was probably used in the edge-to-edge joinery of planks for most Egyptian hulls.

Checking hull symmetry and dimensions were the typical jobs for the plumb bob. Its use helped the boatwright to control the shape of the hull as the planking was assembled. A final examination of the hull shape was made after the planks were assembled, possibly prior to the insertion of the beams. Any flatspots or asymmetries that were found were then highlighted with red ochre and corrected with adzes. As Haldane suggested, the plumb bob was probably used from the onset of construction to set up a centerline and thereafter to check symmetry. Its employment may have been critical for the
reproduction of traditional Egyptian hull designs. Clarke's observation of the use of a plumb bob and line by Egyptian boatwrights in the early 20th century A.D. to establish a center line indicates that construction methodology employed during the Old Kingdom continued to be used into the twentieth century, long after its disappearance from tomb reliefs.

The context of the majority of representations of plumb bobs demonstrates their use for leveling the hull in preparation for setting up the tightening truss. Its frequent appearance establishes that its function was essential for the precision operation of using the truss. The absence of plumb bobs in reliefs post dating the Old Kingdom may be related to the decline of the use of the truss due to changes in edge fastenings and the type and size of boats portrayed in reliefs.

Rope trusses seen in these reliefs serve a different function than those seen on seagoing ships and cargo vessels. As Haldane and Vinson have submitted, they were used to pull the ends of hull planking together so that transverse lashings could be tightened to a degree greater than possible under normal conditions. This would help overcome the forces of hogging. Its inclusion in five reliefs and preparations for its use in other reliefs strongly suggests that its employment was pervasive. It was probably essential for the construction of Egyptian vessels which utilized substantial transverse lashings for plank joinery. This technology likely led to the introduction and development of the hogging truss.

While the copying of reliefs was common in ancient Egypt, evidence for this practice is rare among reliefs depicting boat construction. The reliefs of many private tombs were made by the same artists who were responsible for royal monuments, but the lack of examples of reliefs depicting boat construction from royal funerary temples makes comparisons impossible. Proximity of tombs to one another is the common factor among the few known examples of this custom during the Old Kingdom; the Rā'hotep and Itet reliefs and the Ty and Mereruka reliefs.

The basic hull shape of many of these boats appears the same except for the configuration of the ends. Frequent depictions of sculpting them with chisels and adzes emphasizes the importance of their appearance. Purely utilitarian vessels were always depicted with simple, squared ends. Five different
hull shapes were represented being used by tomb owners in mastabas of the IVth and Vth Dynasty, while this is reduced to two shapes in some VIth dynasty tombs.

Rectangular sections of lashing, used to help fasten together the ends of the hull, were visible along the sheer of outfitted boats, but do not appear in the reliefs. These areas may have been covered by rectangular pieces of wood as seen on the Khufu I barge. Variations in the position and arrangement of these features indicate differences in the construction of hulls.
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APPENDIX 1

CATALOG OF TOMB RELIEFS DEPICTING WOODEN BOAT HULL CONSTRUCTION

The following is a list of all known examples of Egyptian boat construction reliefs. Emphasis is given to reliefs dating to the Old Kingdom period. Included are records of known primary sources for drawings, photographs, and any complete reports on the entire tomb. Summaries of the contents of each relief and its important aspects are listed. Some drawings of the reliefs are included to provide a complete illustration of the entire relief.

Much of this list was obtained from the "compiled lists of selected scenes," in Porter, Moss, and Mélek, Topographical Bibliography of Ancient Egyptian Hieroglyphic Texts, Reliefs, and Paintings III i, ii and J. Sliwa, Studies in Ancient Egyptian Handicraft: Woodworking, 73-74. Other references were found simply by methodically searching through texts and journals, which involved some luck.

This catalog is intended to assist anyone researching these reliefs by saving them the time of trying to locate the best reference or source. I have tried to make it as complete as possible but I certainly hope there are still more of these reliefs waiting to be discovered in Egypt or simply relocated in the basement of a museum or in someone's notes and drawings.

I adopted the chronology used by Harpur in her book Decoration in Egyptian Tombs of the Old Kingdom p. 33-35, 265-84.

The abbreviation PM III i 27 (5) means Porter and Moss, volume III part 1, page 27, section 5.
Tomb of Itet and Neferma'et

Dynasty: IV.1

Original Provenance: Maidûm tomb no. 16

Present Location: Munich, Germany

Line Drawings: W.M.F. Petrie, Medium (London 1898) pl. 25

Sources: Petrie; PM IV 93.

Registers: 2

Intact area of relief at time of documentation: 35%

Hulls: 2 fragmentary

Workers: 5

Tools: Adze - boatwright's (2)
       Mallet (2)

Activities: Pulling lashing
            Adzing
            Chiseling

Hieroglyphs: "remove the red"
             more

Sequence Direction: top to bottom (?)

Notes: - Earliest known boat construction relief
Tomb of Re'hotep

**Dynasty:** IV.1-2

**Original Provenance:** Maidûm tomb no. 6.

**Present Location:** Cairo Museum, Egypt. Two fragments of the relief (no. 15756) in Staatliche Museen zu Berlin, Germany.

**Painting:** W.M.F. Petrie, *Medum* (London 1892) pl. 11

**Sources:** Petrie 23, 37; Y. Harpur, "The Identity and Positions of Relief Fragments in Museums and Private Collections: The Reliefs of R'-htp and Nfrt from Meydum," *JEA* 72 (1986) 32-35; *PM* IV 91.

**Registers:** 1

**Intact area of relief at time of documentation:** 85%

**Hulls:** 1 - papyriform

**Workers:** 4

**Tools:** Adze - boatwright's (1)
   Chisel & mallet (1)

**Activities:** Pulling lashing
   Adzing
   Chiseling

**Hieroglyphs:** "to chisel"
   "lashing"
   more

**Notes:** - Probably a copy of the second register of the Bet relief
   - One of the earliest examples of low base relief sculpture
Relief Fragment from the Tomb of Hemyunu

**Dynasty:** IV.2

**Original Provenance:** Giza tomb G 4000

**Current Location:** Museum of Fine Arts, Boston.
   Inventory # 25-12-301

**Line Drawings:** W.S. Smith, "The Origin of Some Unidentified Old Kingdom Reliefs," *AJA* 46 (1942) 527-28, fig. 14

**Sources:** Smith 527; G.A. Reisner, *A History of the Giza Necropolis* (London 1942) 350, n. 1; *PM III* i 123.

**Registers:** -

**Intact area of relief at time of documentation:** >1%

**Hulls:** -

**Workers:** 1 fragment

**Tools:** Adze - carpenter's (1)

**Activities:** Adzing

**Hieroglyphs:** -

**Notes:** Smith, "... (I) think it must come from one of the contorted figures of craftsman in a boat-building scene."
Three unprovenanced Relief Fragments

**Dynasty:** IV.2-4

**Original Provenance:** Unknown. Possibly a tomb in Giza (*DETOK* 84). Part of fill material from the Pyramid of Amenemhêt I at Lisht.


**Line Drawings:** H. Goedicke, *Re-Used Blocks from the Pyramid of Amenemhet I at Lisht* (Metropolitan Museum of Art 1971) 118-21.

**Photographs:** Goedicke 118-21.

**Sources:** Goedicke 118-21; *DETOK* 84; *PM* IV 77-79.

**Register:** 3 (?)

**Intact Area of Relief at Time of Documentation:** 5% (?)

**Hulls:** 1 fragment

**Workers:** 2 incomplete

**Tools:** Saw - One handed (1)

**Activities:** Processing log

**Hieroglyphs:** Fragment

**Notes:** - Sculpture of exceptional quality, very detailed. Possibly belonged to royal monument. A tantalizing fragment!
Chapel of Prince Khuenrê'

Dynasty: IV.5
Location: Giza tomb MQ 1

Line Drawings: Thesis


Registers: 2

Intact area of relief at time of documentation: 100%

Hulls: 4; 1 papyriform, 1 animal head, 1 square ended, 1 pointed stern

Workers: 29

Tools: Plumb bob (3)
  - Adze - boatwright's (4)
  - Adze - carpenter's (5)
  - Axe (3)
  - Chisel & mallet (4)
  - Staff (1)

Activities: Checking hull symmetry with plumb bob
  - Leveling hull
  - Tightening truss
  - Smoothing hull with adzes and axes
  - Fabricating tenons or treenails

Hieroglyphs: "boatwright" (3)
  "chiseling?"

Sequence Direction: Overall: bottom to top. Upper register: left to right

Sequence Direction: bottom to top. Upper register - left to right

Notes: - Unique depiction of leveling the hull prior to setting up the tightening truss.
  - First extended composition of workshop pursuits
  - Animated, lively scenes
Relief Fragment from the Tomb of Duaenre

**Dynasty:** IV.6

**Original Provenance:** Giza tomb 5110

**Current Location:** Possibly in Museum of Fine Arts, Boston.

**Line Drawings:** Unpublished


**Notes:** Reisner notes, "...(A craftwork or boat-building scene) is suggested by fragments from the chapel of Duwanera."
Tomb of Sekhemkare’

**Dynasty:** V.2

**Original Provenance:** Giza tomb LG 89

**Current Location:** Unknown

**Line Drawings:** Y. Harpur, "The Identity and Positions of Relief Fragments in Museums and Private Collections. Miscellaneous Reliefs from Saqqara and Giza," *JEA* 71 (1985) 41, fig. 10; S. Hassan, *Excavations at Giza IV* (Cairo 1943) 110.

**Sources:** Hassan 106-10; Harpur 40-42; *DETOK* 110; *PM III i* 233 (1)

**Registers:** 1

**Intact area of relief at time of documentation:** 70%

**Boat hulls:** 1 - square ended

**Workers:** 4

**Tools:** Plumb bob? and staff (1)
- Adze - boatwright’s(2)
- Mallet and chisel? (1)
- Axe (2)

**Activities:** -Processing log
-Adzing hull
-Scultping end of hull

**Hieroglyphs:** 2 ideograms

**Sequence Direction:** left to right

**Notes:** Earliest known sequence of browsing goats, tree felling, and wooden boat building. (*DETOK* 110)

- Standing figure with staff might have been carrying plumb bob on a line. A piece of line hangs from right side of his hand in Hassan’s depiction.
Tomb of Nüfer and Kaha

**Dynasty:** V.6

**Location:** Saqqâra

**Line Drawings:** Thesis


**Sources:** Moussa and Altenmüller 27; PM III ii 640 (3).

**Registers:** 1

**Intact area of relief at time of documentation:** 95%

**Hulls:** 1 - animal head

**Workers:** 5 Working on hull

: 6 Launching hull

**Tools:** Stone hammer (1)

**Activities:** Tightening Lashings

: Pounding lashings with stone hammer

: Removing tightening truss

: Launching hull

: Monkeying around

**Hieroglyphs:** none

**Notes:** Hulls were launched before mast and canopy installed.
Tomb of Ni’ankh-khnum and Khnemhotep

**Dynasty:** V.6-7

**Location:** Saqqâra

**Line Drawings:** A.M. Moussa and H. Altenmüller, *Das Grab des Nianchchnum und Chnumhotep* (Mainz 1977) fig. 8.

**Photographs:** Moussa and Altenmüller pl. 21.

**Sources:** Moussa and Altenmüller 74-75; PM III ii 642 (7).

**Registers:** 2

**Intact area of relief at time of documentation:** 90%

**Boat Hulls:** 1 papyriform

**Workers:** 9

- 2 Chopping down tree
- 8 Carrying log

**Tools:** Plumb bob and staff (1)

- Adze - boatwright’s (1)
- Adze - carpenter’s (3)
- Saw - Two handed (1)
- Chisel & mallet (1)
- Axe (2)

**Activities:** Making tenons and/or treenails

- Chopping down tree
- Carrying log with slings
- Sawing planks
- Adzing piece of planking for sheer strake

**Hieroglyphs:** "remove the red"

"fabrication of the sht parts by the carpenter"

**Sequence direction:** top to bottom, lower register - edges of relief move towards hull at center

**Notes:**

- Upper row of relief depicts goats eating leaves off the trees and the trees being chopped down.
- Eight men to carry one log. What does this tell us about the size of the trees available for boat construction?
- Holes in the axe blades.
- Relief depicting the carpenter’s shop includes a worker with an adze and plumb bob.
Tomb of Tepem'ankh

**Dynasty:** V.6-9

**Original Provenance:** Abūsīr

**Current Location:** Berlin Museum, Germany

**Line Drawings:** Thesis

**Photographs:** L. Borchardt, *Das Grabdenkmal des Königs Ne-User-Re* (Leipzig 1907) 123, pl. 103b.

**Sources:** Borchardt 29-30, 122-23; *PM* III i 343

**Registers:** 1

**Intact area of relief at time of documentation:** 50%

**Hulls:** 2 1 rounded end

**Workers:** 9 fragmentary

**Tools:** Plumb bob and staff (1)
Chisels (2)
Adze - boatwright's (1)

**Activities:** Chiseling
Adzing

**Hieroglyphs:** none

**Sequence Direction:** Left to right

**Notes:** - One hull lacking central portion of sheer strake
- Unique depiction of two supports stacked together on left end of right hull
**Tomb of Ra’shepses**

**Dynasty:** V.8

**Location:** Saqqara tomb LS 16

**Line Drawings:** R. Lepsius, *Denkmäler aus Aegypten und Aethiopien* III ii (Berlin 1849-1859) pl. 61; J. Vandier, *Manuel d'archéologie égyptienne* V (Paris 1969) 673, fig. 268.

**Source:** *PM* III ii 495 (6); J. Vandier, *Manuel d'archéologie égyptienne* V (Paris 1969) 672-74.

**Registers:** 2

**Intact area of relief at time of documentation:** 40%

**Hulls:** 3

**Workers:** 12

**Tools:** Saw - one handed (1)
Adze - carpenter's (2)
- boatwright's (1)?
Plumb bob and staff (1)

**Activities:** Adzing hull
Manufacturing battens
Fabricating fasteners
Sawing planks (?)

**Hieroglyphs:** Yes

**Notes:** - Relief destroyed. Only one known drawing of relief
- Long supports at bow and stern of each hull
- Composition of scenes and figures unique
Tomb of Ty

**Dynasty:** V.8-9

**Location:** Saqqāra tomb D 22

**Line Drawings:** H. Wild, *Le Tombeau de Ti* Fascicule II (Cairo 1953) pls. 128, 129.


**Registers:** 3

**Intact area of relief at time of documentation:** 85%

**Hulls:** 5 : 2 papyriform, 1 square end, 1 round end, 1 pointed

**Workers:** 53

**Tools:** Axe (2)

- Saw - two-handed (1)
- one-handed (2)
- Adze - boatwright’s (4)
- carpenter’s (18)
- Chisel and mallet (13)
- Plumb bob and staff (1)

**Activities:** Processing log

- Sawing planks
- Cutting mortises for mortise-and-tenon joints
- Adzing
- Attaching planks with mortise-and-tenon joinery
- Cutting notches for oars
- Manufacturing seam battens
Ty Cont’d

Activities cont’d:

Shaping truss stanchion
Sculpting ends of hull with chisels and a saw


Sequence Direction: Bottom to top. Lower register - ends of relief move towards hull in center

Notes: - Beautiful!
- Best known boat construction relief. Extensively published
- Porter and Moss list a second wooden boat construction relief (PM III ii 473 (35)) among a scene of outfitted boats (Épron and Daumas [1939] pl. 39). An occurrence of two reliefs within the same tomb does not occur in any other mastaba. An examination of this relief and accompanying hieroglyph by John Darnell of the Oriental Institute indicated to him that it actually depicts the assembly of a bed. See the Mastaba of Meruka I pl. —. Letter from John Darnell May 16, 1995.
- Various spellings: Ti, Ty, Tiy, Tiye, Tij, Mr. T
Fig. 76 The two lower registers of the Ty
Fig. 77 The upper register of the Ty relief (}
relief (Wild [1953] pl. 128)
**Tomb of Khunes**

**Dynasty:** V.8-9?

**Location:** Zawyett el-Maiyitin tomb no. 2

**Line Drawings:** A. Varille, *La tombe de Ni-Ankh-Pepi À Zdouyet el-Mayettn* (Cairo 1938) 15; R. Lepsius, *Denkmäler aus Aegypten und Aethiopien* IV ii (Berlin 1849-1859) pl. 108; P. Johnstone, *The Sea-craft of Prehistory* (Cambridge 1980) 70, fig. 7.6. Thesis (incomplete)

**Sources:** Varille 15; *PM IV* 135 (9).

**Registers:** 5

**Intact area of relief at time of documentation:** 75%

**Boat Hulls:** 4 - 1 papyriform, 1 - rounded ends, 2 fragmentary

**Workers:** 19+ Working on hulls

- 4+ Carrying log
- 2 Adzing and chiseling log
- 3 Chopping log
- 1 Chopping down tree

**Tools:** Plumb bob and staff (1)
- Adze - boatwright's (2)
- Adze - carpenter's (3)
- Chisel and mallet (4)

**Activities:** Chopping down tree
- Processing log
- Fashioning hull element
- Transporting log
- Making tenons and/or treenails
- Tightening truss
- Tightening lashing
- Adzing
- Chiseling

**Sequence Direction:** top to bottom, lower register - right to left

**Notes:** - Described as the only complete boat construction sequence.
  - Very diverse and unique assortment of supports for boat hulls.
  - two sizes of boatwright's adzes
Tomb of Kakhent

**Dynasty:** V.8-9

**Location:** El-Hammâmîya


**Source:** Mackay 32; W.S. Smith, *A History of Egyptian Sculpture and Painting in the Old Kingdom* (New York 1978) 216; *PM* V 7 (18).

**Registers:** 4

**Intact area of relief at time of documentation:** 15%

**Hulls:** 1 (?)

**Workers:** 6

**Tools:** Axes (?) (2)

**Activities:** Sawing planks
  Processing log (?)

**Hieroglyphs:** none visible

**Sequence Direction:** bottom to top

**Notes:** - Poor condition when recorded
- W.S. Smith, "There were craftworks scenes as well, probably boat-building."
Tomb of Fetekta

Dynasty: V.6-VI

Location: Between Abúsír and Saqqára tomb LS I


Source: PM III i 351 (5)

Registers: 2

Intact area of relief at time of documentation: 15%?

 Hulls:

 Workers: 4

 Tools: chisel and mallet

 Activities: chiseling
          tightening truss

 Hieroglyphs: none

 Notes: - Unique depiction of cable crossing over two forked stanchions at the end of the hull
Tomb of Kaem'ankh

**Dynasty:** VI

**Location:** Giza tomb G 4561

**Photographs:** H. Junker, *Giza IV* (Leipzig 1940) pl. 10.

**Sources:** Junker 73-75; W.S. Smith, *History of Egyptian Sculpture and Painting in the Old Kingdom* (New York 1978) 213, 349; *PM III* i 132.

**Registers:** 1

**Intact area of relief at time of documentation:** 100%

**Hulls:** -

**Workers:** 3

**Tools:** Axe (1)
  Adze (1)
  ? (1)

**Activities:** Processing logs

**Hieroglyphs:** Numerous

**Notes:** - Lists boats and boat parts
  - Workers very stylized (stickmen)
Unprovenanced Relief Fragment No. 994

**Dynasty:** VI

**Original Provenance:** Giza.

**Present Location:** British Museum, London. No. 944


**Sources:** James 26; *PM III* i 309 (47)

**Registers:** 1

**Intact area of relief at time of documentation:** 25% (?)

**Hulls:** 1

**Workers:** 2 working on hull
- 2 processing log
- 4 carrying log
- 1 chopping down tree

**Tools:** Chisel (1)
- Axe (1)
- Sling

**Activities:** Chopping down tree
- Carrying log
- Processing log
- Chiseling

**Hieroglyphs:** none

**Sequence Direction:** right to left

**Notes:**
Mastaba of Mereruka

**Dynasty:** VI.1

**Location:** Saqqâra

**Line Drawings:** Thesis

**Photographs:** P.W. Wreszinski, *Atlas zur altdgyptischen Kulturgeschichte* III (Leipzig 1942) pl. 37. The Oriental Institute at the University of Chicago negative no. P.18976/N.10983, Sakkarah Expedition field negative no. 37 (unpublished);

**Painting:** Duell et al., *The Mastaba of Mereruka* II (Chicago 1938) pl. 152

**Sources:** Duell et al., *The Mastaba of Mereruka* I, II (Chicago 1938); *PM* III ii 532 (76).

**Registers:** 1

**Intact area of relief at time of documentation:** 85%

**Boat Hulls:** 2 stylized papyriform

**Workers:** 12

**Tools:** Plumb bob (1)
- Rope (1)
- Adze - carpenter's (6)
- Chisel & mallet (1)
- Wooden pounder? (2)

**Activities:** Examining hull symmetry with plumb bob and rope
- Pounding planking
- Adzing (3)
- Chiseling (1)

**Hieroglyphs:** "(see)... the *shabet* boats of *ished* wood by which he will be able to land in the excellent West, by the boatwrights of his kingdom"

**Sequence Direction:** left to right (?)

**Notes:**
- Unique depiction of measuring hull with plumb bob and rope.
- The only other tool in the right half scene beside the plumb bob is the adze, carried by three of the six men.
- Scene of pounding plank section may have been copied from Ty relief.
Relief (After Duell [1938] pl. 152)
Tomb of Ibi

**Dynasty:** VI.4

**Location:** Deir el Gebrāwi tomb no. 8

**Line Drawings:** N. de G. Davies, *The Rock Tombs of Deir el Gebrāwi* Part 1 (London 1902) pl. 13-16.

**Sources:** Davies 20-21; *PM IV* 244 (13).

**Registers:** 1

**Intact area of relief at time of documentation:** 90%

**Hulls:** 2; 1 round ends, 1 trapezoidal stern

**Workers:** 9 working on hulls
- 3 chopping on logs
- 4 carrying log

**Tools:** Axe (5)
- Chisel and mallet (6)
- Sling (1)

**Activities:** Carrying log
- Chopping/ hewing logs
- Shaving hull end with axe
- Chiseling

**Hieroglyphs:** "Lo, I am chiseling"
- "The axe(?)-it cuts home, I am about to see something good"
- "carpenters chiseling"
- others not translated

**Notes:** Very simple
- Only two types of metal tools (no adzes)
- Simple hulls but one shape is unique
Tomb of Za’u

Dynasty: VI.4

Location: Deir el Gebrawi tomb no. 12


Sources: Davies 11; *PM IV* 245 (8).

Registers: 1

Intact area of relief at time of documentation: 50%

Hulls: 2 1 pointed ends, 1 fragment

Workers: 5 working on hull
  4 carrying log

Tools: Chisel and mallet (3)
  Adze - carpenter's (1)
  Axe (1)

Activities: Carrying log
  Adzing truss stanchion
  Chiseling

Hieroglyphs: "striking"
  "working with the chisel"
  "shaping(?) a paddle" (possibly shaping a stanchion)
  "boat-building (caulking?)"
  "workmen belonging to the tomb-estate"

Notes:
Boat Construction Reliefs after the Old Kingdom

Middle Kingdom

Tomb of Khemhotep III - P.E. Newberry, *Beni Hassan I* (London 1893) pl. 29; J. Champollion, *Monuments de l’Égypte et de la Nubie* (Geneva 1970) pl. 356; *PM IV* 148 (20). There are numerous renditions of this relief and every one is different.

New Kingdom


Archaic Period

Tomb of Ibi - K. Kuhlmann and W. Schenkel, *Das Grab des Ibi, Obergutsverwalters der Gottesgemahlin des Amun* (Mainz 1983) pl. 103; *PM I* i 65 (8)

Tomb of Mentuemhêt(?), Brooklyn 51.14 - J.B. Cooney, *Five Years of Collecting Egyptian Art* (Brooklyn 1958) 29-30, pl. 54; R. Fazzini, *Miscellanea Wilbouriana* (Brooklyn 1972) 60-62, fig. 28; *PM I* i 60.
APPENDIX 2

AN ESTIMATION OF THE LENGTH OF THE BOATS DEPICTED IN
THE TOMB OF TY

In order to get some idea of the size of the hulls being built in the reliefs, an estimation was calculated based on the number of rowers on the outfitted boats and the interscalium distance of a roman ship, the unit of length in an oared ship between one tholepin and the next in a fore-and-aft file of oarsmen. This distance certainly varied among vessels of different times and cultures, but the Roman distance will provide a rough estimate of the length of the hulls.

Fig. 79. Boat with rowers. (Épron and Daumas [1939] pl. 49)

No. of rowers: 11

Inter Scalium distance: .888 m.

Estimated length of bulwark: 9.768 m

The length of the hull is determined by measuring the length of the boat and comparing its size in proportion to the bulwark.

Length of bulwark: 7.5 cm

Length of hull: 12.3 cm

\[
\frac{7.5}{9.768} \times x = 16.024
\]

Estimated hull length: 16 m

332 This information was recorded by Vitruvius, a Roman architect. J.S. Morrison and J.F. Coates, The Athenian Trireme (Cambridge 1986) 134.
APPENDIX 3

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7 April 1995

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H. Wild, Le tombeau de Ti fascile II: Première partie (Cairo 1953) pls. CXXVIII, CXXIX.

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