

About geometry in fine arts

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Abstract: the arts and the sciences-this combination becomes unthinkable without each other. Mathematics see in the paintings of laws of non-Euclidean geometry, spatial forms of descriptive geometry and the laws of the golden section. Experts studying the psychophysics view can point out that the human brain, complementing the work of eye, displays world not only according to the laws of geometric optics.

Keywords: geometry, mathematics, painting, projection method, golden ratio, proportion.

Геометрия в искусстве

Аннотация: Искусство и точные науки - такое сочетание становится немыслимым друг без друга. Математики видят на картинах законы неевклидовой геометрии, пространственные формы начертательной геометрии, законы золотого сечения. Специалисты, изучающие психофизику зрения могут отметить, что мозг человека, дополняя работу глаза, отображает мир не только по законам геометрической оптики.

Ключевые слова: геометрия, живопись, математика, метод проекций, золотое сечение, пропорция.

The debate about whether or not science should invade the reserved areas of art has been going on for a long time. In all epochs of prosperity, art entered into an alliance with science. Thinkers, artists, theorists and teachers always have come to the conclusion that without science art grow and prosper. The artist and teacher N. P. Krymov wrote: "They say: art is not science, not mathematics, it is creativity, mood and that nothing can be explained in art - look and admire. In my opinion, this is not so. Art is understandable and very logical, it is necessary and you can know about it, it is mathematical ... It is possible to prove exactly why the picture is good and why it is bad." V.I. Surikov claimed that there is some immutable law in the composition, when nothing can be removed or added in the picture, or even an extra point cannot be put, this is real mathematics. On the doors of the Sicyon School of Drawing in Ancient Greece it was written: "People who do not know geometry are not allowed here." Artists should not be afraid of mathematics, it is outside and inside us. Behind the apparent simplicity and randomness of a living perception of the surrounding reality is hidden mathematics. When we listen to music, our brains are engaged in algebra. When we look at something, our brain is engaged in geometry. A person cannot have an attitude to the object, a feeling, an emotion, until the brain has produced a "measurement", a comparison of this subject with the already existing in memory with something similar. First comes the mathematics, and only then feeling. The work of the

brain produces instantly because we don't notice and are not aware of and it seems to us that feeling occurs immediately.

Consider the basic geometric principles used by artists in their work and their evolution in different historical epochs. Section geometry, studying various methods of image spatial forms in the plane is called descriptive geometry. It is based on the projection method: in the space is selected a fixed point S -the design center and the projection plane K that does not pass through the point S . To construct the image of the object on the projection plane, through the projection center and each object point, the projecting rays go to intersection with the plane K (picture 1). The set of intersection points of the projecting rays with the projection plane gives the image of the object, called the central projection.

However, if you imagine design center goes to infinity, then designing the rays become parallel to each other. This is called parallel projection. Thus, parallel design is a special case of central design. In turn, an important special case of parallel projections is orthogonal projections. In this case, designing the rays form a straight beams with plane K .

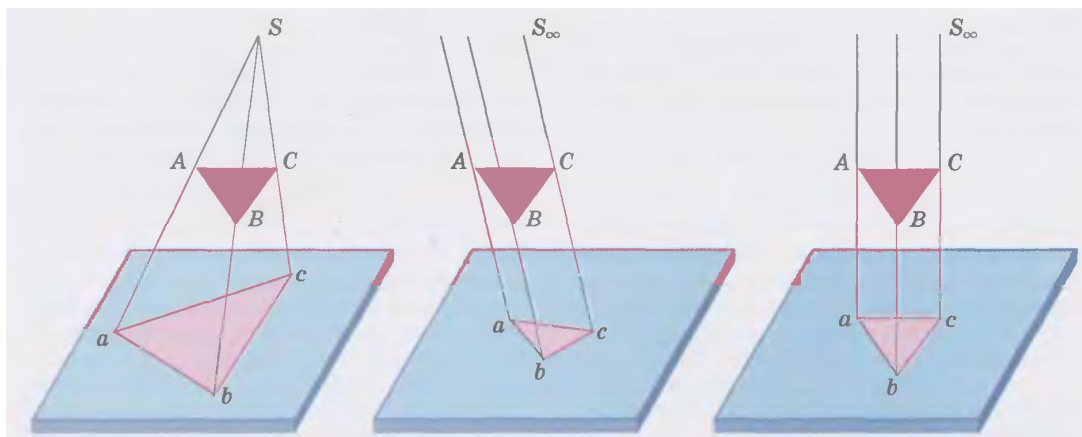


Figure 1: The most important kinds of projections: central, parallel and orthogonal. Most precisely conveys the items property of the orthogonal projection. The orthogonal projection on the plane of the 3-d form repeats, how it casts a shadow on the wall. If you investigate the geometrical laws upon which was built the image in ancient Egypt, it becomes apparent, that this painting differs from the orthogonal projection so that each element is portrayed not with three positions, but with only one-that gives the greatest insight and internal ideas. If you remember the story, human existence was understood as an ancient Egyptian journey through two worlds — earthly and Heavenly. Earthly life for the Egyptian was a reflection of the life of heaven. This was manifested in everything: even the main river of Egypt, the Nile, had its heavenly prototype - the Milky Way. Any part of nature, from tree to man, had its own double, which mirrored two worlds. Therefore, the Egyptian artist,

to a lesser extent than the master of later times, mixed with the depicted something personal, sensual; he worked, rather, on the principle of the most accurate description.

Therefore, the deity depicted strange for us: the head is in profile, torso-front, and feet — again on the side — so it's best visible movement. So we can see nearby objects, part shape in paradoxical combination is one element of the front and the other at the top, the third side.

According to the well-known physicist and at the same time the author of works on geometrical techniques in the painting of Academician B. V. Raushenbach, the artists of Ancient Egypt reached their peak in the technique of drawing, since it is impossible to think of anything better reflecting the essence of that epoch.

In antiquity, a person comprehends the beauty of nature, its proportionality and creates a fundamentally different way of depicting space - a parallel perspective, or axonometry. The image of Ancient Greece and Ancient Rome is created in us through spatial forms - the plastic of columns, arches, the language of sculptures. Parallel perspective is familiar to us from the children's drawings-it is the child who uses it, drawing a house with a gable, and side walls, and a roof. It is three-dimensional, and its faces, when transferred to the plane of the drawing, retain their parallelism, as in three-dimensional space. The proportionality and proportionality of the constituent parts give the ancient artist a sense of the beauty of nature, its reasonable balance, realized according to the divine plan. Not casually axonometry and today is used in architecture, when at the project level, you must catch the ratio of individual items.

The next big revolution time is the middle ages. Medieval artists of the West and the East continue to work with a parallel perspective, but in a completely different aspect. For example, for painting, graphics of China and Japan, this way of depicting voluminous objects turned out to be so organic that it was used up to our century. In this case, the three-dimensional elements often occupy the lower part of the traditionally vertical web. foreground. The oriental artist almost mathematically determined the limit at a distance to which the parallel perspective adequately conveys the volume. Particularly interesting is the so-called high Middle Ages: Gothic. He is characterized by an extraordinary rise in painting and architecture. Several preceding gloomy centuries of the philosophy of the man-sinner are replaced by the worldview of the man-creator, who creates on the earth from the gross matter a heavenly living form. In the works of Gothic artists unfolding amazing

stories. It is the architectural "tie-in" that creates the depth and volume, which allows one to open one of the most beautiful pages of Gothic painting. Everything in everyday life acquires meaning, no matter is trifling. Shepherd, sheep, which a succession of riders-all located on the canvas panorama. The depth that has appeared allows us to place both divine and earthly in one space.

When the Renaissance breaks into the established world of the Middle Ages, the size of a person changes, and along with it a new, mathematically rigorous linear perspective appears. This new scale generates a combination of "man and the universe", "man and space", which, of course, no longer fit into the confines of a closed space. Border where peeps people pushed back farther and farther-the road goes over the horizon. All the basic "coordinate" lines defining the volume converge to one point to which the view is drawn. And there is this point where the earth and the sky unite. Renaissance linear perspective, like the whole philosophy of the Renaissance, opened the window to nature in front of man, boundlessly expanded the horizons of the human worldview.

Speaking about painting, you cannot avoid touching such a topic, as a golden section. It is nature itself. The golden section is present everywhere in the world around us: these are the proportions of the human body, the structure of crystals, various spiral structures, parameters of biorhythms, and much more. Even in the Renaissance, the artists noticed that any picture has definite points that involuntarily attract our attention, the so-called visual centers. It is the principle of the golden section that helps to determine the coordinates of these points. The basis of this method is the concept of proportion. Proportion is the equality between two relations of four quantities: $a : b = c : d$.

The golden section is such a proportional harmonic division of a segment into unequal parts, in which the entire segment so refers to the greater part, as most itself refers to the smaller; or in other words, the smaller segment so refers to the larger, as the greater to everything.



Figure 2: Golden Section

Johannes Kepler called the golden proportion of continuing itself. "It is arranged so that the two youngest members of this endless proportion in the sum give the third term." It should be noted that the construction of a number of segments of the golden proportion can

be made both in the direction of increasing and decreasing. In the latter case, it is necessary to subtract the smaller segment from the larger segment; we obtain an even smaller one: $d - c = b$; $c - b = a$.

Turning to examples of the "golden section" in painting, one cannot help but notice his work on the work of Leonardo da Vinci. His personality is one of the mysteries of history. Leonardo da Vinci himself said: "Let no one, without being a mathematician, dare to read my works." The portrait of the Mona Lisa (Gioconda) has attracted the attention of researchers for many years, who discovered that the composition of the picture is based on golden triangles that are parts of the right star pentagon. Unlike the golden section, the sense of dynamics, excitement, is perhaps the strongest in just another simple geometric figure - the spiral. The multi-figured composition, made in 1509-1510 by Raphael, when the famous painter created his frescoes in the Vatican, is just different in the dynamism and drama of the plot. Rafael did not finish his plan until completion, however, his sketch was engraved by an unknown Italian engraver Marcantini Raimondi, who based on this sketch and created the engraving "Beating the Babies". On the preparatory sketch of Raphael, red lines were drawn from the semantic center of the composition - the points where the warrior's fingers closed around the child's ankle - along the figures of the child, the woman pressing him to him, the warrior with the sword and then along the figures of the same group on the right sketch. If a natural way to connect these pieces dotted curve, with a very high accuracy is obtained the Golden spiral. This can be verified by measuring the ratio of the lengths of segments cut by a spiral on straight lines passing through the origin of the curve.

The peculiarity of geometry lies in the inseparable, organic combination of living imagination with strict logic. The geometry is based on spatial imagination, organized by strict logic. It always contains these two inextricably linked elements: a visual picture and an exact formulation, a rigorous logical conclusion. Geometry combines these opposites, they in it mutually penetrate, organize and direct each other. Without it, not one of the areas of human activity, including art, is not conceivable. It is geometry that helps the artist to convey the three-dimensionality of the world, its beauty and versatility.

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