

MECHANICAL ENGINEERING IN ANCIENT EGYPT, PART 63: PALETTES INDUSTRY

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Article Received on 21/12/2017

Article Revised on 11/01/2018

Article Accepted on 01/02/2018

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ABSTRACT

The objective of this paper is to investigate the development of mechanical engineering in ancient Egypt through the production of palettes during the Predynastic to Late Periods. This study covers the different applications of palettes in the ancient Egyptian society during a time span of about 4000 years. The material, dimensions, use and location of each palette are highlighted. The features and mechanical engineering tradition in each palette are investigated.

KEYWORDS: Mechanical engineering history, ancient Egypt, palettes industry, palette use.

INTRODUCTION

This is the 63rd part in a series aiming at investigating the mechanical engineering technology in ancient Egypt. It focuses on the production and use of palettes. The ancient Egyptians used palettes of various dimensions and materials for different purposes such as: cosmetic and medical purposes, ceremonial purposes, funerary purposes, displacement measurement device, animal-simulated antiques, painting and coloring.

Smith, 1960 in his book about ancient Egypt as represented in the Museum of Fine Arts of Boston presented a number of palettes including slate palettes from the Predynastic Period ^[1]. Arnett, 1968 in his master of History Thesis about the carved slate palettes of the Egyptian Late Predynastic Period presented a catalogue of ancient Egyptian palettes during the quoted era and covering 21 palettes. He outlined that they produced palettes to simulate the form of

natural objects found in nearly every grave near the face of the deceased. He outlined also that the small holes bored for suspension about the neck as amulets for properly magical qualities.^[2] Rafaele, 2003 writing about Dynasty 0 of ancient Egypt presented a palette from Naqada IIIB, carved from one side using schist and located in the Metropolitan Museum of Art.^[3] Mwanika, in her study for the Master of Art presented the Narmer palette.^[4]

Tassie, 2008 in her Ph.D. Thesis presented also the Narmer palette from the 1st Dynasty.^[5] Alice, 2008 in his study of palettes outlined that flat stone palettes were used in Predynastic Egypt for the grinding of pigments and made of mudstone. He outlined also that ceremonial palettes of the Late Predynastic and Early Dynastic Periods were decorated with carved relief over the whole surface, while after the Early Dynastic Period, the production of the palettes diminished significantly. He presented palates from Badarian, Naqada I, Naqada II and Naqada III.^[6] Strandbery, 2009 in her Ph. D. Study presented the two-dogs palatte and the Stockholm palette.^[7] Teeter, 2011 in her book about the origins of the Egyptian civilization presented some scenes from Narmer's palette from the 1st Dynasty, a palette from Naqada II. palette with bovine and bird head from Naqada II, quartz ovoid palette. She presented a detailed study with new interpretation for the Narmer palette. She presented also a 253 mm height cosmetic palette, a 105 mm length siltstone fish-shaped palette, siltstone rhomboid palette from Naqada I-II, 346 mm length siltstone double-bird palette from Naqada II, 130 mm length siltstone pelta-shaped palette from Naqada II, 127 mm length siltstone elephant palette from Naqada II, 122 mm length siltstone rectangular palette from Naqada III, 170 mm length siltstone falcon palette from Naqada III, 225 mm length greywacke composite animal palette from Naqada I and a siltstone 280 mm height battlefield palette from Naqada III.^[8]

Hirsch, 2013 in his Ph. D. Thesis about the ancient Egyptian cubits studied the scribe's palette and how the ancient Egyptians used it as a measuring device. He took the palette of Semendes as an example from the 21st or 22nd Dynasty.^[9] Allen, 2014 studied the myth of the unification of Egypt by the Narmer palette. He made an attempt to interpret the Narmer palette presenting adequate analysis of the plethora of the material written about it.^[10] Wing, 2015 in his Master Thesis about Predynastic Egyptian representation of animals presented a number of palettes including: siltstone palette from Naqada II, siltstone birds-headspalate from Naqada, siltstone bird-shaped palette from Badari, 82 mm siltstone palette from Naqada, 385 mm length 4-bird-heads palette from Naqada II, 730 mm palette from Naqada I, 146 mm length twin-fish palette, 204 mm two-birds palette from Naqada, 425 mm two-dogs

palette from Naqada III, 665 mm hunter's palette, siltstone palette with stem, 325 mm siltstone palette from Badari, 245 mm palette from El-amra and 147 mm siltstone palette.^[11] Reems, 2015 in her Ph. D. Thesis presented a 90 mm height fragment of a Late Period ceremonial schist palette and a scene from Narmer palette.^[12] Berens, 2015 in his Master Thesis presented some palettes including: scenes from Narmer palette and the two-dogs palette from Naqada III.^[13]

Kinsman, 2016 in her thesis for the Degree of BA Egyptology presented the hippopotamus palette from Naqada I showing hunters hunting a hippopotamus and a dog hunting an ostrich, bull-tilapia hybrid palette from Early 1st Dynasty, Narmer palette, Oxford palette (two-dogs palette) from Naqada II-III, four-dogs palette from Naqada III, hunters palette from Naqada III and Battlefield palette from Naqada III.^[14] Wikipedia, 2017 wrote an article about list of Egyptian palettes. They presented the four-dogs palette in display by the Louvre Museum. They listed name of the palette, its dimensions and the present location.^[15] Liverpool Museum, 2018 wrote an article about a cosmetic palette from Naqada II produced from mudstone and having a 101 mm length.^[16]

Palettes Production in the Badarian and Naqada Predynastic Periods

According to Wikipedia, the Badarian culture covered the time span from 4400 to 4000 BC, Naqada I from 4000 to 3500 BC, Naqada II from 3500 to 3200 BC and Naqada III from 3200 to 3000 BC^[17]. The ancient Egyptians innovated palettes for multi-purposes as will be illustrated from the two many examples presented in this research work during the Predynastic and Dynastic eras. Here are some of their production of palettes during the Badarian and Naqada cultures:

- The first example is a siltstone Palette found in Grave 4615 at Badari (4400-4000 BC) in display in the Manchester Museum and shown in Fig.1.^[18] The palette simulated a bird with smooth profiles not to harm the used following the well-known tradition of machine design in recent days. The application of this type of palette may be for preparing ingredients for cosmetic and medical use.
- The second example is a Badarian turtle-shaped palette shown in Fig.2.^[19] The material, dimensions and present location are not assigned. The designer showed the four legs of the turtle and its head with probably inlaid eyes. All the surfaces are rounded.



Fig. 1: Badarian bird-shaped palette.^[18]

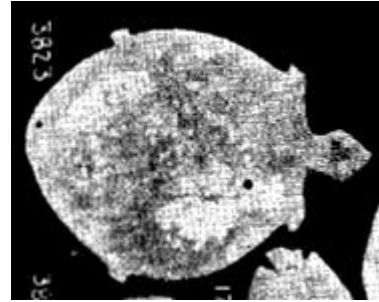


Fig. 2: Badarian turtle-shaped palette.^[19]

- The third example is a Badarian double-heads-bird-shaped palette shown in Fig.3.^[19] The material, dimensions and present location are not assigned. The genius mechanical designer used the birds-two heads to simulate the actual birds standing back-to-back and also to carry the palette or hang it.
- The fourth example is a Badarian bird-shaped palette with central stem shown in Fig.4.^[19] The material, dimensions and present location are not assigned. The designer simulated a bird (may be a parrot) with inlaid eyes and a central stem to carry or hang the palette. All the surfaces are rounded even at the connection between the stem and bird-body.

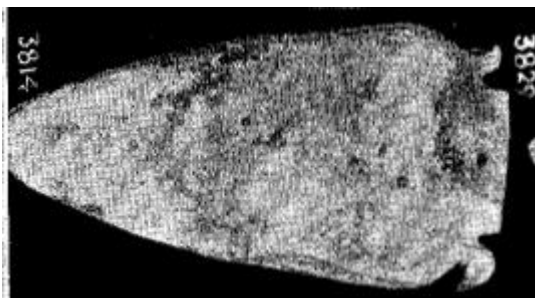


Fig. 3: Badarian double-head-bird-shaped palette.^[19]



Fig. 4: Badarian bird-shaped palette.^[19]

- The fifth example is a greywacke turtle palette from Naqada I (3900-3500 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.5.^[20]
- The sixth example is a greywacke guinea fowl-shaped palette from Naqada I/Naqada II (3650-3300 BC) in display in the Metropolitan Museum of Art and shown in Fig.6.^[21] The palette height is 193.7 mm and all the surfaces are rounded.



Fig. 5: Turtle palette from Naqada I.^[20] Fig. 6: Guinea fowl palette from Naqada I-II.^[21]

- The seventh example is greywacke elephant-shaped palette from Naqada I-Naqada II (3650-3300 BC) in display in the Metropolitan Museum of Art and shown in Fig.7.^[21] All the surfaces are rounded and the designer used two small holes to carry and/or hang the palette. The palette can be carried also from the elephant hose. The palette length is 209.5 mm.
- The eighth example is a gazelle palette from Naqada I-Naqada II (3650-3300 BC) in display in the Risd Museum at Providence, USA and shown in Fig.8,^[21] Its height is 86 mm and it has only one hole to hang or carry the palette. All the surfaces are smooth and rounded and the design of the gazelle horn with the body gives an alternative for hanging or carrying the palette.



Fig. 7: Elephant palette from Naqada I-II.^[21]

Fig. 8: Gazelle palette from Naqada I-II.^[21]

- The ninth example is a 153 mm height mud-two-turtles palette from Naqada I (3650-3500 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.9.^[22] This is an innovative design in Predynastic palettes where more twin-turtles are simulated by the palette.
- The tenth example is a 342 mm schist rhomboidal palette with scorpion relief from Naqada I (4000-3500 BC) from the collection of Tadashi Kikugawa and shown in Fig.10.^[23] The designer assigned his palette by the scorpion set at about one-fourth of the

palette length.



Fig. 9: 2-turtles palette from Naqada I.^[22]



Fig. 10: Rhomboidal palette from Naqada I.^[23]

- The eleventh example is a ram-shaped palette from Naqada I (4000-3500 BC) in display in the Ashmolean Museum at Oxford and shown in Fig.11.^[24] The mechanical designer set a completely rounded and smooth surfaces. He designed the ram-horn to act as a hole to carry and/or hang the palette. I think this is an animal-simulation palette used as an antique.
- The twelfth example is a two-ibexes palette from Naqada I-Naqada II (4000-3200 BC) in display in Petrie Museum at London and shown in Fig.12.^[25] The two ibexes were engraved near the big-end of the palette which had a semi-ovoid shape. There was no hanging holes and it may be used for gradient crushing in the medical, cosmetics and pigments industry.



Fig. 11: Ram palette from Naqada I.^[24]

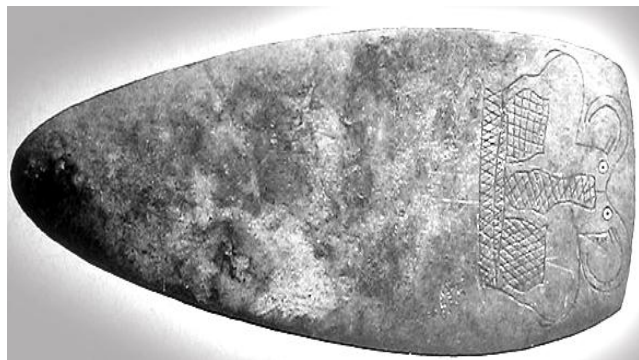


Fig. 12: 2-Ibexes palette from Naqada I-II.^[25]

- The thirteenth example is a 229 mm length schist fish-shaped cosmetic palette from Naqada II (3500-3100 BC) sold by Sothebys for 7,200 US \$ and shown in Fig.13.^[26] The hole in the palette body does not go all through. The reason for this may be the idea of the designer to use the V-shaped tail of the fish to carry and/or hang the palette.

- The fourteenth example is a greywacke fish-shaped palette from Naqada II (3500-3300 BC) in display in the Louvre Museum at Paris and shown in Fig.14.^[27] The designer used two hole (one small and one large) to hang the palette and engraving in the fish body acting as a pool for the grinding of materials for cosmetic, medical or painting purposes.



Fig. 13: Cosmetic palette from Naqada II.^[26]



Fig. 14: Fish palette from Naqada II.^[27]

- The fifteenth example is a 295 mm height schist 2-birds-grinding palette from Naqada II-Naqada III (3500-3100 BC) in display in the Brooklyn Museum and shown in Fig.15.^[28] The designer used very smooth and well-rounded surfaces. He, may be, used the heads of the two birds to carry and/or hang the palette as there was no holes in this design.
- The sixteenth example is a 83 mm height greywacke turtle palette from Naqada II-Naqada III (3500-3050 BC) in display in the Cleveland Museum of Art at Ohio and shown in Fig.16.^[29] The designer here three equal holes, two of them simulating the turtle eyes and the third in the tail. They are used to carry and/or hang the palette.



Fig. 15: 2 birds-palette from Naqada II-III.^[28]



Fig. 16: Turtle palette from Naqada II-III.^[29]

- The seventeenth example is boat-shaped palette from Naqada II (3500-3200 BC) in display in the Louvre Museum at Paris and shown in Fig.17.^[30] The designer used two small holes to carry and/or hang the palette, one exactly in the top-middle and the second

on the front end of the boat (bigger hole). All the surfaces are smooth and rounded.

- The eighteenth example is a schist cosmetic palette from Naqada II-Naqada III (3500-3100 BC) sold by Sothebys for 21,250 US \$ in 2007 and shown in Fig.18.^[31] The palette had an ovoid shape and inscribed fully from one side in parallel bands bounded by straight lines. This means that the ancient Egyptians knew writing from more than 5500 years. This palette has no holes but, a necked head that may be used to carry and/or hang it using a cord.



Fig. 17: Boat-palette from Naqada II.^[30]

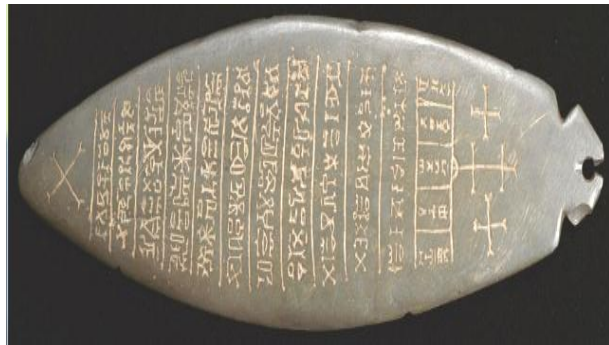


Fig. 18: Cosmetic palette from Naqada II-III.^[31]

- The nineteenth example is a 320.7 mm greywacke four-dogs palette from Naqada II-Naqada III (3500-3100 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.19.^[32] This is a ceremonial palette in which the faces were decorated by scenes. The face shown in Fig.19 shows four dogs and two giraffes. There was no holes and its body was semi-rectangular.
- The twentieth example is a 170 mm length schist fish-shaped cosmetic palette from Naqada II (3200 BC) sold by Bonhams in April 2015 at London for 38,113 US \$ and shown in Fig.20.^[33] This application depends fully on using the 'Sa' symbol as an amulet produced from silver and electrum. The palette had smooth rounded surfaces only with tail and head and without holes. The tail here replaces the holes.



Fig. 19: 4-dogs palette from Naqada II-III.^[32]



Fig. 20: Cosmetic fish palette from Naqada II.^[33]

- The twenty first example is a 127 mm schist Kitchberg palette from Naqada II-Naqada III (3500-3000 BC) from the collections of Kitchberg, Switzerland and shown in Fig.21.^[34] This palette may be a ceremonial one taking the shape of an apple with two birds engraved in its top part with a small hole just below the meeting bills of the birds and a market eyes. All the surfaces were smoothed and rounded to provide a comfortable use of the palette.
- The twenty second example is a palette from Naqada II (3500-3200 BC) in display the Egyptian Museum at Cairo and shown in Fig.22.^[24] Most probably, this is a grinding palette for cosmetic, medicine and painting ingredients and simulates a bull face and using five 6-branches-star symbol for decoration.



Fig. 21: Hitchberg palette from Naqada II-III.^[34]



Fig. 22: Palette from Naqada II.^[24]

- The twenty third example is 410 mm schist ostriches palette from Naqada II (3500-3200 BC) in display in the Manchester Museum at Manchester, UK and shown in Fig.23.^[35] This may be a cosmetic or a ceremonial palette decorated by a number of ostriches engraved near its top part and ostrich-heads above the engraved decorations. The surfaces were carefully rounded and smoothed.
- The twenty fourth example is a 280 mm length fragment of the Battlefield palette from Naqada III in display in the British Museum at London and shown in Fig.24.^[36] The palette was a ceremonial one describing on the ancient Egyptians battles. The other fragment of this palette is in display in the Ashmolean Museum at Oxford.^[36]

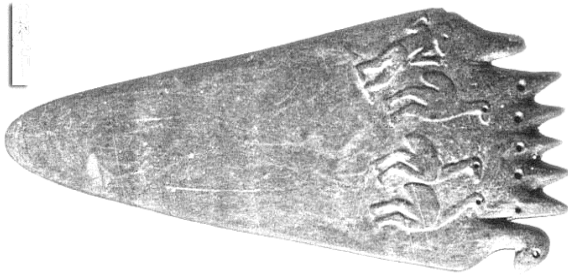


Fig. 23: Ostriches palette from Naqada II.^[35]



Fig. 24: Battlefield palette from Naqada III.^[36]

- The twenty fifth example is a 235 mm length greywacke fish-shaped palette from Naqada III (3300-3100 BC) in display in the Metropolitan Museum of Art and shown in Fig.25.^[37] The designer showed the fish head, fins and tail. The fish eyes may be simulated by a hole going through the thickness of the palette. I think this may be just a fish-simulator and not a cosmetic palette because the fins may harm the user when using the palette for ingredients grinding.
- The twenty sixth example is a 155 mm length greywacke rectangular palette from Naqada III (3300-3100 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.26.^[38] All the corners are rounded with large fillet and all the surfaces are polished. This is a grinding palette without any facilities to carry or hang from.



Fig. 25: Fish palette from Naqada III.^[37]



Fig. 26: Rectangular palette from Naqada III.^[38]

- The twenty seventh example is a 425 mm length siltstone Ashmolean palette from Naqada II-Naqada III (3300-3100 BC) in display in the Ashmolean museum at Oxford and shown in Fig.27.^[39] This is a cosmetic palette decorated by two dogs standing on their feet and holding their hands and engraved scenes on the whole front and back surfaces of the palette.
- The twenty eighth example is a schist duck-shaped palette from Naqada III (3200 BC) in display in the Louvre Museum at Paris and shown in Fig.28.^[40] This is a bird simulator where the duck was simulated fully sitting down on its feet in a complete relaxing position.



Fig. 27: Ashmolean palette from Naqada II-III.^[39]



Fig. 28: Duck palette from Naqada III.^[40]

- The twenty ninth example is a 120 mm length schist palette from Naqada III (3200 BC) sold by Bonhams on October 2012 at London for 4,310 US \$ and shown in Fig.29.^[41] This is a double-parrot cosmetic palette with stem. The stem helps in firm holding the palette during the grinding process.
- The thirtieth example is a 90 mm length greywacke ceremonial palette from Naqada III (3200-3100 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.30.^[42] The palette face was completely engraved by scenes and there were no holes or any other means supporting carrying and hanging the palette.



Fig. 29: 2-parrots palette from Naqada III.^[41]



Fig. 30: Ceremonial palette from Naqada III.^[42]

- The thirty first example is a 162 mm length dog-topped palette from Naqada III (3200-3000 BC) in display in the Geneva Museum of Art and shown in Fig.31.^[43] The palette is a cosmetic one for ingredients grinding and had a rough surface while all the corners are rounded. It had no hold for carrying and/or hanging. The dog-neck may do this job.
- The thirty second example is a 227 mm falcon topped palette from Naqada III (3200-3000 BC) in display in the Basel/Bale Museum at Switzerland and shown in Fig.32a.^[44] This is a rectangular grinding palette with a circular grinding pool carved near the centroid of the palette face. The corners of the rectangle are rounded not to harm the user.

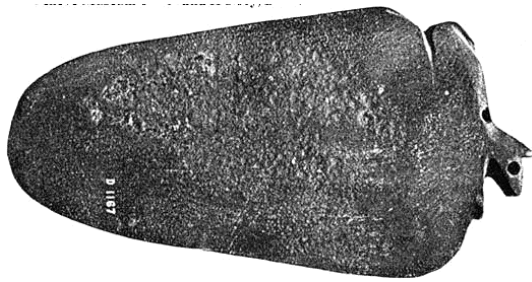


Fig. 31: Dog pallet from Naqada III.^[43]

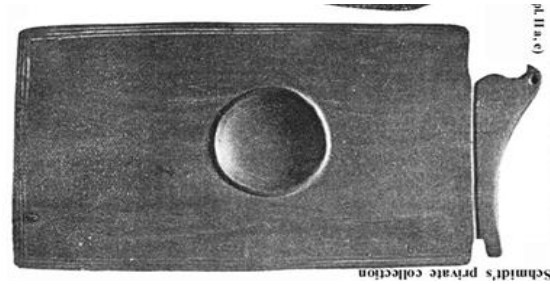


Fig. 32a: Falcon palette from Naqada III.^[44]

- The thirty third example is a 346 mm length fish-shaped palette from Naqada III (3200-3050 BC) in display in the Historisches Museum at Vienna of Austria and shown in Fig.32b.^[45] This may be a fish-simulator palette or a grinder. The designer showed the fish head, tail and fins with engraved eyes. All the surfaces were smoothed and rounded not to harm the user.



Fig. 32b: Fish palette from Naqada III.^[45]

Palettes Production in the Early Dynastic Period

The Early Dynastic Period comprises the 1st and 2nd Dynasties over a time span from 3150 to 2686 BC.^[46] The extensive use of palettes practiced during the Predynastic Periods started to diminish in the next periods starting from the Early Dynastic Period as will be illustrated in the following examples:

- The first example is the 635 mm length palette of King Narmer (Narmer Palette) the founder of the 1st Dynasty 3273-2987 BC) in display in the Egyptian Museum at Cairo and shown in Fig.33.^[47] This was a ceremonial palate showing King Narmer of Unified Egypt crushing the heads of Egypt's enemies in inscriptions on both sides of the palette. The designer included a number of animals and birds in the palette inscriptions.



Fig. 33: Narmer palette from 1st Dynasty.^[47]

- The second example is a 89 mm length mudstone rectangular slit cosmetic palette from the 1st Dynasty from the tomb of King Djer (3100-2896 BC) in display in the British Museum and shown in Fig.34.^[48] The palette had an ivory cover inscribed for Queen Neith-Hotep, wife of King Narmer. The corners of the palette are rounded and its face is inscribed with unclear scenes. This may be the first time to have a casing for the palette. This may be because of the Royal nature of the palette, but it is something amazing that makes one feels that it is a product from the 21st century!!.

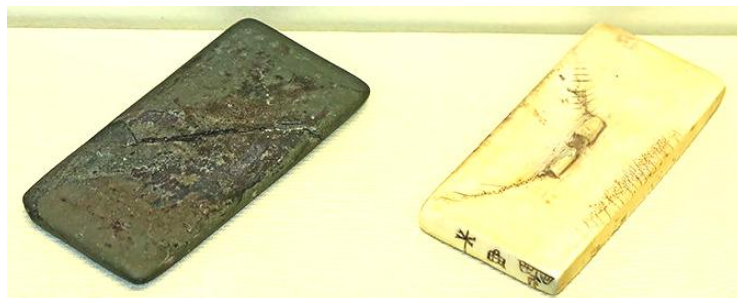


Fig. 34: Rectangular pallet from 1st Dynasty.^[48]

- The third example is a 124 mm length greywacke rectangular cosmetic palette from Early dynastic (3100-2600 BC) sold by Christies in October 2014 at London for 862 US \$ and shown in Fig.35.^[49] This palette had a perfect rectangular shape with rounded corner using small radius fillets.
- The fourth example is a 55 mm height faience cosmetic palette from Early Dynastic (3100-2686 BC) in display in the World Museum at Liverpool and shown in Fig.36.^[50] It is taking the shape of a Shen symbol with cylindrical shallow pool.



Fig. 35: Rectangular pallet from Early Dynastic.^[49]



Fig. 36: Cosmetic palette from Early Dynastic.^[50]

Palettes Production in the Middle Kingdom

The Middle Kingdom comprises the 11th and 12th Dynasties over a time span from 2050 to 1800 BC.^[51] We are still feeling the decay of palettes use after the Predynastic Period as will be depicted through the following examples from the Middle Kingdom:

- The first example is an 106 mm length shallow rectangular palette from the Middle Kingdom (2025-1700 BC) sold by Christies on October 2014 at London for 3,787 US \$ and shown in Fig.37.^[52] This palette may be a scribe's palette or a cosmetic or medicine preparation palette. The surfaces were smoothed and rounded at the corners.
- The second example is a 92 mm length alabaster swan-necked palette from the Middle Kingdom (2000-1800 BC) shown in Fig.38.^[53] It has an ovoid shape, a rounded boundaries pool and a flat base. Its use may be for the production of ingredients for the cosmetic, medicine and/or painting industries.



Fig. 37: Rectangular palette from MK.^[52]



Fig. 38: Swan palette from MK.^[53]

- The third example is a 110 mm grey stone palette from the 12th-13th Dynasties (1981-1640 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.39.^[54] This palette had a rectangular body with rounded corners and an ovoid pool with decreased dimension while going down towards the bottom of the pool. It may be used for cosmetic, medicine and painting applications.

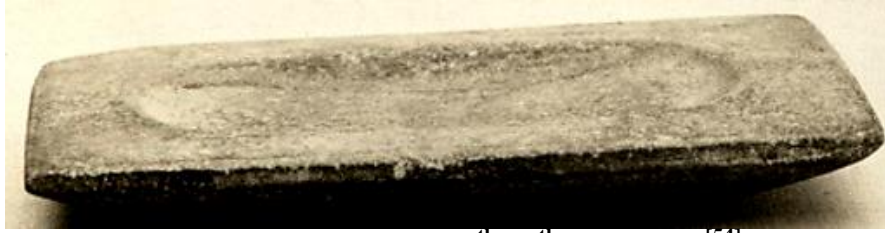


Fig. 39: Palette from 12th-13th Dynasties.^[54]

Palettes Production in the Intermediate Periods

The history of ancient Egypt comprised three intermediate periods: The First Intermediate Period from 2181 to 2055 BC (7th – 10th Dynasties),^[55] the Second Intermediate Period from 1802 to 1550 BC (13th – 17th Dynasties)^[56] and the Third Intermediate Period from 1070 to 664 BC (21st – 25th Dynasties).^[57] We have four examples of palettes from the Second and Third Intermediate Period presented as follows:

- The first example is a 346 mm length wooden scribe's palette from the Middle Kingdom-Second Intermediate Period (2030-1550 BC) in display in the Metropolitan Museum of Art at NY and shown in Fig.40.^[58] The palette had two shallow cylindrical pools for the ink and one recess may be to locate the writing pens. It had rectangular cross-sections in all directions. The designer succeeded to select the proper wood type to survive for more than 3550 years.
- The second example is a 413 mm length wooden scribe's palette from the Second Intermediate Period (1782-1573 BC) sold by Christies on October 2003 at London for 16,187 US\$ and shown in Fig.41.^[59] Three pens were located in their place in the palette while the ink-pools are not clear in the figure.



Fig. 40: Scribe's palette from MK-2nd IP.^[58]



Fig. 41: Scribe's palette from 2nd IP.^[59]

- The third example is 241 mm length wooden scribe's palette from Late 17th Dynasty-Early 18th Dynasty (1635-1458 BC) in display in the Metropolitan Museum and shown in

Fig.42.^[60] It had an ivory cover at one end (may be the cover of the other end is missing) and locations for the ink (pools) and pens (recess).

- The fourth and last example is a 486 mm palette of Smendes, the High Priest of Amun from the 21st Dynasty of the Third Intermediate Period (1045-992 BC) in display in the Metropolitan Museum of Art and shown in Fig.43.^[61] It has a rectangular pool for the ink, a recess for the pens and inscribed for its owner Smendes. The figure shows also two pens of Smendes.



Fig. 42: Scribe's palette from 17th-18th Dynasties.^[60]



Fig. 43: Scribe's palette from 21st Dynasty.^[61]

Palettes Production in the New Kingdom (NK)

The new Kingdom comprised the 18th, 19th and 20th Dynasties over a time period from 1570 to 1069 BC.^[62] We have 12 examples describing the evolution of the palettes industry in ancient Egypt presented as follows:

- The first example is a double-duck cosmetic palette acting as an ointment bowl from the New Kingdom (1570-1069 BC) from the collections of the University of Swansea and shown in Fig.44.^[63] This cosmetic palette had a semi-circular shape with fully inscribed top surface with duck necks designed to serve in carrying and hanging the palette. The dimensions and the material are not assigned.
- The second example is cosmetic palette acting as an ointment bowl from the New Kingdom (1570-1069 BC) from the collections of the University of Swansea and shown in Fig.45.^[64] It has an ovoid shape and may simulating an animal. Again no dimensions or material are assigned.



Fig. 44: Duck-palette from New Kingdom.^[63]



Fig. 45: Palette from New Kingdom.^[64]

- The third example is a 203 mm length steatite palette from the New Kingdom (1550-1070 BC) sold by Christies on October 2017 at NY for 8,750 US\$ and shown in Fig.46.^[65] This is a cosmetic palate simulating an ibex with tied legs. The designer made a loop above the head of the animal for purpose of carrying and hanging the palette.
- The fourth example is a 233 mm length wooden scribe's palette from the 18th Dynasty (1550-1295 BC) in display by the Metropolitan Museum of Art at NY and shown in Fig.47.^[66] This palette design is similar to that shown in Fig.41 where it supports using two colors and two pens.



Fig. 46: Steatite palette from NK.^[65]



Fig. 47: Scribe's palette from NK.^[66]

- The fifth example is a 150 mm length basalt rectangular grinding palette from the New Kingdom (1550-1070 BC) sold by MB Abram Galleries and shown in Fig.48.^[67] All the corners were rounded and the pool had an oval shape.
- The sixth example is a 114 mm length granite rectangular palette from the 18th Dynasty (1550-1295 BC) was in display by Christies for sale with price up to 1500 US \$ and shown in Fig.49.^[68] It has a rectangular external shape and rectangular rounded pool. The outside edges were rounded with less radius fillets than the pool. All the surfaces were polished having better appearance than the palette of Fig.48.



Fig. 48: Basalt palette from NK.^[67]

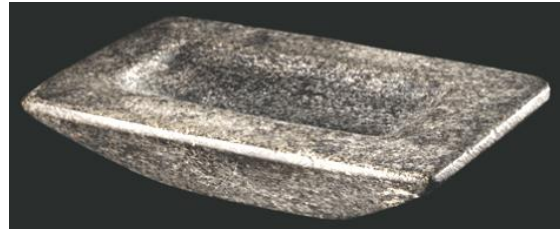


Fig. 49: Granite palette from NK.^[68]

- The seventh example is a 110 mm width alabaster palette from the New Kingdom (1550-1069 BC) sold by Christies on October 2010 at London for 861 US \$ and shown in Fig.50.^[69] It has an ovoid shape and a slit ovoid pool in the face shown in the figure. It may have another pool from the bottom side.. All surfaces were rounded and smoothed.
- The eighth example is a 175 mm length ivory painter's palette from the 18th Dynasty, reign of Pharaoh Akhenaten (1390-1353 BC) in display in the Metropolitan Museum of Art and shown in Fig.51.^[70] This palette has four ovoid pools for the pigments (or inks) and a recess for the brushes or pens. The inscription on its bottom face is for Princess Meketaten daughter of Pharaoh Akhenaten and Queen Nefertiti.



Fig. 50: Alabaster palette from NK.^[69]



Fig. 51: Ivory palette from 18th Dynasty.^[70]

- The ninth example is a 349 mm length ivory scribal palette from Late 18th Dynasty (1336-1295 BC) in display in the Brooklyn Museum and shown in Fig.52.^[71] It has two small circular pools for the ink and a recess for the pens. The corners in this design is sharp (not rounded).
- The tenth example is a 49 mm bronze model for an arm holding a scribe's palette from Late 18th Dynasty-19th Dynasty (1336-1256 BC) in display in the Cleveland Museum of Art at Ohio, USA and shown in Fig.53.^[72] This is a palette model having two ink or pigment pools and a recess for the pens.

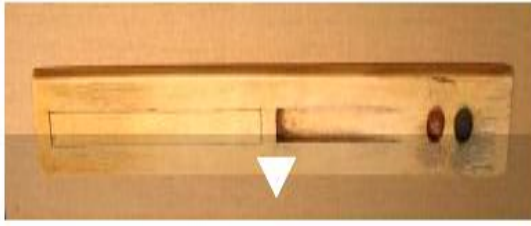


Fig. 52: Ivory palette from 18th Dynasty.^[71]



Fig. 53: Bronze model of scribe's palette from 18th -19th Dynasties.^[72]

- The eleventh example is a 117 mm slate palette from the 18th or 19th Dynasties (?) in display in the Google Cultural Institute and shown in Fig.54.^[73] This may be a cosmetic palette having an ovoid shape and a rectangular hand.
- The twelfth example is a painting palette of Vizier Amendemope of Pharaoh Amenhotep II (1425-1398 BC) of the 18th Dynasty shown in Fig.55.^[74] This palette had two circular and three ovoid pools for the pigments. The dimensions and materials of the palette are not assigned.



Fig. 54: Slate palette from 19th Dynasty.^[73]



Fig. 55: Painting palette from 18th Dynasty.^[74]

- The thirteenth example is a 118 mm length siltstone (or schist?) color palette from the New Kingdom (1550-1069 BC) in display in the Bibliotheca Alexandria Antiques Museum at Alexandria and shown in Fig.56.^[75] This palette had a unique design. The colors pools are big covering the whole width of the palette and standing over a stand. The two colors-pools had circular shape and may be of a spherical-sector shape. The corners of the base were slightly rounded and had a rectangular shape.



Fig. 56: Color palette from New Kingdom.^[75]

Palettes Production in the Late Period

The Late Period comprised the 26th to 30th Dynasties over a time span from 664 to 332 BC.^[76]

The cosmetic and scribal palettes continues to appear during the Late Period but with less extent as will be illustrated by the following three examples:

- The first example is a 260 mm wooden scribe palette from the Late Period (664-332 BC) in display in the Metropolitan Museum of Art and shown in Fig.57.^[77] It has the standard design of scribal palettes presented before in Figs.40-43, 47, 51-53. The ink pools are not clear in the figure while three pens are located besides the palette.
- The second example is a 320 mm scribe palette from the Late Period (664-332 BC) in display in the British Museum at London and shown in Fig.58.^[78] It has a classical design with two circular pools a recess for the pens.



Fig. 57: Scribe palette from Late Period.^[77] Fig. 58: Scribe palette from Late Period.^[78]

- The third and last example is a 120 mm basalt cosmetic palette from the Late Period (664-332 BC) offered by Finch and Company for sale with prices upon request and shown in Fig.59.^[79] It has a circular-conical body with flat base and four pins for carrying and supporting. All the surfaces were rounded and smoothed following the well-established tradition of the ancient Mechanical Engineering.



Fig. 59: Cosmetic palette from Late Period.^[79]

CONCLUSION

- This paper investigated the evolution of mechanical engineering in ancient Egypt through the production and use of palettes.
- The study covered a time span from the Badari culture to the Late Periods.

- The ancient Egyptians produced palettes as earlier as the Badarian Culture (more than 6000 years ago).
- They simulated birds and animals by producing palettes taking their shapes starting from the Badarian Culture
- They designed palettes with stem facilitating carrying and using them since the Badarian Culture.
- During the time of Naqada, they simulated turtles, guinea fowls, elephant, gazelle, ram, ibex, fish, dog, ostrich, duck, parrot, falcon and swan. The simulation was through producing the palette taking the shape of the bird or animal or adding the bird or animal in specific positions in the palette.
- Some of the produced palettes took the shape of rhomboid (during Naqada I), rectangle (during Naqada III, 1st Dynasty 2nd Dynasty, 18th-20th Dynasties), cylinder (during the 1st-2nd Dynasties, 11th-12th Dynasties, 12th-13th Dynasties, 12th-17th Dynasties) and ovoid (during the 18th-20th Dynasties).
- Cosmetic palettes were produced during the time of Naqada I-Naqada II, Naqada II, Naqada II-Naqada III, 11th-12th Dynasties, 18th-20th Dynasties, 26th-30th Dynasties.
- They wrote on some of their palettes since the time of Naqada II-Naqada III.
- Ceremonial palettes were produced during the time of Naqada II-Naqada III, Naqada III and 1st Dynasty.
- Some palettes has a single pool (during Naqada III, 11th-12th Dynasties, 12th-13th Dynasties, 18th-20th Dynasties), double pools (during 11th-17th Dynasties, 17th -18th, 18th-20th Dynasties, 21st Dynasty and 26th-30th Dynasties), four and five pools (during the 18th Dynasty).
- They used different materials in the production of their palettes including: siltstone, mudstone, greywacke, schist, basalt, granite, steatite, slate, alabaster, bronze, faience and ivory.
- They produced palettes having length ranging from 55 mm (models) to 635 mm.
- They produced palettes taking the shape of boats, animals, birds and fruits.

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