

Mechanical Engineering in Ancient Egypt, Part XXIX: Sarcophagus Industry

Galal Ali Hassaan

Emeritus Professor, Department of Mechanical design & Production,
Faculty of Engineering, Cairo University, Egypt
galalhassaan@gmail.com

Abstract— The evolution of mechanical engineering in ancient Egypt is investigated through the sarcophagus industry during the dynastic periods of ancient Egypt. Examples of sarcophagi industry from the 4th to the 30th Dynasties are presented and analyzed. Sarcophagi types, materials, location and features are traced. The capability of ancient Egyptians in carving hard rocks was outlined through the sarcophagi industry.

Index Terms— Mechanical engineering in ancient Egypt, sarcophagus industry, dynastic periods.

I. INTRODUCTION

The ancient Egyptians had an outstanding role in the evolution of mechanical engineering during the man-kind history. This is the 29 part of a series of research papers aiming at exploring the role of ancient Egyptians in building strong technology in many aspects of mechanical engineering. This part deals with the production of sarcophagus for funerary purposes in ancient Egypt.

Sharpe (1864) described the alabaster sarcophagus of King Oimeneptah (Seti I) of the 19th Dynasty. He presented the numerous inscriptions and scenes on the sarcophagus walls [1]. Al-Sadeek (1984) studied the history of Necropolis at Gizah, the Tomb of Thery and analyzed the scenes from Thery Tomb within the 26th Dynasty. She presented the lid of Pakap sarcophagus displayed in the British Museum, the sarcophagus of Ptahhotep displayed in the Ashmolean Museum at Oxford [2]. In the six-grade curriculum material (2010), the Los Angeles Country Museum of Art presented a sarcophagus dated to the middle of the 21st Dynasty (1000-968 BC). In this time high priests of Amun at Thebes ruled Egypt where a number of changes took place in the funerary customs [3]. Mallinckrodt (2013) investigated an ancient Egyptian anthropoid sarcophagus lid in the collection of the San Diego Museum of Man. She presented a technical analysis for the materials and methods of manufacturing [4].

Abdelaal and Mahmoud (2014) examined a wooden sarcophagus found in Saqarra excavation dating to the Late Period to Greco-Roman Period. They used multiple analytical and examination techniques examining the structure of the sarcophagus [5]. Camacho (2014) examined factors influencing the positioning, dominance and orientation of Isis and Nephthys on coffins and sarcophagi. She presented some sarcophagi such as sarcophagus of Pharaoh Ramses II and sarcophagus of Amenhotep III [6]. Reems (2015) in her Ph.D. thesis presented sarcophagi for

Pharaoh Merenptah from the 19th Dynasty, Pharaoh Ramses III from the 20th Dynasty and Pawenhatet from the Late Period [7]. Wikipedia (2016) wrote an article about 'sarcophagus' and defined it as a box-like funeral receptacle for a corpse most commonly carved in stone [8]. Hassaan (2016) investigated the evolution of mechanical engineering in ancient Egypt through the development of wooden coffins in dynastic Egypt up to the 27th Dynasty [9].

II. SARCOPHAGI OF THE OLD KINGDOM

The Old Kingdom comprises from the 3rd Dynasty to the 6th Dynasty cover a time span from 2686 to 2181 BC [10]. The evolution of the sarcophagus industry during the Old Kingdom is investigated through a number of models presented as follows:

- The first sarcophagus example from the Old Kingdom belongs to Kaiemneferet from the 4th Dynasty (2700-220BC) in display in the Roemer and Pelizaeus Museum at Germany and shown in Fig.1 [11]. It is of the rectangular prism type and it was manufactured from rose granite for both lid and trough. The lid has two shoulders at its both ends and a domed surface in between. There is no inscription but the decorations take the form of letter i all around carved on the external walls.



Fig.1 Sarcophagus of Kaiemneferet from the 4th Dynasty [11].

- The second example is for King Menkaure, the 6th King of the 4th Dynasty. This sarcophagus was manufactured from basalt decorated by niches in a wonderful design. It was lost in the Mediterranean sea during its shipping from King Menkaure pyramid to the British Museum in 1838. A line diagram for King Menkaure sarcophagus is shown in Fig.2 [12]. It is of the rectangular prism type

design with too-many decorations. The sarcophagus takes the form of an ancient Egyptian shrine in three colors.

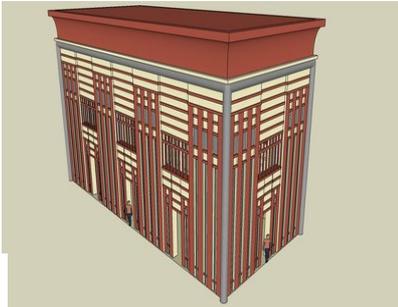


Fig.2 Sarcophagus of King Menkaure [12].

- The third example is a sarcophagus for Mindjedef from the 4th Dynasty (2520-2472 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.3 [13]. It is of the rectangular prism type with flat lid all manufactured from granite. Its length is 2.36m.



Fig.3 Sarcophagus of Mindjedef from 4th Dynasty [13].

- The fourth example is a sarcophagus for King Unas, the 9th King of the 5th Dynasty in display in his pyramid at Saqqara of Egypt and shown in Fig.4 [14]. It is of the rectangular prism type design manufactured from black basalt. It is not clear if it has any decorations or inscriptions.



Fig.4 Sarcophagus of King Unas from 5th Dynasty [14].

- The last example of sarcophagi in the Old Kingdom belongs to Duaena displayed in the Egyptian Museum at Turin and shown in Fig.5 [15]. It is manufactured from pink granite and has the classical rectangular prism type with surface inclination near the ground providing less contact

area with the ground.



Fig.5 Sarcophagus of Duaena [15].

III. SARCOPHAGI OF THE MIDDLE KINGDOM

The Middle Kingdom includes the 11th and 12th Dynasties over a time span from 2000 to 1700 BC [16]. The development of sarcophagi during this period is investigated through the following examples:

- Fig.6 shows the sarcophagus of Queen Ashait, wife of King Mentuhotep II, the 5th King of the 11th Dynasty as displayed in the Egyptian Museum at Cairo [17]. It is manufactured from limestone, decorated by carved scenes for the Queen.



Fig.6 Sarcophagus of Queen Ashait [17].

- The 2nd example is for Queen Kawit, low ranking wife of King Mentuhotep II in display in the Egyptian Museum at Cairo and shown in Fig.7 [18]. The stone sarcophagus of the Queen was decorated by a large number of scenes and inscriptions for the Queen and some domestic activities from the daily life of the ancient Egyptians.



Fig.7 Sarcophagus of Queen Kawit [18].

- The third example of sarcophagi of the Middle Kingdom is from the 12th Dynasty for King Amenemhat III, the 5th King of the 12th Dynasty (1961-1917 BC) shown in Fig.8 [19]. There is no enough data about the sarcophagus except its shape.

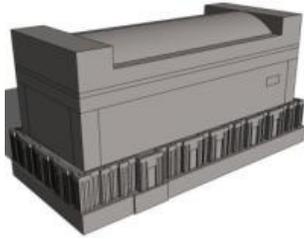


Fig.8 Sarcophagus of King Amenemhat III [19].

It is of the rectangular prism type and its lid has domed external surface and two shoulders at its longitudinal ends.

IV. SARCOPHAGI OF THE NEW KINGDOM

The New Kingdom of ancient Egypt includes the 18th to 20th Dynasties over a time span from 1570 to 1069 BC [20]. We have examples of the New Kingdom sarcophagi from the 18th, 19th and 20th Dynasties presented as follows:

- Fig.9 shows a sarcophagus produced in the reign of Pharaoh Hatshepsut, the 5th Pharaoh of the 18th Dynasty (1473-1458 BC) for her father Thutmose I, the 3rd Pharaoh of the same dynasty and in display now in the Museum of Fine Arts at Boston [21]. It is of the rectangular prism type, has a flat lid and decorated by inscriptions and scenes carved on its surface. Its length is 2.25 m and its weight is 2.72 ton.



Fig.9 Sarcophagus of Thutmose I of the 18th Dynasty [21].

- The second example is again from the 18th Dynasty and belongs to Pharaoh Tutankhamun shown in Fig.10 [22]. It is of the rectangular prism type with flat cover. The trough was cut from brown quartzite while the lid was cut from pink granite [22]. The trough is decorated by fine inscriptions and scenes carved on the surfaces while four of the ancient Egyptian goddesses are carved on the corners spreading their wings to protect the Pharaoh.



Fig.10 Sarcophagus of Tutankhamun of the 18th Dynasty [22].

- The third example is from the 19th Dynasty which belongs to Pahemnetier, the High Priest of Ptah in Memphis during the reign of Pharaoh Ramses II. His sarcophagus is in display in the British Museum and shown in Fig.11 [23]. This is the first stone sarcophagus appearing in the ancient history taking the shape of a human. The lid is designed taking the shape of the deceased with his hands on his chest exactly as was in the designs of the wooden coffin appeared during the end of the 12th Dynasty [9]. This design is much complex and difficult than that in the wooden design because of the difference in the mechanical properties of both types.
- The fourth example is again from the 19th Dynasty belonging to Setau, the Viceroy of Kush in the second half of Ramses II reign. Its lid is in display in the British Museum and shown in Fig.12 [24].



Fig.12 Sarcophagus of Seyau from the 19th Dynasty [24].

- The fifth example is also from the 19th Dynasty belonging to Pharaoh Merenptah, the 4th Pharaoh of the 19th Dynasty (1224-1214 BC). It is in display in the Valley of the Kings at Luxor of Egypt and shown in Fig.13 [25]. It is manufactured from red granite and has a lid having the shape of the Pharaoh putting his hands on his chest. Even though the granite is a very hard rock, the ancient Egyptian artist could cut a very smooth and accurate contours on the lid.



Fig.13 Sarcophagus of Merenptah from the 19th Dynasty [25].

- The six example is from the 20th Dynasty belonging to

Pharaoh Ramses III (1473-1458 BC). His sarcophagus is in display in the Louvre Museum and shown in Fig.14 [26]. It is manufactured from red granite and decorated on the whole external surface with inscriptions and scenes of various designs. It is of the rectangular prism type and the corners are filleted with large radius fillets and the short sides includes the cartouche of the Pharaoh and one of the Goodness spreading her wings.



Fig.14 Sarcophagus of Ramses III from the 20th Dynasty [26].

V. SARCOPHAGUI OF THE THIRD INTERMEDIATE PERIOD

The Third Intermediate Period includes from the 21st to the 25th Dynasties of ancient Egypt over a time span from 1070 to 664 BC [27]. The sarcophagi industry during this period is investigated through two sarcophagi from the 21st and 22nd Dynasties:

- The first example belongs to Pharaoh Psusennes I, the fourth Pharaoh of the 21st Dynasty. It is in display in the Egyptian Museum at Cairo and shown in Fig.15a [28]. It is of the human-shape type with its cover taking the shape of the Pharaoh with his hands on his chest. It is manufactured from granite and the lower band of the lid and the whole external surface of the trough is full with inscriptions and scenes. A part of the sarcophagus inscriptions is zoomed in Fig.15b showing the cartouche of the Pharaoh [28].



Fig.15a Sarcophagus of Psusennes I from the 21st Dynasty [28].

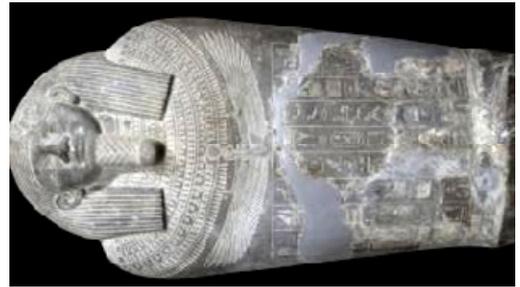


Fig.15b Inscriptions on Psusennes I sarcophagus [28].

- The second example belongs to Pharaoh Shoshenq III, the six Pharaoh of the 22nd Dynasty. It is in display in his tomb at Tanis (Egypt) and shown in Fig.16 [29]. It was of the rectangular prism type and shown without lid. It is decorated by text from the 'Book of dead'.



Fig.16 Sarcophagus of Shoshenq III from the 22nd Dynasty [29].

VI. SARCOPHAGUI OF THE LATE PERIOD

The late period of Egypt includes dynasties from the 26th to the 31st over a time span from 664 to 332 BC [30]. We have four examples of sarcophagi of the Late Period of Egypt presented as follows:

- Fig.17 shows a sarcophagus of Psamtic-Seneb, a High Official in the 26th Dynasty (664-525) which is a gift of Walter Chrysler [31]. It has a human-shape, manufactured from grey Schist and decorated by text written in parallel horizontal columns. Its length is 2.184 m.

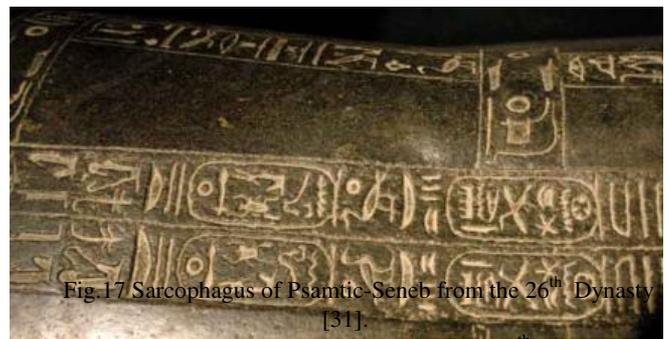


Fig.17 Sarcophagus of Psamtic-Seneb from the 26th Dynasty [31].

- The third example is again from the 26th Dynasty and belongs to the General Kheperren (570-526 BC). It is in display in the Museum of Fine Arts at Boston and shown in Fig.18 [32]. It has a human-shape and

produced from greywacke with text in horizontal columns around the front horizontal centerline. Its length is 2.26 m.



Fig.18 Sarcophagus of Kheperreneset from the 26th Dynasty [32].

- The fourth example is a sarcophagus from the 30th Dynasty belonging to Wennefer (380-332 BC). It is in display in the Metropolitan Museum of Art at NY and shown in Fig.19 [33]. It has a rectangular prism type with lid having stadium prism and a trapezoid prism above the stadium one. It is manufactured from granite and has an overall length of 2.58 m.



Fig.19 Sarcophagus of Wennefer from the 30th Dynasty [33].

VII. CONCLUSION

- The evolution of mechanical engineering in ancient Egypt was investigated through the study of the sarcophagus industry in ancient Egypt.
- The manufacturing of sarcophagi in ancient Egypt during the dynastic period from the 4th to the 30th Dynasties was studied.
- Rectangular prism sarcophagi were designed and manufactured since the 4th Dynasty.
- Flat lid with dome and shoulders was designed since the 4th Dynasty.
- The humanity missed the sarcophagus of King Menkaure of the 4th Dynasty which was lost in the sea during shipping to UK.
- The rectangular prism design of the sarcophagus trough continued to appear during the 5th, 12th, 18th, 22nd and 30th Dynasties.
- The human-shaped sarcophagus started to be designed and manufactured in the 19th Dynasty. It continued to appear during the 21st and 26th Dynasties.

- The ancient Egyptians used limestone, granite, schist, basalt and greywacke in manufacturing their sarcophagi.
- Even though, some of the rock are very hard, the ancient Egyptians could carve them and produce very difficult designs either in the rectangular prism or the human-shaped types of sarcophagi.
- Contours were so smooth and shining through very accurate carving, dimensioning and polishing.
- Most of the human-shaped sarcophagi were as if they are produced by modern CNC machines and not manual using primitive tools.

REFERENCES

- [1] S. Sharpe, "The alabaster sarcophagus of Oimeneptah", Longman, London, 1864.
- [2] W. El-Sadeek, "Twenty six dynasty, Necropolis at Gizeh", *Beitrag Zur Agyptologie*, Band 5, Wien, 1984.
- [3] Curriculum Materials, "Living a virtuous life, the afterlife and the honoring of ancestors", in 'the art of the ancient world', Los Angeles Country Museum of Art, 2010.
- [4] C. Mallinkrodt, "Identification of ancient and modern reuse in a Ptolemaic child sarcophagus", *ANAGPIC Conference*, Los Angeles, California, 26 pages, 24th April 2013.
- [5] S. Abdelaal and N. Mahmoud, "A technical examination and the identification of the wood, pigments, grounds and binder of an ancient Egyptian sarcophagus", *International Journal of Conservation Science*, vol.5, issue 2, pp.177-188, 2014.
- [6] K. Camacho, "Head or foot, right or left: Analyzing the position of Isis and Nephthys on coffins and sarcophagi from Old Kingdom through Ptolemaic-Roman Periods", *Master of Arts Thesis*, The American University in Cairo, School of Humanities and Social Sciences, May 2014.
- [7] D. Reems, "The Egyptian ouroboros: An iconological and theoretical study", *Ph.D. Thesis*, Near Eastern Languages and Cultures 0595UCLA, University of California, Los Angeles, 2015.
- [8] Wikipedia, "Sarcophagus", <http://wikipedia.org/wiki/Sarcophagus>, 2016.
- [9] G. A. Hassaan, "Mechanical engineering in ancient Egypt, Part XXVIII: Wooden coffins industry", *International Journal of Recent Engineering Research*, (Accepted for Publication), 2016.
- [10] Wikipedia, "Old Kingdom of Egypt", http://en.wikipedia.org/wiki/Old_Kingdom_of_egypt, 2016.
- [11] Wikipedia, "Sarcophagus of Kaiemnofret", https://commons.wikimedia.org/wiki/Category:Private_Tombs_at_Giza#/media/File:Sarcophagus_of_Kaiemnofret.jpg, 2016.
- [12] El-Shahed, "King Menkaure sarcophagus", <http://www.pinterest.com/pin/416020084303034388/>
- [13] Metropolitan Museum, "Sarcophagus of Mindjedef", <http://www.metmuseum.org/art/collection/search/552235>
- [14] Wikipedia, "Unas", <http://en.wikipedia.org/wiki/Unas>, 2016
- [15] G. Orti, "Sarcophagus of Duaenti", www.alamy.com/stock-photo-sarcophagus-of-duaenti-egyptian-pink-granite-26946639.html
- [16] Wikipedia, "Middle Kingdom", http://en.wikipedia.org/wiki/middle_kingdom, 2016.
- [17] L. Ambrose, "Limestone sarcophagus of Ashait", www.pinterest.com/pin/110901209549330452/



- [18] Fine Art America, "From the sarcophagus of Queen Kawit", <http://fineartamerica.com/featured/queen-kawit-at-her-toilet-from-the-sarcophagus-of-queen-kawit-egyptian-11th-dynasty.html>
- [19] Wikipedia, "Sarcophagus of Amenemhat III", https://commons.wikimedia.org/wiki/Category:Sarcophagi_of_the_12th_dynasty_of_Egypt#/media/File:AmenemhatIII-dahchour-sarcophagus.jpg, 2007.
- [20] Wikipedia, "New Kingdom of Egypt", http://en.wikipedia.org/wiki/New_Kingdom_of_Egypt, 2016.
- [21] Museum of Fine Arts, "Ancient Egypt: Sarcophagus of Queen Hatshepsut recut for her father", www.mfa.org/collections/object/sarcophagus-of-queen-hatshepsut-recut-for-her-father-thutmose-i-box-130720
- [22] Egyking, "King Tut sarcophagus", <http://en.paperblog.com/king-tut-sarcophagus-735552/>
- [23] Wikipedia, "Pahemnetjer", <https://en.wikipedia.org/wiki/Pahemnetjer>
- [24] Wikipedia, "Setau", <https://en.wikipedia.org/wiki/Setau>, 2016
- [25] P. Sternberg, "Sarcophagus of Merenptah", www.pinterest.com/pin/467670742526635172/
- [26] Y. Fitzell, "Red granite sarcophagus of Ramses III", www.pinterest.com/pin/269793833903462900/
- [27] Wikipedia, "Third Intermediate Period of Egypt", https://en.wikipedia.org/wiki/Third_Intermediate_Period_of_Egypt, 2016.
- [28] Ancient Egypt, "Granite sarcophagus of Psusennes I", www.ancient-egypt.co.uk/cairo%20museum/cm.%20gold/pages/Dynasty%2021%20Psusennes%20I%20sarcophagus%203.htm, 2014.
- [29] Getty Images, "Sarcophagus of Shoshenq III", www.gettyimages.fr/detail/photo/sarcophagus-of-shoshenq-iii-tomb-of-shoshenq-iii-tanis-egypt-photo/639561117
- [30] Wikipedia, "Late Period of ancient egypt", http://wikipedia.org/wiki/Late_Period_of_ancient_egypt, 2016.
- [31] Chrysler, "Sarcophagus of Psamtik-Seneb", www.chrysler.org/ajax/load-artwork/14
- [32] Museum of Fine Arts, "Lid of sarcophagus of General Kheperra", www.mfa.org/collections/object/lid-of-the-sarcophagus-of-general-kheperra-147319
- [33] Metropolitan Museum of Art, "Sarcophagus of Wennefer", www.metmuseum.org/art/collection/search/551899
- Research on Automatic Control, Mechanical Vibrations, Mechanism Synthesis and History of Mechanical Engineering.
 - Published more than 190 research papers in international journals and conferences.
 - Author of books on Experimental Systems Control, Experimental Vibrations and Evolution of Mechanical Engineering.
 - Chief Justice of the International Journal of Computer Techniques.
 - Member of the Editorial Board of a number of International Journals including IJARMATE.
 - Reviewer in some international journals.
 - Scholars interested in the author's publications can visit: <http://scholar.cu.edu.eg/galal>

BIOGRAPHY



Galal Ali Hassaan:

- Emeritus Professor of System Dynamics and Automatic Control.
- Has got his B.Sc. and M.Sc. from Cairo University in 1970 and 1974.
- Has got his Ph.D. in 1979 from Bradford University, UK under the supervision of Late Prof. John Parnaby.
- Now with the Faculty of Engineering, Cairo University, EGYPT.