THE DASHUR BOATS

A Thesis

by

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August 1984

ABSTRACT

The Dashur Boats (August 1984)
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The discovery of six boats buried beside the brick pyramid of Sesostris III at Dashur, Egypt, has allowed archaeologists a rare glimpse into Egyptian hull construction techniques. Since the 1894 and 1901 excavations of a total of four known hulls, no detailed examination of the boats has been published. Personal observation and recording of the boats in Chicago and Pittsburgh revealed unique characteristics of the hulls, including the first use of deep mortise-and-tenon joints in hull construction. These boats from Dashur provide an extraordinary opportunity to study four contemporaneous Bronze Age hulls--an opportunity as yet unequaled in nautical archaeology.

ACKNOWLEDGMENTS

The support of many people has made my research an easy task. J. Richard Steffy has been indefatigable in providing advice and gently suggesting alternatives to sometimes extraordinary statements. George F. Bass provided the inspiration for this thesis in his preclassical seafaring course, and Edward J. Soltes supplied appreciated assistance in identifying a wood sample. Testing of paint samples for elements of their composition was made possible by Dennis James of the Center for Trace Characterization, Texas A&M University.

The staff members of the Chicago Field Museum of Natural History and the Carnegie Museum of Natural History responded quickly to my requests to record the Dashur boats curated by these museums. Glen Cole and the exhibition staff of the Chicago Field Museum were particularly helpful, and James B. Richardson III, Claudia Medoff, and David R. Watters of the Carnegie Museum allowed me to visit the hull in storage there on short notice and have continued an interest in this study.

To my friends, especially K.C. Smith who read a first draft, and to my parents, thank you for your unending support. And to my husband, Douglas Haldane,

who recorded my observations, served as my photographer, edited this manuscript, cooked dinner, washed the dishes, and helped me to stay rational, this is for you.

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INTRODUCTION

The ancient Egyptian fascination with death and the afterlife is readily apparent in both the massive pyramids of the pharaohs and the tombs and graves of their subjects. Objects intended for the use of the dead accompanied burials since predynastic and early dynastic times when tools, pottery containers, and food were included in tombs. Full-sized wood and clay models representing flint and stone materials were also found with predynastic burials.

Egyptian tombs were frequently divided into an offering place and a burial place. Towards the end of the Third Dynasty, painted reliefs on the walls of the offering place replaced actual objects. During the Fourth and Fifth Dynasties, paintings of everyday life covered the tomb walls. Cultivation, harvesting, cattle herding, cooking, hunting, and fishing all had a place in the sustenance of the spirit. Breasted (1919: 69) wrote,

> "The inner walls...bore scenes carved in relief, depicting the servants and slaves of the deceased at their daily tasks on his estate; they plowed and sowed and reaped; they pastured the herds and slaughtered them for the table; they wrought stone vessels or they built Nile boats--in fact they were drawn in field and workshop producing all those things were were necessary for their lord's welfare in the hereafter."

This thesis follows the style of the International Journal of Nautical Archaeology and Underwater Exploration.

During the Fourth Dynasty, massive boat pits were constructed at the bases of royal pyramids: five at the pyramids of Khufu and Khafra at Giza, one at the pyramid of Djedef-Re at Abu-Rowash, one at the pyramid of Shepseskal, and one beside the pyramid of Khent-Kaw-s (Abubakr and Mustafa, 1971: 15). Until 1954, only fragments of gilt and chips of wood had been discovered in these pits, but during the removal of twenty meters of sand from the east face of the pyramid of Khufu, a sealed boat pit was uncovered. A dismantled 42 meter-long ship had been buried there for 4,500 years. To date, this is the largest and oldest Egyptian boat recovered, although it is not the first complete example of ancient Egyptian boatbuilding. After the Fourth Dynasty, boat pits were no longer constructed.

Early in the Sixth Dynasty, statuettes of servants performing their duties were placed in a serdab, or statue chamber, in the tomb. By the end of this period, the statuettes were interred with the mummy in the burial chamber itself. These servants, according to Winlock (1955: 5), worked eternally at their tasks, and the spirit of the deceased could enter any of the tiny portraits of himself to take advantage of their labor. Models of other activities-- --feasting, brickmaking, food preparation--also accompanied the burials. Reisner (1913: iv) noted that these models served the same

purpose as, and probably developed from, the painted scenes of the offering chamber. Boat models with full crews and rigging found in the burial chambers of many tombs would have allowed the dead man's spirit to sail upon the Nile as he had in life.

From the Sixth to the Twelfth Dynasty, the funerary boat also had a place among the models. The same boat type is seen in both models and painted representations. Wall paintings in the offering portion of the tombs frequently show a scene of boats being towed; this may well represent the journey of the funerary vessel to the western desert or to Abydos--centers of worship for Osiris, god of the dead.

After the Twelfth Dynasty, the soul was conceived as wandering with the sun god Re in the underworld after the death of the body. It was about this time that solar boats became important to Egyptian religious practices, and funerary boats were no longer required. Reisner (1913: iv) states that no funeral boat models accompanied the dead after the Twelfth Dynasty.

Midway through the Twelfth Dynasty, six wooden boats were buried in the sand near the brick pyramid of Sesostris III at Dashur. These boats provide important information about hull construction in Middle Kingdom Egypt, and although many major works mention the boats, a great deal of confusion exists even about the number

of boats excavated and their provenience.

While searching for an underground entrance to the pyramid in 1894, Jean-Jacques de Morgan discovered a large brick chamber, walled at both ends, buried beneath a huge pile of debris beyond the south tenemos wall of the pyramid. In the debris and rubble beside the chamber, he discovered and excavated three boats, each about 10 meters long (Fig. 1). About 100 meters south of these boats, another group of three vessels was found buried in the sand. De Morgan did not complete the excavation of these boats at that time, but he did remove one of several 10 meter-long sledges found with the second group (de Morgan, 1895: 81-3).

The boats were buried beneath the level of the diluvium gravels, and unbaked bricks supported the sides of the hulls. Steering oars were found on the decks of the boats, whose general preservation was good. Two of the excavated Dashur boats are displayed in the Egyptian Museum in Cairo; the third was purchased by Mrs. Cyrus McCormick of Chicago in 1896 and donated to the Chicago Field Museum of Natural History.

A fourth boat from Dashur was excavated sometime before July 1901, when it was shipped by steamer to the United States from Cairo. Andrew Carnegie donated the vessel to the Carnegie Museum of Natural History in Pittsburgh (Holland, 1902: 77-9) where it was displayed

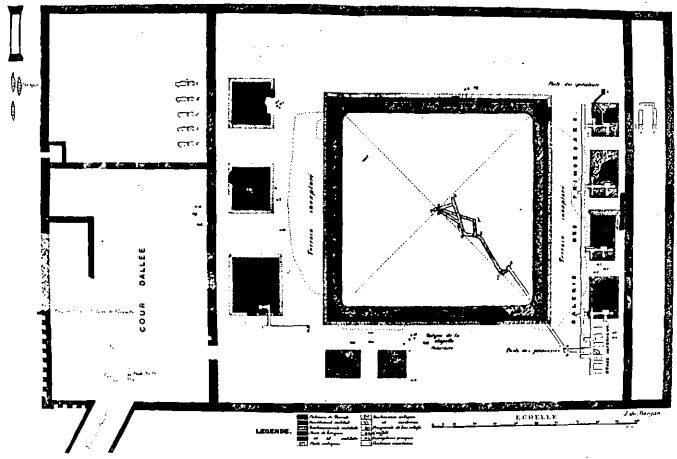

Figure 1. Plan of the brick pyramid of Sesostris III at Dashur (de Morgan, 1895: fig. 105). The boats may be seen in the upper left corner.

from 1905 to 1975. It is now disassembled and in temporary storage at the museum.

Based on the original proximity of the boats to the pyramid, it generally has been accepted that they served as funerary vessels for Sesostris III. Their shape and decoration show them to be of this type, but material found with the boats indicates that perhaps they were used in the funeral of one or more of the numerous non-royal persons buried near the pyramid. Objects found with the Pittsburgh hull indicate that it was used in the funeral of a master of royal water craft (Holland, 1902: 78; Magoffin and Davis, 1929: 53), and a rush basket of crudely shaped and finished miniature amphoras hardly suited for a king's burial was excavated with the Chicago hull and now is displayed with it.

Although certain constructional features and the appearance of the boats influenced Landström (1970: 90) to call them "wretched" and Jenkins (1980: 84) to describe them as "ill conceived and...hastily executed," my observation and recording of the Chicago and Pittsburgh hulls show them to be well-constructed examples of the boatbuilder's craft. The two hulls share many characteristics, although the Chicago boat is slightly larger. Individual pieces are carefully shaped and conform to a pattern which produces a shallow, beamy vessel comparable to the two displayed in Cairo, which

are formally identified by that institution as Cairo 4925 and 4926.

This thesis describes each of the four hulls and presents an analysis of their construction. Hull descriptions are based upon personal observation and recording of the hulls in Chicago and Pittsburgh, and upon printed descriptions of the two boats in Cairo.

These ancient boats from Dashur comprise the largest collection of contemporary ancient craft available to archaeologists. They provide priceless information about boatbuilding techniques of four thousand years ago and the most ancient examples of the use of deep mortise-and-tenon joints in hull construction. Regardless of a somewhat deteriorated condition today, the boats were deemed necessary for the successful journey of the soul of at least one ancient Egyptian buried beside the pyramid of Sesostris III at Dashur, and only careful examination of the boats themselves will aid in understanding their function.

THE CHICAGO BOAT

The Dashur boat acquired by the Chicago Field Museum is one of three excavated by de Morgan in 1894. The boat (Fig. 2) is 9.8 m long, 2.37 m wide and .72 m deep amidships. Constructed of thick cedar planks shaped into symmetrical strakes, it is fastened with dovetail fastenings and mortise-and-tenon joints. A thicker central strake, flush with the hull's outer surface, serves as its structural foundation. Throughbeams rest in notches cut into the upper edge of the third strake, and deck planking lies in grooves which run the length of the throughbeams. Dovetail fastenings and mortise-and-tenon joints secure a gunwale, with its individual planks lashed together, to the third strake. A single steering oar is displayed with the boat, and the two steering oar stanchions remain.

The Chicago hull is in generally good condition although surface erosion of the lower strakes is quite pronounced on the outer surface. While the outer surface of the upper strakes is better preserved, deterioration has occurred there as well. The greater deterioration of the lower strakes may be due to the increased force of the boat's weight upon them during its 4,000-year-long burial. The tip of the central

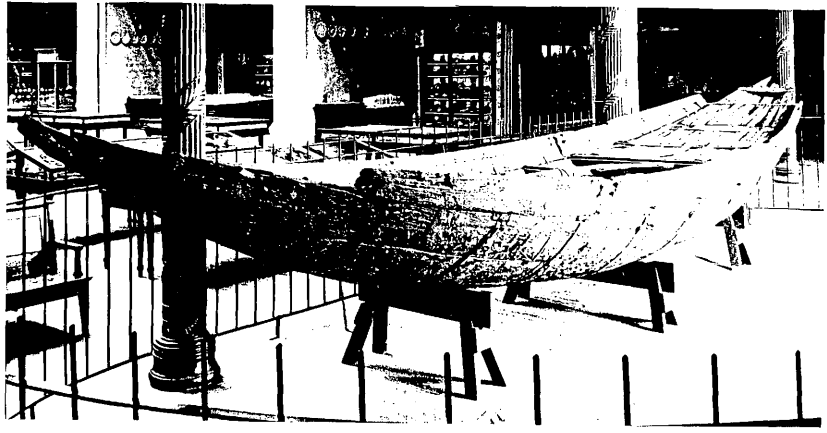

Figure 2. The Chicago Dashur boat. Photograph courtesy of the Chicago Field Museum of Natural History.

strake at the stern lacks at least 15 cm of its original length, as indicated by the uppermost strake (Fig. 2). Although the forwardmost ends of strake 3 are now missing, a reasonable indication of the strake's original length can be discerned from Fig. 2.

Tenons were replaced soon after the vessel's excavation because original fastenings had decayed. Only two throughbeams are original; the others are modern replacements. Iron bands which encircle the hull were nailed to it in Egypt to maintain its rounded curvature; the hull originally incorporated no metal. A white substance visible over much of the lower hull today was probably a modern addition to make the boat appear more ancient (Christine Danziger, personal communication). Early photographs of the boat show a hull nearly free of the compound.

Over the years planks have sagged outward, creating gaps of up to 7 cm between strakes. Only a few modern tenons were replaced within the mortises, and two boards about 15 cm high below the hull support its massive weight, splaying of planks is not unexpected.

Information provided in the following hull description was collected during two days of observation and 11 hours of hull recording. Offsets for body lines were taken from the port side, and dimensions of strakes, throughbeams, deck planking, fastenings, and

the steering oar and its stanchions were recorded. The description follows an approximate order of construction.

I have numbered strakes from the garboard up (1-3), and individual planks have been numbered consecutively from bow to stern; for example, strake 2-2 refers to the second plank aft of the bow in strake 2. Port and starboard are designated by P and S. Throughbeams in the Chicago hull only are lettered forward of midships (A-F) and numbered aft (1-6).

Dating

In 1951, W.F. Libby tested a wooden sample from a deck plank of the Chicago boat to determine the amount of carbon isotope 14 remaining. Other dating techniques had placed the death of Sesostris III about 1849 B.C., so this sample of known age could be used in the original calibration of radiocarbon dating (Collier, 1951: 6-7). The average of dates which resulted from Libby's testing placed the boat's age at 1671 $\pm$ 180 B.C. By 1971, the sample had been dated independently six times at five different laboratories, producing uncorrected dates ranging from 1699 $\pm$ 67 B.C. to 1800 $\pm$ 82 B.C.

The most recent tests, conducted in 1972 by Dr.

H.N. Michaels of the Museum Applied Science Center for Archaeology in Philadelphia, provide a radiocarbon date of 1953 ± 68 B.C., corrected for chronological distance by adding 200 years. Michaels explains the difference between this date and the accepted date of ca. 1850 B.C. for the death of Sesostris III as a function of the age of the tree from which the planks were cut. Based on the slight curvature of growth rings in the plank, he suggests that the plank was cut from wood removed 50-100 years from the bark (Michaels, 1972). Table 1 provides radiocarbon dates obtained by the different laboratories for samples taken from the same section of a single deck plank.

Table 1. Radiocarbon dates for the Chicago Dashur boat.*

Lab number	Uncorrected C-14 date	Corrected C-14 date
UCLA	1800 ± 82 BC	2000 ± 82 BC
BM-22	1678 ± 155 BC	1878 ± 155 BC
C-81	1790 ± 185 BC	1990 ± 185 BC
Libby C-81	1671 ± 180 BC	1871 ± 180 BC
GrN-1157	1699 ± 67 BC	1799 ± 67 BC
GrN-1178	1761 ± 62 BC	1961 ± 62 BC
P-1821	1753 ± 68 BC	1953 ± 68 BC
Averages	1747 ± 47 BC	1949 ± 47 BC

*data from Michaels, 1972

Central strake

The central strake, composed of three sections,

tapers towards bow and stern and swells slightly in the midsection of the boat (Fig. 3). Dimensions of each plank may be seen in Table 2. Total length of the strake is 10.21 m; its maximum width is 38 cm. This is the thickest strake used in construction, and the strake itself is thickest and widest from midships forward.

Table 2. Central strake dimensions in meters.

Plank	Length	Width at fwd. end	Width at aft end	Maximum width	Thickness
C1	2.87	.15	.31	.31	.12
C2	4.55	.32	.27	.39	.12 to .09
C3	2.79	.26	.15	.26	.09

The planks are butted against each other with long and narrow dovetails on the inner surface whose mortises have almost disappeared. There are no other fastenings visible in plank ends, but deep mortise and tenon joints in the strakes above unite the central strake to all others. Average mortise dimensions are 13 cm deep, 7.5-8 cm long, and 1.8 cm thick, in planks slightly over 30 cm broad. Not all mortises were accessible for examination by probing.

A series of three vertical mortises in the forward end of C1 begins about 15 cm from the bow extremity. Horizontal mortises for attachment of the ends of the third strake are cut to avoid passing through these vertical mortises (Fig. 4).

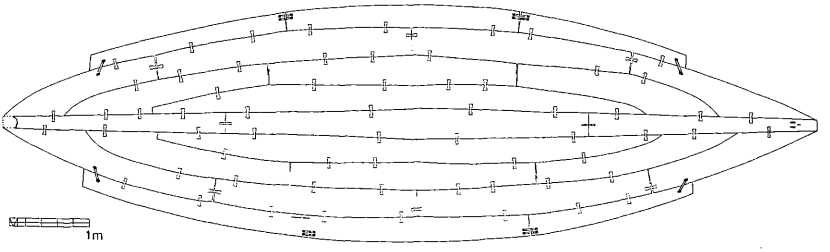

Figure 3. Flattened planking plan, Chicago Dashur boat. The bow is to the right.

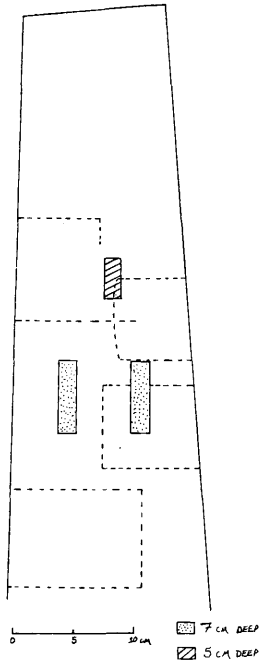

Figure 4. Mortises in C1 of the Chicago boat.

Bow and stern

Both bow and stern are narrow and about 40 cm higher than midships. Both ends probably were decorated in typical funerary vessel style with upright decorative posts. The C1 mortises suggest the manner of fastening forward; the after end of C3 is missing and eroded. No other means of fastening the decorative end posts is evident.

Round holes just forward and aft of the gunwales may indicate a crosspiece of the type present on Cairo 4925, see p. 77.

Throughbeams

Thirteen lateral supports stiffen the hull and bear the deck planking. Eleven throughbeams rest below the gunwale in notches cut into the upper strake and the gunwale; the remaining two lie across the hull in shallow grooves at bow and stern. Throughbeams spaced about 75 cm apart are flush with the outer surface of the hull (Fig. 5). Only throughbeams 5 and 6 are original; the others are replacements patterned after the original pieces and Cairo 4925 (p. 76). The two original throughbeams are in highly eroded condition, with knots protruding 2 to 4 cm above their surfaces in

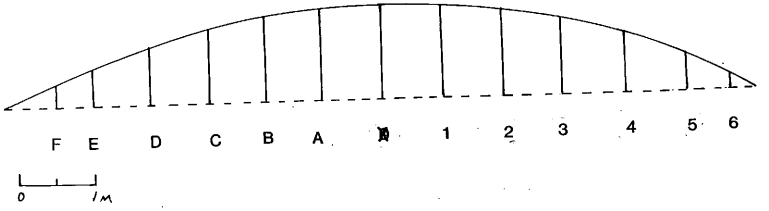

Figure 5. Throughbeam spacing of the Chicago boat.

some places. Nonetheless, preliminary dimensions are still available: each shows a width of about 12 cm and a thickness of 6 cm. Grooves for deck planking measure 3 cm long and 2.5 cm high (Fig. 6).

Throughbeams were originally fastened to strake 3 with rectangularly sectioned treenails about 2.5 cm by 3 cm, which now are disintegrated. Treenails passed diagonally through the wood and were probably flush with the outer hull surface. Treenail mortises can be seen below throughbeam notches.

Most notches are cut into strake 3 only; however, throughbeams A, midships, 1 and 2 have notches cut in the gunwale and strake 3 both port and starboard. Throughbeams 3, 4, and 5 under starboard gunwale section 3 also exhibit double notches. These double notches are poorly cut and may have been added to the hull during reconstruction.

In addition to being wider than any of its companion members, throughbeam 4 probably had large square mortises to allow passage of the stanchions that supported the steering oars. Throughbeam 5 has a series of mortises running through it vertically which may be related to securing the steering oars (Fig. 7) (Winlock, 1955: fig. 85U).

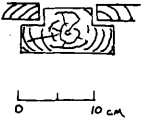

Figure 6. Throughbeam grooves and deck planks.

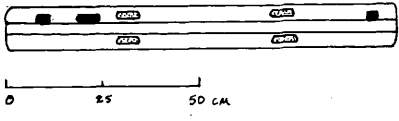

Figure 7. Throughbeam 5 of the Chicago hull. Top view.

Planking

The hull is built of seven strakes--a central strake and three strakes port and starboard. The central strake is fabricated in three sections, as are strake 2 and the gunwales. Strake 1 has two planks, and strake 3 has four. Each of the 27 planks was fashioned from the same type of wood and smoothly finished on the inside. The outer surface may have been smooth at one time, but the present surface condition prevents interpretation. The pieces range in length from 1 m to 4.5 m, with most about 3 meters long. Maximum recorded width is 42 cm, found on three different planks. Maximum breadth and maximum thickness occur in the forward half of the hull, where the planks overall are a few centimeters thicker and broader than aft of amidships.

By examining the flattened planking plan (Fig. 3, p. 14), the symmetry of the hull is easily discerned. At amidships, butt joints in strakes 1 and 3 are almost directly in line. Other butts in the hull are parallel to those on the opposite side, and planks below and above butt joints widen slightly to meet them. The narrowest part of a plank or strake is found at either a butt joint or at the point at which it runs into the central strake. Table 3 shows the distribution, length, width, and thickness of each plank.

Table 3. Planking distribution and dimensions for the Chicago boat.

Strake	Length	Maximum Width	Minimum Width	Thickness
P1-1	2.82 m	30.0 cm	27.0 cm	10.0-13.5 cm
P1-2	3.34 m	33.5 cm	10.0 cm	8.0-10.5 cm
S1-1	3.14 m	34.0 cm	19.0 cm	6.0-11.0 cm
S1-2	3.26 m	32.5 cm	26.0 cm	7.5-11.0 cm
P2-1	2.56 m	42.0 cm	20.0 cm	8.0- 9.5 cm
P2-2	3.10 m	36.0 cm	28.0 cm	9.0-11.5 cm
P2-3	2.89 m	26.0 cm	16.5 cm	8.5-10.5 cm
S2-1	2.57 m	23.0 cm	13.5 cm	10.0-11.0 cm
S2-2	3.08 m	33.0 cm	28.0 cm	8.5-10.0 cm
S2-3	2.95 m	39.0 cm	21.0 cm	8.3-10.5 cm
P3-1	2.26 m	34.0 cm	23.0 cm	7.0- 7.5 cm
P3-2	2.44 m	40.0 cm	35.0 cm	9.5-10.5 cm
P3-3	3.13 m	40.0 cm	36.0 cm	7.5-10.0 cm
P3-4	1.99 m	33.5 cm	30.0 cm	8.0- 8.5 cm
S3-1	2.07 m	31.5 cm	25.0 cm	8.0- 9.0 cm
S3-2	2.82 m	37.0 cm	29.0 cm	8.0- 9.0 cm
S3-3	2.80 m	39.0 cm	32.0 cm	10.0-10.5 cm
S3-4	2.40 m	34.0 cm	27.5 cm	8.2- 9.8 cm

All planks follow a straight grain, and many were cut from the center of the tree. Most had a shallow curve hollowed out of the inner surface. Plank edges are beveled in two different ways, resulting in a wider inner surface or a wider outer surface but retaining a regularity of shape. Adjacent planks are beveled in opposite directions producing a fit as seen in Fig. 8.

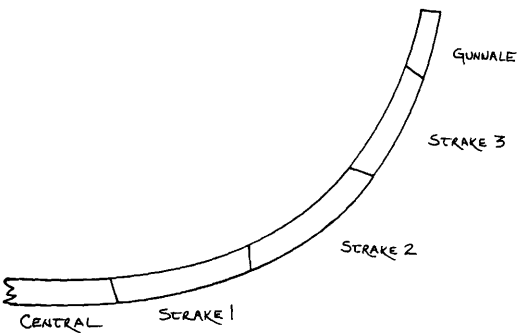

Figure 8. Planking edge diagram. Not to scale.

Fastenings and joins

Mortise-and-tenon joints, dovetail fastenings, and gunwale lashings are present in the Chicago hull. (See gunwale description, p. 28 for discussion of lashing.) The Dashur boats provide the earliest example of the use of deep mortise-and-tenon joints in ship or boat construction. Plank width averages about 30 cm, and mortises 8 cm to 12 cm deep on each plank edge receive tenons. Mortises 7.5 cm to 8 cm wide and 2 cm thick are sunk into planking edges and upper and lower edges of butt joins. Mortises are sunk only 5 cm deep into butt joins but are a normal depth in the strake above or below (Fig. 9). All planks within a strake are butted against each other and fastened by mortise-and-tenon joints at their upper and lower edges. In the forward part of the hull, mortises are about 12 cm deep in each plank; the central plank has 13-cm-deep mortises. Mortises in the after half of the hull measure 8 cm to 10 cm deep. Not all mortises could be examined, however, so these measurements may not be typical of all mortise-and-tenon joints. Tenons may have fit tightly within the mortises, although no original tenons could be located during the recording process to confirm this. Mortises are spaced regularly along planking edges--one on each side of a joint or as a part of it, and one on

each side of a throughbeam as well. Additional mortises are located about every 60 cm between these pairs.

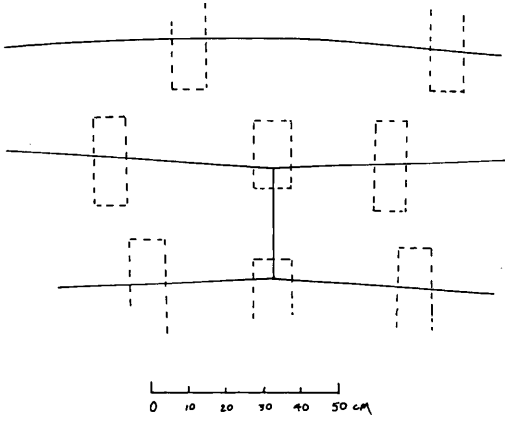

Figure 9. Butt with mortise-and-tenon joints.

As strakes 1 and 2 merge with the central strake, long, curving junctions develop. Joins at the stern in strake 1 are the exception: their ends are cut-off squarely and overlapped by strake 2. Strake 3 overlaps the curved end of strake 2 (Fig. 3, p. 14). Starboard strake 1-1 also exhibits a cut-off end, but starboard strake 2-1 is shaped as if to overlap a curved tip.

Mortises in these joins pass through several planks. For example, a mortise-and-tenon joint passes from strake 2 through the tip of strake 1 and into the central strake (Fig. 10).

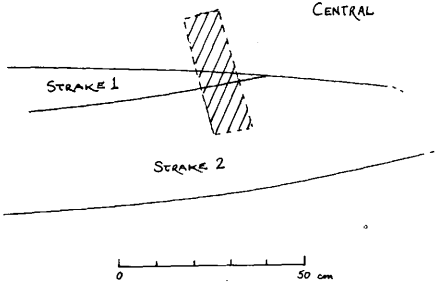

Figure 10. Strake tip fastening on the Chicago boat.

Dovetail tenons cross planking seams, central strake butt joints, and strake 3 butt joints on the inner surface of the hull. Typical dovetails measure 14 cm to 16 cm long, 5 cm wide at the ends, 2.5 cm to 3 cm wide at the narrow center, and 2 cm deep. Dovetails on planking seams are spaced about 80 cm to 100 cm apart. These dovetails follow the shape of the inner surface: they are generally flat, but angle sharply near bow and stern at the central strake. Precise measurements could not be obtained for central strake dovetail mortises. Dovetails across strake 3 butt joints are placed approximately in the center of the joint or slightly higher.

Gunwale

The gunwale encloses the deck area of the boat from throughbeams E to 5. Total length of the port gunwale is about 7.11 m; the starboard gunwale measures 7.02 m. Both gunwales are about 9 cm thick with a maximum width of 30 cm at amidships over the strake 3 butt. Each is constructed of three planks lashed through double holes in plank ends at butt joints (Figs 3, p. 14, and 11). Mortise-and-tenon joints, lashing through diagonally placed mortises, and dovetail fastenings secure the gunwale to strake 3. Edgerton (1923: 128) counted 23

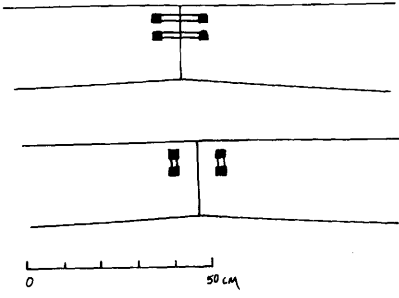

Figure 11. Gunwale lashing holes. The inner surface of the gunwale (above) and the outer surface (below).

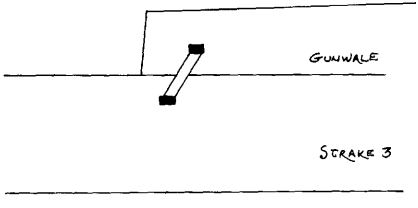

Figure 12. Diagonal lashing holes in the gunwale and strake 3.

mortises and eight dovetails spaced along the gunwale; my observations verify the number of dovetails.

Lashing between strake 3 and the gunwale binds the gunwale tightly to the body of the boat. Holes 2.5 cm high and 3 cm wide pass through strake 3 and the gunwale at both stem and stern and create a diagonal lashing groove 16 cm long and 2 cm deep (Fig. 12). Lashing between plank ends passes through two holes 2.5 cm high and 3 cm wide in the end of each plank; the holes are connected by a horizontal groove across the two planks on the inner surface, and a vertical groove connects holes in the same plank on the outer surface. Shallow mortises 5 cm long, 1.8 cm wide, and 5 cm deep on each section end are found on the gunwale's upper face. These fastenings are similar to mortise-and-tenon joints at butts in planking strakes (Fig. 9, p. 24).

Four slots pass diagonally through the upper face from its center outwards. These mortises are 7.5 cm long and 1.8 cm wide, and are located about 50 cm from each end of the gunwale both port and starboard.

Like the strakes, the gunwale widens slightly over butt joints in the strake below it, but is slightly more narrow at its own butts.

Steering oar and stanchions

The boat had the typical steering arrangement of Egyptian funerary vessels, with one oar on each side of the stern. Two large stanchions, connected by a crosspiece, supported the upper ends of the steering oars (Fig. 13). A crosspiece just aft of the gunwale probably extended over the sides of the hull and supported the lower end of the oar looms. The stanchions passed through a square hole in throughbeam 4 and rested on the hull surface. One steering oar and two stanchions are exhibited with the boat.

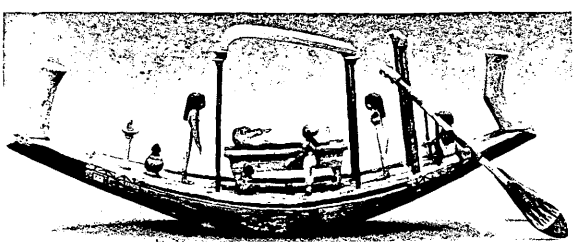

Figure 13. Typical steering oars and stanchions as seen on a funerary boat model (Glanville, 1972: pl. IIIb).

The round-tipped steering oar is 3.98 m long with a blade length of 1.42 m (Fig. 14). Its loom is slightly curved and was hewn from the center of a tree. The round cross section flattens about 1.36 m above the lower terminus of the blade and forms a central area of rectangular section between the two blade halves. An 11 cm-long slot running diagonally through the loom about a meter below its upper end probably held a tiller. A small tenon on the upper end of the loom may have been for the attachment of a decorative hawk's head.

The two blade halves of the oar are tenoned to the loom at three points on each side in mortises 7 cm long spaced about 40 cm apart. One blade section is broken, but a maximum width of 64 cm was determined for a point 50 cm from the butt end. The blade is thickest near its upper end, 8 cm, narrowing to 5 cm at the butt end, and 3 cm on the lower blade edge. One blade half has a 3 cm by 2.5 cm hole cut through its center about 45 cm from the top of the blade. Several boat models also exhibit this hole; a rope runs through it and back to the stanchions to secure the steering oar to the hull.

The two stanchions measure 2.02 m and 1.62 m in length; Bartlett and Hobbs (1897: 9) noted that both measured slightly under two meters. The upper end of the shorter stanchion appears to have been cut or sharply broken off. Stanchions are round in section,

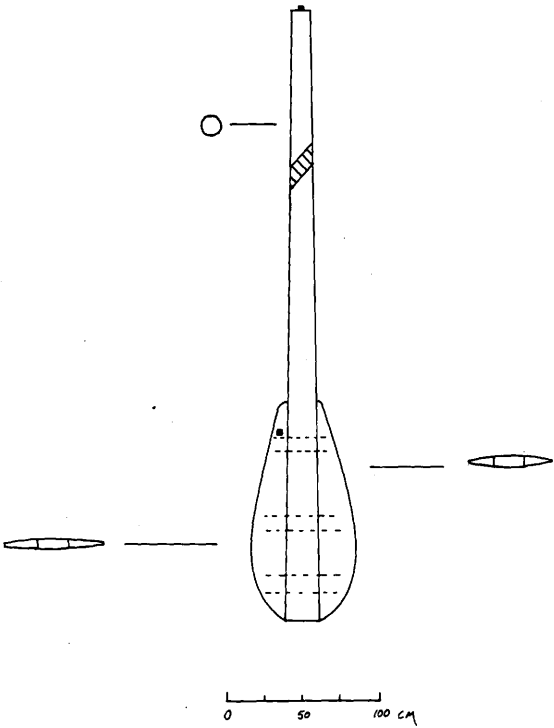

Figure 14. The steering oar from the Chicago boat.

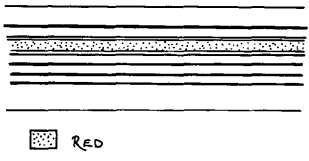

Figure 15. Gunwale decoration of the Chicago boat.

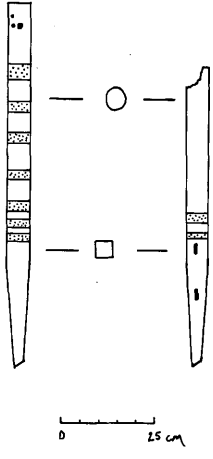

Figure 16. Stanchion patterning, Chicago Dashur boat.

gradually thickening and becoming flattened to a nearly square section about 55 cm from the beveled lower end which rested on the hull's inner surface. Circumference of the round sections is 37 cm; maximum width of the flattened area is 10 cm. A hole 2 cm wide, long, and deep is located 13.5 cm below the top of the stanchion. Stanchion holes in throughbeam 4 are about 85 cm apart.

Decoration

The boat originally was plastered and then decorated with finely painted colored stripes along the sheer and, presumably, a solid color below. Traces of red and blue stripes, represented by the heavy black lines in Fig. 15, are visible today, particularly at the ends of the starboard gunwale and near the forward end of the port gunwale. The tenon atop the steering oar and scant, decayed remains of a tenon on the longer stanchion indicate that they probably were equipped at one time with hawk's heads like those found with Cairo 4925, see p. 80.

Preliminary analysis of paint samples taken from the hull indicates a small amount of calcium present in the white paint and a statistically insignificant amount of iron in the red paint. Source-excited x-ray fluorescence spectrometry was used in the analysis

(See Appendix). Larger paint samples may provide a more accurate identification of elements incorporated in the paints; age and size of the sample probably prevented more precise results.

Both stanchions display an interesting pattern of bands of darker, more dessicated wood beginning about 10 cm above the flattened area at their base. Fig. 16 shows the pattern of seven bands on stanchion A and two on stanchion B. The surface of these bands is 2.5 mm below that of the stanchions. No definite cause of the bands can be established at this time.

Deck

The deck of the Chicago boat originally extended from the forwardmost to the aftermost throughbeams. About 45 deck planks remain; the forward part of the hull (to throughbeam A) is covered with planking laid in grooves. Approximately 15 other deck pieces are stored below deck in the bow. These, the smallest components of the remaining hull, are in much poorer condition than any other members. Many have broken, split, warped and decayed surfaces, but Fig. 17 shows the fresh appearance of the interior.

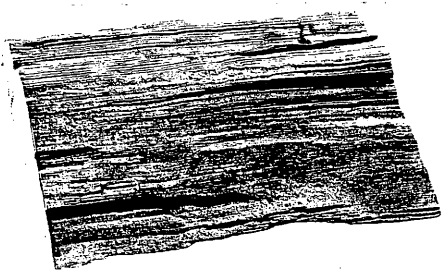

Figure 17. Deck plank. Photograph courtesy of the Chicago Field Museum of Natural History.

Plank length varies according to position in the boat, but most are 60 cm to 68 cm long. Width also varies from 13 cm to 35 cm, but much of this variation is due to breakage. Thickness ranges from 2 cm to 4 cm, probably due to dessication and warpage.

The deck pieces placed beside the hull's inner surface conform to the vessel's shape--one edge is curved to lie flush against the side of the hull. Most pieces have a hole 8 mm in diameter about two cm from the edge of each end angled towards the throughbeams they rested upon. These may have accommodated treenails which fastened deck to throughbeams.

Tool marks

Several types of tool marks remain visible on the hull. Plank ends show saw marks, and adze marks can be seen on the outer surfaces of upper strakes. Score marks on planks below butt joints are also present in at least four places on the hull: on forward section of the central strake where port strake 2-1 and starboard strake 1-1 merge with it, on strake 3 below the starboard gunwale sections 1 and 2 butt, and on port strake 3 below the port gunwale sections 1 and 2 butt.

Wood

The Dashur boat in Chicago is built of a wood type which resembles juniper. It is a coarse-textured softwood without resin canals, and a straight and even grain can be seen. Small and large knots, 2 cm to 20 cm in diameter, are present in almost every plank. Wood grain is compatible to timber direction, and many planks have the small rings characteristic of growth near the center of a tree. One of the larger knots (18 cm diameter) on port gunwale section 1 has a mortise cut through it, but elsewhere, knots had been avoided. The wood is red in color.

A small wood sample taken from a dovetail mortise

on strake 3-1 is fairly well preserved (Fig. 18), and was tenatively identified as a juniperus species, based on comparison with modern charred and fresh wood specimens. Specific gravity of this sample is 0.418, which corresponds well to the specific gravity of many junipers. A deck plank used for radiocarbon dating (Fig. 17, p. 35) shows the relative freshness of wood within even a small hull component.

Other materials

Two 8 cm-long pieces of twisted fibers were recovered from a split in starboard strake 2-1. Microscopic examination of these fibers shows them to be of two different types. One is a loose twist of plant fibers; the other sample, also plant fiber, is twisted much more tightly into a string and has a small loop in one end and a knot in the other (Fig. 19).

These may be some form of caulking material, or perhaps simply a bit of string lost by a workman during construction, burial, excavation or reconstruction of the hull.

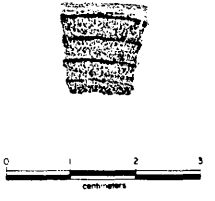

Figure 18. Transverse section of the wood specimen from the Chicago boat. Photograph by Douglas Haldane.

Figure 19. String and twisted plant fiber. From the Chicago Dashur boat. Photograph by Douglas Haldane.

THE PITTSBURGH HULL

A fourth Dashur boat arrived at the Carnegie Museum of Natural History in 1901. No published report of its excavation can be located, yet it is doubtless one of the second group discovered by de Morgan based on its similarity to the Chicago and Cairo hulls. Newspaper reports of the period (Pittsburgh Dispatch, 1901) credit Emil Brugsch Bey with discovery and excavation of this hull and "one or two others". However, Brugsch certainly was aware of de Morgan's 1894 finds and expressed great interest in them. A letter written by Brugsch's brother Henri to de Morgan noted Emil Brugsch's awareness of de Morgan's discoveries (de Morgan, 1903: 108). Emil Brugsch is also credited with photographs in de Morgan's 1895 publication which included the boats.

Although the boat was greeted with a great fanfare upon its arrival in the United States, only one brief descriptive note (Holland, 1902: 77-9) and a single photograph (Magoffin and Davis, 1929: 53) have been published to date. The boat was displayed in Pittsburgh until 1975, but its existence had been overlooked by ship scholars and Egyptologists alike. Göttlicher and Werner (1971: 18) include Holland's article in a bibliography, but mention only the Chicago and Cairo

Dashur boats. After locating Holland's "Boat 4,500 Years Old," and confirming its location in the Carnegie Museum, a visit to the museum supplied information not available from the Chicago hull because the Pittsburgh boat is now disassembled, and its planks, stacked three or four deep, are stored on shelves in a CMNH facility. Not all planks are accessible for recording, but measurements were taken of starboard strake 3, starboard gunwale 3, and section 3 of strake 2 starboard and port. Tentative measurements for two sections of the central strake were also noted, and photographs (Figs 20-25) provide other information incorporated into the flattened planking plan and the following hull description. Length, width, thickness, fastening locations, and throughbeam notches were recorded where possible. The strake and plank numbering system is identical to that used for the Chicago hull.

The boat appears to be in excellent condition, although no outer surfaces could be examined. Most plank edges are still well defined, and inner surfaces are well preserved (Fig. 26). A preservative applied to the hull's inner and outer surfaces stained the planking edges, but no record of treatment is available. Close-fitting strakes seen in photographs of the boat suggest that it was in better condition in 1975 than the Chicago hull is today. The boat is now awaiting

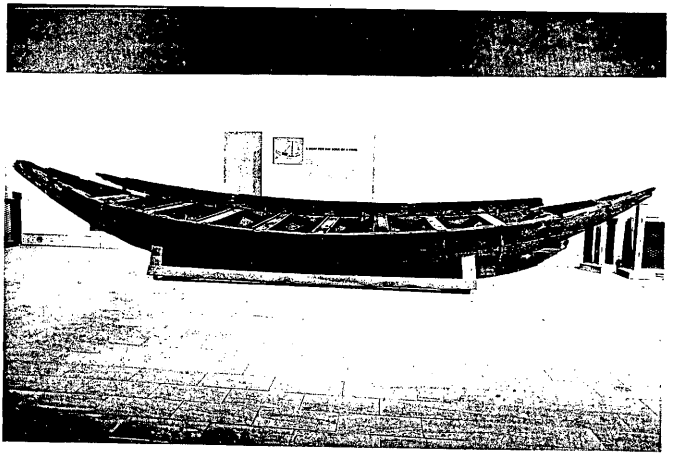

Figure 20. Sheer view of the Pittsburgh Dashur boat during disassembly. Throughbeams and the starboard gunwale have been removed. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

Figure 21. Top view of the Pittsburgh boat. The bow is in the foreground. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

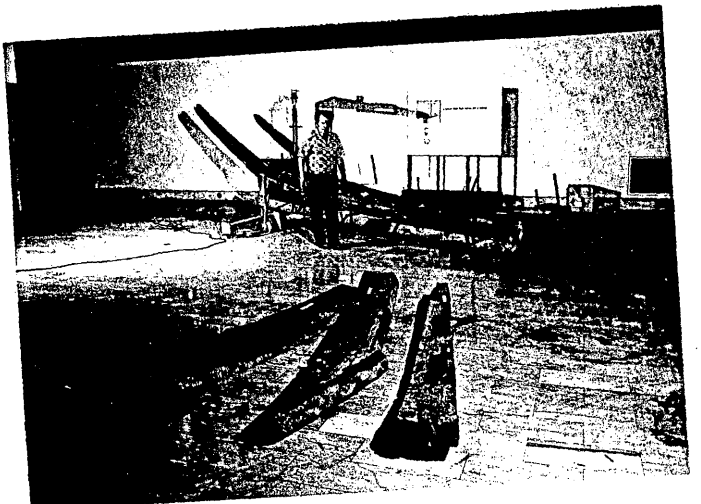

Figure 22. Disassembly of the Dashur boat in Pittsburgh. C1 is in the right foreground. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

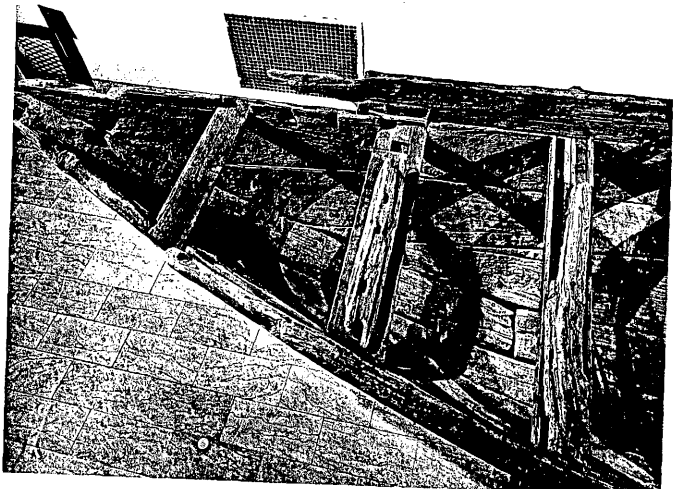

Figure 23. Stern of the Pittsburgh Dashur boat. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

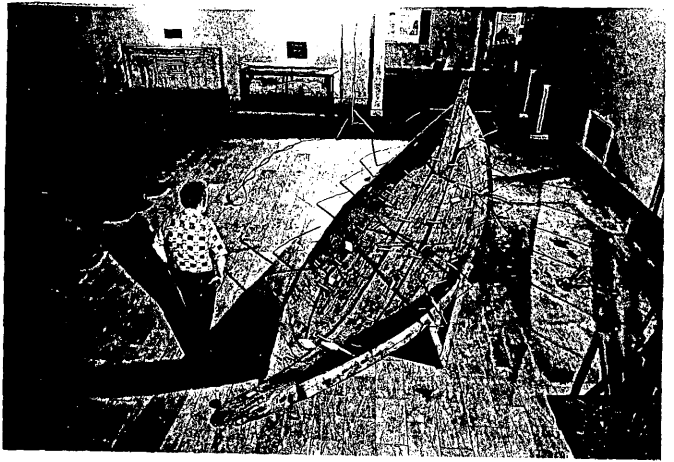

Figure 24. Lower strakes of the Carnegie Museum Dashur boat. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

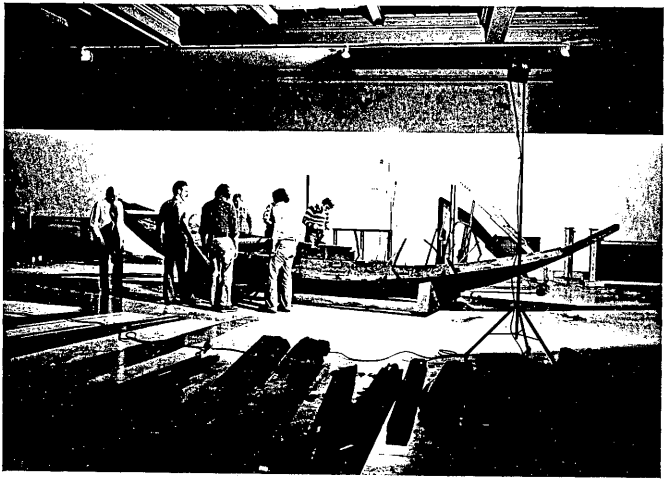

Figure 25. Disassembly of the Pittsburgh Dashur boat. Photograph by V.J. Abromitis, Carnegie Museum of Natural History.

Figure 26. Strake 2-3, Pittsburgh Dashur boat. Photograph by Douglas Haldane.

conservation and reconstruction.

Similarities to the Chicago hull are striking, and although the Pittsburgh hull is slightly smaller, the same regular planking plan is present (Figs 3, p. 14, and 27). Three strakes of two, three, and four planks were fastened to either side of a thicker central strake and capped by a gunwale of three planks lashed together. Dovetail fastenings on the inner surface closed planking seams, and deep mortise-and-tenon joints in plank edges provided a rigid framework for construction. Eleven grooved throughbeams supported deck planking and were fastened with rectangularly sectioned treenails to the upper strake. A steering oar with a tiller and three other unidentified pieces of wood are preserved with the boat.

No precise overall dimensions are available for the hull. Recorded measurements of 9.14 m long, 2.44 m wide, and 1.52 m deep may be found in Holland (1902: 78); a museum staff member in the 1930s measured the hull from outside its case and found it to be 9.14 m long, 2.31 m wide and .91 m deep. In comparison with photographs and known measurements, the latter dimensions are probably more accurate.

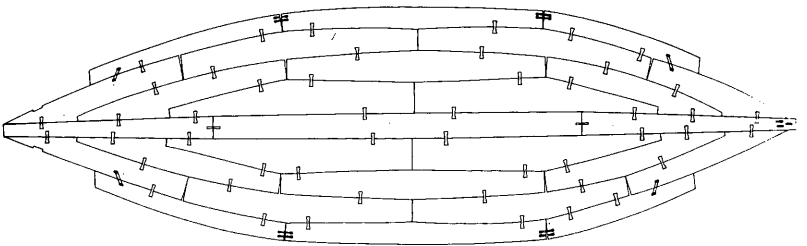

Figure 27. Flattened planking plan, Pittsburgh boat. The bow is to the right. Not to scale.

Central strake

Like those of the other three Dashur boats, the central strake of the Pittsburgh hull is composed of three sections which narrow towards bow and stern. The forward- and aftermost ends are quite well preserved and in better condition than in any of the other hulls. The greatest width appears to be at the strake 1 butt joint. Tentative measurements were recorded for C1 and C2. Central strake 2 measures 2.88 m long and .31 m wide at its forward end. Central strake 3 is 3.08 m long, .38 m wide, and .11 m thick at its forward end. The after end is 9 cm thick, 11.5 cm wide on its outer face, and 8 cm wide on the inner face. Positive identification of these planks was not possible, but the size and shape of the planks suggests that they belonged to the central strake.

Shallow mortise-and-tenon joints in the plank edges join individual sections of the strake, and small dovetails cross butt joins on the inner surface. Mortises in plank edges appear to be about 5 cm deep (Fig. 22, p. 43); only one-quarter of each fastening is cut into the two abutting planks, and one-half is cut into the strake above. (See Fig. 9, p. 24.) Mortise-and-tenon joints and dovetail fastenings along planking seams held the central strake to the other hull members.

Three mortises at the forwardmost end of the strake are arranged in a pattern much like that of the Chicago hull. These mortises probably allowed the attachment of a decorative stempiece.

Throughbeams

Twelve grooved throughbeams crossed the hull and were fastened to the upper strake by diagonally driven treenails. Parts of seven original throughbeams remain, and several are complete. From an examination of photographs (Figs 21, p. 42, and 23, p. 44), it appears that throughbeam fragments were not be in their original positions at the time the hull was disassembled, but until the hull is reconstructed, proper orientation is virtually impossible. The photographs do show the locations of some of the rectangular treenail holes and the grooves which supported deck planking.

Identifiable and accessible throughbeam fragments and replacements were recorded (Table 4). Throughbeam 7 appears to be at midships with a width of approximately 2.40 m. Only a third of the original throughbeam could be located, but coordination with photographs and drawings of the assembled boat supplies a reliable figure. Average throughbeam width is 18 cm on the lower face and 13 cm on the upper face; thickness is 6 cm to 7

cm, and groove dimensions are 3 cm wide and 2.5 cm deep. Throughbeam 11, with a pair of vertical mortises in its center, is much like throughbeam 5 in the Chicago hull (Figs 28 and 7, p. 19).

Table 4. Recorded throughbeam dimensions for the Pittsburgh boat in meters.

Throughbeam number	Length of replacement	Original length
4	1.60	
5	1.92	
7	2.22	* 0.68
8	2.19	* 1.09
9	2.07	* 1.32
10	1.35	
11		0.98

*denotes measurement of one fragment only

Throughbeam notches are cut only into the upper edge of strake 3. No instances of gunwale cuts were noted. These notches tend to narrow outwards from a frequently flared cut at the inner surface (Fig. 29). Holes for treenails which fastened throughbeams to the upper strake are centrally located and average 3 cm square. In one case (throughbeam 5 on the starboard side), the treenail hole was never cut.

Gunwale

A gunwale encloses the deck area from throughbeams 2 to 11. Each gunwale is composed of three sections

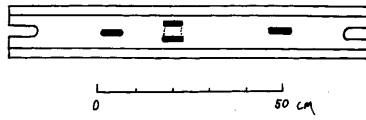

Figure 28. Throughbeam 11 of the Pittsburgh Dashur boat. Top view.

Figure 29. Throughbeam notch. Pittsburgh Dashur boat. Photograph by Douglas Haldane.

secured to the third strake by dovetail fastenings, mortise-and-tenon joints, and lashing. Gunwale ends are lashed at butts through paired holes 3 cm high and 3.5 cm long, and grooves connecting these holes appear to be more worn than those present on the Chicago hull. Diagonal lashings pass from each end of the gunwale towards the stem, if forward, or stern, if aft. (See Fig. 12, p. 27.) These lashings prevent horizontal slippage and vertical movement of the gunwale.

Twenty-three mortise-and-tenon joints in strake 3 and gunwale plank edges, and one at each butt joint in the gunwale's upper surface, provide a fixed fastening system. Two dovetail fastenings spaced evenly along each gunwale section join the gunwale to strake 3 on the inner surface.

The gunwale remains in good condition with the exception of port gunwale 3 which is quite eroded. Most of the gunwale's upper surface is smoothed, as if handworn. Since the boat was displayed in the open for many years, this is probably a recent action on the hull.

The entire starboard gunwale was accessible for study; it measures 7 m long with an average width of 23 cm. Its three sections (from bow to stern) are 2 m, 2.73 m, and 2.27 m long.

Planking

Twenty-seven timbers used in fabricating the Pittsburgh hull are distributed in the same pattern of strakes and planks present in the Chicago hull (Table 5). Reported measurements indicate a hull some 60 cm shorter than the Chicago boat, and strake 3 measurements are 60 cm shorter overall than strake 3 in the Chicago hull. Gunwales are 7 m long in both cases; starboard and port strake 2, plank 3 measurements are respectively 30 cm and 17 cm shorter in the Pittsburgh boat. Plank shapes in both boats are similar (Figs 27, p. 49, and 3, p. 14). The largest boards are used in the central and first strakes; overall planking dimensions decrease with each subsequent strake. Starboard strake 2-3 measures 34 cm wide and 12 cm thick at its forward end; starboard strake 3 is 32 cm wide and 11 cm thick at the aft end of plank 3. Plank lengths diminish also (see Table 5).

Planking seams fit more closely in the Pittsburgh hull than in the Chicago hull. Consequently, the widening of planks located above and below butt joints appears to be slightly more pronounced. Fig. 23, p. 44, illustrates this widening in starboard strake 2-1 and 2-2 , and in strake 1 particularly.

Table 5. Planking distribution and dimensions for the Pittsburgh hull.

Strake	# of planks	Dimensions
Central	3	C2 2.88 m long, 31 cm wide
		C3 3.08 m long, 38 cm wide
Strake 1	2	none available
Strake 2	3	S2-3 2.61 m long
		P2-3 2.72 m long
Strake 3	4	S3-1 1.99 m long
		S3-2 2.72 m long
		S3-3 2.85 m long
		S3-4 1.87 m long
Gunwales	3	S-1 2.01 m long
		S-2 2.73 m long
		S-3 2.26 m long

Fastenings and joins

The disassembled Dashur boat in the Carnegie Museum provides an excellent opportunity to study fastenings in plank edges. As in the other three boats, dovetail tenons and mortise-and-tenon joints are combined with gunwale lashing to connect hull members. Mortises exhibit average dimensions of 7 cm to 8 cm long, 1.8 cm wide, and 12 cm to 13 cm deep. Their shape is slightly oval, and vertical score lines running the length of several mortises near their centers suggest the use of a mortising chisel with a possible blade width of 3 cm to 3.5 cm. At least one mortise in P2-3,

only partially complete, is 13 cm deep for 4 cm of its 7 cm length and 9.5 cm deep for the remaining 3 cm. Port strake 3-4 was not accessible to determine if it lacks the partner mortise, but a second incomplete mortise on starboard strake 3-2 has no partner in the gunwale above it.

Mortise-and-tenon joints are located on each side of a throughbeam with a single joint spaced midway between throughbeams. Twenty-three mortise-and-tenon joints align the gunwale to the hull; the same number was reported in the Chicago hull (Edgerton, 1923: 128). Each section of planking is joined to the strake above or below it by two dovetail fastenings in addition to the mortise-and-tenon joints. Dovetails are placed in in pairs, one dovetail fastening on each side of a butt. Placement of these pairs alternates between fastenings closer to the joint (lower edge of the port strake 2, sections 2-3 butt) and farther from it (the upper edges of the same butt). This is a regular pattern in the hull, easily seen in Fig. 27, p. 49.

Typical dovetails measure 16 cm to 17 cm long, 5 cm wide at the broad end, 3 cm wide at the narrow center, and 2 cm deep. Dovetails are not always symmetrical. The lower edge of S3-4 has half of a dovetail mortise which measures 12 cm long; the other mortise half on S2-3 is 7.5 cm long.

As in the other hulls, planks within a strake are butted against each other. Shallow mortise-and-tenon joints unite plank edges at butts. The method of merging planking strakes with the central strake differs slightly from the Chicago hull in that the long, curving seams are replaced by straight-sided joints like those in the lowest strake in the stern of the Chicago boat (Figs 3, p. 14, and 27, p. 49). Strake ends are cut off squarely in strakes 1 and 2; strakes above overlap the ends and form vertical joints. No fastenings were recorded in strake joint ends, but few were available for examination.

Steering oar

A steering oar 3.3 m long with a curved tiller was recovered with the Pittsburgh hull. The loom was broken in two sections; the upper end was topped by a tenon 6.5 cm long and 3 cm square. Two blade sections were tenoned to a round loom like that of the Chicago example. The loom flattened 2.55 m from its upper end to accommodate the blade. Two tenons 35 cm apart pass completely through the loom and into the blades (Fig. 30). A small hole 3.5 cm long and 3 cm wide passes completely through the upper edge of one blade; two similar holes pass through the other blade 12 cm and 20

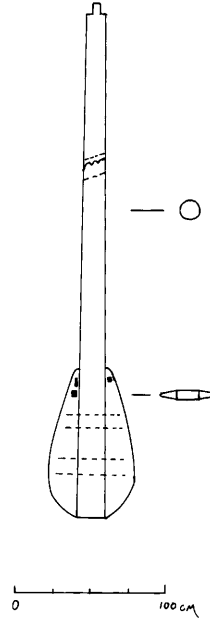

Figure 30. Steering oar stored with the Pittsburgh hull.

cm below its upper edge. Blades measure 1.08 m and 1.05 m long; a maximum width of 20 cm occurs 75 cm from the upper end of the blades. The blades are thickest (5 cm) at the upper edge nearest the loom and taper to 3 cm at outer edges and 3 mm at the base.

A curved tiller (Fig. 31) 95 cm long probably passed through a diagonal slot in the loom; the breakage pattern suggests that the mortise is located at the break 1.01 m below the upper end of the loom. The tiller piece has a semicircular cross section 3 cm across the flat and 2 cm high at its narrow end. The wider end is flatter with a length of 5.5 cm. Three rope impressions 5 mm wide encircle the tiller. Similar rope impressions with the same spacing at about half the loom's length suggest that these pieces may have been lashed together before burial.

Miscellaneous pieces

Three wooden pieces of varying size and unknown function are stored with the hull. A tapering piece 1.85 m long has a round cross section and a small tenon 2 cm long, 2 cm wide, and 5 mm thick at one end. Two mortises pass through the piece at 14 cm and 34.5 cm from the untenoned end. Holland (1902: 78) called it a

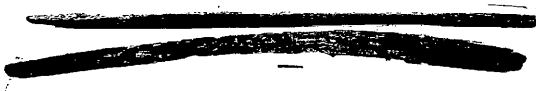

Figure 31. Curved tiller and unidentified wooden piece found with the Pittsburgh Dashur boat. Photograph by Douglas Haldane.

short mast, but that is unlikely. It may be, however, part of an oar.

The two smaller pieces, each about a meter long, are shaped much like the steering oar stanchions from the Chicago hull, but their dimensions are less than a third of the Chicago example (Fig. 31). The pieces are rounded on one end and flatten as they come to a point at the opposite end. Both pieces have diameters of 3 cm which gradually become 1.5-cm-wide sides of the point. Lengths of 1.11 m and 1.065 m were recorded; flattening begins at .93 m and .91 m respectively. These pieces may have supported a small altar table or other structure.

Decoration

As most pieces are stacked on shelves with inner surfaces facing up, any traces of paint or plaster remaining on the hull are difficult, if not impossible, to see. Nevertheless, slight traces of red paint are visible on the outer surface of starboard strake 2-3. Photographs (Fig. 20, p. 41) give little indication of decoration; several white patches are visible on the hull. Holland (1902: 78) describes a hull painted white above the waterline, set off above and below by finely drawn double black lines. Red paint was also visible beneath white and black paint on the body of the boat at that time.

Deck

Small deck planks of the same approximate dimensions as those recorded in Chicago are stacked with hull members. Several have shaped edges which formerly fit the inner curvature of the hull. Many have undergone warping and twisting, probably due to the relatively thin wood used in construction of the deck.

Tool marks

Score lines across the upper planking edges of

strake 3 mark gunwale joints. Other unidentified planks also bear score lines, which presumable locate butt joints. Plank ends and strake end overlaps were sawn; throughbeam notches display saw marks on straight edges and faint adze marks on curved sides. Adze marks are visible on most hull members, and chisel impressions can be seen in many mortises.

Heavy, rectangular-headed hammer impressions are present along at least two planks (S3-2 and an unidentified plank). The impressions cover a roughly circular area and have a cross-hatched rectangular impression in their centers. These are probably recent additions to the hull, as the outlines of each blow have bronze, tools (Fig. 32).

Wood

Wood used in construction of the Pittsburgh boat appears to be the same type as that used in the Chicago hull. Large knots are present, and similar grain and coloration may be observed. The wood retains good structural stability. Tapping produced a solid, dull sound rather than the hollow sound produced by dessicated or rotted wood.

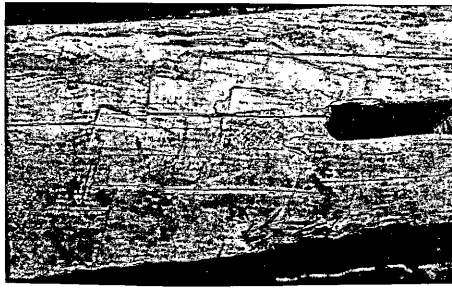

Figure 32. Hammer marks on the Pittsburgh Dashur boat. Photograph by Douglas Haldane.

Based on the wood identification for the Chicago hull, this boat was also built of a juniperus species. No wood samples were taken.

CAIRO 4925

In general shape and construction, the hull seems to be quite similar to those recorded in Chicago and Pittsburgh. This boat is the largest of the four excavated, measuring 10.2 m long, 2.24 m wide, and .85 m deep (Reisner, 1913: 83). Most published drawings of the Cairo pair (Morgan, 1895: fig.203; Reisner, 1913: figs 311-21; Landström, 1970: fig. 275; Casson, 1971: fig. 13; Göttlicher and Werner, 1971: pl. 44) illustrate this boat, as it is in better condition than the smaller 4926, also displayed in the Egyptian Museum of Cairo.

Although no photographs of 4925 have been published, with the possible exception of de Morgan's excavation report showing two partially excavated hulls (Figs 33-34), a drawing in Göttlicher and Werner (Fig. 35) illustrates the somewhat decayed condition of the hull. Landstrom's description of the boats suggests that they are less well preserved than those in Chicago and Pittsburgh.

Hull descriptions of the two Dashur boats in Cairo are based solely upon published information.

Figure 33. Excavation of a Dashur boat (de Morgan, 1894: pl. xxix).

Figure 34. De Morgan's excavation of one of the Dashur hulls (de Morgan, 1894: pl. xxx).

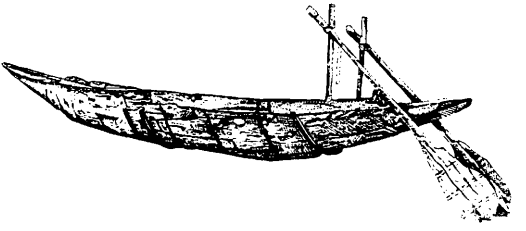

Figure 35. Drawing of one of the Cairo hulls (after Göttlicher and Werner, 1971: pl. 44).

Figure 36. Sheer drawing by de Morgan (de Morgan, 1894: fig. 203).

Central strake

Three planks, joined by long and narrow dovetails, form a thick central strake which served as the foundation for construction. No mortise-and-tenon fastenings connecting the plank ends were observed in this strake by Reisner (1913: 83-6), Göttlicher and Werner (1971: pl. 44), or Landström (1970: 90-3). The strake tapers toward bow and stern, and both ends are eroded. The strake, although thicker than the others (Göttlicher and Werner, 1971: pl. 44), may not be considered as a true keel because it is flush with the outer hull surface. Göttlicher and Werner report that this strake was 8 cm thick and 20 cm wide.

Bow and stern

Reisner (1913:83) wrote, "There is no indication that the stern is like that in de Morgan's figure," and that instead it was rounded. I believe Reisner was referring to the sheer view (Fig. 36) by Morgan, which shows a double-ended hull with pointed stem and stern. Unfortunately, Reisner does not provide a sheer drawing to illustrate his interpretation, and Landström's 1970 drawing shows only an eroded stern (Fig. 37). Reisner

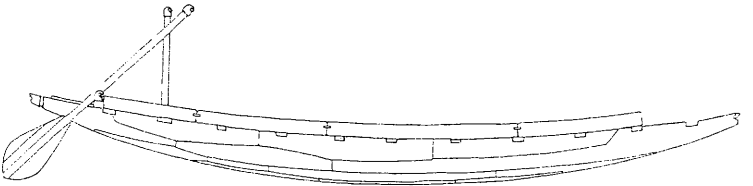

Figure 37. Sheer drawing by Landström (after Landström, 1970: fig. 25).

also suggests that an upright, bent stern piece was attached to the stern by means of a mortise-and-tenon joint and by a groove around the stern for a metal or leather band to bind this decorative stern piece to the hull. A "horizontal hole" (Reisner, 1913: 85) was also used in fastening this post to the hull. Battens lying atop the upper strake were cut off sharply at their aftermost ends, implying to Reisner that they abutted the post (1913: 83).

The bow configuration represented by de Morgan is also somewhat different than that of later depictions, perhaps due to preservation. De Morgan's top view (Fig. 38) shows two small pieces of wood attached to the forwardmost part of the bow; these look a great deal like supports for the decorative stempiece of the Cheops ship (Fig. 39). De Morgan obviously had no knowledge of the Cheops ship, discovered in 1954, and these pieces may cautiously be considered as representing stem piece supports. However, these two pieces are nowhere else drawn or described, and the drawing itself is highly stylized, so, for now, they must remain a mystery.

Planking

Four strakes, approximately 20 cm wide (Göttlicher

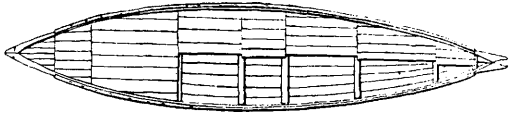

Figure 38. Top view of a Dashur boat by de Morgan. The bow is to the right. (de Morgan, 1894: fig. 203.)

Figure 39. Stem piece supports from the Cheops ship. (After Abubakr and Mustafa, 1971: plan 3).

and Werner, 1971: pl. 44) and 9 cm thick (Casson, 1971: 15, n.18) rise from either side of the thicker central strake. Although individual planks appear to be irregularly shaped, when the planking scheme of the entire hull is examined, symmetry in construction and similarities to the Chicago and Pittsburgh hulls are apparent.

The same widening of planks at butt joint locations in upper or lower strakes is present, and the long, smooth joins of strake ends to the central strake create a planking plan remarkably like those of the Chicago and Pittsburgh hulls (Figs 3, p. 13; 27, p. 49; 40).

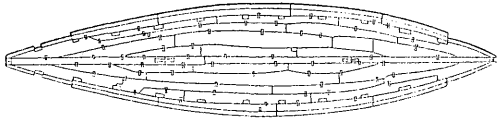

Figure 40. Top view of Cairo 4925. Bow is to the right. (Reisner, 1913: fig. 313).

Table 6 shows the planking distribution in the hull. Discrepancies in the numbers of sections between opposing strakes can be clarified by looking at the planking plan of the boat (Fig. 40). Starboard strake 2-3 and 2-4 are butt joined to create a shape analogous to that of P2-3. Likewise, P3-1 and P3-2 are joined to mirror starboard strake 3.

Table 6. Planking distribution for Cairo 4925.

Strake	# of sections
Central	3
P1	3
S1	3
P2	4
S2	3
P3	3
S3	4
P4	3
S4	3
Gunwale	
port	4
starboard	4

This last join is unique in that it is the only true scarf recorded on any of the hulls with the possible exception of the starboard gunwale 2/3 join in the Chicago hull (Fig. 41). The scarf is a simple one, and the throughbeam notch is cut into it. Göttlicher

and Werner show a scarf on the port side (Fig. 35, p. 68), and Landström has retained Reisner's illustration of the join which shows an unclear sketch of the scarf, leaving its exact details unpublished.

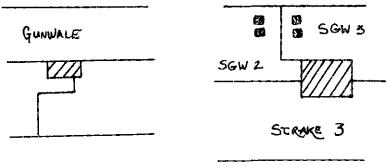

Figure 41. Possible scarfs in Cairo 4925 (left) and the Chicago gunwales. Not to scale.

Strakes 1 and 2 narrow as they approach the central strake at bow and stern, showing the abruptly truncated tips present in the Pittsburgh and Chicago hulls. Strake edges are fastened to the central strake and to each other by means of mortise-and-tenon joints and dovetail fastenings similar to those in the previously discussed hulls. Dovetail fastenings are more numerous than in the Pittsburgh hull--64 compared to 50--but, they are not as evenly spaced. In comparing Reisner's drawing (Fig. 40, p. 73) to the Chicago and Pittsburgh hulls (Figs 3, p. 14, and 27, p. 49), several dovetails appear to be absent, most notably in the stern. For

example, one dovetail connects S3-1 to the central strake; this is the only dovetail joining the central and third strakes. There are no dovetails placed across butt joints as in the Chicago boat.

Throughbeams

Eleven throughbeams cross the hull, resting in notches cut in the uppermost strake. These are flush with the outside of the hull and are secured to the planking by rectangularly sectioned treenails, about 2 cm by 3 cm.

Unlike holes in the Chicago and Pittsburgh boats, the fastening holes in the throughbeams are not hidden by the gunwale and are visible inside the boat. The holes are vertical rather than diagonal (Reisner, 1913: fig. 318) and pass from the upper face of the throughbeam through the upper strake, stopping short of protruding the hull. The throughbeams upper surface would have been entirely covered by deck planking that was treenailed to it, and so the hidden diagonal fastenings of the Chicago and Pittsburgh hulls would have been unnecessary.

Five of the original throughbeams remain. Throughbeam 11 was larger and thicker than the others and had two large, square mortises cut through it for

passage of steering oar stanchions. Square holes like the treenail mortises in other throughbeams do not pass completely through throughbeam 11; Reisner suggests that these may have been for canopy supports (1913: 85, n.1).

Two pieces which extended beyond the outside of the hull were fastened to the top strake just forward of the gunwale in the bow and aft of it in the stern.

Fastening holes for the forward crosspiece were round, but those in the stern were square-sectioned (Reisner, 1913: 86). These crosspieces were missing by Reisner's 1913 examination, but may have been ornamented with hawk's heads at their tips and probably supported the steering oars (Fig. 37, p. 70).

Gunwale

Four planks of both the port and starboard gunwale are secured to strakes 4 and 3 by means of mortise-and-tenon joints and dovetail fastenings. Individual sections are lashed together at their ends through single square holes connected by a groove (Reisner, 1913: 84). Landström (1970: 90-3), following Reisner, suggests copper bands were used for lashing. There is little evidence to support this statement. Mortise-and-tenon joints on the upper edge across the butts

unite the gunwale plank ends except starboard planks 1 and 2.

Four mortises angle from the center of the gunwale's upper edge to its outer surface as found in the Chicago and Pittsburgh hulls. Other mortises sunk into the upper edge are spaced along its length, with one to four cuts (in addition to the angled mortises) in each section.

Gunwales are cut off straight and are aligned with the forward edge of throughbeam 2 and the after edge of throughbeam 11. Smaller battens with a semicircular cross section were treenailed to the hull and extended beyond the gunwale along the upper edge of strake 3 in both bow and stern. Bow battens are not preserved.

Deck

The entire ship was decked with small boards laid in hatches treenailed to throughbeams. Mortise-and-tenon fastenings between board edges created a solid, fixed deck (Reisner, 1913: 85).

Steering oars and stanchions

Two steering oars and two stanchions crowned with

hawk's heads were recovered with the hull. Stanchions pass through square holes in throughbeam 11 and rest in shallow recesses in the hull's inner surface (Reisner, 1913: 85-6). The two stanchions should have been joined by a crosspiece just below the hawk's heads; however, the port stanchion has a longitudinal mortise for this piece, while the starboard stanchion is notched to receive it. In addition, the stanchions are painted different colors (Reisner, 1913: 84, n.1), and the port stanchion did not fit the hole made for it in throughbeam 11, which was enlarged during restoration (Reisner, 1913: 84, n.2). It is probable that the port stanchion did not originally belong to the boat.

Steering oars have round looms, tillers and rounded blades of two pieces which are joined to the looms by three mortise-and-tenon joints as in the Chicago hull. One of the oars had a blade built up of three pieces (Fig. 37, page 70); i.e., a small piece was added to one side to form a complete blade. A number of holes 1 cm in diameter through the blade were recorded by Reisner (1913: 86) and Landström (1970: 91). The looms flatten as they merge with the blades and have slanting slots for holding tillers. De Morgan's plate 30 (Fig. 33, p. 66) shows one of these tillers in place.

Decoration

Reisner reports traces of plaster and paint present on the boat in 1913 (Reisner: 84) and describes a yellow or ochre hull. Stripes of blue, red, and blue outlined in black decorated the gunwale. The upper surface of the deck boards was painted white, and throughbeams were probably unpainted. The port steering oar stanchion was painted red; the starboard stanchion was painted yellow. Hawk's heads fastened to stanchions, steering oar loom ends, and perhaps crosspieces at bow and stern had blue wigs with yellow skin and green eyemarks (Reisner, 1913: 84). Steering oars were elaborately painted with lotus leaves, rosettes and wedjat eyes (Fig. 42). By 1970, only a few traces of red paint remained (Landström, 1970: 90-3).

Wood

Göttlicher and Werner (1971: 8) report that one of the Dashur boats is made of mulberry wood. Although a measurement of 10.10 m length is provided for the boat they describe, I believe that they may be referring to Cairo 4926 on the basis of other information provided. No other wood identification has been published beyond the general identification of these boats as cedar in

Figure 42. A steering oar recovered with the Cairo boats (de Morgan, 1894: pl. xxxi).

Jenkins (1980: 84).

Reisner notes that several pieces of wood were probably reused. These had holes from previous construction filled with wood or plaster (Reisner, 1913: 86).

CAIRO 4926

According to Reisner, this boat is much like 4925 (1913: 86), although it is not as well preserved. About two meters of upper planking in the stern was missing in 1906 (Wassersport: 6-7), but this may refer to the general rotted condition fo the entire gunwale which Reisner noted (1913: 87), and not to the uppermost strake. Bow and stern are eroded, and the steering oars are badly broken (Reisner 1913: 87).

Lines for this boat (Fig. 43), drawn in 1906 by a New York yachtsman named Hyslop, are based on a hull 9.8 m long and 2.13 m wide (Wassersport, 1906: 6-7). However, Reisner supplies dimensions of 9.9 m long, 2.28 m wide, and .74 m deep. Göttlicher and Werner (1971: 8) report a length of 10.10 m, which would seem to apply to the larger 4925, but their other measurements do not correspond. Only lines drawings have been published for this vessel.

Cairo 4926 also has 11 throughbeams, about 12.7 cm wide and 5 cm thick, which are grooved like the Chicago and Pittsburgh hulls to bear deck planking (Wassersport, 1906: 6-7). Bow and stern configuration of 4926 is also much like that of 4925, even to the planking shapes in those areas (Reisner, 1913: 87). Casson (1971: 15, n.17) records a planking thickness of 7 cm for the boat; a thickness of 6.3 cm and width of 20 cm for planking is

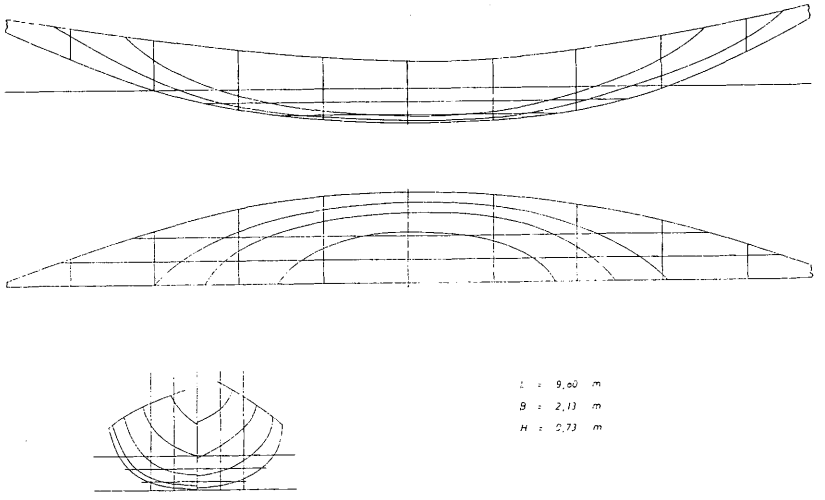

Figure 43. Lines for Cairo 4926. Adapted from Wassersport, 1906: 7.

reported by Wassersport (1906: 6-7) and followed by Göttlicher and Werner (1971: 8).

Throughbeams are fastened to the hull in the same manner as in 4925, except for the forwardmost throughbeam which is fastened with diagonal treenails to strake 3. Steering oar stanchions pass through holes in throughbeam 11 as in 4925. A mortise-and-tenon joint may have secured the crosspiece which supported the steering oar to the hull beyond the gunwale . Dovetail fastenings are used "sparingly" according to Reisner (1913: 87), and use of mortise-and-tenon fastenings must be assumed.

A gunwale of four sections on each side was linked by mortise-and-tenon joints and lashing of plank ends. Lashing holes on 4926 are double, like those present on the Chicago and Pittsburgh hulls. The starboard gunwale "middle section' has nine wood-plugged holes along its lower edge. Semicylindrical battens beyond the gunwales seen on 4925 are present on 4926 (Reisner, 1913: 87).

Deck pieces rest between throughbeams in grooves and are curved to fit flush against the inside of the hull as seen in the Chicago and Pittsburgh boats. Reisner (1913: 87) notes that the underside of the deck was unfinished.

Stanchions and two badly broken steering oars are similar to those found in 4925. A crosspiece 4 cm square with a tenon 1.5 cm square fits a mortise 15 cm

below the top of each post (Reisner, 1913: 87).

In 1913, the hull retained traces of white plaster and yellow paint. Throughbeams and the gunwale had been painted red; the deck was white except where deck plank ends rested on the throughbeams and were painted red. Blue-wigged hawk's heads topped stanchions and steering oars. Steering oars were painted like those of 4925, but the stanchions were yellow with a green-red-green pattern of striped bands around their upper ends (Reisner, 1913: 87).

Wood used in construction of this boat was "old" according to Reisner (1913: 87). Gottlicher and Werner suggest that this hull was built of mulberry (1971: 8), based on Hyslop's 1906 evaluation of the vessel.

ANALYSIS

Previous studies of these hulls (Reisner, 1913: 83-7; Boreux, 1925: 286-90; Landström, 1970: 90-3; Hornell, 1971: 215-17; and Jenkins, 1980: 84, 124) describe basic features of their construction. The use of mortise-and-tenon joints, dovetail fastenings, a central strake, and oddly shaped planks is frequently mentioned in these descriptions, but few details are presented. My investigation of the hulls centered on discovering both the plan behind their construction and the means used to achieve this plan. Boats valued highly enough to be buried near the pyramid of a powerful Middle Kingdom pharaoh would not have been "ill-conceived" (Jenkins, 1980: 84) and are not "wretched" (Landström, 1970: 90). Instead, these hulls, built of carefully fashioned planks, exhibit the characterisitc shape and decorative style of funerary boats. The assumed purpose of funerary vessels is a final voyage from the dead person's home to Abydos. The voyage to Abydos, site of the temple of Osiris, is documented in many tomb reliefs. The tomb of Khnumhotep has a representation of his mummy voyaging to Abydos in a towed funerary boat (Newberry, 1893: 68). From the tomb of Amenemhat, we see a funeral barge being towed by two ships in full sail, "voyaging against the stream to obtain the benefits of Abydos for the prince Amenemhat,"

(Newberry, 1893: 32). An accompanying relief illustrates a boat load of women making a journey downriver to obtain the benefits of Busiris for Amenemhat (Newberry, 1893: pl. xvi).

Egyptian model boats from the Middle Kingdom are of two types: practical and cermonial. Hunting, fishing, travelling, cargo, and pleasure boats can be placed into the first category, and funerary boats are included in the second. The major identifiying characteristic of a funerary vessel is the presence of a mummy on board the model, but other features of the hull are also standard.

The hull itself is papyriform with red painted bars (throughbeams) crossing a white deck. Decorative posts are found at stem and stern, and two steering oars rest on crosspieces and are supported by stanchions. The presence of hawk's heads on crosspieces, the stanchions, and each steering oar is a distinctive funerary boat attribute. Some ceremonial models have a single hawk-headed, painted steering oar, but these boats have a slightly different hull shape (see Glanville, 1972: fig. 19). Decoration of funerary vessel models is also standard. Hulls are usually green, light green, or yellow with striped gunwales and wedjat eyes at the bows. Steering oars are elaborately painted, and stanchions are frequently green and yellow instead of the red and white of other boat types.

All four Dashur boats exhibit the standard hull

shape of funerary boat models. Decorative details of the two Cairo boats are closest to the ideal--yellow hulls with paired hawk-headed steering oars, yellow and green hawk-headed stanchions, red throughbeams, and white decks. The Chicago hull has a red and blue striped gunwale, but no reliable description of its original hull color is available. The stanchions and single steering oar retain no traces of paint, although bands of decoration are indicated on the stanchions. The boat in Pittsburgh was white with red traces visible; the gunwale had only black and white stripes. No stanchions were seen during hull recording, and the steering oar lacked any indication of paint. Both boats have tenons atop steering oars, presumable for the attachment of hawk's heads, and the Chicago boat may have had tenons atop the stanchions.

Since the latter two hulls were not described in excavation reports or prior to their exportation from Egypt, it is difficult to reach a conclusion about these aspects of their decoration. Paint quickly disappeared from the Cairo boats after excavation; the same may have happened during the arduous journeys of the Chicago and Pittsburgh hulls to the United States.

Until more information is available, and new details of the Cairo hulls can be compared with the Chicago and Pittsburgh boats, I believe that all of the hulls should continue to be regarded as funerary

vessels. To bury the boats beside the pyramid was not an easy task--the Nile was 8 kilometers from the pyramid in de Morgan's day, and it has not appreciably changed its course since the Middle Kingdom. The ownership and original purpose of these vessels remain obscure for now, but further research can provide confirmation of or alternatives to prevailing published opinions.

Lines drawings prepared for the Chicago hull (Figs 44 and 45) illustrate a beamy, light-drafted hull which served its purpose ideally. Body stations in the lines drawings are equivalent to throughbeam centers. A plumb line was dropped from the sheer to the floor, and horizontal measurements were taken with the aid of a level line at 20 cm intervals to the outside of the planking. These points and the hull width at each throughbeam were converted to the body shapes of Fig. 44. Buttock and waterlines could then be plotted (Fig. 45). Hull lines illustrate the ideal form of the vessel's outer surface. Compensation for sagging planks and distortion of the hull was necessary in the drafting process, but few changes were made.

The shallow depth of the hull probably facilitated passage over treacherous Nile sandbars, and the hull's round cross-section provided remarkable stability. The cross-section of the hull may be compared to an inverted arch, recognized by Bell (1933: 101-11), Hornell (1971:

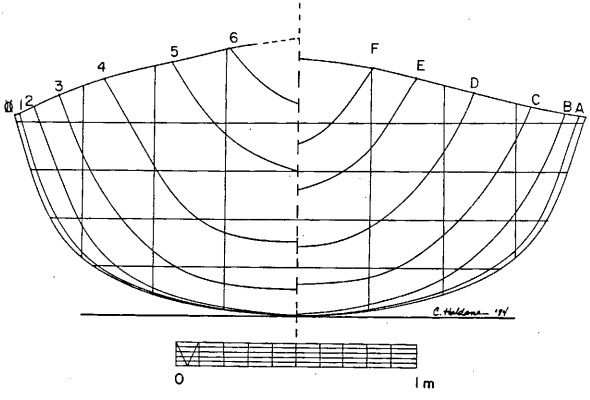

Figure 44. Body shapes for the Chicago Dashur boat.

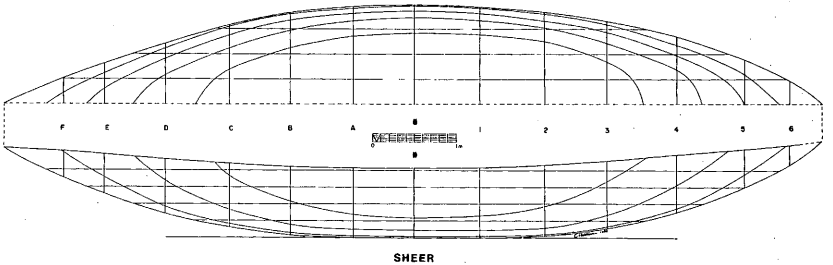

Figure 45. Buttock and waterlines for the Chicago hull.

215-17), and Hausen (1979: 211-30), which was best suited for load bearing on deck and not within the hull.

Both Reisner (1913: xxii-xxiv) and Hornell (1971: 215-217) recognized the similarities between the Dashur boats and the twentieth-century cargo-carrying river boats of Upper Egypt. These boats are characterized by the same round cross section and a planking pattern similar to that found in the Dashur hulls. Hornell (1971: 213-218) describes modern boatbuilding on the Nile using acacia wood and similar tool types and techniques to construct a vessel little different from the Dashur boats (Figs 46 and 47). Iron nails replace mortise-and-tenon joints, and modern cargo-carrying hulls are not as well-proportioned as the Dashur hulls, but the cross- section of the hull remains semi-circular. Thick planking continues to be one of the structural essentials of the hulls; planks were never less than 5.7 cm thick and ranged in thickness up to 9 cm. Hornell's suggestion that contemporary Nilotic sailing craft are "direct and lineal descendants" of an Egyptian boatbuilding tradition from the Middle Kingdom (1971: 215) is not unreasonable, although archaeological continuity has not yet been demonstrated.

A boatbuilding scene from a Middle Kingdom tomb at Beni Hasan (Fig. 48) provides a contemporary illustration of this type of boatbuilding from the local acacia, or

Figure 46. A Nilotic cargo boat (from Hornell, 1971: pl. 35).

Figure 47. A Nile nuggar on stocks (from Hornell, 1971: pl. 36).

sunt (Newberry, 1893: pl. xxix). Plank lengths appear to be much shorter than those used in construction of the Dashur hulls and perhaps may be better compared to a description of Egyptian boatbuilding by Herodotus.

Figure 48. Boatbuilding scene from Beni Hasan (Newberry, 1893: pl. xxix).

Herodotus, a fifth-century B.C. historian, describes the construction of the boats thus:

> "From this acacia tree they cut planks three feet long, which they put together like courses of brick, building up the hull as follows: they join these 3-foot lengths together with long, close-set dowels [tenons] ; when they have built up a hull in this fashion (out of planks), they stretch crossbeams over them. They use no ribs, and they caulk seams from the inside, using papyrus fibers." Herodotus II, 96 (Casson, 1971:14, n.15).

Construction of the Dashur boats began with the selection of sturdy cedar timbers which were probably shaped with traditional means and tools. After rough trimming with axes and adzes, timbers were sawn to

approximate lengths and widths, usually about 3 m long and 30 cm wide. The central strake was the first to be laid. Each strake in turn was fitted to the strake below it; edges were carefully beveled and smoothed to create a tight seam. A score line marked forward and aft strake ends and butt joins for precise fitting. After the shaping of plank edges and ends, mortises were cut and tenons placed. As planks were added to the hull, additional supports may have been placed below it to reduce the strain upon the tenons.

Throughbeam notches in the upper edge of the third strake were probably cut before the gunwale was fitted. Throughbeams could then be securely fastened to the hull by means of treenails driven diagonally from strake edge centers to the outer surface. Mortises for the gunwale sometimes passed through the throughbeam and were cut into the walls of the throughbeam notch.

Mortise-and-tenon joints in the Dashur boats provide us with the most ancient example of reliance upon these structural components as internal strengthening devices. The relatively great depth of the joints in comparison to plank width, combined with the weight of the massive 8 cm to 13 cm thick planks made pegging of the tenons unnecessary. Pegged tenons were doubtless known to the boatbuilders; wooden statues, furniture and even a sledge found with the hulls (Reisner, 1913: 88) have pegged tenons (Fig. 49).

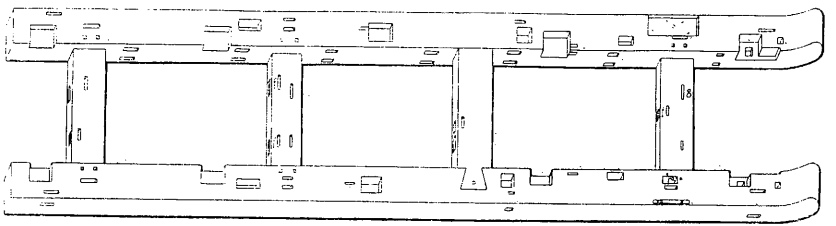

Figure 49. Wooden sledge recovered with the Dashur boats. After Reisner, 1913: fig. 326.

Mortise-and-tenon fastenings in the Cheops boat (Nour, et al., 1960; Abubakr and Mustafa, 1971: 1-15; Landström, 1971: 26-34) served only to align planks temporarily, until the binding of the hull was completed.

The consistency of certain measurements found in both the Pittsburgh and Chicago hulls suggests that a system of mensuration was employed. The Egyptian cubit of 52 cm remained fairly constant from 3000 B.C. to the mid-nineteen century (Skinner, 1957: 775). The cubit was divided into seven palms of 7.5 cm or 28 digits of 1.87 cm; average mortise dimensions for the Chicago and Pittsburgh boats are 7.5 cm to 8 cm long--one palm--and 1.7 to 2 cm wide--one digit. Other measurements in the hull (plank dimensions) are so varied that similar correlations may be coincidental.

The method of fastening butt joints in the Chicago and Pittsburgh hulls is unique in ship or boat construction. A shallow mortise cut into each plank butt made a rigid joint utilizing a mortise of standard 11 cm to 13 cm depth in the plank above (Fig. 13, p. 29). This means of fastening provided secure joints at butts without weakening plank ends unnecessarily.

During my analysis of the Chicago and Pittsburgh hulls, I closely examined the dovetail mortises. Their edges are clearly delineated and many appear to be of less careful workmanship than the remainder of the hull.

Reisner's introduction to Models of Ships and Boats includes this statement: "So far as I was able to learn, the greater part, if not all of the dove-tail joints are modern. At any rate I so understood M. Barsanti," (Reisner, 1913: xxiii, n.1). He also states that, "the hull is constructed of mortised and tied [lashed] planking," with no mention of the dovetail fastenings (Reisner, 1913: xxiii).

Reisner has previously been interpreted as referring to the dovetail tenons, obviously replacements, and not to the entire fastening. Although his statement above, and another comment (Reisner, 1913: 86) are somewhat ambiguous, several factors must be considered before accepting these dovetail fastenings as original hull components.

Neither de Morgan's description, albeit brief, of the singular construction of these hulls nor his drawings include such fastenings (de Morgan, 1895: 81-3). (See also Figs 37, p. 69, and 38, p. 71.) Photographs, although difficult to interpret, provide no indication of dovetail fastenings at the time of excavation.

Dovetail fastenings, although somewhat patterned, are irregularly spaced, superfluous in some planks, and absent where expected. Mortises for the dovetail tenons are frequently asymmetrical and do not exhibit the consistency found in mortise-and-tenon joints. Dovetail

fastenings across butt joints are found only in the upper strake of the Chicago hull. The Chicago and Pittsburgh hulls are almost identical in shape, construction, and dimensions, but the Chicago hull has 66 dovetail fastenings, while only 50 far more regularly patterned dovetails are present in the Pittsburgh boat (see Figs 3, p. 14, and 27, p. 49). One of the major differences between these two hulls is the greater separation between plank edges in the Chicago hull. A discrepancy in the number of dovetails present in the two Cairo boats also occurs--illustrations of 4925 show 64 dovetails, and 4926 is only "sparingly" furnished with the fastenings (Reisner, 1913: 87). With the exception of these four vessels from Dashur, no other evidence for the use of dovetail fastenings in ship or boat construction has been discovered: tomb reliefs, models, and other depictions give no indication of their use.

The technique of joining wood with dovetail fastenings existed from at least 2500 B.C. Egyptian carpenters of the Fourth Dynasty made use of dovetail clamps in the construction of furniture found in the tomb of Hetepheres (Lucas, 1948: 513), and the makers of a sledge found with the unexcavated Dashur hulls (Fig. 49, p. 96) dovetailed one end of a crosspiece into a runner. Other crosspieces, and the opposite end of the dovetailed piece, had tenons which fit into mortises in

the runners. These tenons and the dovetailed end are also pegged (Reisner, 1913: 88). Dovetail fastenings were also used in construction of the stone base of the brick pyramid of Sesostris III (de Morgan, 1895: 48, fig. 108). However, just as the technique of pegging wooden materials (coffins, statues, furniture) existed but was not applied to the construction of these hulls, so might dovetail fastenings commonly used in other manufactured objects not have been used in hulls.

If the dovetails are not original, they were a major addition to the hulls during the reconstruction process. While this prospect is somewhat distressing to modern scholars, the excavators allowed heavy iron bands to be strapped around each hull and nailed to it--a modification of significant proportions. Only further examination of the hulls and perhaps de Morgan's field notes and photographs will answer the question raised here, but for now, I suggest that considerable caution be employed in referring to these dovetail fastenings as an ancient and unique Egyptian means of joinery.

CONCLUSIONS

The description and analysis of the four known Dashur boats presented here was begun out of curiosity. The hulls offered archaeologists an opportunity to examine four contemporary Bronze Age hulls, yet they were frequently given little consideration in the history of seafaring and nautical craft. The "loss" of the Pittsburgh hull is only an example of the lack of scholarly interest in these vessels.

Through observation and recording of these hulls, I learned that they were extraordinarily well-constructed with consistency and planning visible in each step of construction. The use of deep mortise-and-tenon joints and the ingenuity displayed in other aspects of joinery in the hulls shows that these vessels of 1850 B.C. were built by craftsmen familiar with the need for rigid fastening systems. I believe that it is not unreasonable to expect Egyptian seagoing ships of the period to share many of the constructional features of the hull--reliefs frequently illustrate throughbeams, the same basic hull shape seen in the Dashur boats, and a cargo carried on deck in addition to particular features such as the hogging truss. This study has only begun to explore Middle Kingdom Egyptian boatbuilding

methods; further comparisons with both earlier and later ships can add to our understanding of the origin of mortise-and-tenon joints in hull construction and other possibly unique methods of uniting wooden planks to create vessels which floated upon the water.

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APPENDIX

Facsimile of a report from Dennis James, Center for Trace Characterization, Texas A&M University

Your three paint scraping samples have been studied as requested using source excited x-ray fluorescence spectrometry. Results are basically negative with the white paint scrapings giving a small indication of calcium. As noted during your visit, the red paint sample x-ray spectrum did exhibit an anomaly at an energy which would correspond to iron. However, the spectrum deveiation was not significant with respect to spectral background variation.

The technique is based on the excitiation of matrix electrons (characteristic of constituent elements) by interaction with emissions from a radioactive source. In our case gammas are emitted from a 100 millicurie americium-241 source. The decay of excited electrons into more stable configurations is accompanied by the emission of x-rays to provide energy loss. These x-rays emitted from the sample are detected by a lithium drifted silicaon solid state photon detector. This detection can be used for qualitiative and quantitiative evaluation of the sample.

VITA

Cheryl Ward Haldane was born December 16, 1960 to Richard and Elizabeth Ward. She received an Associate of Science degree from Cisco Jr. College, Cisco, Texas, in 1980 and a Bachelor of Arts degree from Texas Tech University in Lubbock, Texas, in 1982. Her archaeological experience before entering Texas A&M included excavation of a mammoth at Cisco, Texas, a six-week field season at Ghost Ranch, New Mexico, and a field course in Mesoamerican archaeology. The summer of 1983 was spent at the Bodrum Museum of Underwater Archaeology in Turkey working under F.H. van Doorninck of the Institute of Nautical Archaeology on a variety of projects including retrieval of amphora contents, amphora mending, and wood recording. She married David Douglas Haldane in November, 1983. Her permanent address is 2517 Limestone Lane, Garland, Texas, 75040.