

# Mechanical Engineering in Ancient Egypt, Part XIII: Stone Vessels (Predynastic to Old Kingdom Periods)

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**ABSTRACT:** *The objective of this paper is to investigate the development of mechanical engineering in ancient Egypt through its stone vessels industry. This study covers the time period from the Predynastic Period to the Old Kingdom Period. The features and innovation of the available stone vessels in those periods are investigated. The material, dimensions, location and shape are stated wherever possible.*

**Keywords** –*Mechanical engineering history, stone vessels industry in ancient Egypt, Predynastic to Old Kingdom periods.*

## I. INTRODUCTION

The ancient Egyptians required using vessels for their daily life and funeral purposes. The rock-raw material is available in too many locations in Egypt. Thus, the Egyptian man thought to use those free materials to manufacture his vessels from very early times. Because he was an ingenious human being he could produce stone vessels of wonderful designs and from both soft and hard stones.

Lilyquist (1995) studied the Egyptian stone vessels from the time of Kian to the time of Thutmosis IV. She presented the vessels functions, provenance, source, features and catalogue items from 15<sup>th</sup> to 18<sup>th</sup> dynasties [1]. McGovern et. Al. (1997) studied the beginning of winemaking and viniculture in ancient near east and Egypt. They presented samples of wine jars from Iran and Egypt including stone vessels [2]. Newman (1998) stated that many ceramic and stone vessels found in museums were originally made to hold organic materials such as foodstuffs, cosmetics and perfumes. He took vessel samples from the Museum of Fine Arts at Boston, the Metropolitan Museum of Art at NY including duck flask, pot with monkeys, two monkeys jar,

amphora, fish flask, bag-shaped jar, spouted dish and monkey jar [3].

Mallory (2000) stated that the origin of predynastic basalt vessels was Northern Egypt, and during the first dynasty the rulers gained control over the basalt vessel industry. She prepared a catalogue of basalt vessels covering 583 vessels [4]. Bevan (2004) studied the role of Egyptian stone vessels as an important piece of evidence of early cultural contact in the Aegean. He addressed the thorny issue of Predynastic – Old Kingdom vessels found unstratified or much later Bronze Age Aegean contexts [5]. Raffaele (2005) stated that as early as the Badarian and Naqada I cultures of Middle and Upper Egypt, stone vessels started to be deposited in certain tombs. These vessels were used to contain costly substances such as perfumes, unguents, oils, beverages and food [6].

Limme (2008) presented the Belgian archaeological research in Elkab district 15 km North to Edfu and opposite to Kom el-Ahmar. Among the findings was a number of calcite vessels from Naqada III cemetery [7]. Harrel and Storemyr (2009) stated that over 200 quarries discovered in the Nile Valley and Eastern desert (with some in the Western desert) covering about 3500 years from Late Predynastic to Late Roman Periods. Among some artifacts produced from those quarries are three anorthosite gneiss vessels and three travertine jars located in the Louvre Museum of Paris [8]. Pommerening, Marinova and Hendrickx (2010) studied the association of the water-lily with architect and art in ancient Egypt. They stated that large quantity of different types of objects during the Middle and New Kingdoms were decorated with water-lilies. They presented some vessels of stone and faience from the early dynastic period based fully on the water lily. The ancient Egyptians produced stone vessels with different colors through using different stones representing the colors of the plant [9].

Abdel Kader and Mohammed (2013) stated that ancient Egyptians used a lot of stones for their life like: limestone, sandstone, granite and alabaster. They showed that alabaster vessels belonging to the first and second dynasties in Atfiyah Museum Store exposed to deterioration factors in the burial and exposure environment such as pressure, temperature, humidity and salts. The alabaster vessels were conserved at the restoration laboratory in Atfiyah Museum Store by cleaning, consolidation, assembling and completion [10]. Ayad (2014) presented an overview for the different stone vessel typologies. He outlined a catalog for Heit el-Ghurab stone vessels covering bowls, jars, miniature vessels and body part fragments [11]. Bonadies (2014) reviewed some soft stone vessels at the Louvre Museum in Paris. She outlined the links existed between these soft stone vessels and the ceramic production of Syro-Palestinian and Levantine area [12]. Hassaan (2016) studied the techniques used by ancient Egyptians to cut stones for artifacts production including vessels. He presented the use of stone sawing, drilling and turning in the cutting process. He also presented other tools used in stone cutting by the ancient Egyptians and led to very accurate cuts and dimensions [13].

## II. PREDYNASTIC STONE VESSELS

The ancient Egyptians in a very early period could manufacture stone vessels from different stone materials. Here are some examples:

- Fig.1 shows a jar manufactured from breccias stone by the Badarians of ancient Egypt (5000-4000 BC) [14]. It is located in Brooklyn Museum and has a maximum diameter of 185 mm. It has wide mouth, flat rim, semi-spherical body and two semi-cylindrical handles for purpose of hanging. It is self decorated by the colors strands of the stone itself and it is clear that it was polished.



Fig.1 Badarian breccias jar [14].

- Fig.2 shows a basalt jar manufactured during Naqada I Period (4400-3500 BC) and located in the Louvre Museum of Paris. [15]. It has an open mouth, round small rim, ovoid long body (280 mm length), medium flat base with medium foot and two small handles cut with the body.



Fig.2 Basalt jar from Naqada I [15].

- Another model of basalt jars from Naqada I is shown in Fig.3 [15]. The design is different than that in Fig.2 of the same period. The rim is wide and flashing out, the body is almost cylindrical with little curvature near the base and lengthy (428 mm), there is a swallow near the top for hanging and the base is round.



Fig.3 Tall basalt jar from Naqada I [15].

- A new design of a travertine vessel manufactured during the Naqada II Period (3500-3200 BC) is shown in Fig.4 and located in Petrie Museum of UK [15]. It simulates a pig and has a wide mouth with rim flashing inside, ovoid body, large flat base and holes for hanging.



Fig.4 Travertine vessel from Naqada II [15].

- A second model from Naqada II is a porphyritic stone vessel shown in Fig.5 [16]. It has a medium mouth with small round rim, ovoid body, flat medium base and two small handles cut with the body. The surface is completely polished.



Fig.5 Porphyritic stone vessel from Naqada II [16].

- Now, we move to the Naqada III Period (3200-3000 BC) where we have a number of fantastic models of stone vessels. Fig.6 shows a duck-shaped theriomorphic vessel located in the British Museum [15]. It has a small mouth, wide flat rim, gradually size-changing body simulating the duck, round base and two small handles for hanging. The vessel is naturally colored and neatly polished.



Fig.6 Theriomorphic vessel from Naqada III [15].

- Another wonderful model from the Naqada III Period is shown in Fig.7 which is a cosmetic vessel taking the form of a frog and located in the British Museum [17]. The mouth is medium, the neck is short, the body is hemi-spherical, the rim flashing out, the base is the four legs of the frog and it has two hanging handles integrated with the body. The colors are natural and the surface is polished.



Fig.7 Breccia frog-vessel from Naqada III [17].

- The last model from Naqada III is a limestone jar displayed in the Metropolitan Museum of Art at NY and shown in Fig.8 [18]. It has a medium mouth, flat rim flashed outside, small neck, ovoid body, medium flat base and two small handles for hanging. It seems that it is decorated by painting and engraving the outside body surface and using about three colors.



Fig.8 Limestone jar from Naqada III [18].

### III. EARLY-DYNASTIC STONE VESSELS

The early dynastic period covers the first and second dynasties of ancient Egypt from 3100 to 2686 BC [19]. The wonderful design and manufacturing technology of stone vessels in the Predynastic Period continued to appear in the Early Dynastic Period of the ancient Egyptian history as illustrated in the following examples:

- Fig.9 shown an alabaster bowl from the first dynasty [20]. It has a round vertical rim and medium flat base. It is naturally decorated by the colored layers of the alabaster itself.



Fig.9 An alabaster bowl from the 1<sup>st</sup> dynasty [20].

- Fig.10 shows another alabaster bowl of completely different design than that in Fig.9 [21]. It has a small cavity in the middle, wide round rim with recess in its middle. It has a unique orange color. The cavity is filleted as it meets the rim.



Fig.10 Small cavity alabaster bowl from the 1<sup>st</sup> dynasty [21].

- A third strange and amazing tri-lobed disc manufactured from a very fragile and delicate schist stone located in the Egyptian Museum is shown in Fig.11 [22].



Fig.11 Schist lobed disc from the 1<sup>st</sup> dynasty [22]. This strange unit has a 610 mm diameter and 106 mm height [22]. It has three lobes bent vertically and had a curved triangular shape. It has a tube shaft in the center and a rind at the circumference. If it is a metallic unit we would say how they could manufacture it 5000 years ago. But how they do this using a fragile and delicate stone ?. It is a mysterious work from the old Egyptians. Egyptologists have paid good effort to know the application of this unit. Some of their opinions: It is a car steering wheel, it is a flamed oil lamp, it is for a religious purpose [22]. As a mechanical engineer, I add to the suggestions of the Egyptologists that this unit may be a rotor for a certain type of centrifugal pumps. The tube in the center is to connect the driving shaft. Extensive analysis and/or experiments are required to prove this conclusion.

- Now we move to the second dynasty of the Early Dynastic Period and present a spherical jar manufactured from andesite porphyry and displayed in the British Museum. It is shown in Fig.12 [15]. It has

a 100 mm height, a medium mouth, spherical body, flat round rim, point base and two gold small handles for hanging. The design of the handles is unique. A semi-tubular piece is integrated with a semi-flat plate rounded to take the shape of the jar body at the place of fixation. The handles are secured to the body using an adhesive since the gold can not be soldered to a rock. No body knows how they could invest this adhesive to survive for thousands of years. Another important point in the manufacturing of this jar is its stability. With a point base, to have a stable jar with point base, its centre of mass has to be exactly above the point contact which very difficult to maintain, but the ancient Egyptians did it.



Fig.12 Porphyry Jar from the 2<sup>nd</sup> dynasty [15].

- We have more wonderful vessels from the Early Dynastic Period with dynasty not exactly assigned. Fig.13 shows an andesite porphyry jar [23] . It has an ovoid body, medium mouth, round rim, medium flat base. The decoration is natural and it is highly polished.



Fig.13 Andesite porphyry jar [23].

- Another model of stone vessels having a different design is shown in Fig.14 [24]. It has a concave body, wide mouth, round

rim, large flat base and manufactured from alabaster.



Fig.14 Concave alabaster vessel [24].

- One more wonderful model reflecting the high technology used in ancient Egypt to produce stone vessels is displayed in the Egyptian Museum of Cairo and shown in Fig.15 [25]. They produced this amazing unit from schist which is a hard stone [26]. It has wide mouth, concave body and small flat base. They could carve the body either manual or mechanically using lathe turning [13] to get perfectly a homogeneous concave surface with thickness decreasing to a thickness of a piece of paper at the tip [25].



Fig.15 Schist tall vase from I-II dynasties [25].

- One more model from the late Early Dynastic Period / Early Old Kingdom is shown in Fig.16 [27]. It is manufactured from alabaster and has a medium mouth, medium neck, round flaring rim, ovoid

body, medium base filleted with the body and a strip single handle between the jar rim and its shoulder. It is polished and the decoration is natural through the stone itself.



Fig.16 Alabaster jar with a single handle [27].

- A last model from the I-III dynasties is a miniature granite Kohl pot which is a collection of the Czech diplomat Stanislav Kovar and shown in Fig.17 [28]. It has a 60 mm height, small mouth, semi-spherical body, round flanged rim, short neck and medium flat base. The question is that how can they control their available machines to produce such small objects using the hard granite ?.



Fig.17 Miniature granite kohl pot [28].

#### IV. OLD KINGDOM STONE VESSELS

The Old Kingdom covers the 3<sup>rd</sup> to 6<sup>th</sup> dynasties over the time span from 2686 to 2181 BC [29]. This is the Kingdom of the Pyramids builders, the builders of the huge stone structures, but what is about their small structural objects ? .. What is about their stone vessels ? . Here is the answer.

- Fig.18 shows a travertine bowl from the 3<sup>rd</sup> dynasty displayed in the Ashmolean Museum of Oxford, UK [30]. It has one

color, round rim, medium flat base with internal recess near the bottom leading to the base.



Fig.18 Travertine bowl from the 3<sup>rd</sup> dynasty [30].

- Another bowl manufactured from calcite and has more complex shape than the bowl of Fig.18 and displayed in the British Museum is shown in Fig.19 [31]. It has a round narrowing rim to prevent liquid splashes, convex body and medium flat base. It is polished and has natural colors of the calcite..



Fig.19 Calcite bowl from the 3<sup>rd</sup> dynasty [31].

- Another wonderful model from the 3<sup>rd</sup> dynasty is a metasiltstone bowl having 380 mm diameter and displayed in the Egyptian Museum and shown in Fig.20 [32]. The rim is corrugated forming five lobes and five spouts. The rim is round, the base is flat and marked internally by a neat engraved circle. This design is very difficult to produce using rock raw material, but they have done it.



Fig.20 Metasiltstone bowl from the 3<sup>rd</sup> dynasty [32].

- The last model from the 3<sup>rd</sup> dynasty is a semi-cylindrical 300 mm long vessel from Saqqara, manufactured from alabaster and shown in Fig.21 [33]. It has round rim flourished outside, wide mouth, slightly parabolic body and a medium flat base. There is no decoration except the natural decorations of the alabaster stone itself.



Fig.21 Alabaster vessel from the 3<sup>rd</sup> dynasty [33].

Now, we move to the 4<sup>th</sup> dynasty (2613-2494 BC) to examine the development of the vessels stone industry during it. This is illustrated through a number of stone vessels models available in the world-museums:

- Fig.22 shows a wonderful spouted bowl displayed in the **Cleveland Museum of Art, OH, USA** and manufactured from **anorthosite gneiss** [34]. It has a **vertical rim of diameter less than the maximum bowl diameter. The design prevents splashing of liquids inside the bowl. The spout is taking a U shape and its top edge is in the level of the maximum diameter of the bowl at its top. It has a hemi-spherical body and a flat base. The surfaces are neatly polished and the decoration is natural through the stone construction itself.**



Fig.22 Spouted bowl from the 4<sup>th</sup> dynasty [34].

- Another wonderful model from the 4<sup>th</sup> dynasty is a 200 mm diameter gneiss

bowl of the design presented in Fig.20 of the 3<sup>rd</sup> dynasty displayed in Phoebe Apperson Hearst Museum of Anthropology, University of California at Berkeley and shown in Fig.23 [35]. The technique of bending the rim to take the five lobe shapes producing 5 uniform spouts is mysterious. This nowadays can be done to this accuracy only by CNC machine (if available for stone manufacturing). But, the old Egyptians could produce the very accurate uniform and difficult surfaces shown in Fig.23 using a stone material !!



Fig.23 Gneiss bowl from the 4<sup>th</sup> dynasty [35].

- One more stone vessels model from the 4<sup>th</sup> dynasty has less quality regarding its surface finish. It is displayed in the Museum of Fine Art of Boston and shown in Fig.24 [36]. The mouth is small, the rim is a narrowing one and the base is flat. The body is almost hemi-spherical with medium flat base.



Fig.24 Stone bowl from the 4<sup>th</sup> dynasty [36].

Now, we move to the 5<sup>th</sup> dynasty of the Old Kingdom (2494-2345 BC), we have a number of stone vessels highlighting the situation of the stone vessels technology in the Old Kingdom.

- Fig.25 shows an alabaster har from the 5<sup>th</sup> dynasty during the reign of King Djedkare Isesi (2388-2356 BC) [37]. It has a wide mouth with round lib flourished outside

with a flange, semi-conical body, flat base with large fillet between the base and jar body.



Fig.25 Alabaster jar from the 5<sup>th</sup> dynasty [37].

- A second model of stone vessels in the 5<sup>th</sup> dynasty is a stone bowl displayed in the National Museum in Prague and shown in Fig.26 [38]. It has a wide mouth, round rim and a spherical sector body. It is polished and the decoration is natural through the structure of the bowl material.



Fig.26 Stone bowl from the 5<sup>th</sup> dynasty [38].

- The last model from the 5<sup>th</sup> dynasty is an alabaster vase belonging to King Unas and displayed in the Louvre Museum of Paris and shown in Fig.27 (a) [39]. The vase has a small mouth, round rim flourished outside, short neck, spherical body and medium flat base. It has inscriptions of the upper half of the body as zoomed in Fig. 27 (b) including the Cartouche of the King



Fig.27 (a) Alabaster vase of King Unas [39].



Fig.27 (b) Inscriptions of King Unas vase.

Now, we move to the last dynasty of the Old Kingdom, dynasty 6 (2345-2181 BC). We have good number of models oriented to this dynasty as illustrated below.

- Fig.28 shows a 145 mm height alabaster jubilee vessel of King Pepi I of the 6<sup>th</sup> dynasty located in the Walters Art Museum of USA [40]. The vessel has a wide mouth, round rim flourished outside, conical body, flat base flourished outside for better stability and filleted with the body with a large fillet.



Fig.28 Alabaster jubilee vessel of King Pepi I [40].

- The second model from the 6<sup>th</sup> dynasty is an alabaster spouted jar shown in Fig.29 [41]. It has a wide mouth, round rim, ovoid body, medium flat base and a spout in the top 40 % of the body. The spout has a V shaped output orifice while its body has a U-shape. This may be to restrict the flow rate through the spout and give it a specific flow shape.

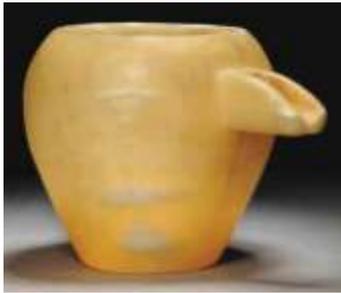


Fig.29 Alabaster spouted jar from the 6<sup>th</sup> dynasty [41].

- The third model from the 6<sup>th</sup> dynasty is an alabaster inverted jar located in the Metropolitan Museum of Art of NY and shown in Fig.30 [42]. It has a medium mouth, round rim, ovoid body with large fillet with a flat small base. It has no decoration and the surface is polished.



Fig.30 Alabaster inverted jar from the 6<sup>th</sup> dynasty [42].

One more model from the rein of King Pepi I, the 3<sup>rd</sup> King of the 6<sup>th</sup> dynasty is an alabaster jar located in the Metropolitan Museum of Art which is shown in Fig.31 (a) [ 43]. It has a medium mouth, round rim, short straight neck, rounded shoulder, semi-conical body and a medium flat base. It is not decorated but inscribed on the shoulder by inscriptions zoomed in Fig.32 (b). The inscriptions are neatly carved on the jar shoulder including the King Cartouche.



Fig.31 (a) King Pepi I alabaster jar [43].



Fig.31 (b) Jar inscriptions.

## V. CONCLUSION

- The manufacturing of stone vessels in the periods from the Predynastic to Old Kingdom of ancient Egypt was investigated.
- This investigation covered stone vessels from Badarian, Naqada I, Naqada II and Naqada III Periods.
- In the era of Ramses VI of the 20<sup>th</sup> They could produced highly sophisticated stone jars during the Predynastic Period using limestone, travertine, basalt, breccias and porphyritic stones.
- They could produce vessels simulating birds such as a duck and animals such as frog and pig.
- They designed their stone vessels with the feature of hanging possibility using small handles or holes in the body from the Predynastic Period.
- Natural decoration took place through the structure of the stone itself and high and accurate degree of polishing even for the small parts of the vessel.
- During the Early Dynastic Period (1<sup>st</sup> and 2<sup>nd</sup> dynasties), they produced stone vessels using alabaster, schist, porphyry and granite.
- Wonderful stone vessels with excellent design and production appeared during the Early Dynastic Period including a strange 3-lobed schist disc of unknown function.
- In the 2<sup>nd</sup> dynasty, they succeeded to produce a stable porphyry spherical jar with point base and gold handles adhered to the jar stone body. It was a mysterious engineering work.
- In the Early Dynastic Period, they produced stone vessels without handles, with one handle and with two handles.
- In this period they had the mechanical technology to produce a schist vase of a parabolic body with a very small thickness at the mouth (paper thickness )

without failure of the vase during manufacturing !!.

- In the 3<sup>rd</sup> dynasty, they has the mechanical machinery and technology to manufacture stone vessels having corrugated rim providing five spouts !!.
- During the Old Kingdom, they had the skill and technology to produce miniature cosmetic pots from hard granite as small as 60 mm height.
- They produced stone vessels in the Old Kingdom with straight, flaring and narrowing rims.
- In the 4<sup>th</sup> dynasty, they produced one-piece spouted bowls with spouts having U shape (open channel flow rate).
- They used different designs in the 4<sup>th</sup> dynasty to control liquid splashing from stone bowls.
- Wonderful corrugated-rim-bowls with five spouts were also produced in the 4<sup>th</sup> dynasty.
- In the 5<sup>th</sup> dynasty, they used engraved inscriptions on royal stonewares.
- In the 5<sup>th</sup> dynasty, royal stoneware carried engraved inscriptions with black color survived for thousands of years.
- Spouted stone jars continued to appear in the 6<sup>th</sup> dynasty with spout modification.
- Inverted jar design appeared during the 6<sup>th</sup> dynasty of the Old Kingdom.

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