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Designing Harmonious Proportions

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Abstract. Analysis of work of art may be treated as some sort of classification of information: does the work is really artistic or not. This article is an attempt to introduce some classification criteria, though the author understands that the problem is extremely delicate and complicated. Attractiveness of work of art is determined by its proportions. The screen of a computer by itself is a mechanism for arranging proportions, however it is not able to resolve the problem of proportions completely. By starting with the horizontal (or vertical), which touches the main element of the picture, a grid can be constructed. Other elements of the picture become interlocked with the grid. In this paper, a method of construction of proportional grids, which can serve as an implement to creation of art or as criterion of coherence, artistic value and style of works of art, is proposed. Variety of proportional grids can be great, and we can create its from grids of coordinated geometrical forms.
Key words: proportions, proportional grid, structure of works of art, criterion of coherence and artistic value, coordinated geometrical forms.

1. The Problem of Proportions and its Short History

Why do we find one building majestic and beautiful, and another building of same size, built for the same purpose and from the same materials, does not stir our admiration. Attractiveness of a building is determined by its proportions, i.e., the ratio of building dimensions and its components dimensions. Among all the scarce means of architectural expression, proportion is the most important one. Proportions are no less important in other fine arts, however, they can be overshadowed by other specific means of expression: colour, play of light, rendering of movement, the plot, etc.

Any individual is able to feel proportions, and talented artists have a gift of constructing nice proportions intuitively. However, capricious intuition sometimes fails to satisfy creators. From ancient times, people have started thinking about balancing components consciously for the sake of harmony and coherence and in order to create a desired mood among spectators – such as respect, horror, humility to gods or the mighty of our Earth. Canons – systems of rules and norms of art – have been created for this purpose. Later, the canons have been transformed into the basis of certain artistic styles.

Researchers of ancient Egypt monuments discovered remains of square grids used for sculpture and mural painting. These grids did not serve for the enlargement of the sketches alone, but also played an important constructive role (Panofsky, 1993). The Egyptian formal logical system of proportions was reborn in the Middle Ages. Magic pentagrams, triangles, quadrangles and circles (that had no relation to anatomy) became the basis for rendering figures of human beings and animals. In the Gothic, a system of proportional lines, constructed as an ornamental drawing, became the basis, upon which, as a skeleton, the body of a building was created (Petrovich, 1979). The Ancient Greece and Rome had other means of finding harmonious ratios-proportions of a well-built man were applied to buildings; compasses of proportions were used (Shevelev, 1986). Since the Renaissance, proportional systems have been trying to imitate, though with some exceptions, the Ancient Greek approach. In New Age, Messel (1936), Hambidge (1920), Le Corbusier with his modular, Glikin (1979) and others have been constructing their proportional systems.

2. Notions and Designations

Grid – a combination of geometrical forms, upon which a sketch of the work of art is drawn.

Structural grid – a grid that has lines coinciding with or touching structural lines of the drawing.

Relative ruler – a ruler consisting, for example, of 10 large equal parts and 100 small equal parts. The length of the ruler equals to the width of the picture, and is used for measuring the distances between details and borders of the picture. The height of details are measured with the same ruler rotated by 90 degrees and stretched (or compressed) from one border of the picture to the other.

Coordinated grids – grids meeting at least one of these requirements:

1. they have common lines;
2. at least 4 lines of one grid are touching circles, ellipses or arches of another grid;
3. there are points where at least one line of one grid intersects with at least 2 lines of another grid.

3. Proportional Grids and Computers

Probably, many of us have noticed that a relatively poor picture becomes much nicer by scanning it into a computer. The screen of a computer by itself is a mechanism that arranges proportions – it consists of a certain number of pixels, evenly arranged in rows and columns. Accidental blots are measured in integer pixels, therefore they become put in order. Being put in order is a condition of harmony. Therefore, the computer itself becomes a creator of harmony.

The screen can be compared with some fabric made of smallest threads of equal thickness. However, that has nothing to do with the construction of a work of art. Information in the pictures tends to concentrate in certain areas, whereas the larger part of the surface remains passive. Also (as you will see from the further analysis) compositional bonds of a work of art are so complex and intricate that the square grid of a computer screen is not able to solve the problem. That is why, it is important to construct proportional grids.

4. Analysis of Work of Art by Means of Rectangular Grids

A work of art differs from an accidental photograph or any other chaotic medley, first of all, incoherence of its forms, i.e., by the presence of mathematical proportional relations in its shapes. In other words, after ascertaining the distance between a detail and one of the sides of a picture, and after having constructed a grid (as described below), all other elements of the picture become interlocked with the grid.

There are cases when grids of equal rectangles are structural – these grids have many lines that touch structural lines of the drawing. For example, in Leonardo da Vinci's picture *St. Jerome*, you find that rectangules grids, made by dividing sides into 23, 24, 25, and 32 equal parts, are structural all together.

But not in all cases, the structure of a picture is so nicely determined by the grids of integer equal parts. Often distances among the borders of a picture and the main details are measured in hundredths or thousandths. In such cases, one would need grids with huge numbers of equal rectangles, and the grids would loose their sense. The solution is creation of grids with a few lines, as described above. The principles of constructing a proportional grid (Fig. 1) are as follows:

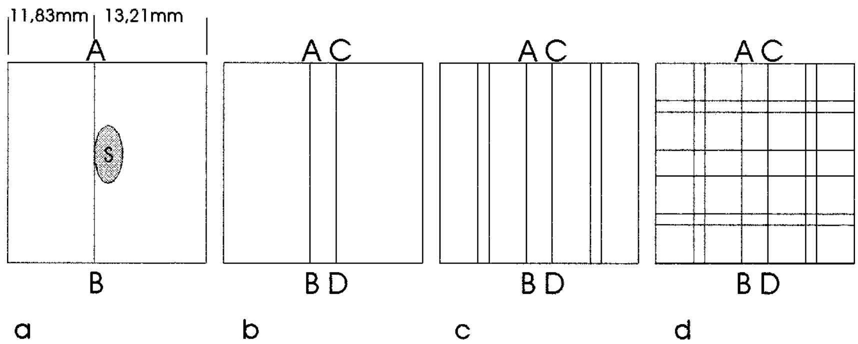

Fig. 1. The way of creation of grid.

1. A vertical (or horizontal) AB, which is touching an important structural detail of the picture S, is drawn. In this concrete case, width of the sketch is 25,04mm, and the vertical, which is touching the detail, divides the rectangle of the skech into two rectangles with the widths of 11.83mm and 13.21mm (Fig. 1a).
2. An analogous vertical is drawn symmetrically on the other side (Fig. 1b).
3. Analogicaly, the rectangles in the sides are divided in the same ratio (Fig. 1c).
4. Horizontal grid is a rotated vertical grid (Fig. 1d).

In the work of art, the same law applies for the whole and for its parts. If a structural line AB from one side is at certain distance, the lines from all others sides are at the same

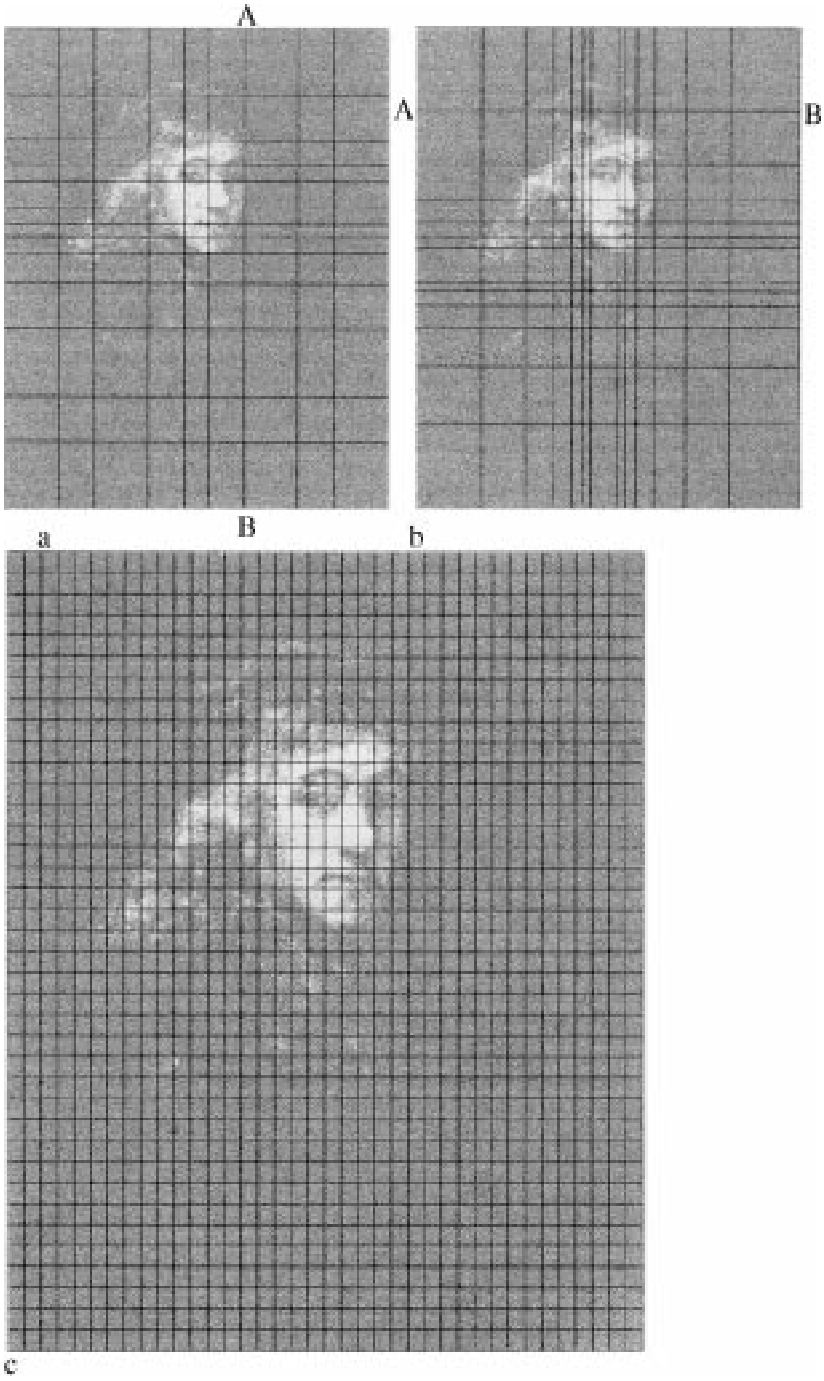

Fig. 2. Rembrandt's portrait of Titus in grids: 2a, 2b – created from lines AB; 2c – grid of equal rectangles with 38 parts in the side.

distance (or at the same relative part) and they are structural too. Further divisions of a grid meet the law of the existence of the whole in its parts. Thus, in the respect of a work of art, the grid (Fig. 1d) is structural.

After having reviewed 20 masterpieces of painting (Leonardo's *The Virgin and Child and Saint Anne, St. Jerome, The Virgin of the Rocks, The Last Supper;* Caravaggio's *Narcissus, Bachus*; Rembrandt's three self-portraits, portrait of Titus and others), by using the grids constructed in the way described above, it has been discovered that these grids are structural. For example, in Fig. 2a you can see Rembrandt's *Portrait of Titus* with a grid created starting from the line AB which is touching the cheek from the right side. New lines are touching the boy's chin, lips, nose from the left and below, eyes, forehead, hair and the spots of light on the clothes. All the lines of the grid, which are in the empty places and do not touch any details, are not eliminated because you can clearly understand the construction of the grid. Another grid can be created for *Titus* by starting with the line AB again, and coinciding it with the line of decoration of the cap (Fig. 2b). This grid has many coincidences with the lines of the drawing as well. Let us imagine, that the starting line AB does not touch the structural element of the picture but it is very close to this element. Then the lines of the grid will become close to the other elements too, however they will not coincide with them. It means that this grid does not meet the requirements of the structural grid.

It is important to notice that a few grids can be structural in one picture. Leonardo's *The Virgin of the Rocks* can be almost be fully squeezed into the grids at points 0.3365 (the part of height from the picture's bottom to the top of the child's elbow and the part of width from the picture's left side to the vertical line of the rock near Virgin's head), 0.41 (the part of width from the picture's left side to Virgin's forehead), 0.624 (the part of height from the picture's bottom to the top of Virgin's forehead), and 0.722 (the part of width from the picture's left side to the left side of angel's face)(Fig. 3). Such measurements are carried out with the relative ruler. As the experiments revealed, these grids, stretched to squares with a side equal to the height and width of the picture, are structural, too.

How come that one grid is not be completely structural? It is because that a work of the art is very complex and there are things in the arts, which we can described as endless. If a picture is inline with only one grid, it is a very limited work.

It is not right that one accidental grid with many lines must coincide itself with the lines of the picture better than the grids with a few lines. As you see quite clearly, in Fig. 2a there are 8 verticals and 12 horizontals and in Fig. 2c there are 38 verticals and 38 horizontals, however they do not touch the main lines of the face of Titus, whereas in the first two cases, many structural details of the picture are touched by the grids. It is the proof of superiority of grids created in the way shown in Fig. 1.

That is how it works with the works of art. They have no accidental components – every detail, line, or dot can be located where it belongs. Objects, such as a tree in its full height, are similar cases. With every year, a tree grows a little bit, it branches expands around its stem in a certain way up and down under certain angles. Therefore, any tree is a perfect mathematical object. The same applies to the live nature. However

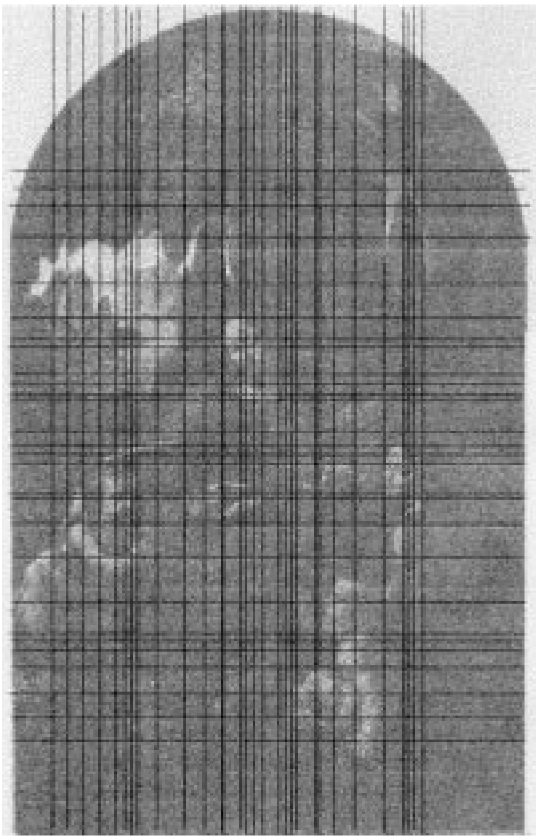

Fig. 3. Leonardo's *The Virgin of the Rocks* in the grid.

in a landscape, trees, moving animals and people, even the stones, soil, and buildings, form random configurations, which cannot be bound together by regular grid of lines. That does not require a proof of visual examples, because if we suppose that certain object lines coincide with the gridlines, the location of the object (for example, of a stone) itself is not pre-determined. So is its shape. In some cases, it fits into the grid, but if changed without affecting the essence of the whole picture, it would not fit into the grid anymore. In Fig. 4, you see a grid analysis of a random photograph. Its motive is a littered corner that nobody and nothing never tried to compose or aestheticize, except for the computer (digitalisation). The only law prevailing among these things is the law of Earth gravitation. One could think that the line AB that passes the lower part of the cat's belly and tail, and dividing the height of the photograph into parts 0.44 and 0.56 (according to which a grid is constructed), is related neither to other parts of the cat nor to the second cat nor to the doors or the wall. Among small rubbish, you can find one or another coincidence, however it does not change the heart of the matter. On the contrary, should there were no occasional coincidences, one would think that the total *non-coincidence* is regular, and thus it would reveal an existence of certain order. One could say that is *an exception that proves the rule*.

The majority of pictures are somewhere in between masterpieces and “rubbish”. Thus proportion grids can serve as a criterion of coherence, artistic value, and style of works of art.

5. Qualities of Grids of Equal Rectangles

If the lines of a grid of equal rectangles are touching the objects of the picture, the grid extended by one rectangle in all sides shall touch the objects of the picture too. For example, if a grid has 3 cells wide and 3 cells high, the extended one has 5 each, and still further extended – 7, etc. If a grid has 2 cells wide and 2 cells high, the extended one has 4, 6, 8, etc. Therefore, all grids of equal parts belong to two groups: even, growing from 0, and odd, growing from 1. Even grids have their top, bottom, their left and right (Fig. 5a). Odd grids, in addition, have middle parts between the top and the bottom, and between their left and right (Fig. 5b) If we make many abstract drawings in the even and odd grids, we can notice a difference in their mood – the even ones express sadness and seriousness, the odd ones – joy. Maybe similarly, also intuitively, people in Lithuania bring an even number of flowers (2, 4 or 6) to a funeral, and an odd number of flowers – to a wedding or birthday? However, it is more complex with grids: often one grid comprises several more simple grids. For example, inside a grid made by dividing sides into 36 equal parts there are grids made by dividing sides into 2, 3, 4, 6, 9, 12 and 18 equal parts. The qualities of these grids are also interconnected. Thus, along with the attempt to classify grids, we have to acknowledge that every grid has an individual face.

6. Grids of Other Geometrical Forms

The experiments show that other geometrical forms available in Corel DRAW can be structural too. Ellipses and circles can connect parts of the picture. In Fig. 6 there are ellipsis (Fig. 6a, b) and circles (Fig. 6c, d)(drawn inside the picture borders) put according to the height (Fig. 6a, c) and to the width (Fig. 6b, d) of the picture of P. Cézanne. You can obviously see that they connect details in same way that in the rectangular grids. As a sample, we took a picture of P. Cézanne, who is one of the most rational painters of all times. But it does not mean that our conslusions will not be applicable for intuitive artists such as Rembrandt or van Gogh.

Stars with 7, 8, 9, 10 and 11 corners and polygons with 7 and 8 corners have many lines coinciding or touching constructional lines of Caravaggio’s *Narcissus,* and they all together can to be called structural (Fig. 7). But the regular stars do not touch all the main objects of the picture. For example, the good visible incline sleeve of Narcissus near of the cull in right is not touched by any of the stars. We must construct a new star which beam coincide with the sleeve line. In the picture (Fig. 8), the beams touching more visible details were drawn from the intersection of a line crossing the centre and touching a hanging-down skein with an ellipsis drawn inside the picture borders. Such a “torch” was

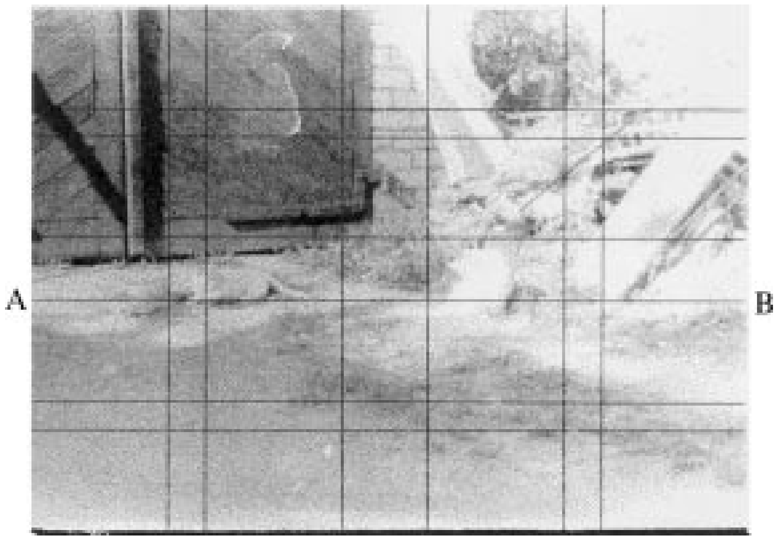

Fig. 4. Photograph with the grid.

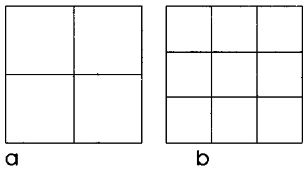

Fig. 5. Even und uneven grids.

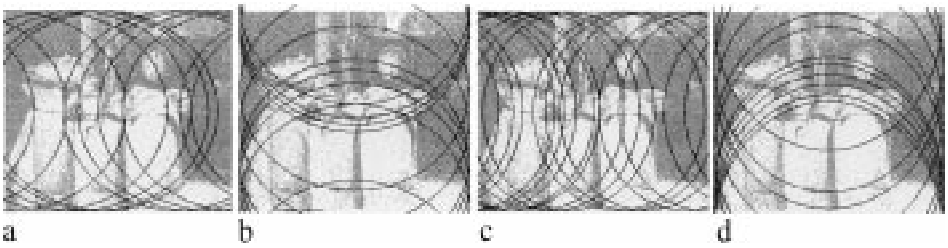

Fig. 6. Cézanne's *Still Life with the Clock* under elipses and circles.

symmetrically duplicated in the right and at the bottom and from the middle points of the bottom and top sides of the picture. The line mentioned above is touching one of the beams. The beams of the "torch" are touching the lines of the drawing, and are structural in all six positions. Thus we constructed a peculiar unregular structural star consisting of six "torches".

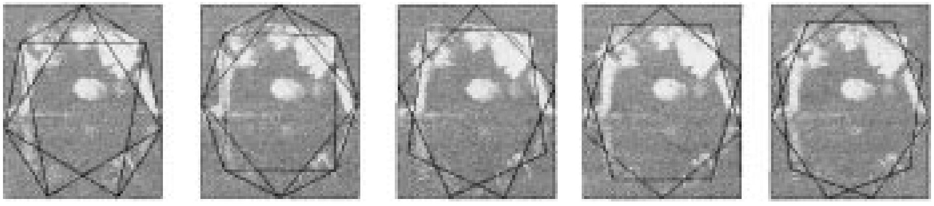

Fig. 7. The stars and polygons over *Narcissus* of Caravaggio.

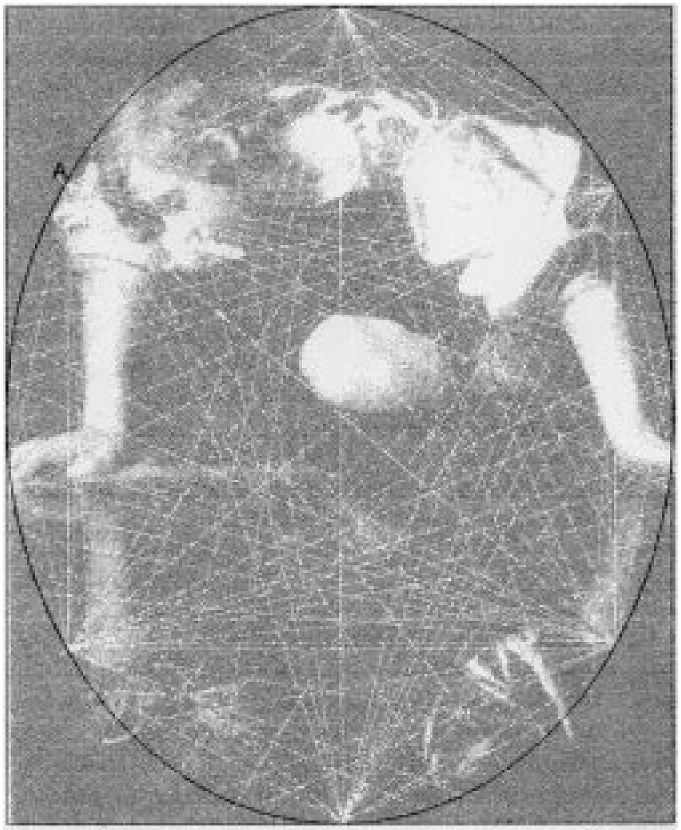

Fig. 8. Constructed star for Caravaggio's *Narcissus*.

The experiments schowed that logarithmic spirals determine certain aspects of composition, too. Logarithmic spirals with number of revolutions 3, 6 and 7 are touching *Rembrandt's Mother, Reading* main details (Fig. 7). A rose (Fig. 8) constructed from eight logarithmic spirals, rotated 90 degrees and brought into one centre. Four of these spirals are constructed within a square with its sides equal to the height of the picture. The other four spirals are constructed within a square with its sides equal to the width of the picture. This rose putting on the *Rembrandt's Mother, Reading* compositional centre (head) like

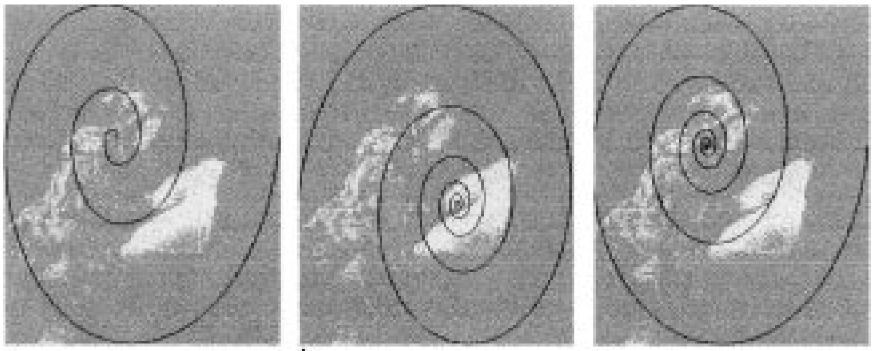
a b c

Fig. 9. *Rembrandt's Mother, Reading* with logarithmic spirals.

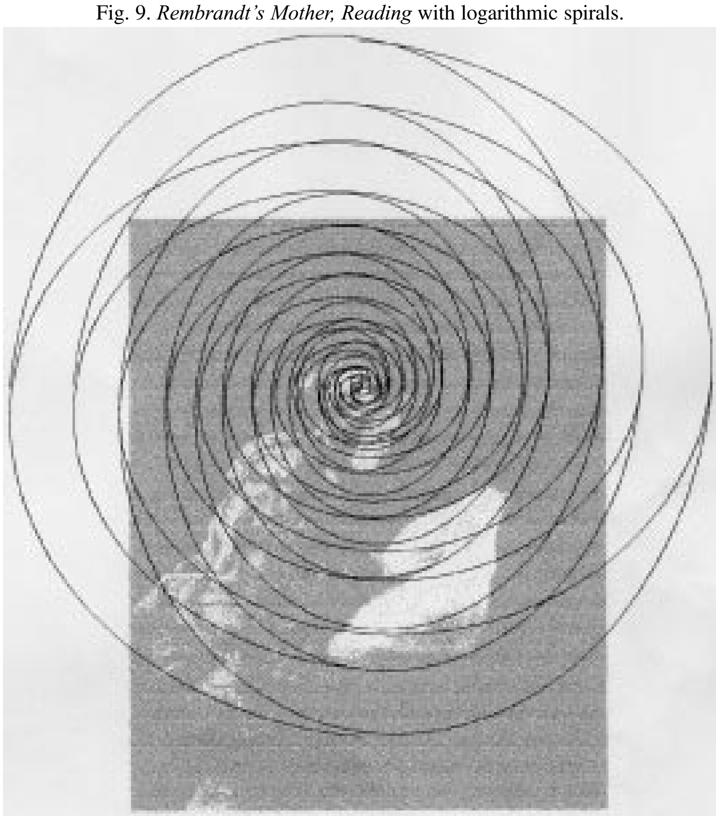

Fig. 10. *Rembrandt's Mother, Reading* with a rose.

a stone thrown into the water that makes ribles on the surface, perianths of a rose are touching the painted things that are echoing the centre. This same effect shall be, if we will move the rose to another compositionally significant place, such as mother's hand.

The experiments show that such grids connect even smallest brush strokes alongside with the big details too.

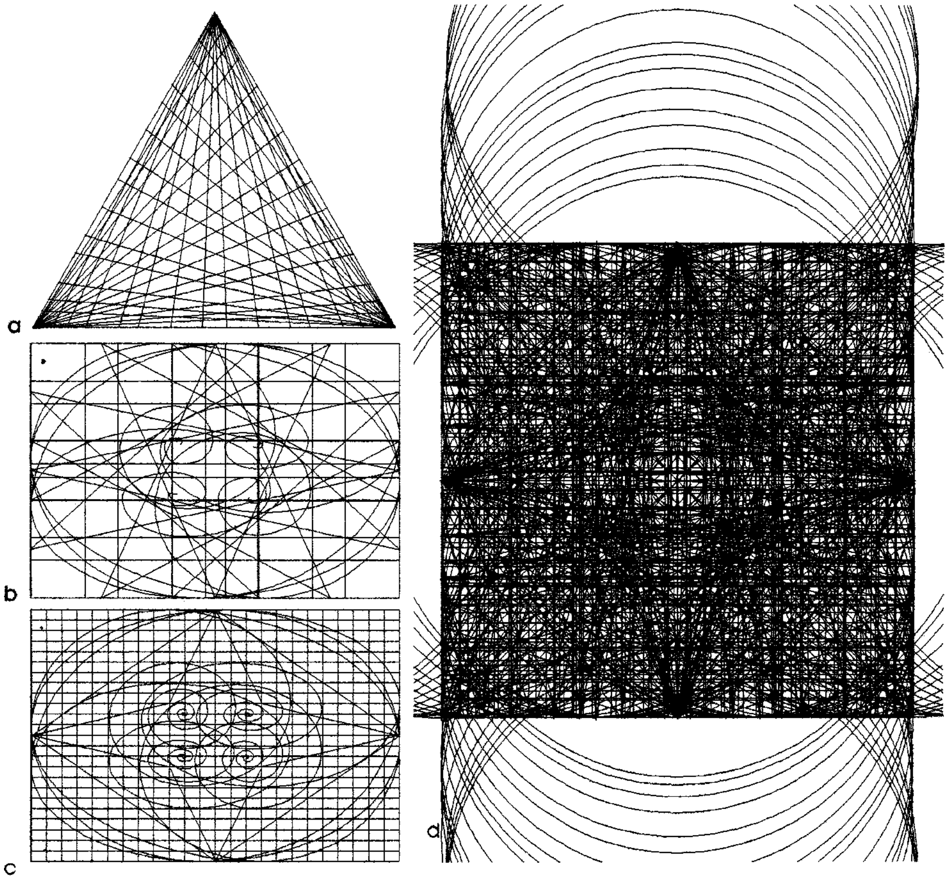

Fig. 11. Proportional grids.

7. Using Grids in Art

After having reviewing masterpieces of painting, we discovered that structural grids emerge according to various mutual relations of parts. We also discovered that the golden section, the favourite form of the ancient times, in fact is not prevailing. Therefore, we can state that the important factor is not the specific ratio (upon which the grid is based), but compatibility of several grids. This would probably explain why has the ratio *0.444, but not 0.447* (Shevelev, 1986) been systematically used in the proportions of Parthenon.

One of the ways of coordinating grids is to check all combinations from 2 to 50 Graph Paper, Polygon, Star, Logarithmic Spiral in pairs, to build a table of mutually compatible geometric forms, and by laying the forms one on the another to get complex proportional grids. For example, such grid can be created from grid of rectangles with golden section ratio, four logarithmic spirals with number of revolutions 3 rotated 90 degrees and four pentagrams, rotated too (Fig. 11b). In Fig. 11c grid created from 24 equal rectangles grid, four logarithmic spirals with number of revolutions 6 rotated 90 degrees and four polygons as star with four corners rotated 90 degrees. They look good. Another way is just to construct proportional grids. Variety of proportional grids can be great. In Fig. 11a, you can see a proportional triangle of golden section used for creating objects not restricted by a frame. This triangle is formed from the same three triangles rotated 120 degrees. The principle of division of sides is as in Fig. 1. A more complex grid shown in Fig. 11d, in which there is a grid of rectangles with golden section ratio, circles connecting stright lines of this rectangular grid, rectangular grids, made by dividing sides into 6, 7, 8, 9, 12, 25 equal parts, 3 and 4 corner polygons as stars and 5, 6, 7, 8 corner stars rotated 90 degrees, and triangles as in Fig 11a.

In such grids, an artist can draw his sketches like the ancient Egyptians used to in their square grids.

It is not easy to work with grid by means of a computer, however proportional grid is a step towards perfection.

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Harmoningų proporcijų sudarymas

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Meno kūrinio patrauklumą lemia jo proporcijos. Kompiuterio ekranas pats savaime yra proporcijų sutvarkymo mechanizmas, tačiau pilnai proporcijų problemos neišsprendžia. Pradedant nuo vienos horizontalės (vertikalės), liečiančios pagrindinę paveikslo detalę, galima sukonstruoti tinklą, kurio linijos sukabins jį su kitomis paveikslo detalėmis. Toks tinklas yra struktūrinis. Jis gali būti rišlumo, meniškumo, stilingumo kriterijumi, gali pasitarnauti, kuriant dailės kūrinių eskizus. Kitos geometrinės formos gali būti struktūrinėmis taip pat. Dailėje ne tiek svarbus konkretus santykis, pagal kurį braižomas tinklas, kiek kelių tinklų suderinamumas.