

## Intersections Between Architecture and Mathematics

Michael J. Ostwald

Published online: 27 May 2014  
© Kim Williams Books, Turin 2014

**Abstract** Co-Editor-in-Chief of the *Nexus Network Journal*, Michael J. Ostwald, introduces eleven papers in vol. 16, no. 2 (2014).

Volume 16, Issue 2 of the *Nexus Network Journal: Architecture and Mathematics (NNJ)* brings together eleven papers that have been refereed by experts, revised in response to this process and edited in preparation for publication. They do not possess a single defined theme, but as is common for this journal, the majority consider applications of geometry to historic buildings. The approaches they take vary from the computational to the philosophical, and their scope from isolated structural elements to entire urban regions, but they all have a common interest in intersections between the built environment and mathematics.

The opening papers in the issue combine architectural history with post-Euclidean or computational geometries. In the first of these, fractal dimensions are used to measure the formal properties of French Gothic cathedrals. The authors of this first paper, Albert Samper and Blas Herrera, analyse 20 gothic cathedrals and use the results to suggest that these buildings possess a general and non-random geometric or formal pattern. Samper's and Herrera's paper is of interest because it applies a rigorous method to a subject—the geometric properties of gothic architecture—which has often only been examined intuitively or qualitatively. Sonja Krasic's and Petar Pejic's paper, "Comparative Analysis of Terrestrial Semi-Automatic and Automatic Photogrammetry in 3D Modeling Process", describes an application of computer software and hardware to capturing the forms of historic buildings. Krasic and Pejic demonstrate and assess two versions of the method using the archaeological remains of The Palace with an Octagon in the town of Niš in

---

M. J. Ostwald (✉)  
School of Architecture and Built Environment, The University of Newcastle,  
Callaghan, NSW, Australia  
e-mail: Michael.Ostwald@newcastle.edu.au

Serbia. Bojan Tepavčević's and Vesna Stojaković's paper, "Representation of Non-Metric Concepts of Space in Architectural Design Theories" examines the relationship between theories and depictions of architecture which are not conventionally Euclidean. Such projective, transformative, topological and non-metric spaces have become increasingly commonplace over the last two decades but are often poorly understood by architectural designers.

The next four papers in this issue are about the geometric construction of historic architectural forms. In the first of these four, Christopher Bartlett examines the geometrical properties of the Great Pyramid of Khufu. Bartlett considers various theories associated with the golden ratio and pi in the context of different measures that have been derived from the plan of the pyramid. Bartlett's research concludes with the suggestion that an alternative explanation of the geometry of the Great Pyramid of Khufu might be found in Ancient Egyptian proportional studies of the human body. In the next paper Mojtaba Pour Ahmadi sets out to define a method for naming and understanding Persian *karbandis* according to their geometrical properties. A *karbandi* is a type of domed-roof structure, which is commonly found in classic Iranian and Islamic buildings. Because of its complex geometric form, it often defies classification or understanding. The following two papers, which are both by Angelo Alessandro Mazzotti, are about the geometric construction of ovals, eggs and curves in historic buildings. This topic is significant because, throughout history architects have created such shapes, but little evidence remains today about how they used geometry to construct them. While, in many cases we may never know how these shapes were actually produced, the existence of Euclidian techniques, which can be constructed using a ruler and compass, offers an important clue as to what might have happened. Thus, in the first of Mazzotti's papers, "A Euclidean Approach to Eggs and Polycentric Curves" the author offers detailed demonstrations of the geometric constructions that were possible using the tools of the Renaissance architect. Mazzotti's paper includes an appendix which outlines and diagrams nine proofs of his approach. In the second of these papers, Mazzotti provides a speculative response to the question, "what might Borromini have known about ovals?" Drawing on the work of Ragazzo, Mazzotti identifies several geometric constructions that were possible at the time Borromini created the oval shapes for the dome of San Carlo alle Quattro Fontane.

The next two papers in the issue have an urban focus. In the first of these, Nahid Mohajeri and Agust Gudmundsson present an application of statistics to quantifying the difference between types of urban spaces. Using the edge lengths of building plan-forms, they compare old and new parts of the city of Yazd in Iran. Their method is fundamentally one of data analysis, using statistical approaches to architectural measurements, in order to quantify the difference between urban forms. In contrast, Akshay P. Patil's and Alpana R. Dongre's paper, "Emergent Properties of The Public Realm and Encroachments in the Urban Environment" describes the use of an agent-based computational model to experiment with various urban conditions. Patil and Dongre then analyse some aspects of their simulated data in the context of real-world observations.

The Didactics section of the *NNJ* is dedicated to papers that seek to explain concepts and demonstrate techniques, which have an educational premise or

application. This issue contains the second and third parts of Ahmed A. Elkhateeb's "Remarks on the Surface Area and Equality Conditions in Regular Forms". The first part, in *NNJ* 16(1), was concerned with the geometry of triangular prisms, examining the interrelationships between the variables that control measures of perimeter, floor area, wall surface area and total surface area. The second part, in the present issue, is co-authored with Esraa A. Elkhateeb. It is focussed on the geometry of regular quadratic prisms and it examines rectangular and isosceles trapezoidal rooms. The third part in this series is about the volume, area and perimeter of multi-sided prisms.

The last section in this issue includes a book review and an edited transcript. The book review is of Giuseppe Fallacara's *Stereotomy: Stone Architecture and New Research*. The word "stereotomy" is used broadly to describe geometric knowledge that is concerned with the modelling and assemblage of solid forms. More commonly it refers to the art and science of cutting stone blocks to allow them to be combined to create larger structures. The review of Fallacara's book is by Peter Attila Andrusko. The edited transcript that concludes this issue is of the 2012 round table discussion from the *Nexus: Architecture and Mathematics Conference* in Milan. In 2002, at the Nexus conference in Obidos, Portugal, a round table forum was convened on the topic of "mathematics in the architecture curriculum". The 2012 conference offered an opportunity to revisit this topic, but with a more precise focus on the role of descriptive geometry. The event was chaired by Ivan Tafteberg Jakobsen and Jesper Matthiasen and the invited participants included Ahmed Ali Elkhateeb, Federico Fallavollita, Sylvie Duvernoy, Cornelia Leopold, Arzu Gonenc Sorguc, João Pedro Xavier and myself. Given the constitution of this panel, the discussion was informed by a diverse range of opinions, founded in different geographic and cultural settings and traditions.

Finally, this is my first issue of the *NNJ* as Co-Editor-in-Chief. To mark this occasion I went back through my files to try to determine when my first involvement with the Nexus group occurred. In my files I found a letter (yes, a printed and posted document) dated February 1997. I also have notes from the 1998 conference I attended about the possible formation of a journal of architecture and mathematics. After 17 years working with the Nexus group and the *NNJ* in various roles and positions, it is an honour to share editorial responsibilities for the journal with its founder, Kim Williams.

**Michael J. Ostwald** is Professor and Dean of Architecture at the University of Newcastle, Australia. He has a PhD in architectural history and theory and a higher doctorate (Doctor of Science) in design mathematics. Michael has authored over 300 research publications and he has been awarded more than twenty major research grants and fellowships including those from the ARC and ALTC in Australia and the Graham and Getty foundations in the USA. His latest book, co-edited with Kim Williams, is the two-volume, *Architecture and Mathematics from Antiquity to the Future* (Birkhauser, 2014). Michael is Co-Editor-in-Chief of the *Nexus Network Journal: Architecture and Mathematics*.