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GOLD GEOMETRIC ELEMENTS AND THEM COMPOSITE ARTISTIC GRAPHIC COMPOSITIONS

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Annotation

The scientific article highlights the material associated with geometric figures called “golden elements” and artistic compositions like pentagons, pentagons, decagons, Penrose mosaics created with the participation of such elements.

Keywords: golden dot, golden ratio, golden triangle, golden gnomon, Robinson triangle, golden rectangle, golden rhombus, Penrose tiling.

Аннотация

Илмий мақолада “тилло элементлар” деб номланувчи ўнлаб хил геометрик шакллар ва улар иштирокида ҳосил қилинадиган, пентакл, пентагон, декагон, Пенроуз мозаикаси каби ўнлаб хил бадиий график композициялар ҳақида сўз юритилган.

Калит сўзлар: тилло нуқта, тилло тўғрам, тилло учбурчак, тилло гномон, Робинсон учбурчаги, тилло тўғри тўртбурчак, тилло ромб, Пенроуз мозаикаси.

Аннотация

В научной статье освещен материал, связанный с геометри-ческими фигурами, называемыми “золотыми элементами” и художествен-ными композициями на подобие пентаклов, пентагонов, декагонов, мозаик Пенроуза, создаваемыми с участием таких элементов.

Ключевые слова: золотая точка, золотое сечение, золотой треугольник, золотой гномон, треугольник Робинсона, золотой прямоугольник, золотой ромб, мозаика Пенроуза.

Gold point. This is such a point D that it divides the section AB lying on a straight line in the ratio of 62 : 38 (Fig. 1).

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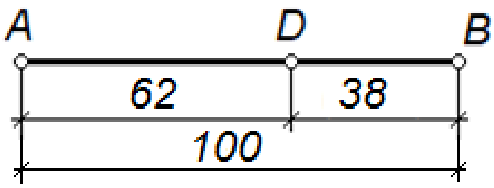
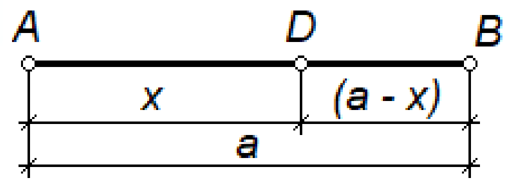


1-figure.



2-figure.

The Golden Ratio ("Golden grain"). The ratio of two numbers in the form of 62 : 38. This phrase is used in the form of "The Golden Ratio" in English, "Aurea Ratio" in Latin, and "Zolotoe sechenie" in Russian. Its origin is based on the idea of "dividing the cross-section in the edge and middle ratio" first put forward by Pythagoras (6th century BC). In this case, the cross-section is divided into two parts such that the ratio of the length of the cross-section a to the long part x is equal to the ratio of the long part x to the short part (a – x) (Fig. 2). It is possible to express this statement in the form of a : x = x : (a – x) proportion (mutual equality of two fractions), create an equation in the form of x2 + ax – a2 = 0 based on it, and use the expression to determine the positive value of the number x. According to this expression, the division of the section AV into the edge and middle ratio produces the ratio AB : AD = AD : DB. If |AD| = x; |AB| = 1, we get the exact arithmetic value as ... DB = 1 – x = 0.382.... Let's say, if the section has 100% length, then its edge and middle ratio is divided into the long part (62%, the short part is 38%. This 62 : 38 ratio is the "golden slice" ("golden grain") in the section.) is called.

Conditionalities in defining the elements of the golden ratio. In the scientific literature, the quantity a in Figure 2 is denoted by the Greek letter F (phi) and its 1.618..., AD in this drawing is 1 of the quantity, |DB| it is emphasized that the magnitude is equal to F – 1 = 0.618.... The last quantity is also found in the form 1/F = (= (– 1)/2 = 0.618.

Different names of "Golden piece". Euclid (365 - 355 BC) called the "golden ratio" as "the correspondence of the edge and the middle" [5], Abu Ali ibn Sina (980 - 1037) called it "harmonic proportion" [1], Luca Pacoli (1445 - 1517) as "divine proportion", [5] Johann Keppler (1571 - 1630) called it "one of the two treasures of geometry". It is said that Leonardo da Vinci (1452 - 1519) introduced the phrase "golden plate" into scientific circulation. In books, this phrase is also found in views such as "Golden proportion" [Vasyutin], "Non-symmetrical symmetry" [6].

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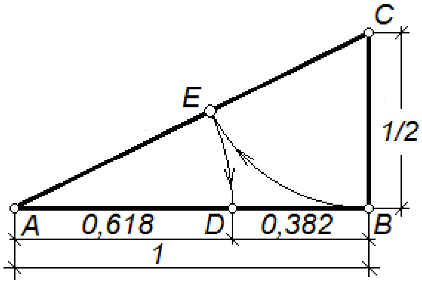
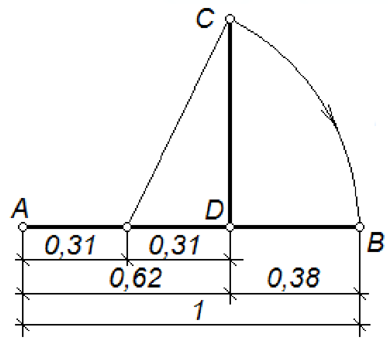
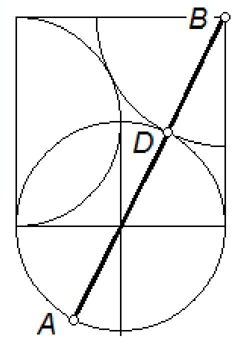


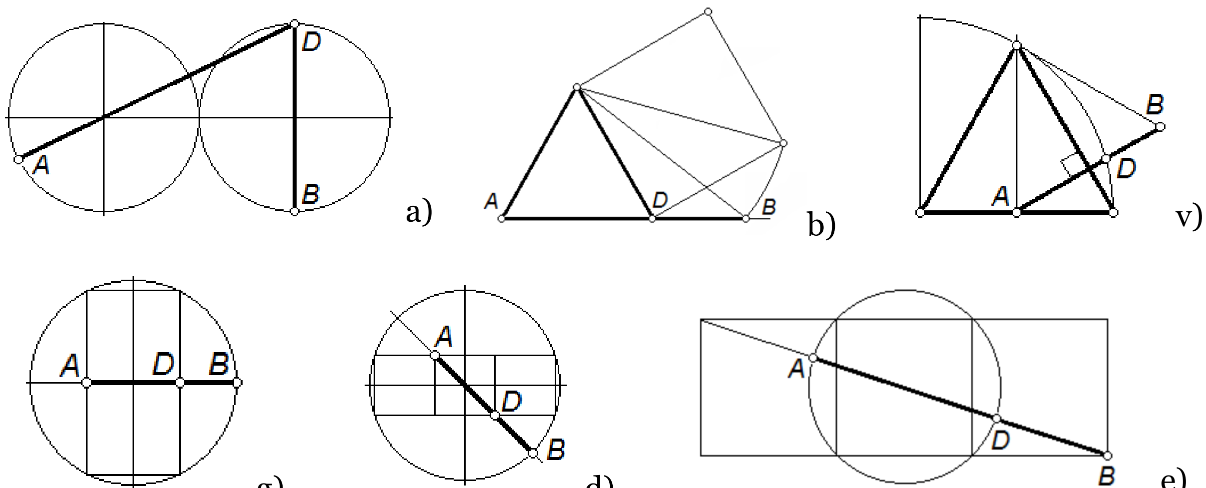
3-figure.



4-figure.



5-figure.



6-figure.

Creating a gold log by making geometrical cross-sections. Figure 3 shows the procedures for creating a gold log by internal geometric cutting of section AB and Figure 4 by external geometric cutting of section AD. Along with this, if you look at the scientific literature devoted to the research of gold leaf, you can witness that there are hundreds of ways of creating gold leaf by geometrical construction. Figure 5 and Figures a-e in Figure 6 show some examples of evidence supporting this idea.

Golden triangle. This is an equilateral triangle whose side a and base b form a rhombus. The angle between the sides is 36°, and the angles attached to the base are 72° (Fig. 7, (BCD).

Gold gnomon (Gold scale). It is an equilateral triangle such that one of its mutually equal sides forms a ratio of 1/F to the base. The angle between the sides is 108°, the angles adjacent to the base are 36° (Fig. 7,∆ACD).

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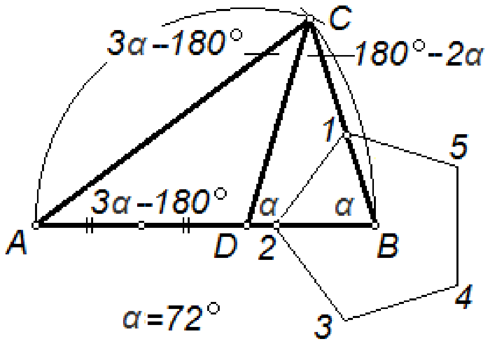
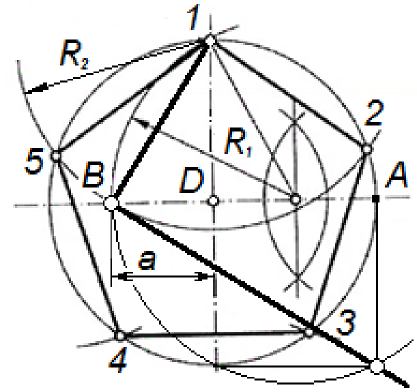


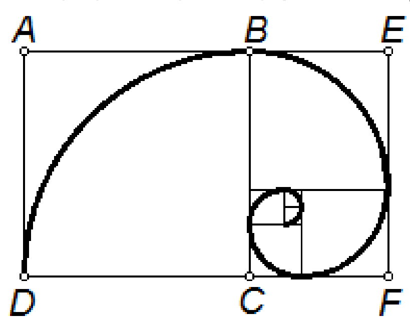
7-figure.



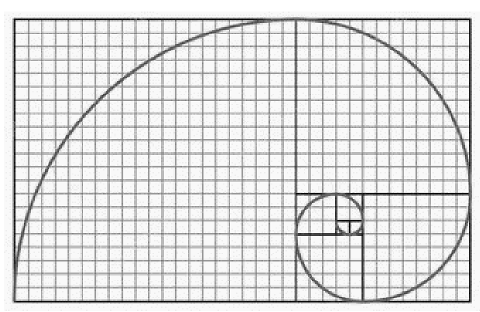
8-figure.

Robinson's triangle. These are two adjacent triangles with one common side, one of these triangles serves as a **golden triangle,** and the other triangle serves as a **golden gnomon** (Fig. 7, (ABC). Based on the properties that work in the process of constructing the Robinson triangle, dividing the Euclidean circle by equal 5 (7 -figure) found a way [5]. Ptolemy (II century) used the properties of the geometry of the golden circle from Robinson's triangle to solve the problem of dividing the circle by 5 (figure 8). Based on some properties of this triangle, Abu Ali ibn Sina divided the circle into 10 Albrecht Dürer (1471 – 1528) proved that the distance a in Ptolemy's drawing is equal to one side of a regular 10 angle inscribed in a circle [3]. In the literature on the Golden Triangle, it is written about the formation of a logarithmic spiral by means of a decreasing or increasing series of Robinson's triangle. is also mentioned.

Gold rectangle. A rectangle with side 1 and side 0.618... Archimedes (287 - 212 BC) found that if a square with sides equal to 0.618 is removed from a golden rectangle, another golden rectangle is removed from the remaining part of the rectangle, and a new golden rectangle is formed (Figure 9). Albrecht Dürer showed that if a quarter circle is drawn on each of these squares, their sequence forms a kind of spiral (Fig. 10). If a cell appears on the background of this spiral based on certain sizes, it was determined that the number of cells on the sides of the quarter circle squares gives Leonardo Fibonacci numbers (0, 1, 1, 2, 3, 5, 8, 13, 21, 34...) (10- picture).



9-figure.


10-figure.

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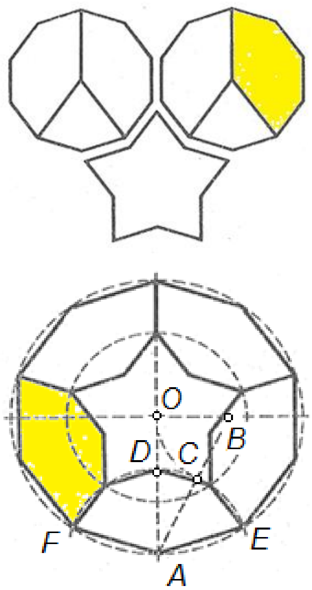
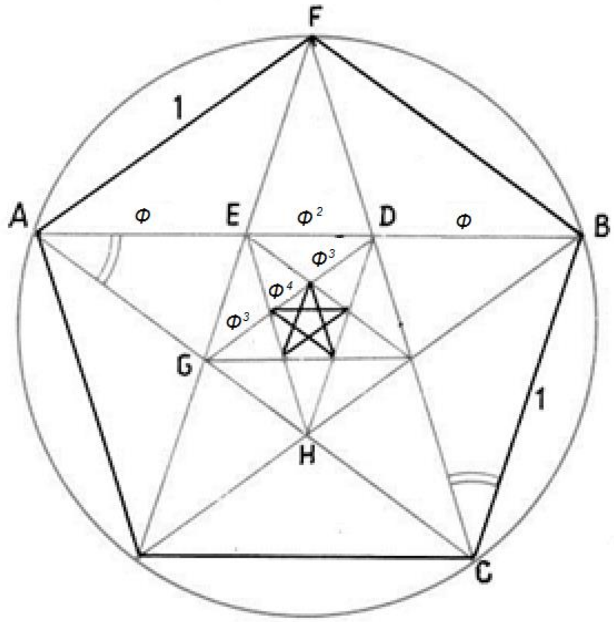
A regular decimal. In the treatise "Introduction to the Doctrine of Similar and Corresponding Forms" written by an unknown author who lived in Baghdad in the 11th century, there is an example of making one large regular decagon from two regular small decagons and a five-pointed star with an angle of 72° (Fig. 11).



а)

б)

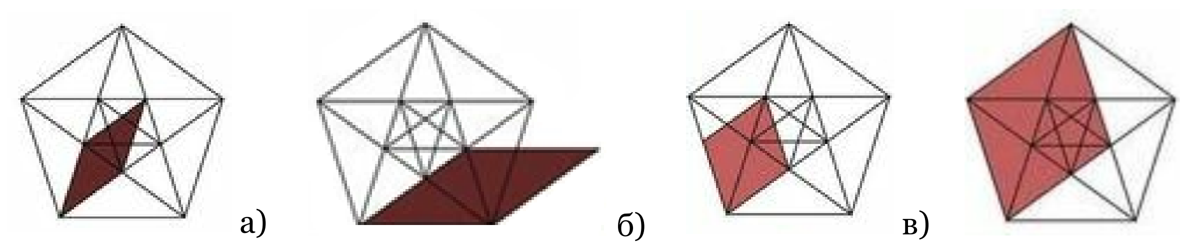
11-figure.



12-figure.

A regular five-pointed and five-pointed star. Italian mathematician Luca Pacoli (1445 - 1517) in his work called "Divine Proportion" determined the existence of many quantities related to the golden circle in the elements of regular pentagons, five-pointed stars and regular polyhedra (Fig. 12).

Gold rhombus. A rhombus formed by joining the centers of the sides of a golden rectangle. The ratio of its diagonals is equal to the ratio of the golden ratio. The obtuse angle of this rhombus is equal to the dihedral angle of the icosahedron (Fig. 14).



а) б) в) г)

13-figure.

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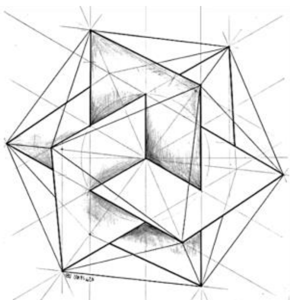
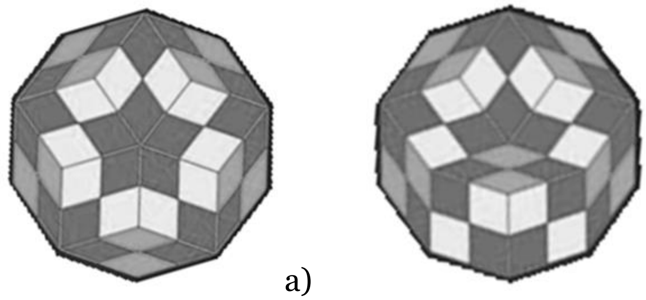
Diamonds consisting of pairs of golden triangles. Such rhombuses are formed by pairing two identical golden triangles at their bases (Fig. 13 a- and b- drawings). They are called narrow rhombuses.

Rhombuses consisting of a pair of gold gnomons. Such rhombuses are formed by pairing two identical gold gnomons at their bases (Fig. 13 v- and g- drawings). They are called wide rhombuses.



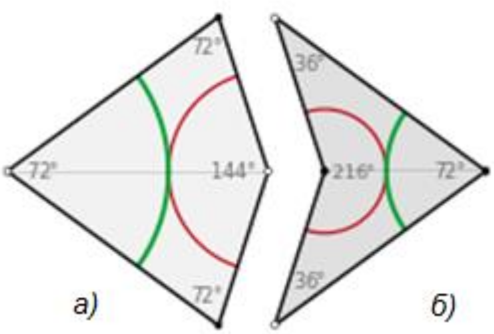
14-figure.



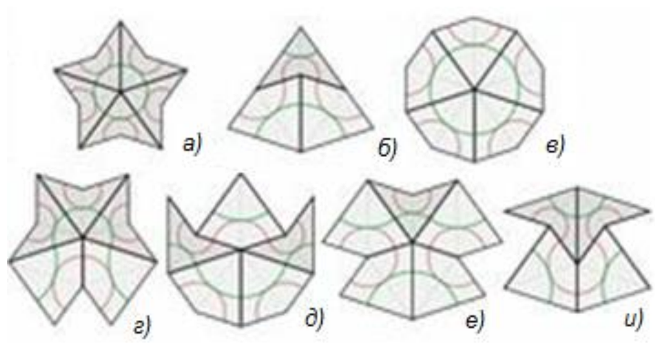
a) b)

15-figure.

At the beginning of our century, there was a period in the field of design, in which the creative exercise of creating compositions related to filling a regular decagon with 20 wide and 20 narrow rhombuses was widespread (Fig. 15).



16-figure.



17-figure.

Penrose clays, elements known as "spearhead" and "sheet". In the 1970s, the well-known British mathematician and physicist Roger Penrose (born in 1931) proposed ceramic (tile) samples that could be laid out on a flat surface in a non-standard (non-regular) order. One of them is called "spearhead" and it is formed by pairing the sides of two identical gold gnomons (Fig. 16 b- drawing). The second one is called "sheet", it is formed by pairing two identical gold triangles with their sides (Fig. 16 a- drawing). Penrose makes seven different (Fig. 17) large tiles from these two types of tiles, and by multiplying one or two of them and placing them side by side in a certain order on a flat surface, he

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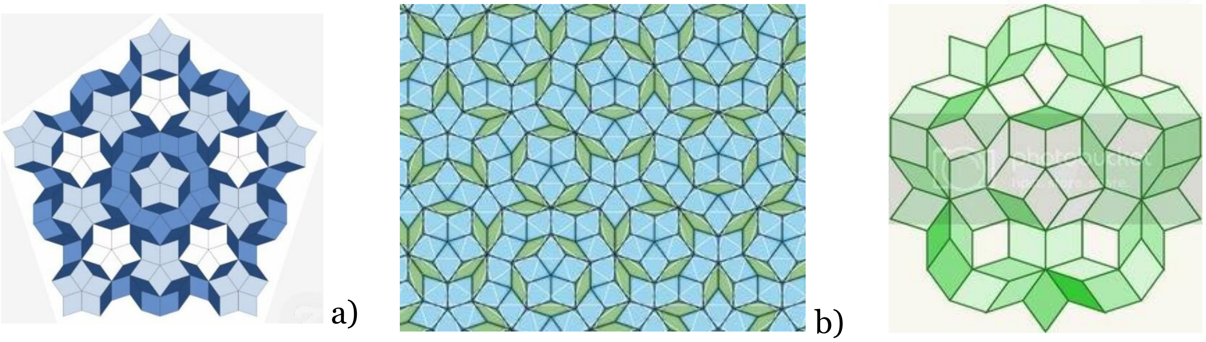
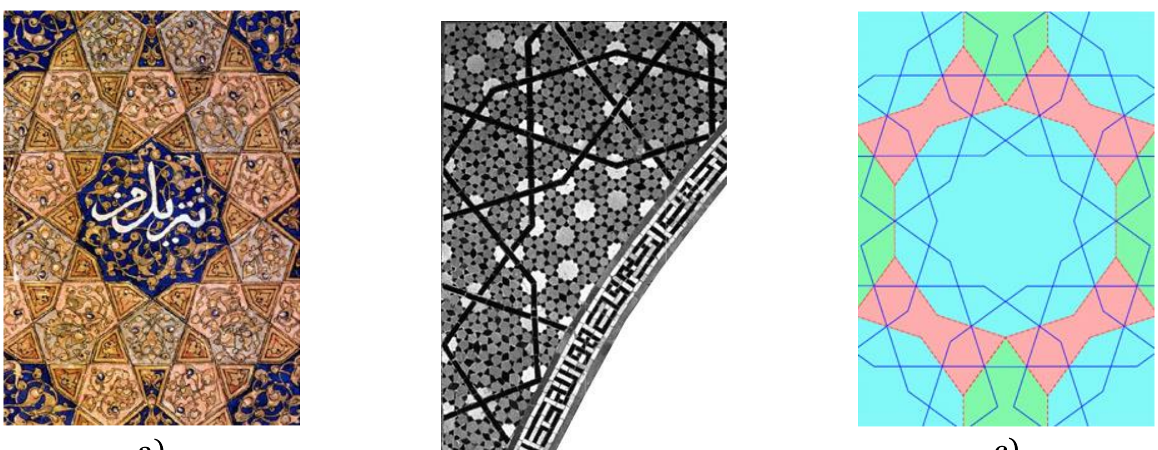
creates unique examples of patterns (Fig. 18). Such mosaic compositions bring even greater fame to Penrose, who already has great fame.



a) b) v)

18-figure.

Golden elements in the work of Central Asian architects. In 2007, the "Science" magazine published an article by American scientists Peter Lu and Paul Steinhardt [7] on medieval Islamic architecture. The article mentions that during their visit to Uzbekistan, compositions similar to the Penrose mosaic were widely used by painters and architects of the XIV-XV centuries there (Fig. 19).



a) b) c)

19-figure.

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