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КЊИГА АПСТРАКАТА
BOOK OF ABSTRACTS

ПРВА МЕЂУНАРОДНА КОНФЕРЕНЦИЈА SMARTART УМЕТНОСТ И НАУКА У ПРИМЕНИ FIRST INTERNATIONAL CONFERENCE SMARTART ART AND SCIENCE APPLIED

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IV APPLIED GEOMETRY IN VISUAL ARTS
THREE-DIMENSIONAL ROSETTES
BASED ON THE GEOMETRY
OF CONCAVE DELTAHEDRAL SURFACES

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The rosette becomes a dominant architectural detail in the first half of the 12th century in France, when the builders of religious architecture, under the influence of Neoplatonic ideas, became fascinated by light as a means to connect with God. Conceptually, the Christian church became the temple of light – a temple bathed in the light of God. With an altered construction system and the use of new constructive elements, it became possible to install spectacular stained glass windows, through which the filtered sunlight entered the cathedral. In this system, the unique rosette-shaped window opening stands out. Its circular shape and complex geometry have made this architectural element the most representative product of Gothic applied art.

Approximately at the same period of time, Islamic geometrical patterns are used as a matrix for shaping decorative architectural elements. Their application is a full integration of geometry with architecture. The base of these patterns consists of regular constructible polygons (such as hexagons and octagons) and star-shaped polygons that are formed from them. These shapes represent the rosette leaves. Depending on the number of apexes (n) of regular polygons generated from them, a new term is introduced in the classification – the ‘geometrical n-point pattern’, where the type of the rosette depends on the polygon from which it is derived. The evolution of Islamic geometrical patterns can be followed through the type of use of n-sided polygons, from the hexagon to more complex polygon types and through the rosettes formed from them.

In this paper, the link between these two concepts is made through the application of concave polyhedral surfaces. Forming composite polyhedral structures based on the geometry of concave deltahedral surfaces over a n-sided polygonal base, we have demonstrated one possible method of geometrical generation of three-dimensional rosettes. The concave polyhedral surface is the surface layer of the concave polyhedrons of the second, fourth and higher sorts, consisting of series of equilateral triangles, grouped into spatial hexagons. Positioned polarly around the central axis of the regular polygon in the polyhedron’s basis and linked by connected triangles, the spatial hexagons form the deltahedron’s surface area. The sort of the concave polyhedron is determined by the number of equilateral triangle rows in thus obtained polyhedron’s net. In this study, composite polyhedral structures whose surface areas form the three-dimensional rosette are obtained through the combination of concave cupolas of the second sort (CCII), concave cupolas of the fourth sort (CCIV), concave antiprisms of the second sort (CA II) and concave pyramids (CP). By means of elongation, gyro-elongation and augmentation of the listed concave polyhedrons it was possible to generate complex polyhedral structures, which can be used to create three-dimensional rosettes. The parameters of the solids were determined constructively by geometric methods and analytical methods which use iterative numerical procedures.
The orthogonal projections onto the basis plane of thus formed composite polyhedral structures are the rosettes in the plane, with distinct geometry. They are, just like Gothic and Islamic rosettes, characterized by multiple symmetry, proportion and order. The complexity of their configurations is the result of the very procedure by which the deltahedral surface area is generated, although they contain a single geometrical shape – the triangle.

We examine the applicative potential of three-dimensional rosettes as architectural details. Modern architectural trends recognize the value of modular solutions, as these are quick and less expensive to install. When three-dimensional rosettes are observed as a composite structure consisting of polyhedral surfaces, their modularity is reflected in the fact that complex patterns are obtained through the application of a single standard element – the equilateral triangle. On the other hand, the same structure can be observed as a three-dimensional grid, whose modularity is reflected in the application of the same-length bars – the sides of the equilateral triangle.

In this paper, the building blocks of three-dimensional rosettes (equilateral triangles) are also treated as glass surfaces of different colors, whose light refractions and cast shadows are examined as an asset in architectural design. In this manner, analogously to the Gothic architecture, the filtered light penetrates and refines the modern interior. Three-dimensional rosettes based on the geometry of concave polyhedral surfaces can be applied as an architectural detail on the façade, as an interior detail, as cupolas, roof constructions or as independent spatial constructions (entire objects).

Three-dimensional rosettes, contrary to two-dimensional, allow for the overlapping of the shadows cast by their (triangular) sides, depending of the angle of the light shining on them. These shadows, in turn, create dynamic pictures (patterns or compositions), which change with hours and seasons. Furthermore, these will neither be mere projections of flat images nor familiar pictures, but complex compositions obtained through an interplay of their positions and spatial relationships. Future research can focus on the engineering of these compositions – on how to obtain a certain distribution of light and shadows at a given time of day or on a given day in a year, as an additional architectural accomplishment.

**Keywords:** rosette, polyhedron, architecture, light, shadow

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