

### MECHANICAL ENGINEERING IN ANCIENT EGYPT, PART 81: BOATS INDUSTRY DURING PREDYNASTIC TO MIDDLE KINGDOM

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**ABSTRACT**

The objective of this paper is to investigate the development of mechanical engineering in ancient Egypt through the study of the boat industry during a time span from the Predynastic Period to the Middle Kingdom. This study covers the different types of boats produced in the ancient Egyptian society during this period and the different materials used. The use, design, period, dimensions, characteristics and present location are all outlined.

**KEYWORDS:** Mechanical engineering history, ancient Egypt, boats industry, Predynastic to Middle Kingdom.

**INTRODUCTION**

This is the 81<sup>st</sup> part in a series aiming at investigating the mechanical engineering technology in ancient Egypt. It investigates the industry of boats in ancient Egypt since it was one of the important industries required to facilitate transportation and trading through the long River Nile crossing Egypt longitudinally from the borders with Sudan to the Mediterranean Sea.

Vinson, 1987 in his Master of Arts Thesis about boats of Egypt before the Old Kingdom presented a scene of a sickle-shaped boat on a vase from Gerza, a boat scene on a label from Naqada, number of boat scenes on a label for Menes, papyrus craft, symmetrical and asymmetrical boat images, boat scene on a dish, boat scene as a pot mark from Naqada, boat scenes on decorated ware, scenes of sickle-shaped boats with cabins, boat on a pot in the

British Museum, angular symmetrical boat scenes from Early Dynastic, Predynastic boat scenes with fish ensigns, scene of an Early Dynastic papyrus raft boats with Early Dynastic profiles, models of reed boats, boat model with crew, boat model with superstructure, models with Early Dynastic profiles and Old Kingdom boat construction scene<sup>[1]</sup>. Altenmuller, 2002 examined the meaning of boat graves of the Old Kingdom. He presented a rowing and sailing boat scenes from the tomb of Seneb at Giza, sailing boat scene from the tomb of Fetekty at Abusir, rowing and sailing boats from the tomb of Kakhent at El-Hammiya, the barque of Khufu near his pyramid, barques from the boat pit of Queen Neith at Saqqara.<sup>[2]</sup> Creasman, 2005 in his Master of Arts Thesis presented an image for a boat on a Naqada II vessel, models of fishing boats from the tomb of Meketry, Senusret III 10 m length boat in display in the Egyptian Museum at Cairo. He presented also some collections of 12<sup>th</sup> and 13<sup>th</sup> Dynasties boat models in the Egyptian Museum at Cairo, boat in site from Dahshur excavations, second boat from Dahshur in display in Cairo Museum.<sup>[3]</sup> De Moortel, 2007 pointed out that thousands of surviving boat images and models told us about the appearance of Egyptian boats and ships, texts telling about shipbuilding materials, ship construction, nature of hull parts, types, uses and voyages. She reviewed a book entitled: sacred and secular ancient Egyptian ships and boats by C. Ward and published in 2000.<sup>[4]</sup>

Darnell, 2008 in his extensive study about Wadi of Horus QA-A of Egypt presented a large number of boat scenes from Predynastic and Early Dynastic Periods. He presented four rowing boats rock inscriptions from Dominion behind Thebes, rowed boat with domed deck, boat with two stories cabin, an animal transportation boat protected by an armored man from the 3<sup>rd</sup> Dynasty.<sup>[5]</sup> Creasman and Doyle, 20104 in their paper about overland boat transportation during the Pharaonic Period presented a scene for a funerary boat transportation during the 1<sup>st</sup> Dynasty, portable sacred barque of Amun, the construction of a funerary shrine in a boat from tomb TT51, boat-shaped wheeled wagon, papyrus funerary boat from the tomb of Antefoker, dragged boat scenes from the tomb of Huy, colored boat scene from the tomb of Sobeknakht II, wheeled boat model from Gurob.<sup>[6]</sup> Kroenke, 2010 in his Ph. D. Thesis about the provincial cemeteries of Naga ed-Deir presented a boat model in N3575 burial, a line drawing for a Middle Kingdom boat and its key parts labelled, steering oar from SF5203, boat from N241, rowed boat model from N202, sailed boat model from N4172, steering oar from SF5214, model boats from N4003, N4401, clay boat model from N3575, divine bark from SF218 and wooden boat model from SF170.<sup>[7]</sup> Vinson, 2013 in his paper about use of boats presented the funerary ship of Khufu, sailing boat inscribed on a

rock at Nubia, scene for Old Kingdom transport boats, relief from Medinet Habu for the Naval Battle against the Sea People, boat scenes inscribed in Tomb 100 of Hierakonpolis, scene for ceremonial bark of Sokar.<sup>[8]</sup>

Hassaan, 2016 in his study of the models industry in ancient Egypt presented a boat model from Naqada II, boat model from Naqada II/Naqada III, boat models from the 6<sup>th</sup> Dynasty, 9<sup>th</sup>/10<sup>th</sup> Dynasties, transport boat model from the 11<sup>th</sup> Dynasty, two fishing boat models from the 11<sup>th</sup> Dynasty and boat models from the 12<sup>th</sup> and 18<sup>th</sup> Dynasties <sup>[9]</sup>. Vanhulle, 2018 in his paper about boat symbolism in Predynastic and Early Dynastic presented rock inscriptions in Nagel-Hamdulab for a number of boats, boats rock inscription in Gua Kain Hitan <sup>[10]</sup>. Inglis, 2018 studied the 3<sup>rd</sup> Dynasty Abusir boat discovered by the Czech Institute of Egyptology of the Charles University at Prague in 2015. He outlined that Abusir boat was the sole vessel dated to the 3<sup>rd</sup> Dynasty and explained the dramatic changes in form, size and construction of boat-burials occurred between the 1<sup>st</sup> and 4<sup>th</sup> Dynasties.<sup>[11]</sup> Wikipedia, 2018 wrote an article about Abydos boats discovered in 1991 where 14 boats buried during the reign of King Khesekhmwy of the 2<sup>nd</sup> Dynasty. They presented an image for the solar bark of King Senusret III of the 12<sup>th</sup> Dynasty and the solar bark of King Khufu of the 4<sup>th</sup> Dynasty.<sup>[12]</sup> Hassaan, 2018 in his investigation of the rock inscriptions in ancient Egypt presented a rock inscription for a boat from Naqada II and a boat inscription from the 1<sup>st</sup> Dynasty.<sup>[13]</sup>

### **Predynastic Boats**

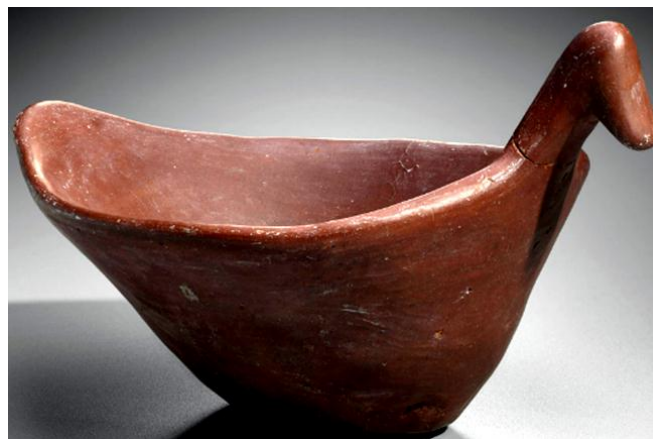
The ancient Egyptians were in need to produce boats for multiple purposes. They needed boats for fishing, hunting, travelling, transportation, entertainment and for funerary purposes. All those purposes were because of the crossing of the River Nile to Egypt from its extreme south to its extreme North in the Delta. They were pioneers in boat construction from the early days of the Predynastic Period as will be depicted by the following examples

- The first example is a 253 mm length greywacke boat-shaped palette from Naqada I (3900-3500 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.1,<sup>[14]</sup> The grinding palette reflected a symmetrical boat design about the vertical axis with cabin in its middle.



**Fig. 1: Boat-shaped palette from Naqada I.<sup>[14]</sup>**

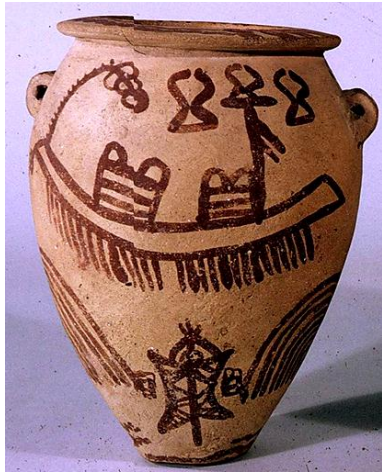
- The second example is a clay boat-shaped vessel from Naqada I (3700 BC) in display in the Museum of Fine Arts at Boston and shown in Fig.2 <sup>[15]</sup>. The vessel simulates an asymmetric boat about the vertical axis with duck head in its front end. It reflects how the ancient Egyptians appreciated boats and wanted to see them all times inside their homes in terms of houseware.



**Fig. 2: Boat-shaped vessel from Naqada I.<sup>[15]</sup>**

- The third example is a boat scene on a 145 mm height pottery jar from Naqada II (3650-3500 BC) in display in the Metropolitan Museum of Art and shown in Fig.3. <sup>[16]</sup> The painted boat was of the crescent type and had two cabins, two rows of oars each row comprised 28 oars and two poles: one flexible at the stern of the boat and one rigid in front of the first cabin.

- The fourth example is a boat scene on a pottery vase from Gerzah (Naqada II) (3500-3200 BC) in display in the Metropolitan Museum of Art and shown in Fig.4. <sup>[17]</sup> The design of the boat was similar to that in Fig.3 except the tall cabin in the middle of the deck with a person standing in it.



**Fig. 3: Boat scene on a jar from Naqada II.<sup>[16]</sup> Fig. 4: Boat scene on a vase from Naqada II.<sup>[17]</sup>**

- The fifth example is a boat scene on a terracotta vase from Gerzeh (Naqada II) in display in the Brooklyn Museum at New York and shown in Fig.5.<sup>[18]</sup> The design of the boat was similar to that in Fig.3 except the omitted poles in this design.
- The sixth example is a scene of a papyrus boat on a pot from Gerzeh (Naqada II) in display in the Brooklyn Museum at New York and shown in Fig.6.<sup>[18]</sup> The design of the boat was similar to that in Fig.3 except the person standing above the first cabin and the two persons standing above the second cabin.



**Fig. 5: Boat scene on a vase from Gerzeh.<sup>[18]</sup> Fig. 6: Boat scene on a pot from Gerzeh.<sup>[18]</sup>**

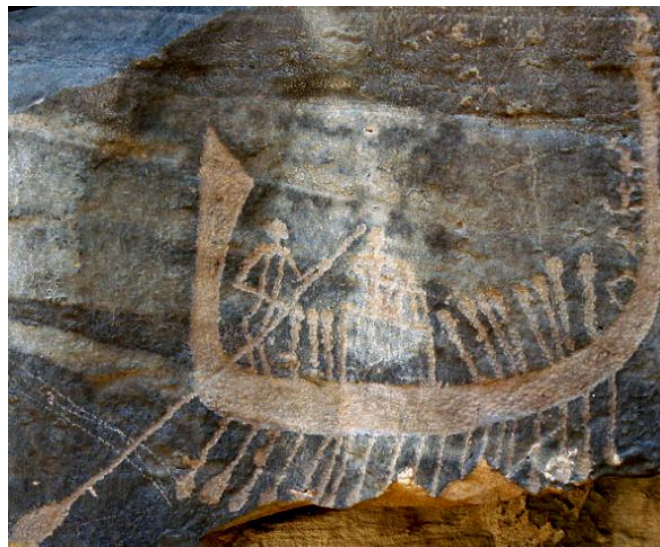
- The seventh example is a boat image on a pot from Naqada II (3500-3200 BC) in display in the British Museum at London and shown in Fig.7.<sup>[18]</sup> The design of the boat was completely different than that in the previous examples. It was of the sail-powered type with long pole on its bow and about three sails on its deck.
- The eighth example is a painted pottery boat model from Naqada II/Naqada III (3500-3000 BC) sold by Christies and shown in Fig.8<sup>[19]</sup>. It had an asymmetrical design with wide

stern and then bow. The deck edges simulated wild animal teeth. It had one cabin floorished towards the stern.



**Fig. 7: Boat scene on a pot from Naqada II.<sup>[18]</sup> Fig. 8: Boat model from Naqada I I/Naqada III.<sup>[19]</sup>**

- The ninth example is a rock boat scene from Naqada III (3200-3000 BC) in Wadi Abu Subeira and shown in Fig.9.<sup>[20]</sup> This boat was of the sickle-shaped type powered by two rows of oars each had 19 oars and one long steering oar. The front pole was longer than the back pole. The steering oar was set by an oarsman shown in the scene.



**Fig. 9: Rock boat model from Naqada III.<sup>[20]</sup>**

- The tenth example is a rock scene of a boat from Naqada III (3200-3000 BC) with a King standing on a platform and shown in Fig.10.<sup>[21]</sup> This boat was of an asymmetrical type powered by two rows of oars each had about 23 oars and one long steering oar. The front pole was longer than the back pole. The King was shown on a platform looking forward and may be holding a staff. The boat was labeled by a pole in front of the King with a fish on its

top (this means that the ancient Egyptians new boat identification from more than 5000 years).

- The eleventh example is a boat inscription in Wadi Shalul from Naqada III and shown in Fig.11.<sup>[22]</sup> It reflected a sickle type boat without rowing and steering facilities. It seems to be a transportation boat for animals transportation.



**Fig. 10: Rock boat scene from Naqada III.<sup>[21]</sup>**



**Fig. 11: Boat inscription from Naqada III.<sup>[22]</sup>**

- The twelfth example is a sailing boat inscription in Wadi Abu Wasil from Naqada III (3100 BC) and shown in Fig.12.<sup>[23]</sup> It was of the asymmetric type with cabin, sail and two steering oars near its stern.



**Fig. 12: Sailing boat inscription from Naqada III.**<sup>[23]</sup>

### Early Dynastic Boats

The authorization of boats design and use during the Early Dynastic Period is depicted through the following examples

- The first example is a rock inscription for a boat carrying the Serekh of King Narmer of the 1<sup>st</sup> Dynasty (3150-3125 BC) in Wadi al Homor and shown in Fig.13<sup>[24]</sup>. It was of the asymmetrical type without any powering tools.



**Fig. 13: Boat scene carrying King Narmer Serekh from the 1<sup>st</sup> Dynasty.**<sup>[24]</sup>

- The second example is an ivory boat model from the Early Dynastic Period (3100-2649 BC) in display in the Egyptian Museum at Cairo and shown in Fig.14<sup>[25]</sup>. It was of the asymmetrical type with decorated hull, pointed bow and flattened stern.



**Fig. 14: Ivory boat model from the Early Dynastic Period.**<sup>[25]</sup>



- The third example is a terracotta boat model from the Early Dynastic Period (3100-2649 BC) in display in the Louvre Museum at Paris and shown in Fig.15.<sup>[26]</sup> It was of the asymmetrical type bow end thinner than its stern end. It had a passenger cabin of a trapezium shape to allow passengers to have good view of the surroundings.



**Fig. 15: Terracotta boat model from the Early Dynastic Period.**<sup>[26]</sup>

### Old Kingdom Boats

We are with the Period of Great Kings, the Period of the Pyramids builders. We expect to have good example of boat use and authorization as will be depicted through the following examples

- The first example is a solar bark of Khufu, the second King of the 4<sup>th</sup> Dynasty and the builder of the Great Pyramid at Giza (2589-2566 BC) in display in a Solar Boat Museum beside Khufu's Pyramid and shown in Fig.16<sup>[27]</sup>. It had a semi-symmetrical hull powered by two rows of oars each row had five long oars with a passenger (or funerary) cabin flourished towards the boat-stern. It had also two steering oars near its stern. It had a straight pole at its bow and a curved pole at its stern.



**Fig. 16: Solar boat of Khufu from the 4<sup>th</sup> Dynasty.**<sup>[27]</sup>

- The second example is 43.6 m length second solar bark of King Khufu in display in a Solar Boat Museum beside Khufu's Pyramid and shown in Fig.17.<sup>[28]</sup> It had a long straight

vertical pole at its bow and curved pole at its stern, powered by 12 oars in two rows and two steering oars near its end. It had a large cabin near its center.



**Fig. 17: Second solar boat of Khufu from the 4<sup>th</sup> Dynasty.**<sup>[28]</sup>

- The third example is a colored scene of hunting boats from the tomb of Ti, the Supervisor of the Pyramids from the 5<sup>th</sup> Dynasty (2474 BC) and shown in Fig.18.<sup>[29]</sup> The scene showed Ti standing in a boat and supervising the hunting process of hippopotamus in another boat where two hunters are using spears and one hunter supporting them.



**Fig. 18: Scene of boats of Ti from the 5<sup>th</sup> Dynasty.**<sup>[29]</sup>

- The fourth example is a colored scene of hunting boats from the tomb of Ti, the Supervisor of the Pyramids from the 5<sup>th</sup> Dynasty (2474 BC).<sup>[30]</sup> The scene depicted two groups of boat construction workers. The first group in Fig.19 (a) is constructing a papyrus boat while the second group in Fig.19 (b) is constructing a crescent symmetrical wooden boat. Workers are using tools suitable with each type of boat material.



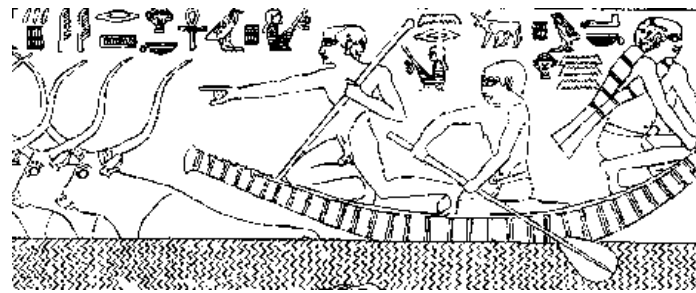
(a) Papyrus boat



(b) Wooden boat

**Fig. 19: Scene of boats construction, Ti's tomb from the 5<sup>th</sup> Dynasty.<sup>[30]</sup>**

- The fifth example is a scene of a papyrus boat from the Mastaba of Ti from the 5<sup>th</sup> Dynasty (2474 BC) and shown in Fig.20.<sup>[31]</sup> The scene depicts three men driving cattle through the River Nile.

**Fig. 20: Scene of papyrus boat from Ti's Mastaba from the 5<sup>th</sup> Dynasty.<sup>[31]</sup>**

- The sixth example is a scene of a sailed boat from the tomb of Nefer, Supervisor of Artisans during the reign of Niuserre, the 6<sup>th</sup> King of the 5<sup>th</sup> Dynasty (2445-2421 BC) at Saqqara and shown in Fig.21.<sup>[32]</sup> The scene depicted a symmetrical boat powered by a sail and steered by two oars near its stern and fully crewed. The sail was supported by a bipod mast in the middle of the boat.

**Fig. 21: Scene of sailed boat from Nefer's tomb from the 5<sup>th</sup> Dynasty.<sup>[32]</sup>**

- The seventh example is a scene of a papyrus boat in a foiling trip from the tomb of Ptah-Hotep at Saqqara, Vizier of Djedkare Isesi, 8<sup>th</sup> King of the 5<sup>th</sup> Dynasty (2414-2375 BC) and shown in Fig.22.<sup>[33]</sup> The boat had an asymmetrical design with bow and stern of different structure. The boat was crewed by four active staff.



**Fig. 22: Scene of papyrus boat from Ptah-Hotep's tomb from the 5<sup>th</sup> Dynasty.<sup>[32]</sup>**

- The seventh example is a scene of a fishing papyrus boat from the tomb of Kagemni, Vizier of King Teti, the founder of the 6<sup>th</sup> Dynasty (2345-2333 BC) and shown in Fig.23<sup>[33]</sup>. The scene was professionally carved on the tomb walls depicting a fishing asymmetrical papyrus boat crewed by three fishermen using different fishing tools.



**Fig. 23: Scene of papyrus boat from Kagemni's tomb from the 6<sup>th</sup> Dynasty.<sup>[33]</sup>**

### Middle Kingdom Boats

Middle Kingdom was one of most wealthy Periods in ancient Egypt and it is expected to get expansion in boat use and production as will be depicted by the following examples.

- The first example is a 0.775 m length wooden boat model from the Middle Kingdom (2181-1794 BC) in display in the North Carolina Museum of Art and shown in Fig.24.<sup>[34]</sup> The boat was powered by oars and a sail and crewed by seven (only five shown) sailing men: four rowers, one steering, one sail operator, one pilot. An official is sitting under a thin frame. This boat was of the asymmetrical type with a vertical pole at its bow and a curved pole at its stern.



**Fig. 24: Wooden boat model from the Middle Kingdom.**<sup>[34]</sup>

- The second example is a wooden hunting boat model from the 11<sup>th</sup> Dynasty (2134-1991 BC) shown in Fig.25.<sup>[35]</sup> The model was powered by two rows of oars, each row comprised nine oars and its direction was steered by a long steering oar joined to its bow.



**Fig. 25: Wooden boat model from the 11<sup>th</sup> Dynasty.**<sup>[35]</sup>

- The third example is a wooden transportation boat model from the Middle Kingdom (2134-1783 BC) shown in Fig.26<sup>[36]</sup>. The model was powered by four oarsmen, only three were shown in the model. It was of the asymmetrical type designated by an animal head at its stern. It had a cabined carried by four columns for an official sitting in it on a chair.



**Fig. 26: Wooden boat model from the Middle Kingdom.**<sup>[36]</sup>

- The fourth example is a wooden travelling boat model from the tomb of Meketre, chancellor and high steward during the reign of Mentuhotep II and Mentuhotep III of the 11<sup>th</sup> Dynasty and died during the days of King Amenemhat I, the founder of the 12<sup>th</sup> Dynasty (2061-1988 BC) shown in Fig.27.<sup>[37]</sup> The model was powered by two rows of oarsmen each row comprised nine rowing oars and steered by one long steering oar joined to the boat bow. It was of the asymmetrical type design and had a pilot standing near the boat end. It has a mast for sail powering during return back to the south.



**Fig. 27: Wooden boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.**<sup>[37]</sup>

- The fifth example is a 1.325 m length wooden traveling boat model from the tomb of Meketre from the 11<sup>th</sup>-12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Metropolitan Museum at New York and shown in Fig.28<sup>[38]</sup>. The model was powered by two rows of oarsmen each

row comprised eight rowing oars and steered by two long steering oar joined near the stern end of the boat. It was of the asymmetrical type design and had a pilot standing near the boat front. It has a mast for sail powering during return back to the south.



**Fig. 28: Wooden traveling boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.**<sup>[38]</sup>

- The sixth example is a 1.217 m length wooden sporting boat model from the tomb of Meketre from the 11<sup>th</sup>-12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Metropolitan Museum at New York and shown in Fig.29<sup>[39]</sup>. The model was powered by two rows of oarsmen each row comprised three rowing oars and steered by one long steering oar joined near the stern end of the boat. It was of the asymmetrical type design and had a decorated cabin set in front of the steering oar.



**Fig. 29: Wooden sporting boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.**<sup>[39]</sup>

- The seventh example is a two wooden fishing boat models from the tomb of Meketre from the 11<sup>th</sup>-12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Egyptian Museum at Cairo and shown in Fig.30<sup>[40,41]</sup>. The two boats were powered by two rowing staff on each boat while seven fish men on the two boats are cooperating in holding and discharging fishing net

between the two boats. The boats were of the crescent symmetrical type with sterns thinner than the bows.



**Fig. 30: Wooden fishing boat models from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.**<sup>[40,41]</sup>

- The eighth example is a 1.17 m length wooden traveling boat model from the tomb of Meketre from the 11<sup>th</sup>-12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Metropolitan Museum at New York and shown in Fig.31<sup>[42]</sup>. The model was powered by two rows of oarsmen each row comprised nine rowing oars and steered by one long steering oar joined on a pole near the bow end of the boat. It was of the asymmetrical type design and had a decorated cabin set in in the middle of the boat with a pilot standing at the end near the stern and a man sitting behind him.



**Fig. 31: Wooden traveling boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.**<sup>[42]</sup>

- The ninth example is a wooden funerary boat model from the Middle Kingdom (2050-1750 BC) in display in the Museum of Fine Arts at Boston and shown in Fig.32<sup>[43]</sup>. The model was powered by two rows of oarsmen each row comprised five rowing oars and

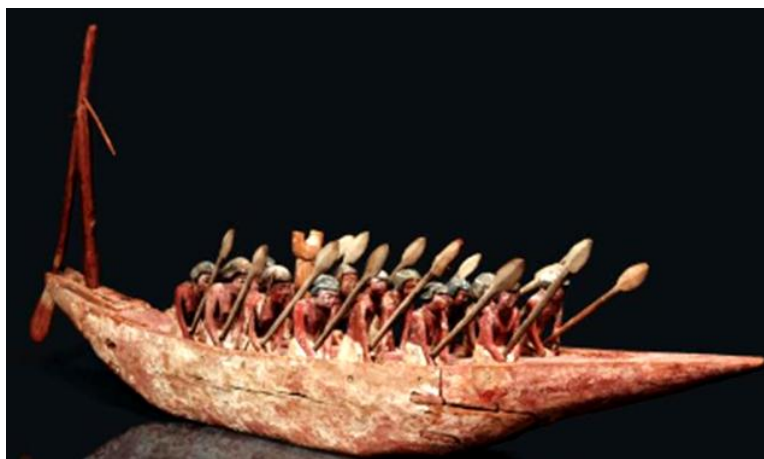


steered by one long steering oar actuated by an oarsman sitting behind the rowing crew. It was of the symmetrical type design with equal inclined pole at the bow and stern of the boat.



**Fig. 32: Wooden funerary boat model from the Middle Kingdom.**<sup>[43]</sup>

- The tenth example is a 1.52 m length wooden boat model from the Middle Kingdom (2050-1710 BC) sold by Pierre Berge and Associates for 804,060 US \$ and shown in Fig.33<sup>[44]</sup>. The boat was powered by two rows of oarsmen each row comprised seven rowing oars and steered by one long steering oar joined to end of a pole near the stern of the boat. The crew was shown resting and taking a break raising all their oars. It had an asymmetrical design with sharp tip at the bow.



**Fig. 33: Wooden boat model from the Middle Kingdom.**<sup>[44]</sup>

- The eleventh example is a model of a river boat from the 12<sup>th</sup> Dynasty (2046-1794 BC) in display in the Art Institute at Chicago, USA and shown in Fig.34<sup>[45]</sup>. The boat was powered by two rows of oarsmen each row comprised seven rowing oars and steered by one long steering oar joined to the bow of the boat and resting on a pole in front of the crew. A pilot

near the end of the boat is leading the sailing process. The mast in the middle most probably for sail powering of the boat when going south through the River Nile.



**Fig. 34: Wooden boat model from the 12<sup>th</sup> Dynasty.**<sup>[45]</sup>

- The twelfth example is a wooden funerary boat model from the Middle Kingdom (2040-1640 BC) in display in the Athens Museum at Athens and shown in Fig.35<sup>[46]</sup>. The boat was of the symmetrical design with two long poles at its bow and stern. It was powered by a crew consisting of three oarsmen besides a long oar most probably used for boat steering. A pilot was standing in front of the crew giving sailing directions. The man near the stern may be the steering man extending his arms to hold the steering oar. The image indicates that this may be an actual full-scale boat.



**Fig. 35: Wooden funerary boat model from the Middle Kingdom.**<sup>[46]</sup>

- The thirteenth example is a wooden boat model from the Middle Kingdom (2000-1800 BC) in display in the Cincinnati Art Museum at Cincinnati, USA and shown in Fig.36.<sup>[47]</sup> The boat had almost a asymmetrical design and powered by two rows of oarsmen each row

comprised five rowing oars and steered by a single long steering oar joined with the bow of the boat. Near the stern of the boat one of the sailors was shown holding a tool may be for measuring the water depth under the boat.



**Fig. 36: Wooden boat model from the Middle Kingdom.**<sup>[47]</sup>

- The fourteenth example is a wooden boat model from the Middle Kingdom (2000-1800 BC) in display in the British Museum at London and shown in Fig.37<sup>[48]</sup>. The boat had a symmetrical design and powered by two rows of oarsmen each row comprised two rowing oars and steered by a single long steering oar hold by both hands of a sailor standing near the stern of the boat. A pilot was shown standing near the bow of the boat and an official was shown sitting in front of the steering sailor.



**Fig. 37: Wooden boat model from the Middle Kingdom.**<sup>[48]</sup>

- The fifteenth example is a 1.11 m length wooden boat model from the 12<sup>th</sup> Dynasty (1991-1802 BC) in display in the British Museum at London and shown in Fig.38<sup>[49]</sup>. The boat had a symmetrical design and powered by a square white sail and steered by a single long steering oar joined to the stern of the boat. A pilot was shown standing near the bow of the boat and an official was shown sitting in front of the pilot while other passengers and the crew were shown standing around the sail mast.



**Fig. 38: Wooden boat model from the 12<sup>th</sup> Dynasty.<sup>[49]</sup>**

- The sixteenth example is a model of a travelling colored wooden boat from the tomb of Meketre from the 11<sup>th</sup>/12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Metropolitan Museum of Art and shown in Fig.39.<sup>[50]</sup> The boat had a symmetrical design and powered by two rows of oarsmen each row comprised six rowing oars and steered by a single long steering oar joined to the bow of the boat. A pilot was shown standing near the stern of the boat and the steering oar operator was shown sitting behind the oar. The passenger cabinet was nicely decorated and had square windows with safety bars set vertically in each window. The pole near the middle may be a sail mast.



**Fig. 39: Wooden travelling boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.<sup>[50]</sup>**

- The seventeenth example is a model of a funerary colored wooden boat from the 12<sup>th</sup> Dynasty (1991-1802 BC) in display in the British Museum at London and shown in Fig.40.<sup>[51]</sup> The boat had a symmetrical design and steered by two long oars joined near the boat bow. The boat was designated by L-shaped parts fixed to the boat bow and stern. It had an open cabinet from all sides taking the design of a shrine with the deceased laid inside it. There was a two-persons chair set before the stern with two ladies standing around the shrine.



**Fig. 40: Wooden funerary boat model from the 12<sup>th</sup> Dynasty.<sup>[51]</sup>**

- The eighteenth example is a model of a funerary colored wooden boat of Meketre tomb from the 11<sup>th</sup>-12<sup>th</sup> Dynasties (2061-1988 BC) in display in the Metropolitan Museum at New York and shown in Fig.41.<sup>[52]</sup> The boat had a symmetrical design and powered by two rows of oarsmen each row comprised nine rowing oars. The deceased coffin was set inside a domed cabinet with priests sitting in front of it and an official or deceased relative sitting near the stern of the boat. The pilot of the boat was shown standing near the stern.



**Fig. 41: Wooden funerary boat model from the 11<sup>th</sup>-12<sup>th</sup> Dynasties.<sup>[52]</sup>**

- The nineteenth example is an 0.98 m length wooden boat model from the 12<sup>th</sup>-13<sup>th</sup> Dynasties (1981-1640 BC) in display in the Metropolitan Museum at New York and shown in Fig.42.<sup>[53]</sup> The boat had almost a symmetrical design and powered by two rows of oarsmen each row comprised five rowing oars and steered by a long oar joined to the bow of the boat with an operator sitting facing the oarsmen . The sail was shown down during the present journey powered by oarsmen. The pilot was shown sitting near the boat



**Fig. 42: Wooden boat model from the 12<sup>th</sup>-13<sup>th</sup> Dynasties.**<sup>[53]</sup>

- The twentieth example is an 1.15 m length wooden funerary boat model of Akhhotep, the Nomarch of the 14<sup>th</sup> nomos of Upper Egypt during the reign of King Senusret I of the 12<sup>th</sup> Dynasty (1971-1926 BC) in display in the Metropolitan Museum at New York and shown in Fig.43.<sup>[54]</sup> The boat had an asymmetrical design and powered by one oarsman in the front of the boat and steered by a long oar joined to the stern of the boat with an operator sitting facing the cabinet. The cabinet was a two stories funerary shrine with the coffin set on the top of the first story. And three persons (two ladies and a man) looking after the deceased.



**Fig. 43: Wooden funerary boat model from the 12<sup>th</sup> Dynasty**<sup>[54]</sup>

- The twenty first example is a 2.75 m length Acacia wooden funerary boat model of Imhotep, from the 12<sup>th</sup> Dynasty during the reign of Kings Amenemhat II and Senusret II (1919-1887 BC) in display in the Metropolitan Museum at New York and shown in Fig.44.<sup>[55]</sup> The boat had an asymmetrical crescent design and an inclined pole at its bow and an almost a straight vertical pole at its stern.



**Fig. 44: Wooden funerary boat model of Imhotep from the 12<sup>th</sup> Dynasty.**<sup>[55]</sup>

- The twenty second example is wooden boat model of Djehutihotep, from the 12<sup>th</sup> Dynasty during the reign of Kings Amenemhat II, Senusret II and Senusret III (1929-1839 BC) shown in Fig.45.<sup>[56]</sup> The boat had a symmetrical crescent design and powered by two rows of oarsmen each row comprised five rowing oars. A pilot standing in front of the boat is leading the sailing process. The boat seems to be a passenger one where a big cabinet with domed roof was set flourished towards the boat stern.



**Fig. 45: Wooden travelling boat model of Djehutyhotep from the 12<sup>th</sup> Dynasty.**<sup>[56]</sup>

- The twenty third example is a colored wooden boat model of Mentuhotep, from the 12<sup>th</sup> Dynasty (1900 BC) in display in the Egyptian Museum at Berlin shown in Fig.46.<sup>[57]</sup> The boat had a symmetrical crescent design with curved pole at its bow and powered by two rows of oarsmen each row comprised eight rowing oars and one long steering oar joint to a vertical pole near the bow with an operator holding its rope. A mast in the middle of the boat supports the sail which was shown laid down during this trip. A pilot standing before the boat stern is leading the sailing process.



**Fig. 46: Wooden boat model of Mentuhotep from the 12<sup>th</sup> Dynasty.<sup>[57]</sup>**

- The twenty fourth example is an 0.806 m length sailing wooden funerary boat model of Djehuty, from the 12<sup>th</sup> Dynasty during the reign of King Amenemhat II (1900-1885 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.47 <sup>[58]</sup>. The boat had a symmetrical crescent design with curved flat pole at its stern and powered by a sail joined to a mast in the middle of the boat (not shown). The coffin was set inside a cabin (shrine) flourished towards the stern end with colored columns with the relatives of the decease standing and sitting around the shrine. A pilot in the frond leads the trip.



**Fig. 47: Wooden funerary boat model of Djehuty from the 12<sup>th</sup> Dynasty.<sup>[58]</sup>**

- The twenty fifth example is an 0.710 m length wooden boat model of Djehuty-Nakht, Nomarch during the reign of King Sensusret III of the 12<sup>th</sup> Dynasty (1878-1839 BC) in display in the Virginia Museum of Fine Arts at Virginia and shown in Fig.48 <sup>[59]</sup>. The boat had a symmetrical crescent design with curved flat pole at its stern and powered by a sail joined to a mast in the middle of the boat (not shown). The coffin was set inside a cabin (shrine)



flourished towards the stern end with colored columns with the relatives of the deceased standing and sitting around the shrine. A pilot in the front leads the trip.



**Fig. 48: Wooden boat model of Djehuty-Nakht from the 12<sup>th</sup> Dynasty.<sup>[59]</sup>**

## CONCLUSION

- This paper investigated the evolution of mechanical engineering in ancient Egypt through the production of boats.
- The study covered a time span from the Predynastic to Middle Kingdom.
- The ancient Egyptians authorized their knowledge and use of boats since the dating of Naqada I from more than 5700 years ago by producing house ware having the shape of boats.
- During the time of Naqada II (3500-3200 BC) they produced vases and jars painted by scenes of rowed boats.
- They started boat models since the Predynastic Period.
- They inscribed rocks by boat scenes since the time of Naqada III (3200-3000 BC).
- They designed crescent, U-shaped, animal mouth and sickle boats since the Predynastic Period.
- They knew how to label their boats since the time of Naqada III.
- They authorized using sailing boats since the time of Naqada III.
- The rock inscription by boat scenes continued during the 1<sup>st</sup> Dynasty.
- They continued to produce boat models during the Early Dynastic Period using ivory and terracotta.
- They produced giant boats during the 4<sup>th</sup> Dynasty with length more than 43 meters and kept samples of them near the Great Pyramid of King Khufu at Giza.

- They authorized the use of boats for hunting purposes during the 5<sup>th</sup> Dynasty through tomb scenes.
- They authorized the production of papyrus and wooden boats through tomb scenes during the 5<sup>th</sup> Dynasty.
- They continued to authorize the use of sailed boats during the 5<sup>th</sup> and 6<sup>th</sup> Dynasties through tomb scenes.
- They continued to produce boat models and leave them inside their tombs during the Middle Kingdom.
- They extensively produced funerary boat models for their Nobles and Royal tombs during the Middle Kingdom.
- During the Middle Kingdom, they authorized using boats for travelling and hunting.
- During the Middle Kingdom, they powered their boats by sails and/or rowing using to 18 oars per boat.
- They designated their boats using special designs at the bow and stern of the boat during the Middle Kingdom.
- During the Middle Kingdom, they used cabinets on the boat-deck of travelling and sporting boats.
- They used either one or two steering oars to steer the boats joined to either the bow or the stern of the boat.
- They designed and produced symmetric papyrus fishing boats powered by two oars.
- They produced symmetrical and asymmetrical boats during the Middle Kingdom.
- They authorized the use of sailed boats with square sails during the 12<sup>th</sup> Dynasty.
- They used cabinets with windows and image-labeled during the Middle Kingdom.
- They used an elaborated shrine as a cabinet in funerary boats during the Middle Kingdom.

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