SYMMETRIES IN IMAGES ON ANCIENT SEALS

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Abstract
In this paper, we discuss the presence of symmetries in images engraved on ancient seals, in particular on stamp seals. Mainly used to secure the containers from tampering and for owner's identification, these objects appeared during the 5th millennium BC in Mesopotamia. Usually the seals were engraved with simple images, suitable to communicate immediate information. Rotational symmetries are already displayed by the most ancient stamp seals, whose images reach a quasi-perfect symmetry in their small circular or ovoid spaces. Bilateral symmetries are quite common in Egyptian scarab seals.

Introduction
If we want to discuss about symmetry, we have two possibilities. The first possibility is to follow the aesthetic sense, which involves the pleasure in observing good proportioned and balanced forms. The simplest symmetry, the bilateral one, seems to be deeply connected with human perception, as a character of health and then beauty of living beings. The second meaning of symmetry is a well-defined concept of pattern self-similarity, which can be proved according to precise operations in time and space. This is the symmetry in science. In physics for instance, symmetry means invariance of the physical laws under specific transformations. Conservation of energy, momentum and angular momentum can be viewed as a consequence of symmetry for continuous translation in time and space and for rotation. The use of symmetry in science is not separated from a certain aesthetics satisfaction that we gain with these theoretical descriptions [1].
An innate inclination to view symmetrical objects as beautiful produces a consequent improvement of the visual result of many human artefacts. In this paper, we will discuss the presence of symmetry in some ancient artefacts, the stamp seals. They were objects widely used, mainly for sealing and identification purposes, at any social level. Usually engraved with very simple images, they were suitable to communicate immediate information to people. Considered as a form of art of non-primary importance, engraved images can be not only beautiful but also rather important for archaeological studies. We will see that, sometimes, the images reach a quasi-perfect symmetry in their small circular or ovoid spaces. Before the discussion on symmetry, let us shortly report information on the time-line development of seals.

The ancient seals
Sealing is the impression made by the impact of a hard-engraved surface on a softer material, such as clay or wax. The word seal (Latin “sigillum”, old French “scel”) refers either to the device or to the impression. Ancient stamp seals and cylinder seals were made of a hard material, usually stone, and used to press an engraved figure or a short inscription into soft clay. In ancient times, seals were used for the securing of bags, baskets, jars, etc.. The sealing method was either to shape clay over the container stopper or make a fastening with cord and place clay around the knot. The impressed seals on clay were both used to avoid tampering and as method of identification of content or owner.

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The seals were of two main types, the cylinder and the stamp. The cylinder first appeared in Mesopotamia in the late 4th millennium BC, then widespread in Syria and Egypt and in the Aegean area. Stamp seals preceded cylinders, first appearing in Mesopotamia in the 5th millennium BC. Early stamp seals were also used in Iran, northern Syria, and Anatolia (4th and 3rd millennia BC). In Egypt, the scarab seals largely replaced cylinder seals early in the 2nd millennium BC and continued as the main type. They were replaced by the signet ring in Roman period. In the Aegean, stamp seals were used throughout the 2nd and much of the 1st millennium BC, until the signet ring became dominant, in Hellenistic and Roman times [2].
For Egyptians, the scarab seal was not only an impression seal: it was also an amulet with images and symbols engraved to protect the owner [3]. Scarabs were used extensively in Egypt, but they became quite popular and produced also outside of Egypt. In fact, stamp seals with round or ovoid shapes are considered as scarab seals, even when the round back of the object is not precisely shaped as a scarab.
Images on seals are of several types. In the case of Egyptian scarabs, we find of course inscriptions with names of kings and gods, human figures and animals. Coils and entanglements of cords are characteristic of the Middle Kingdom Period. Among images of animals, goats and antelopes had a great success during the Hyksos period, because Hyksos took the antelope form of the Egyptian god Seth to represent their own deity [3].
In the case of Egyptian scarabs, books reporting the collections are available on public domain [4-6]. It is therefore possible to create a sort of statistics of the used images and check if symmetries are present and what are the preferred image arrangements. We find a relevant number of stamp seals with cords and coils, highly symmetric, mainly with bilateral symmetry (see Fig.1), sometimes with two- and four-fold rotational symmetry.

Fig.1 A seal of the Middle Kingdom with spiral coils showing a bilateral symmetry, at the Egyptian Museum of Torino.

The mirror symmetry, or bilateral symmetry, is the symmetry with respect to reflection. A figure, which is indistinguishable from its mirror image, is called mirror symmetric. A way to think about this symmetry is to fold the image in the middle, and check if the two halves are identical. In this case, the image has two halves that are each other's mirror image. Rotational symmetry is symmetry with respect to rotations in the space. In the case of an image, it has a rotational symmetry, when we observe that it is invariant for rotation about an axis perpendicular to its plane. We find a two-fold symmetry if we rotate the image of 180 degrees, a four-fold one when the rotation is of 90 degrees. Generally, we have n-fold rotation when angle is $2\pi/n$.

Rotational symmetry.

In many cases, the presence of symmetry in an image turns out to be associated with an idea of beauty, strength and order. Nevertheless, an excessive symmetry can be boring and constraining the creative action. A perfect bilateral symmetry for instance, gives to the observed object a highly static position (an example from an Egyptian bas-relief is shown in Fig.2). In images or statues, a too fixed appearance can be avoided by a slight breaking of symmetry[1].

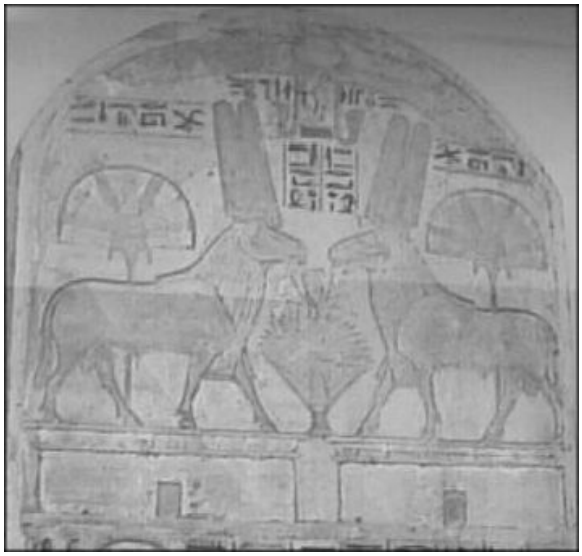

Fig.2. This image shows the upper part of a bas-relief, representing god Amon as a double-ram (at the Egyptian Museum of Torino). Note the perfect bilateral symmetry, so important in art and architecture of ancient Egypt.

The rotational symmetry is different, because it is quite natural for us to follow the image in its rotation in the space. This symmetry produces a feeling of motion and evolution. A breaking of symmetry in this case enhances the idea of inter-penetration or contrast. Let us consider for instance a well-know symbol, the Yin-Yang symbol of Taoism. As in many religious symbols, the symmetry is used to convey an intuitive meaning. And in fact, we see that the ancient Taijitu image of Taoism has a fascinating use of symmetry for rotation about the central point (a two-fold one), combined with black-and-white inversion of colours (see Fig.3). The image actually intends to be a representation of the complementary need for male and female concepts. The rotational symmetry of the shape plus the breaking of colour symmetry, catches our attention with a feeling of development in the frame of complementary actions, not of mere recurrence.

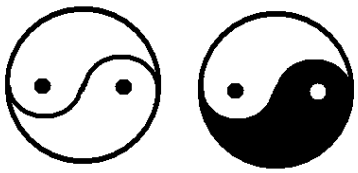

Fig.3 A two-fold rotation symmetry on the left gives an idea of recurrence. The rotational symmetry is broken in the Yin-Yang symbol (on the right).

[1] A discussion on symmetry and symmetry breaking in physics can be found in the Stanford Encyclopaedia of Philosophy, at http://plato.stanford.edu/entries/symmetry-breaking/

How old is the rotational symmetry in images? Well, we have small objects that can help us in investigating this question, and these artefacts are the stamp seals. In a very old stamp seal from the region North Syria/Iraq/Iran [7], dated 5th-4th millennium BC, we see a standing male figure between two horned quadrupeds back to back and head to end (see Fig.4a). The overall structure of the image is built to respect the two-fold rotational symmetry. On the right side of the same figure (Fig4.b), we see a stamp seal from Susa[2]. The seal depicts two goat-antelopes head to tail, inside and outside an oval [8]. In this seal, the idea of motion is strongly enhanced, the two antelopes seem to run on the rim of the seal.

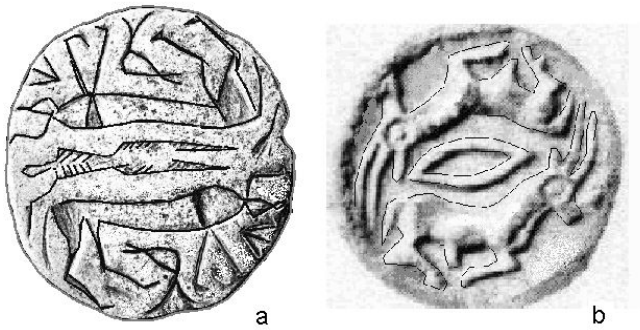

Fig.4 Images on a stamp seal from the region North Syria/Iraq/Iran [7], dated 5th-4th millennium BC (on the left) and on a stamp from Susa [8] at Louvre Museum (on the right).

What is the evolution of this kind of images? Let us imagine a breaking of the two-fold rotational symmetry, obtained by depicting two animals again, but in this case a predator/prey couple. The Figure 5 shows a late bronze age seal from Aegeus with a lion and horned quadruped. This is the hunting between two opposite components. And, finally, men fighting with bulls, in a beautiful Minoan stamp (Fig.6). Note the increase in creativity.

Fig.5. An image from a late bronze age seal from Aegen area (adapted from [9])

Fig.6 Men fighting with bulls, for Minoan area (adapted from [10]).

[2] Susa, in Iran, is one of the oldest known settlements of the world, possibly founded about 4200 BC, although the first traces of an inhabited village have been dated to ca. 7000 BC.

Scarab seals.

To evaluate the presence of two-fold rotational symmetry in images engraved on Egyptian seals, a possibility is to read the catalogues of the huge collections, for instance, of British Museum or Egyptian Museum of Cairo [4-6], when of course, the direct inspection is not possible. The two-fold symmetry seems to be not so frequent among Egyptian scarab seals, depicting animals. In catalogues, we find few scarabs with two symmetric animals (scorpions, lions, crocodiles or lizards, see Fig.7). It is not clear if these seals were unusual or not enough interesting to deserve a place in a museum collection. In fact, the quality of images on these seals is rather poor. In an exiguous number of cases, we observe two different animals. The hunting predator/prey represented in Fig.7 is probably from Hyksos period.

The collection of the Egyptian Museum of Torino too has few scarabs with rotational symmetry. We can see a seal with two scorpions and one with two crocodiles. But the collection possesses a quite unusual seal with two men, may be twins (Fig.8). This seal can be dated to 2200-2040 BC, the first intermediate period of Egypt. The former scarabs with human figures were developed during this period. The human figure was depicted with a linear style, as if it were composed by sticks [3].

Fig.7. Images with two-fold rotation symmetry [6]. A seal of Hyksos period [4], on the right.

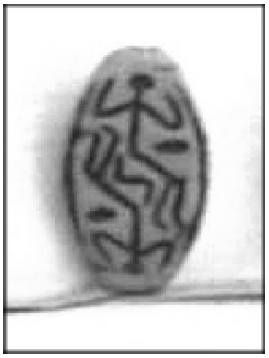

Fig.8 The twins at the Egyptian Museum of Torino.

A huge number of Egyptian scarabs is engraved with coils and spiral, according to the style of the Middle Kingdom. Figure 9 shows a selection of these images from Ref.4. Engraved patterns develop two-fold, four-fold rotational or bilateral symmetries.

When we observe these images, we are amazed about the knowledge of plane pattern symmetries of ancient Egyptian and we can ask ourselves how deep was this knowledge. Common opinion is that Egyptians had used all the 17 types of plane patterns. B. Grünbaum discussed the subject in 1984, telling that this is a misconception, because Egyptians appear to have missed the five symmetry groups, which have three-fold rotation [11]. And in fact, on seals we do not observe three-fold symmetric images. To tell the true, it is difficult to arrange

such images in an ovoid shape (I found just one attempt, shown in Fig.10, amongst seals in Ref.6).

Fig.9 The two symmetries, rotational and bilateral of seals (adapted from Ref.4).

Fig.10 The three-fold symmetry is difficult to obtain in ovoid shapes (adapted from Ref.6).

Conclusions

This paper discussed the presence of symmetries in images engraved on ancient seals. We can conclude asking ourselves, as P. Gerdes uses in his papers, why symmetry is such a common phenomenon in human culture. An easy answer for the bilateral one seems to be quite naturally associated with the fact that animals and human beings possess this symmetry. But why symmetries, which are rare in nature, for instance the two-fold rotational symmetry, are common amongst us, as noted by Gendes. According to him [12,13], these symmetries can naturally arise in solving problems involved in weaving activities.

It is necessary to note that this conclusion is rather specific, because it was reached in studying entanglements of fibres to create baskets or textiles. Nevertheless, we can extrapolate an interesting consequence: the use of symmetries in human artefacts is not a mere copy of natural objects. Symmetries in images started as a creative human action in very ancient times, without the conscious use of geometry.

References

[1] R. Feynman, R. Leighton and M. Sands, The Feynman Lectures on Physics. 3 volumes 1964,1966. Library of Congress, Catalog Card No. 63-20717

[2] Encyclopaedia Britannica, at www.britannica.com

[3] F. Magnarini, Catalogo ragionato di una collezione di scarabei-sigillo egizi, BAR International Series 1241, Oxford, 2004

[4] J. Ward, The sacred beetle: a popular treatise on Egyptian scarabs in art and history, John Murray, London 1902

[5] K.H. Hall, Catalogue of Egyptian scarabs, etc., in the British Musuem, Royal scarabs, British Museum, London 1913
[6] P.E. Newberry, Scarab-shaped seals, Archibald Constable and Co., London 1907
[7] M. Schøyen, Seals, at www.schoyencollection.com/index.html
[8] Stamp seals, at www.hindunet.org/hindu_history/sarasvati/lapis/lapis_lazuli.htm
[9] Late bronze age stamp seal, at en.wikipedia.org/wiki/Image:Late_bronze_age_seal.jpg
[10] S. Davies, Minoan Seal Depicting Bull-Jumping in Action, at www.utexas.edu/courses/introtogreece/lect2/img6minseal.html
[11] B. Grünbaum, The emperor's new clothes: full regalia, G-string, or nothing?, Math. Intelligencer, 6(4), 47, 1984
[12] P.P.J. Gerdes, On ethno-mathematical research and symmetry. Symmetry in a kaleidoscope, Symmetry Cult. Sci., 1(2), 154 ,1990
[13] P. Gerdes, Fivefold symmetry and (basket) weaving in various cultures, in I. Hargittai Editor, Fivefold Symmetry, World Scientific, Singapore, 1992.