

Do You Like Paleolithic Op-art?

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Abstract

We consider the history of certain modular elements: Op-tiles, Kufic tiles, and key-patterns, which occur as ornamental archetypes from Paleolithic times until the present.

Paleolithic ornaments

We have found that the oldest examples of ornamentation in Paleolithic art were from Mezin (Ukraine) dated to 23 000 B.C. Note that 23 000 years is a time period ten times longer than the complete written history of mankind. At first glance, the ornament on the right side of Fig. 1a appears to not be significant, it is an ordinary set of parallel lines. On the right side of Fig. 1b this pattern is transformed into a set of parallel zig-zag lines— an ornament with a symmetry group of type **pmg**, generated by an axis of reflection perpendicular to another axis of glide reflection (Fig. 1b). Let's see how the creative process for the design of this ornament may have developed. Imagine a modern engineer who begins a construction project. At first he makes a rough sketch, and then he begins to work more seriously to solve the problem.

The next series of ornaments from Mezin is more advanced. The previously mentioned sets of parallel lines are arranged in friezes and meander patterns that can still be considered as sketches (Fig. 1c,d).

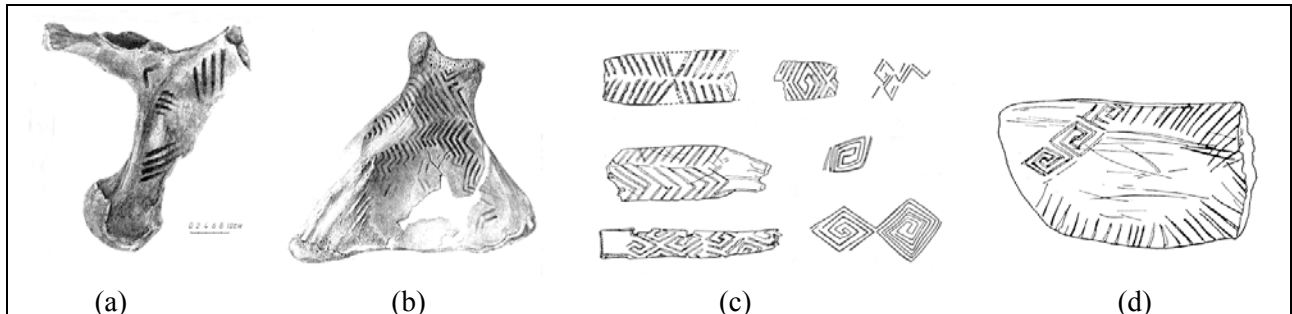


Figure 1: Basic patterns from Mezin.

In Figure 2a we see the final result, the masterpiece of Paleolithic art— the Birds of Mezin decorated by meander ornamentation. The man of prehistory has applied the symmetry constructions that he learned, and he has preserved them for posterity. On the mammoth bone, modelled in the form of a bird, he engraved the meander pattern which represents the oldest example of a rectilinear spiral in the form of a meander ornamentation.

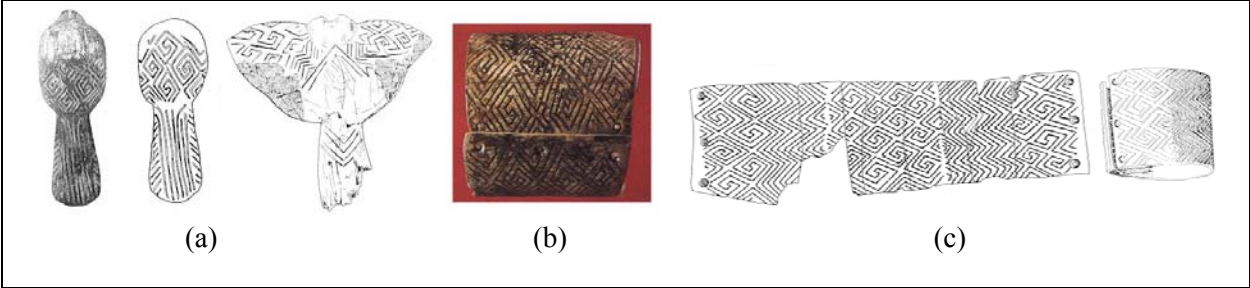


Figure 2: (a) *Bird of Mezin*; (b) *Mezin bracelet*; (c) *developed bracelet*.

The next artifact is an engraved bracelet from the same excavation site (Fig. 2b). As you can see, this bracelet is carved from a mammoth bone only two millimeters thick. If you try to engrave such an ornament on the tiny bone layer, you will not succeed since it will break. Therefore, the man of prehistory made this bracelet with the expenditure of much time and effort in the following way: first he cut a portion of the mammoth bone, then on its surface engraved the ornamentation, removed the internal part of the bone, and he obtained the engraved bracelet. If we look at this bracelet in developed form (Fig. 2c), we notice that there is a continuous transition from one ornament to another via a third ornament: on the left corner; you can see the meander ornamentation, then the set of parallel zig-zag lines used as a symbol of water, and again the continuous transition to another meander ornamentation. In order to make a continuous transition from one ornament to the next, it is necessary to have a relatively high level of the mathematical knowledge and precision, which is unexpected for Paleolithic times [1,2].

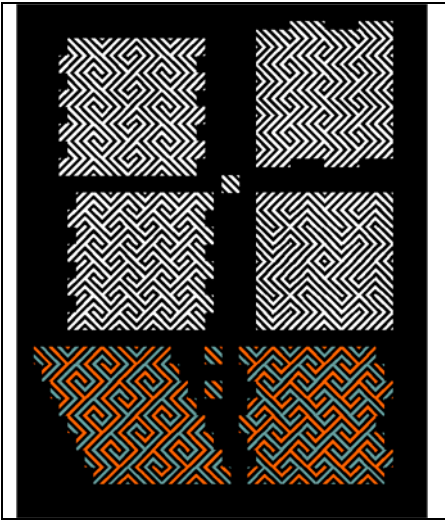


Figure 3: *Modular key-patterns*.

How is the continuous transition from one ornament to another made? The ornaments on Fig. 3 look very different one from another. Among them are black-white and colored ornaments, and at first glance, it appears that there is no unifying principle. Their common property is that they all consist of a single element (module). Notice the small black-white square in the middle. It consists of a set of parallel diagonal black and white lines (strips). If this square is used as the basic motif, then all of these ornaments can be constructed from it. We call this method of construction the principle of modularity. Our goal is to construct all ornaments or structures by using the smallest number of basic elements (modules) and to obtain, by their recombination, as many different ornaments (structures) as possible. This module, a square or rectangle with a set of parallel diagonal black and white strips, we will call an Op-tile; it is the basis of Mezin meander patterns (Fig. 2).

Figure 4 shows the ornaments from Scheila Cladovei culture (Romania, 10 000 B.C.) based on similar modules– rectangular Op-tiles.

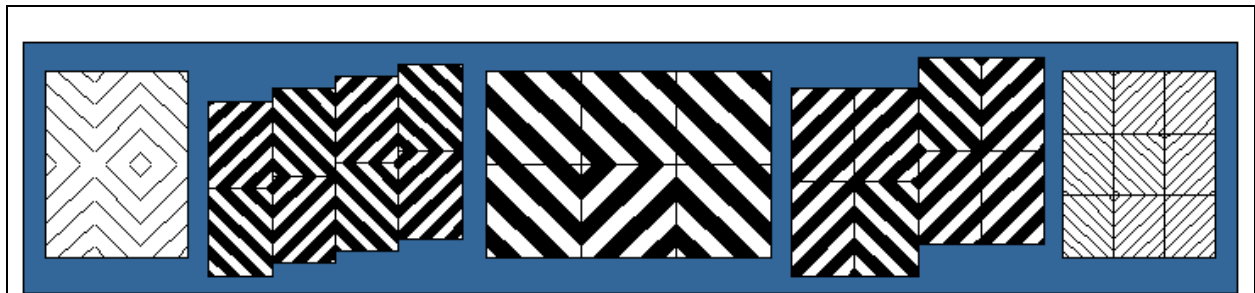


Figure 4: *Ornaments from Scheila Cladovei culture (Romania, 10 000 B.C.).*

Neolithic ornaments

Figure 5 shows a series of ornaments from Titsa culture (Hungary) and Vincha (Serbia), dating to 3 000- 4 000 B.C. They are painted on ceramic and can be found in similar Neolithic settlements. How did the Neolithic people come to the idea of constructing such ornaments? We will try to show that all ornaments were derived from the simplest of human technologies: basketry, weaving, matting, plaiting, or textiles. Then the best of ornament (in an aesthetic sense) were copied to the stronger media of bone, stone, and ceramics. Many of these ornaments are obtained from interlaced patterns (fabrics). If we take two bands of different colors and make the simplest possible interlacing pattern: „over-under“, „over-under“,...we obtain the antisymmetric („black-white“) checkerboard pattern. By replacing the simple code: „over-under“, „over-under“,...by a more sophisticated code (a repetitive algorithm), we obtain more complex and visually more interesting interlacing patterns [3].

Notice that ornaments from Vinca (Fig. 5b) are all based on meanders, continuing the tradition of Paleolithic ornaments from Mezin and Scheila Cladovei.

By observing the numerous examples of Neolithic „black-white“ ornaments, with the black part („figure“) congruent to the white part („ground“), we conclude that all of them originated from basketry, matting, plaiting, weaving, or textiles and then were copied to the stronger media of stone, bone and ceramic.

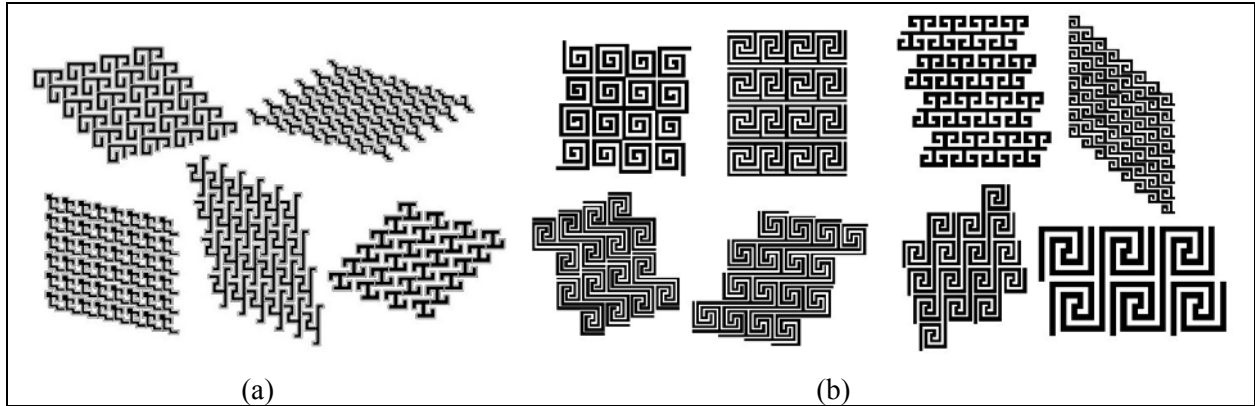


Figure 5: Neolithic ornaments from (a) Tisza culture (Hungary) and (b) Vincha (Serbia).



Figure 6: Neolithic ornaments on ceramics: Tisza (Hungary), Cucuteni (Romania), Vincha (Serbia), Dimini (Greece), Tisza and Miskolc (Hungary), Serra d'Alto (Italy), Rakhmani (Greece).

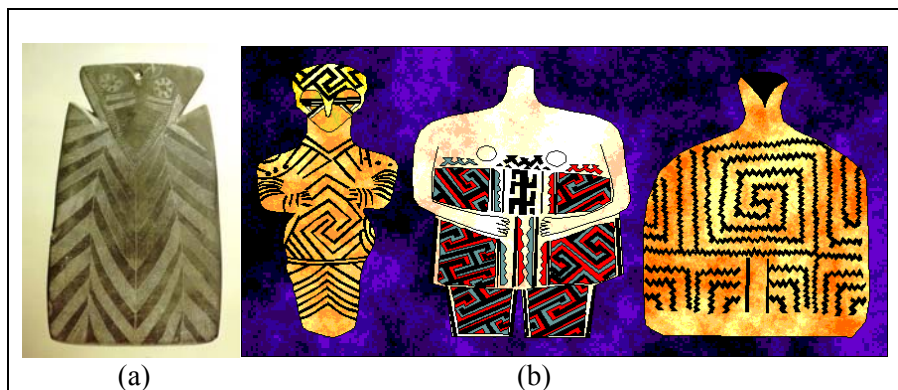


Figure 7: Neolithic plate from Portugal; (b) Neolithic figurines from Vincha (Serbia), Tisza region (Hungary), and Vadastra (Romania).

In this sense, it is very convincing to observe that the left image in Fig. 7a shows a well dressed Neolithic man wearing a dress with stripes which is similar to the module used for the construction of the ornaments from Mezín. In Fig. 7b there are Neolithic figurines, the first from Vincha, the second from the Tisza region (Hungary), and the third from Vadastra (Romania),

where on parts of their clothes appear very similar types of meander ornamentation transferred from one culture to the other. This is also a testament to the notion that textile ornamentation was used as a model for similar ornamentation on ceramic.

The best textile patterns were copied to ceramic vessels which requires great skill since the surface of the ceramic vessels are curved. We can find similar examples all over the world (e.g., in Neolithic Lapita ceramics from Fiji (Fig. 8a), or Anasazi ceramics, (Fig. 8b).

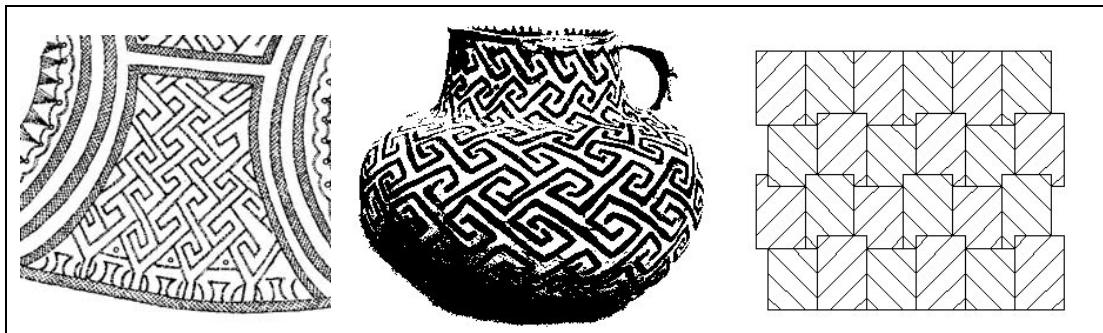


Figure 8: (a) *Lapita ceramics (Fiji); Anasazi ceramics.*

Kufic tiles

If in a black and in a white square we construct one diagonal region of opposite color, we obtain two modular elements called Kufic tiles. From these modular elements, named by S. Jablan „Kufic tiles“, you can create square Kufic letters and Kufic scripts: the writing of letters, names, or texts, where all black and white lines are of the same width. The Kufic tile is the simplest Op-tile: a white square with one black diagonal strip, or its negative. The following example shows the name of Allah (Alli) written in ornamental Kufic script (Barda, Azerbaijan, XIV century). By using Kufic tiles, we can (re)construct ornaments from the Alhambra (e.g., the famous “Maple leaf” pattern in Fig. 10a), or make a Kufic script logo for “Bridges” (Fig. 10c, design by Lj. Radovic and S. Jablan).

Kufic tiles can be also used for simple constructions of Islamic ornaments and Moorish patterns from the Alhambra (Granada, Spain) [4]. In this case overlapping of tiles is permitted as you can see from the „Maple leaf“ tiling constructed using the complete set of Kufic modules (Fig. 10).

Professor Donald Knuth, a master of computer art and the author of the program *TeX*, designed new TeX-fonts from our Kufic tiles (<http://www-cs-faculty.stanford.edu/~knuth/graphics.html>).

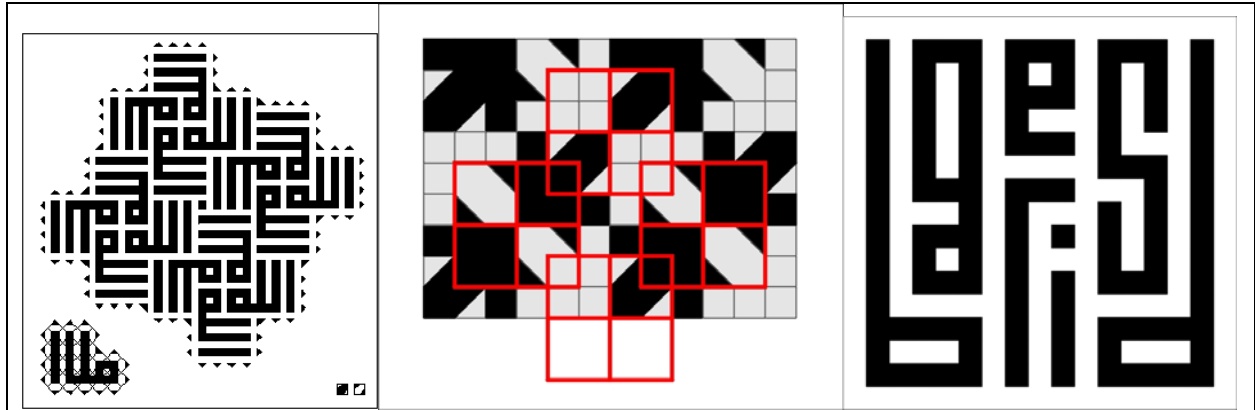


Figure 10: (a) Ornamental Kufic script (Barda, Azerbaijan, XIV century); (b) reconstruction of the “Maple leaf” ornament from Alhambra; (c) “Bridges” in Kufic script.

Labyrinths

The word „labyrinth“ is derived from the Latin word *labris*, meaning a two-sided axe, the motif related to the Minos palace in Knossos. The walls of the palace were decorated by these ornaments while the interior of the palace features bronze double axes. This is the origin of the name „labyrinth“ and the famous legend about Theseus, Ariadne, and the Minotaur. The Cretan labyrinth is shown on the silver coin from Knossos (400 B.C.) (Fig. 11a).

How does one construct a unicursal maze? Figure 11 shows the most elegant way: draw a black meander (Fig. 11b), remove several rectangles or squares, rotate each of them around its center by the 90° angle, and place it back to obtain a labyrinth (Fig. 11c). Even very complex mazes can be constructed in this way (Fig. 12).

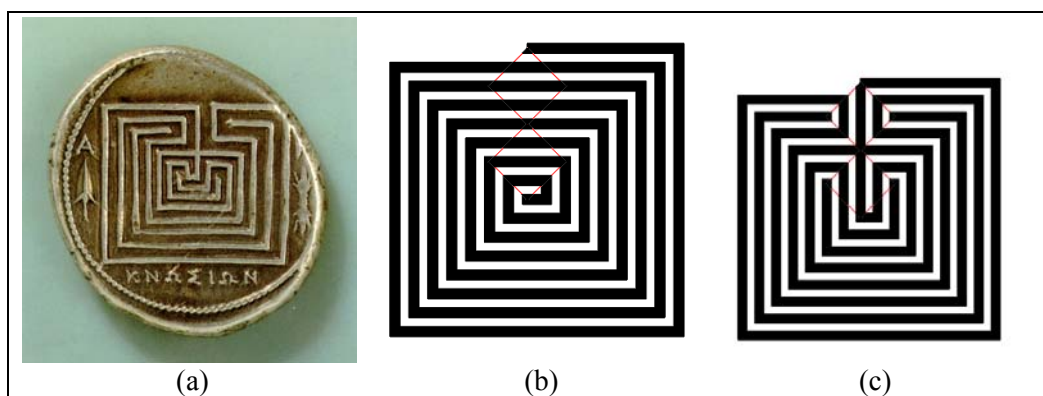


Figure 11: (a) Silver coin from Knossos with the image of labyrinth; (b) meander which can be composed from *Op*-tiles; (c) its transformation to maze.

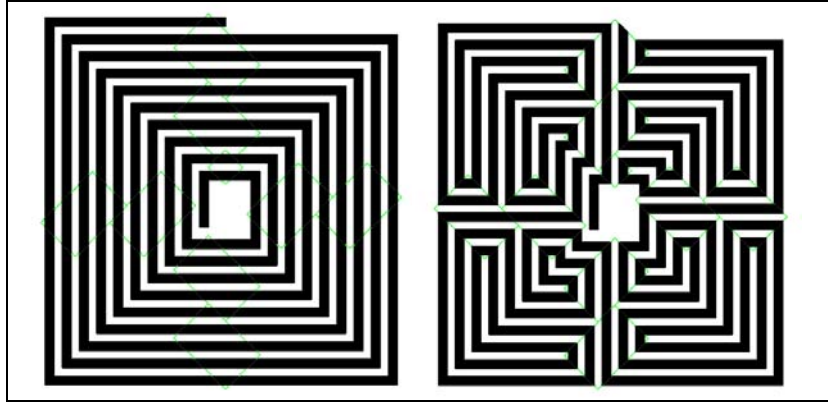


Figure 12: *Construction of a more complicated maze.*

Op-art

Op-tiles, which first appeared in Mezin (Ukraine, 23 000 B.C.), are named after Op-art (optical art) from the end of twentieth century where they are abundantly used. Representative examples are „Square of Three“ by R. Neal (1964) (Fig. 13), „Hyena stomp“ (1962) by F. Stella (Fig. 14a), with colored Op-tiles producing a meander, and a variation on the theme of Op-tiles by V. Vasarely (Fig. 14b) [5,6].

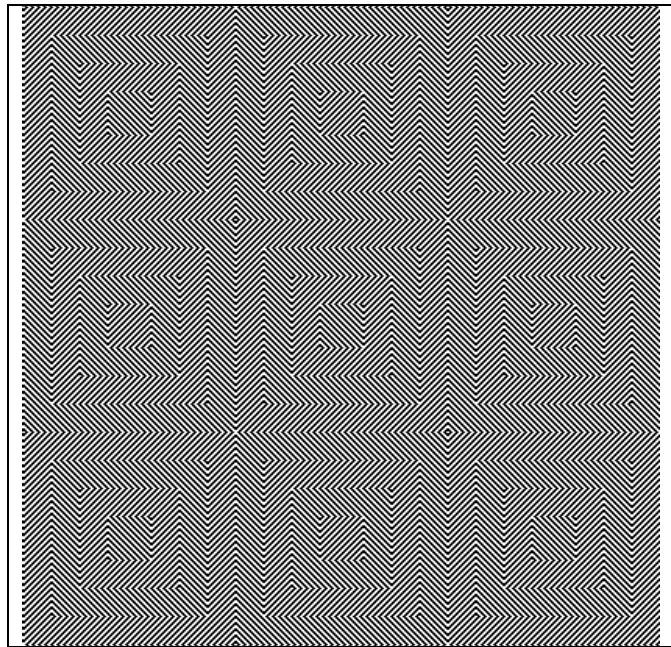


Figure 13: *„Square of Three“ by R. Neal (1964).*



Figure 14: (a) „Hyena stomp“ (1962) by F. Stella; (b) variation on the theme of Op-tiles by V. Vasarely.

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