The Search for Pattern in Architecture and Mathematics

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Abstract

Editor-in-Chief Kim Williams examines the role of the search for pattern in establishing relationships between architecture and mathematics, and introduces the articles in *Nexus Network Journal* vol. 22 no. 2 (2020).

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A recurrent theme in the research published in the *Nexus Network Journal* is pattern. The *Cambridge English Dictionary* defines “pattern” in a variety of ways: as any regularly repeated arrangement of elements such as lines, shapes, or colours; as a particular way in which something is done, is organized, or happens; as a design that provides a model for how to make something. In our field, the discovery of a pattern can allow the investigator to make evident an underlying order, shed light on the design process of the creator, provide connections to site or cultural context, and reveal aspects of design and structure that might not otherwise become apparent. This present issue of the *NNJ*, featuring a rich variety of topics and research methods, underlines the fundamental nature of the search for pattern. That search may take the form of visual examination, computer visualisation, structural analysis, on-site survey, or mathematical analysis, but finding a pattern can allow the research to go from intuition to certainty.

Several articles in this issue deal with visual, two-dimensional geometrical patterns, which are used in every epoch and by every culture for ornamentation in architecture. These are examples of the first definition of patterns: regularly repeated arrangements. Two articles in this issue examine very old patterns. Mojtaba Sabetfard and Hadi Nadimi, in “[Generating Square Kufic Patterns Using Cellular Automata](#)” interpreted square Kufic scripts, a type of architectural decorative art in Islamic culture, as visual patterns and then develop three methods for their generation. Emil Makovicky, in “[Byzantine Floor Patterns of Interlocking Twisted Cable Loops](#)”, analyses a special kind of geometric pattern based on combinations

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of loops and knots that generate a broad versatility of design and a rich spectrum of extant patterns. Instead, in “[Tessellations in the Architecture of Pablo Palazuelo](#)”, Gonzalo Sotelo Calvillo examines the twentieth-century work of Spanish artist Pablo Palazuelo, who sought a “new” geometry, which he called “transgeometry”, and demonstrates the existence of geometric patterns that order the seemingly random designs. Geometric patterns associated with a analysis of length dimensions in a modular system are the focus of “[Ancient Aegean Measurement Systems Analysed Through the Treasury of Atreus](#)” by Maria Teresa Como. In this issue’s “Geometer’s Angle” column “[Method of Construction of Decagonal Self-Similar Patterns](#)”, by Aziz Khamjane, Rachid Benslimane and Zouhair Ouazene, provides today’s designers with a method for constructing new self-similar patterns based on successive subdivisions of the golden mean triangles.

Structures provide examples of patterns in the sense of “a particular way in which something is done, is organized, or happens” can be useful in structures. For example, as Vicenta Calvo Roselló, Esther Capilla Tamborero and Juan Carlos Navarro Fajardo explain in “[Oval Domes. The Case of the *Basílica de la Virgen de los Desamparados* of Valencia](#)”, fundamental to the study of oval domes is the determination of the exact shape because that allows conclusions to be drawn about how it was built. Their mathematical approach of comparing the pattern of distances between the points that make up the real data cloud and those that form a hypothetical ellipse or oval allows them to determine the shape of the dome being studied. In “[Was There Ever an Arch in the So-Called Ark-e-Alishah?](#)”, Amin Moradi and Mansour Houseinpour Mizab describe how the use of the finite element method allowed them to determine that had an arch ever existed in this monumental structure, it would have led to patterns of deformation and fracture that would have resulted in its collapse. Cristina Ramos-Jaime and José Sánchez-Sánchez, in “[Hyperboloid Modules for Deployable Structures](#)”, describe how assemblies of hyperboloid modules form interwoven patterns that can define planar or curved surfaces. In “[A Gothic-Renaissance Synthesis in a Diego de Riaño Vault](#)” Antonio Ampliato and Eduardo Acosta analyse geometric designs in order to reveal the designer’s investigation of new solutions to the problem of vaulting an early sixteenth-century antesacristy.

Other examples of patterns as particular ways in which something happens are illustrated by two very different fields: stars and numbers. Juan Antonio Belmonte, Antonio César González-García, Andrea Rodríguez-Antón and María Antonia Perera Betancor, in “[Equinox in Petra: Land- and Skyscape in the Nabataean Capital](#)”, analyse a very complete sample of data and direct observations to show how patterns of astronomical phenomena influenced Nabataean symbolism, religion and systems of marking time. In the case of “[Mathematical Commentary on Le Corbusier’s Modulor](#)”, Natasha Rozhkovskaya discovered deviations from numerical patterns that Le Corbusier claimed formed the basis for his iconic proportional scale, allowing her to provide evidence for her criticism of it.

Finally, we come to the definition of patterns is as “something designed or used as a model for making things”. Theodora Vardouli, in “[Skeletons, Shapes, and the Shift from Surface to Structure in Architectural Geometry](#)”, explains the process by which the architectural design problem is modelled in the form of a graph,

and skeletal vision then modelled upon the graph, whose abstract structure then underlies and delimits geometric appearance. Models as tools for visualization are very important for architects as well as mathematicians. Tomás García-Salgado, in “[Leonardo’s Missing Sketch for the Adoration of the Magi](#)”, another feature in the “Geometer’s Angle” column, uses the technique of perspective to re-create a hypothetical preparatory sketch that Leonardo is presumed to have used as a model to lay out his enigmatic, unfinished painting. Seyed Hossein Zargar, Jaleh Sadeghi, Mona Hashemi, Narjes Motallebi and Ali Andaji Garmaroodi, in “[Introducing a New Method to Convert a 2D Hand-Drawn Perspective to a 3D Digital Model](#)” employ edge detection algorithms which rely on pattern recognition.

I hope you enjoy reading this interesting and varied issue!

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Kim Williams received her degree in Architectural Studies from the University of Texas in Austin. She became interested in mathematics and architecture while writing *Italian Pavements: Patterns in Space* (Anchorage Press, 1997) about the role of decorated pavements in the history of Italian architecture, and it has been her field of research ever since. She is the founder and director of the international, interdisciplinary conference series “Nexus: Relationships between Architecture and Mathematics”, and is the founder and co-editor-in-chief (with Michael Ostwald) of the *Nexus Network Journal*. Her latest publication is *Daniele Barbaro’s Vitruvius of 1567* (Birkhäuser, 2019).