Mechanical Engineering in Ancient Egypt, Part 50: Alabaster Products (Middle and New Kingdoms)

Galal Ali Hassaan
Department of Mechanical Design & Production, Faculty of Engineering, Cairo University, Giza, Egypt

Abstract:
This paper is the 50th research paper in a series investigating the evolution of mechanical engineering in ancient Egypt. It tries to achieve this purpose through investigating the alabaster products during the Middle and New Kingdoms. Each alabaster product is presented chronologically with present location if known and with engineering analysis showing its creativity. The innovation in the designs is outlined and the main characteristics of mechanical design methodology in ancient Egypt are outlined.

Keywords — Mechanical engineering; ancient Egypt; alabaster products; Middle Kingdom; New Kingdom.

I. INTRODUCTION
This is the 50 paper in a series of research papers aiming at exploring the role of ancient Egyptians in the evolution of mechanical engineering. The paper presents the alabaster products in ancient Egypt during the Middle and New Kingdoms.

Lilyquist (1995) in her book about Egyptian stone vessels studied the vessel features such as shapes, and sizes and presented a historical summary of her catalogue items. Among the jars she presented was an alabaster jar from the 13th Dynasty, albastron from Late Bronze Age and alabaster vessels from Drah Abu el-Naga [1]. Janik (2002) in his paper about ancient Egyptian agriculture and the origin of Horticulture presented the cover of the alabaster canopic vessel of Pharaoh Tutankhamun with painted hip stick and eyes [2]. Willems and Mohammed (2010) in their article about a note on the origin of the Toponym el-Barsha stated that the ancient Egyptian toponym Pr-ss means 'alabaster house' and it was argued to be the ancestor of the modern place name 'al-Barsha' [3].

Tomorad (2012) in his paper about ancient Egyptian funerary statuettes in Croatian collection announced that the Archaeological Museum in Zagreb comprises one shabtis from the Middle Kingdom, 65 shabtis from the New Kingdom, 4 shabtis from the Third Intermediate Period and 76 shabtis from the Late Period. The material of the shabtis were not assigned in his study [4]. Forshaw (2013) in his Ph. D. Thesis presented an alabaster ointment jar from the 26th Dynasty in display in the Metropolitan Museum of Art at New York [5]. Selim, Basheer, Elqady and Abdel-Hafiz (2014) outlined that a combined rear surface geophysical survey conducted in archaeological site at the western bank of Luxor area showed that the geophysical method offered the possibility to characterize and reconstruct the geometry of subsurface structures without destroying the deposits. It was possible to locate using this technique an alabaster statue for Queen Tie, wife of Pharaoh Amenhotep III having 1.30 m height and 0.73 m width [6]. Hassaan (2016) in his investigation of Mechanical Engineering in ancient Egypt through studying the stone cutting processes presented an unfinished alabaster vessel in display in the Petrie Museum marked for drilling [7].

Wikipedia (2017) wrote an article about 'alabaster' and presented an alabaster jar and an alabaster perfume jar of Pharaoh Tutankhamun in display in the Egyptian Museum at Cairo [8]. Hassaan (2017) studied the evolution of mechanical engineering in ancient Egypt through the manufacturing of alabaster products during the time interval from Predynastic to Old Kingdom. He presented examples of alabaster products such as:
II. MIDDLE KINGDOM

The Middle Kingdom comprised only two Dynasties, the 11th Dynasty and the 12th Dynasty over a time span from 2055 to 1650 BC [10]. There are ten examples illustrating the development of the alabaster products industry in ancient Egypt during the Middle Kingdom presented as follows:

- The first example is a 45 mm height alabaster kohl pot from the 11th Dynasty (2000 BC) which is a Private Pennsylvania collection and shown in Fig.1 [11]. The mechanical designer designed the pot with a medium opening, flat rim flush outside, moderately elongated ovoid body and a medium flat base. He used the natural layers of the alabaster stone for decoration.

- The second example is an alabaster cosmetic vessel in the shape of a cat with 140 mm height, 137 mm length and 62 mm width from the 12th Dynasty (1990-1900 BC) in display in the Metropolitan Museum of Art and shown in Fig.2 [12]. This application is difficult to achieve because of the cavity of the vessel without breaking the body. The designer showed the casing setting on a parallelogram base, hole in the head, two colors-eyes most probably using other stones and a ring in the cat nose as depicted in the zoomed image of Fig.2.

- The third example is an alabaster ointment jar from reign of Amenemhat I, the 1st King of the 12th Dynasty (1981-1952 BC) in display in the Metropolitan Museum of Art and shown in Fig.3 [13]. The dimensions are missing. The jar has a wide opening, round rim flushed outside, slight-concave body and medium flat base with round rim.

- The fourth example is an alabaster 20 g weight having 44 mm length, 27 mm width from the 12th-13th Dynasties (1981-1640 BC) in display in the Metropolitan Museum of Art and shown in Fig.4 [14]. All the corners of the weight are perfectly rounded following the ancient Egypt design tradition of corner filleting not to harm the user.
The fifth example is a 50 mm height and 40 mm maximum diameter oil jar from the 12th Dynasty (1950-1851 BC) in display in the Metropolitan Museum of Art and shown in Fig.5 [15]. The present location is not assigned. The jar has a wide opening, round rim flushed outside, conical body and medium flat base. The designer used the alabaster stone layers to decorate the outer surface of the jar.

![Fig.5 Oil jar from 12th Dynasty](image1)

The sixth example is a 33.3 mm height and 30.2 mm maximum diameter alabaster kohl jar from the 12th Dynasty-13th Dynasty in display in the Brooklyn Museum at New York and shown in Fig.6 [16]. The designer used a small opening, conical rim flashed outside, elongated ovoid body and medium flat base. The outer surface was well polished giving a clear shining specially for the body.

![Fig.6 Kohl jar from 12th-13th Dynasties](image2)

The seventh example is a 42 mm height alabaster kohl jar produced in el-Haraga, Egypt during the 12th Dynasty (1900 BC) in display in the Museum of Applied Arts and Sciences, Australia and shown in Fig.7 [17]. Its characteristics are similar to that of the kohl pots shown in Figs.1 and 6. However this kohl pot has little bit smaller opening and bad appearance.

![Fig.7 Kohl jar from 12th Dynasty](image3)

The eighth example is a 107 mm length cosmetic spoon from the reign of Senusret II, the 4th King of the 12th Dynasty (1897-1878 BC) in display in the Metropolitan Museum of Art and shown in Fig.8 [18]. This is a wonderful design in which the designer used the ankh symbol as a handle for the spoon in a pure while alabaster while the spoon bowl was decorated naturally through the alabaster layers. All the corners are rounded not to harm the user following one of the mechanical design characteristics in ancient Egypt.

![Fig.8 Cosmetic spoon from 12th Dynasty](image4)

The ninth example is an 0.374 m overall height and 0.215 m maximum diameter alabaster canopic jar of Princess Sithathoryunet from the 12th Dynasty (1887-1813 BC) in display in the Metropolitan
Museum of Art and shown in Fig.9 [19]. The jar lid took the shape of the Princess, the body has an elongated ovoid shape with medium flat base and the decorations of the body were through the layers of the alabaster stone itself (i.e. natural decorations). The lid rests firmly on the jar opening as clear in the zoomed image.

Fig.9 Canopic jar from 12th Dynasty [19].

- The tenth example is a 42 mm height and 40 mm maximum diameter alabaster kohl pot from the 12th Dynasty (1800 BC) in loan to the Michael Carlos Museum of the Emory University (1998-2015) and shown in Fig.10 [20]. The jar had a small opening, wide-flat-rounded rim, short neck, elongated ovoid body and flat-rimmed medium base.

Fig.10 Kohl pot from 12th Dynasty [20].

III. NEW KINGDOM

The New Kingdom of ancient Egypt comprises three Dynasties: the 18th Dynasty (1543-1292 BC), the 19th Dynasty (1292-1187 BC) and the 20th Dynasty (1187-1069 BC) [21]. This Kingdom is the strongest and wealthy one across the whole ancient history of Egypt. We expect to see great evolution of the alabaster products industry during this kingdom as will be depicted through the following examples presented according to the Dynasty:

The 18th Dynasty:

- The first example is a an alabaster jug from the New Kingdom (1550-1070 BC) in display by Christies for sale and shown in Fig.11 [22]. This is an elaborated design in which the jug had a medium opening, conical rim flashing outside, cylindrical neck of medium diameter, ovoid body, medium-flat base and single vertical handle.

Fig.11 Jug from the New Kingdom [22].

- The second example is a 180 mm length and 85 mm width alabaster cosmetic spoon taking the shape of a Tilapia fish with water lilies from the 18th Dynasty (1550-1295 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.12 [23]. This is an innovative design having more than 3300 years old from ancient Egypt. In one spoon, the designer set three bowls in one spoon, one in the fish body and four in the water lilies. On the other hand, the spoon handle can be at the fish side or at the lilies side depends on use.
Fig.12 Cosmetic spoon from 18\textsuperscript{th} Dynasty [23].

- The third example is a 255 mm height alabaster Stele from the 18\textsuperscript{th} Dynasty (1550-1292 BC) sold by Christies on 14 April 2011 at London for 40,875 US$ and shown in Fig.13 [24]. It had a rounded top and inscribed with images for deities Khnoum and Hekat holding sceptres with inscriptions in hieroglyph for two overseers of the granary [24].

Fig.13 Stele from the 18\textsuperscript{th} Dynasty [24].

- The fourth example is a 150 mm length and 120 mm height alabaster fish-shaped vessel from the 18\textsuperscript{th} Dynasty (14\textsuperscript{th} century BC) in display in the Israel Antiquities Authority and shown in Fig.14 [25]. The designer showed the fish opening its mouth, having fins and tail with wonderful natural decorations on the whole body. It is not clear if the vessel opening is through the mouth or there is another opening somewhere on the top from the rear side.

Fig.14 Fish-shaped vessel from 18\textsuperscript{th} Dynasty [25].

- The fifth example is an alabaster strap handled amphora from the 18\textsuperscript{th} Dynasty in display in the Michael Carlos Museum of the Emory University and shown in Fig.15 [26]. The designer showed the amphora having medium mouth, round rim flushing outside, cylindrical neck with the opening diameter, ovoid body, two vertical strap handles and medium flat base with round rim.

Fig.15 Amphora from 18\textsuperscript{th} Dynasty [26].

- The sixth and last example is a 220 mm height alabaster amphora from the 18\textsuperscript{th} Dynasty from the Old Belgian collection in 1960's and shown in Fig.16 [27]. This design is similar to that in Fig.15 except its body which is spherical. It has no decoration but it was well carved with homogeneous dimensions and high professionalism in carving the handles without breaking the body.

Fig.16 Amphora from 18\textsuperscript{th} Dynasty [27].

- The seventh example is a 220 mm height and 120 mm diameter alabaster vase from the the 18\textsuperscript{th} Dynasty (1500 BC) in display in
London for sale for an estimated price of 6,750 US$ and shown in Fig.17 [28]. The vase has a wide opening without rim, long neck semi-conical body and medium flat base.

Fig.17 Vase from 18th Dynasty [28].

- The eighth example is a 245 mm height and 142 mm diameter alabaster amphora from the reign of Thutmose III, the 6th Pharaoh of the 18th Dynasty (1479-1425 BC) in display in the Metropolitan Museum of Art and shown in Fig.18 [29]. This amphora had a medium opening, large round rim flushed outside, two vertical strap handles, elongated ovoid body and medium flat base. The white stand under the amphora may be a separate part prepared by the designer or by the displaying museum.

Fig.18 Amphora from 18th Dynasty [29].

- The ninth example is an 117 mm height and 93 mm maximum diameter alabaster ointment jar from the reign of Pharaoh Thutmose III of the 18th Dynasty (1479-1425 BC) from the tomb of his three foreign wives in display in the Metropolitan Museum of Art and shown in Fig.19 [30]. The jar had a body with concave surface with maximum diameter at the opening, round rim, flat base and a 4 mm thickness lid. The lid, rim and base were decorated may be by gold leaf.

Fig.19 Ointment jar from 18th Dynasty [30].

- The tenth example is a 207 mm height, 42 mm opening diameter and 71 mm rim diameter alabaster amphora inscribed by the Royal Cartouche of Amenhotep II, the 7th Pharaoh of the 18th Dynasty (1425-1398 BC) in display in the Metropolitan Museum of Art and shown in Fig.20 [31]. The amphora had a medium opening with wide rounded rim flushed outside, short neck, conical shoulder, parabolic body, two vertical thick strap handles and concave base with medium height-rounded rimmed flat base.

Fig.20 Amenhotep II amphora [31].

- The eleventh example is a 210 mm height and 70 mm maximum diameter alabaster jug
from reign of Thutmose IV – Amenhotep III, 8th and 9th Pharaohs of the 18th Dynasty (1400-1352 BC) in display in the Metropolitan Museum of Art and shown in Fig.21 [32]. In this unique design, the jug had a small opening, thick rounded rim flushed outside, long concave neck, long single vertical handle between the hug shoulder and one-third of the neck, elongated ovoid body and medium flat base.

Fig.21 Jug from 18th Dynasty [32].

- The twelfth example is a 140 mm height and 105 mm diameter alabaster goblet inscribed with the names of Akhenaten, the 10th Pharaoh of the 18th Dynasty (1351-1334 BC) and his wife Nefertiti in display in the Metropolitan Museum of Art and shown in Fig.22 [33]. The designer used parabolic shapes for the body of the goblet and his base-stem. The body consisted of two stages each of a parabolic shape All the surfaces were perfectly rounded including the medium flat base.

Fig.22 Goblet from 18th Dynasty [33].

- The thirteenth example is a 108 mm height perfume bottle inlaid with a figurine of a princess from the reign of Pharaoh Akhenaten in display in the Metropolitan Museum of Art and shown in Fig.23 [34]. The bottle had a small opening, medium neck, elongated ovoid body, parabolic long base stem, large flat base and a parabolic lid for tight closing of the bottle. The figuring and decorations under the feet of the princess were manufactured from carnelian, obsidian, gold and colored glass.

Fig.23 Perfume bottle from 18th Dynasty [34].

- The fourteenth example is an alabaster statue for Pharaoh Akhenaten of the 18th Dynasty (1351-1334 BC) found in Tell el-Amarna in display in the Egyptian Museum at Berlin and shown in Fig.24 [35]. The designer showed the Pharaoh standing behind a Stele, holding it by both hands and wearing the Blue Crown of ancient Egypt. More details of the Pharaoh face are depicted from the zoomed image in Fig.24. Unfortunately, no dimensions were given for the statue.

Fig.24 Statue of Pharaoh Akhenaten [35].
Fig.24 Akhenaten statue from 18th Dynasty [35].

- The fifteenth example is a an alabaster stele of Pharaoh Akhenaten from the 18th Dynasty (1351-1334 BC) in display in the Petrie Museum at London and shown in Fig.25 [36]. The stele was professionally carved from alabaster showing the Pharaoh, his Great Wife Nefertiti and daughter Meritaten making offerings to Aten with the Pharaoh Cartouches carved in the right side of the stele.

Fig.25 Akhenaten stele from 18th Dynasty [36].

- The sixteenth example is 12 mm height and 19 mm maximum diameter alabaster ear stud from the 18th Dynasty (1350 BC) in display in the Petrie Museum and shown in Fig.26 [37]. The designer selected the mushroom to simulate his ear-stud. The dome was the difficult part to carve. However, the carver did it perfectly rounding all the surfaces and the pin-part of the stud had a cylindrical shape. Functionally, something else is missing to hold the ear ring.

Fig.26 Ear stud from 18th Dynasty [37].

- The seventeenth example is an alabaster vase inscribed by the names of Tutankhamun, the 13th Pharaoh of the 18th Dynasty (1332-1319 BC) and his Great Royal wife Ankhesenamun in display in the Egyptian Museum at Cairo and shown in Fig.27 [38]. This is the first example from the treasures of Pharaoh Tutankhamun. It is a master piece reflecting the glory of the alabaster industry during the era of the 18th Dynasty. First of all it seems that this is not a vase as documented in the information source which is not the Egyptian Museum at Cairo. It may be an ointment or perfume jar because of its lid. The designer used an elaborated scheme of decorations on the lid and on the body. He authorised the owner of the jar through three Cartouches inscribed on the jar body with hieroglyph texts around them. No dimensions given and no details about the materials used in the decorations. The decorations are outlined in the zoomed images of Fig.27.

Fig.27 Tut vase from 18th Dynasty [38].

- The eighteenth example is a triple lamp simulating lotus flowers for Pharaoh Tutankhamun in display in the Egyptian Museum and shown in Fig.28 [39]. There are no dimensions available for this product !. The designer simulated the lotus plant using its stem, leaf, sepals and
blossom. He used three lotus stems, the central one supporting a big blossom, while the other two supporting smaller blossoms. The central blossom has a sepals while the other two are without sepals. The designer connected the three stems in two locations and emerge from circular flat base to strengthen the product. The lighting oil is set in the three blossoms.

Fig.28 Tut triple lamp from 18th Dynasty [39].

- The nineteenth example is a magic alabaster chalice of Pharaoh Tutankhamun from the 18th Dynasty in display in the Egyptian Museum at Cairo and shown in Fig.29 [40]. The designer simulated a lotus blossom and stem as a lighting chalice. The chalice was supported by an alabaster frame from both sides showing a deity setting on a lotus plant and the Cartouche of the Pharaoh and the ankh symbol. When the lamp led, it reflects a scene for the Pharaoh setting with his wife. With lamp OFF, the scene disappears. This why it is called 'magic'.

Fig.29 Tut magic chalice from 18th Dynasty [40]. The scene was drawn on the outside surface of an alabaster layer assembled with the inside surface of the chalice [40]. Unfortunately, there are no dimensions available.

- The twentieth example is an alabaster drinking cup of Pharaoh Tutankhamun in display in the Egyptian Museum at Cairo and shown in Fig.30 [41]. Again, the designer used the lotus plant to design this wonderful cup. He used a half-opened blossom for the cup bowl with flat vertical decorated rim decorated by a band of hieroglyph text and a body inscribed by three Cartouches of the Pharaoh. The cup bowl rested on a parabolic neck with flat rounded base. Two lotus plants with closing blossoms supporting a boat carrying a deity completes the design of the cup.

Fig.30 Tut drinking cup from 18th Dynasty [41].

- The twenty first example is an alabaster perfume jar for Pharaoh Tutankhamun in display in the Egyptian Museum and shown in Fig.31 [42]. The jar represents an elaborated design of alabaster jars in the time of Tutankhamun. The jar had a medium opening, long neck, elongated ovoid body, long parabolic-necked-flat-rounded base and a lid. The jar was inscribed for the Pharaoh through two of his Cartouches and decorated on the neck, shoulder and body. The jar was supported by a complex alabaster frame from two
sides at 180 degrees. The lower part of the frame reflects two ankh signs and the top part reflects parts of the lotus plant. No dimensions available.

Fig.31 Tut vase from 18th Dynasty [42].

- The twenty second example is an alabaster boat for Pharaoh Tutankhamun in display in the Egyptian Museum and shown in Fig.32 [43]. This is a master piece representing the top technology in alabaster products manufacturing. It represented the funerary ibex-boat of the Pharaoh. The designer selected two ibex heads (one from each side) with curved horns. The boat model carried a 4-pillars shrine on which the Pharaoh body is set. The boat was set in a specially designed box-shaped stand. The whole elements of the boat and stand are highly decorated using a very elaborated scheme with gold and (may be) semi-precious stones). No dimensions available !!.

Fig.32 Tut funerary boat from 18th Dynasty [43].

- The twenty third example is an alabaster perfume jar of Pharaoh Tutankhamun in display in the Egyptian Museum at Cairo and shown in Fig.33 [44]. In this alabaster product the designer selected a small diameter-long neck, wide flat-rounded rim, lid, slight concave body and flat base. The designer set a supporting structure different than that in Fig.31 where the lotus plant elements are hold by two nude girls, one from each side with two Cobras on the top of the frame just beside the lid. The jar was set on a box-type base decorated by two vultures supporting or protecting the Pharaoh Cartouche by their wings. The jar body was inscribed by three Cartouches of the Pharaoh as illustrated in the zoomed image in Fig.33.

Fig.33 Tut perfume jar from 18th Dynasty [44].

- The twenty fourth example is an alabaster ibex-shaped unguent jar for Pharaoh Tutankhamun from the 18th Dynasty in display in the Egyptian Museum at Cairo and shown in Fig.34 [45]. The designer showed the ibex setting on an ovoid base and used a black color to identify the horn, ears, eyes, moth, face marks, neck hair, knees and hoof. The ibex tongue was in red. The ibex owner was identified by the Cartouche of the Pharaoh –in black- on the ibex shoulder. It was possible to apply the
black and red colors through the inlay process using semi-precious stones. The opening of the jar is in the ibex back which complicated the design by making cavity for the unguent.

Fig.34 Tut ibex-unguent jar from 18th Dynasty [45].

- The twenty fifth example is an 0.93 m height and 0.54 m width canopic chest containing the canopic jars of Pharaoh Tutankhamun in display in the Egyptian Museum at Cairo and shown in Fig.35a [46], [47]. The box comprises four canopic jars for the Pharaoh internal organs and a tight lid to close-up the box. On each corner of the box there is one of the ancient Egyptian deities spreading its arms and holding two of the box corners. Both the box and lid are decorated in black by funerary text as depicted in Fig. 35b [48].

Fig.35a Tut canopic chest from 18th Dynasty [46].

Fig.35a Tut canopic chest [48].

- The twenty sixth example is a decorated alabaster chest for Pharaoh Tutankhamun in display in the Egyptian Museum and shown in Fig.36 [49]. The chest has a tight lid and both lid and chest-box were professionally inlaid with various scenes including three Cartouches of the Pharaoh from the left side of the chest. The designer used black knobs from the sides to raise the chest. Unfortunately there are no authorised dimensions available.

Fig.36 Tut chest from 18th Dynasty [49].

The 19th Dynasty:

- The first example of alabaster products from the 19th Dynasty is a 2.845 m alabaster sarcophagus of Seti I, the 2nd Pharaoh of the 19th Dynasty (1290-1279 BC) in display in the Soane Museum at London and shown in Fig.37a [50]. The sarcophagus was carved
taking the outside boundaries of the Pharaoh to occupy minimum volume. To avoid putting the sarcophagus directly on the ground, the designer simulated two human feet to support the sarcophagus in an innovative way never used before. The view of the sarcophagus in Fig.37a does not depict clearly the inscriptions on the outer surfaces of the sarcophagus. Another hand-drawn image illustrated the inscriptions of the sarcophagus covering the whole surface as illustrated in Fig.37b [51]. Fig.37b depicts that the sarcophagus was supported by four feet not two as depicted from Fig.37a.

- The second example from the 19th Dynasty is a 60 mm height alabaster vase model for Ramses II, the 3rd Pharaoh of the 19th Dynasty (1297-1213 BC) which was a private collection shown in Fig.38 [52]. The designer used a conical body, rounded rim and rimmed-base. The body of the vase model was inscribed for the Pharaoh including his Cartouche as illustrated in the zoomed image of Fig.38.

Fig.38 Ramses II vase from 19th Dynasty [52].

- The third example is a 177 mm height alabaster Royal head from the 19th Dynasty (1292-1185 BC) sold by Christies in a sale on 6 December 2016 at London for 87,588 US$ and shown in Fig.39 [53]. The designer showed the Pharaoh wearing a damaged Nemes headdress and having a thin long beard. Even though its high cost, it is an example of the side effects of bad excavations by tomb robberies or by archaeological bodies.

Fig.39 Royal head from 19th Dynasty [53].

- The fourth example is an alabaster sphinx of a Royal Pharaoh from the 19th Dynasty in display in the Open-air Museum at Memphi of Egypt and shown in Fig.40 [54].
The designer showed the Pharaoh wearing a Nemes headdress and having a long thin beard while his body takes the shape of a line as a symbol of the glory and strength of the ancient Egyptian Pharaohs.

Fig.40 Royal sphinx from 19th Dynasty [54].

- The fifth example is a 209 mm alabaster ushabti of Siptah, the 7th Pharaoh of the 19th Dynasty (1197-1191 BC) in display in the Metropolitan Museum of Art and shown in Fig.41 [55]. The designer showed the Pharaoh as a small model of scale about 1:6 standing in full dress, wearing the Nemes headdress with Cobra on his forehead and putting his right arm on his left arm. The inscriptions on his dress refers to the Pharaoh including his Cartouche as depicted in the zoomed image.

Fig.41 Siptah shabti from 19th Dynasty [55].

The 20th Dynasty:
- The first example is a 174 mm height alabaster shabti from the 20th Dynasty (1190-1075 BC) sold by Sothebys in 2012 for 11,875 US$ and shown in Fig.42 [56]. This is an shabti of a ladi in a standard position of ancient Egyptian shabtis with wax decoration of the head, hands and feet. The zoomed view depicts the decorations of the face.

Fig.42 Ushabti from 20th Dynasty [56].

- The second example is a 18 mm alabaster fish amulet from the 20th Dynasty (1085 BC) displayed for sale by Live Auctioneers (lot 0185) for an estimated price 150 – 200 US$ and shown in Fig.43 [57]. The designer could put the Tilapia fish detain in a projection area less than 200 x 100 mm² including the mouth, eyes tail and fins. The seller put a designation card almost three-times the projection area of the alabaster product itself. This is something good the Egyptian Museums need to learn from it.

Fig.43 Fish-amulet from 20th Dynasty [57].

IV. CONCLUSIONS
- Ancient Egyptians were pioneers in manufacturing alabaster products..
The evolution of the alabaster products industry during the Middle and New Kingdoms was investigated through the presentation of one example from the 11th Dynasty, nine examples from the 12th Dynasty, twenty five examples from the 18th Dynasty, five examples from the 19th Dynasty and two examples from the 20th Dynasty.

The ancient Egyptians used the Egyptian alabaster stone as a raw material for their cosmetic vessels during the 11th, 12th and 18th Dynasties.

They succeeded to produce cosmetic vessel in the shape of a setting cat in the 12th Dynasty.

They used alabaster to produce balance-weight during the 12th Dynasty.

They succeeded to produce complex designs of kohl pots of heights as small as 42 mm during the 12th Dynasty.

They used alabaster in producing cosmetic spoons of various designs during the 12th and 18th Dynasties.

They used alabaster as one of the stones used in the production of canopic jars starting from the 12th Dynasty with tight lid to suit the special conditions of storing human organs.

They used alabaster in producing complex jugs and amphorae during the 18th Dynasty.

They used alabaster in producing Royal stele during the 18th Dynasty.

They produced alabaster vessels simulating fish and animal during the 18th Dynasty.

They produced alabaster perfume bottles with tight lid during the 18th Dynasty.

They used alabaster in producing Royal inscribed goblets during the 18th Dynasty.

They used alabaster to produce Royal statues during the 18th and 19th Dynasties.

They used alabaster also to produce miniature products such as ear studs during the 18th Dynasty and fish amulet during the 20th Dynasty.

The great revolution in the alabaster products industry occurred during the reign of Pharaoh Tutankhamun where wonderful designs and decorations accompanied the alabaster products. The Royal alabaster products were inscribed by the Pharaoh Cartouche.

Innovative alabaster products during the reign of Tutankhamun included: triple lamp, magic chalice, drinking cup, funerary boat, perfume jar, ibex-jar, canopic chest and chest. All those products were well designed, professionally carved and decorated.

They used alabaster in producing the sarcophagus of Pharaoh Seti I of the 19th Dynasty with complete inscription of the sarcophagus external surface.

They used alabaster in producing shabtis during the 19th and 20th Dynasties.

DEDICATION

I dedicate this research work to all the staff of the Hatshepsut for Alabaster Factory at Luxor. The new Egyptian generation who are trying to remind the whole world with the alabaster products manufactured by their ancient grandfathers.

REFERENCES


33. Markus, Goblet inscribed with the names of King Akhhenaten and Queen Nefertiti, https://www.pinterest.com/pin/231302130838169300/


41. Tour Egypt, Drinking cup in the form of a half-opened lous flower, http://www.touregypt.net/museum/tut67.htm
42. A. Hill, Unquent vase from the tomb of Tutankhamun, https://www.pinterest.com/pin/58969076346830385/
43. A. Accebbi, Egyptian Museum, Alabaster boat model, alabaster, horn and gold, 18th Dynasty, https://www.pinterest.com/pin/71987294014727386/
44. Mōi, Alabaster perfume ase from King Tut's tomb, https://www.pinterest.com/pin/25825397833417057/
48. CCIV, King Tut's canopic shrine: Exception or anomaly, http://ccivcopy.site.wesleyan.edu/project-6/egyptian-vases-and-canopic-jars/

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.
• Research on Automatic Control, Mechanical Vibrations, Mechanism Synthesis and History of Mechanical Engineering.
• Published more than 210 research papers in international journals and conferences.
• Author of books on Experimental Systems Control, Experimental Vibrations and Evolution of Mechanical Engineering.
• Chief Editor of the International Journal of Computer Techniques.
• Member of the Editorial Board of some international journals including IJET.
• Reviewer in some international journals.
• Scholars interested in the authors publications can visit: http://scholar.cu.edu.eg/galal