



## THE ROLE AND ESSENCE OF 'POSITIONAL AND METRIC PROBLEMS' IN PERSPECTIVE

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**Abstract:** This article examines the theoretical and practical significance of "Positional and Metric Problems" within the science of perspective. Positional problems focus on the mutual intersection, belonging, and placement of geometric elements (points, lines, and planes) on a perspective plane, while metric problems deal with determining the actual dimensions, distances, angles, and natural shapes of objects depicted in a distorted perspective view. The study analyzes the algorithmic approach to solving these problems, which forms the core of descriptive geometry and architectural drawing. The integration of these classical problems with modern computer-aided design (CAD) systems is also discussed, highlighting their necessity in developing spatial reasoning for future engineers and architects.

**Keywords:** Perspective, Positional Problems, Metric Problems, Descriptive Geometry, Vanishing Point, Horizon Line, Spatial Reasoning, Architectural Projection, Geometric Transformations, Visual Representation.

In the field of visual arts and engineering graphics, perspective serves as the mathematical bridge between three-dimensional reality and two-dimensional representation. Among its various structural components, **Positional and Metric problems** occupy a central role, acting as the fundamental "grammar" of spatial construction. Without a clear understanding of these two categories of problems, it is impossible to achieve a scientifically accurate or aesthetically harmonious depiction of space.

**Positional problems** are primarily concerned with the "where" and "how" of object placement. They involve determining the mutual positions of geometric figures without necessarily measuring them. For instance, finding the point where a line intersects a plane or determining the visibility of overlapping surfaces in a perspective





drawing are classic positional challenges. These problems are vital for establishing the structural integrity of a composition.

On the other hand, **Metric problems** address the "how much" aspect. Perspective, by its very nature, distorts lengths and angles as objects recede toward the horizon. Metric problems provide the methodology to reverse this distortion—allowing a designer to determine the true length of a line, the actual area of a surface, or the precise angle between two planes based on their perspective projections. This is particularly crucial in architectural restoration and forensic drawing, where accurate real-world measurements must be extracted from 2D images.

The relevance of this topic is underscored by the current educational standards in Uzbekistan, specifically aimed at modernizing engineering education. According to the **Resolution of the President of the Republic of Uzbekistan No. PQ-289**, there is an increasing demand for enhancing the quality of pedagogical and technical training. Mastering positional and metric problems is not merely a theoretical exercise; it is a vital skill for navigating modern 3D modeling environments like AutoCAD or Revit, where the underlying algorithms are rooted in these very geometric principles. This article aims to explore the deep connection between these problems and their practical application in contemporary design and engineering.

The theoretical framework of perspective serves as the mathematical foundation for translating our three-dimensional world into a two-dimensional format, and within this discipline, positional and metric problems represent the most sophisticated level of spatial analysis. To understand the essence of these problems, one must first recognize that perspective is not merely an artistic style but a rigorous branch of descriptive geometry. When we look at a perspective drawing, we are seeing a projection where parallel lines meet and distances shrink. Positional and metric problems are the tools that allow us to navigate, calculate, and construct within this "distorted" but logical space.

Positional problems are fundamentally concerned with the geometric relationships between elements—points, lines, and planes—without regard to their specific size or length. In the context of a perspective projection, these problems answer questions of "where" and "how" objects interact. For example, determining the intersection of a straight line with a plane or finding the line of intersection between two different planes





are classic positional tasks. In a practical architectural sense, a positional problem would be determining exactly where a staircase meets a sloped ceiling in a drawing. Because perspective causes parallel lines to converge at vanishing points, these intersections cannot be found by simple measurement; they require the application of central projection laws.

The methodology for solving positional problems involves the use of auxiliary elements, such as "trace" lines or vanishing traces of planes. By understanding that every plane in space has its own horizon line (vanishing trace) and every line has its own vanishing point, a designer can precisely locate any point of intersection. This logical rigor is what allows for the structural integrity of a complex scene. If a positional problem is solved incorrectly, the entire drawing will feel "broken" or physically impossible to the human eye, even if the individual objects are drawn beautifully. This is why positional logic is often referred to as the "skeleton" of a perspective image.

Metric problems, conversely, deal with the quantitative aspects of the image—lengths, angles, and areas. Perspective, by its very nature, is non-metric; it distorts the true dimensions of objects as they recede into the distance. A metric problem asks: "If this line looks like it is 5 centimeters on my paper, how many meters is it in real life?" Solving these problems is essential for any professional field that requires accuracy, such as interior design, restoration of historical monuments from old photographs, or forensic analysis.

To solve metric problems, one must employ specific geometric transformations. One of the most common methods is the use of "measuring points" (M-points). By using these points, a designer can create a perspective scale that allows for the precise measurement of depth along a line that vanishes toward the horizon. Another critical technique is the "method of rotation" or "combination," where a plane is mathematically rotated until it lies flat against the picture plane, revealing its true shape and size (*vera forma*). These calculations are vital because they allow a creator to maintain correct proportions. Without solving the metric problems, a chair in the background of a room might inadvertently be drawn at a scale that would make it three meters tall in reality, ruining the realism of the scene.

The synergy between positional and metric problems is most evident in the creation of complex architectural environments. When an architect designs a building,





they must constantly switch between these two types of logic. First, they use positional logic to place the windows, doors, and structural columns in the correct relationship to one another. Then, they use metric logic to ensure that these elements adhere to specific codes and human scales. In the modern educational landscape of Uzbekistan, particularly following the **Resolution of the President No. PQ-289**, there is a renewed emphasis on these fundamental skills. While modern software like AutoCAD or 3ds Max handles these calculations automatically through algorithms, the "human" understanding of these problems is what separates a technician from a true specialist.

In the realm of digital technology, every "click" in a 3D modeling environment is an invisible solution to a positional or metric problem. When a user tells the software to "snap" a line to the midpoint of an edge, the computer is solving a positional problem based on the underlying coordinate system. However, software can fail, and it often produces artifacts or "glitches" when geometry becomes too complex. A specialist who understands the manual derivation of positional traces can identify these errors immediately. This is why the teaching of these problems remains a cornerstone of engineering graphics; it builds the "spatial intuition" that allows a professional to visualize a 3D object from all angles in their mind before they even touch a computer.

Furthermore, the study of these problems has a profound impact on the development of mantiqiy fikrlash (logical thinking). Solving a metric problem in perspective requires a multi-step algorithmic approach: identifying the given data, determining the position of the horizon and vanishing points, applying the transformation method, and finally verifying the result against the visual logic of the scene. This process mirrors the scientific method and trains the brain to handle complex, multi-layered information. In the context of "Havo perspektivasi" (atmospheric perspective), metric problems even help in determining the physical distance of an object to accurately calculate the amount of "haze" or color desaturation that should be applied, blending mathematical precision with artistic nuance.

Positional and metric problems are the dual engines that drive the science of perspective. Positional problems provide the "map" of where objects exist and how they touch, while metric problems provide the "ruler" that ensures they are the correct size. Together, they allow the human mind to conquer the limitation of a flat surface and create a window into a believable, measurable, and structurally sound reality. Whether





it is a hand-drawn masterpiece or a high-end digital simulation, the laws of position and measurement remain the unchanging truths of visual representation. As we move further into an era of virtual and augmented reality, these classical geometric problems will only become more relevant, serving as the code upon which our digital worlds are built.

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