LETTER FROM THE EDITOR

Nexus 20/21, Relationships Between Architecture and Mathematics

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Abstract
This letter from the editors commences by reporting on Nexus 20/21, the 13th international, interdisciplinary conference for architecture and mathematics. This event took place in July 2021 as an online conference. From over 50 presentations at the conference, the Scientific Committee nominated a series of works for potential inclusion in two special issues of the Nexus Network Journal. This letter introduces eleven papers selected for Vol. 24(2), with the remainder to appear in Vol. 24(3).

Keywords Architecture · Mathematics · Nexus 20/21 Conference

Introduction
This special issue of the Nexus Network Journal presents eleven papers specially chosen for development and expansion from the talks given at the 13th international, interdisciplinary conference “Nexus 20/21: Relationships Between Architecture and Mathematics” (Fig. 1). This event was originally planned for July 2020 in Kaiserslautern, Germany, but was delayed by COVID-19 and took place from the 26th to the 29th of July 2021 as an online conference. The conference was presented by RCA (Research Culture in Architecture) and hosted by fatuk (Faculty of Architecture, Technische Universität Kaiserslautern) and Kim Williams Books. The conference was also supported financially by DFG (Deutsche Forschungsgemeinschaft, German Research Foundation). As this was the first online conference in the Nexus series, additional effort was invested in making the event as

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engaging as possible, allowing for productive exchanges to occur. This letter from the editors describes the event and then introduces the eleven papers.

About the Nexus 20/21 Conference

The Nexus 20/21 Conference in Kaiserslautern was the latest edition of this international series, with the first being in Fucecchio (Florence) in Italy in 1996. Directed by Kim Williams, and hosted by a variety of institutions, the conference series include Mantova, Italy (1998), Ferrara, Italy (2000), Óbidos, Portugal (2002), Mexico City (2004), Genova, Italy (2006), San Diego, USA (2008), Porto, Portugal (2010), Milan, Italy (2012), Ankara, Turkey (2016), Donostia-San Sebastian, Spain (2016) and Pisa, Italy (2018).

The team from fatuk responsible for organising the Nexus 20/21 Conference was comprised of Cornelie Leopold, Paula Kaminski, Peter Spitzley, Ulrike Weber, Florian Budke (graphic design), and Dagmar Häßel (secretary). The Conference Coordination Committee included Marco Giorgio Bevilacqua as Director (co-director of the previous Nexus conference in Pisa) and Francesca Fatta, Hans Hagen, Daniel Lordick, Christopher Robeller, Katja Schladitz, and Ulrike Weber, also part of fatuk. The organizations providing patronage were Deutsche Gesellschaft für Geometrie und Grafik (DGfGG), Architecture Geometry Initiative Kaiserslautern, and the Unione Italiano per il Disegno (UID).

The preparations for the Nexus 20/21 Conference started in 2019 with a Call for Proposals (https://nexus2021.architektur.uni-kl.de) that was distributed via scholarly communities, educational institutions and individuals. The Call for Proposals suggested eight potential categories for research: design theory (mathematics as a design tool); design analysis (mathematics used to analyse an existing monument or site); geometry (applications of geometry, including descriptive, projective, fractal, etc., to architecture); topology (applications of topology to architecture); rule-based design (shape grammars, parametric design); representation of architecture (perspective, modelling); structures (architectural engineering application and statics related to form); computer applications (morphogenesis, digital fabrication, virtual reality); and didactics (methods, approaches and projects in the classroom, at all levels of education). Authors could also suggest alternative categories for their research.

The Call for Proposals generated 110 submissions by researchers from 23 countries (Australia, Belgium, Brazil, Czech Republic, Egypt, Germany, Greece,
Hungary, India, Iran, Israel, Italy, Japan, Lithuania, Poland, Portugal, Russia, Saudi Arabia, Serbia, Spain, Turkey, United Kingdom, and the United States). On the basis of extended abstracts, the conference’s Scientific Committee selected 54 papers for presentation, either verbally or via posters. The Scientific Committee was co-directed by Kim Williams and Cornelia Leopold, with secretary Sylvie Duvernoy. Its members were Marco Giorgio Bevilacqua, Alessandra Capanna, Andrea Giordano, Snezana Lawrence, José Calvo López, Michael J. Ostwald, Mine Özkar, Mojtaba Pour Ahmadi, Alberto Pugnale, Roberta Spallone, Vesna Stojaković, Vera Viana, Stephen R. Wassell, João Pedro Xavier, and Maria Zack. All members of the Scientific Committee have been closely involved in either past conferences in this series or in the Nexus Network Journal.

The initial reviewing and selection process for the papers took place in early 2020, for the planned July 2020 event. However, in light of the emergencies due to the COVID pandemic, quarantine measures, and the risks of international travel and meetings, in April 2020 it was decided to postpone the conference until 2021, still hoping to realise it in person in Kaiserslautern. In early 2021, as updated abstracts were collated for the conference book (Fig. 2), the decision was made to hold the conference online due to continuing uncertainties surrounding COVID and travel.

The conference book, which is 323 pages in length and was prepared and printed under the guidance of Kim Williams, was sent to conference participants prior to the event. The chapters, made up of abstracts in the conference book, correspond to the 13 sessions of the conference program. The topics range from relationships between spatial concepts and representation to parametric design, mathematics of natural forms and structures, design theories and methods, mathematics in

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**Fig. 2** The cover of the Nexus 20/21 conference book and the ‘make your own’ conference hat.
architectural education, mathematical analyses of historical examples of architecture and construction, and computer-aided methods in architectural and urban design. Mathematical methods proved to be suitable research approaches for architecture in these diverse subject areas. Mathematics, and especially geometry, can mediate between disciplines in the architectural production and creation process, something which is evident throughout the history of architecture. Since today, architecture has been permeated by computer-aided methods in all fields, the significance of mathematics for architectural research has increased considerably.

The careful compilation of the papers in the different sessions proved to be effective for developing synergies and promoting fruitful debate at the end of each session, when all presenters of the session engaged with the audience. The selected moderators for each session contributed to the effective exchange on the topic with the participants. A total of 103 international participants took part in the conference and the event was also recognised as “continuing education” by chambers of architects in Germany.

Planning the Online Conference

With a goal of achieving an engaging online event, the following elements were considered critical: a conference book, preview videos of presentations, recordings of the live sessions, moderated discussion groups, breakout rooms for questions and communication, an on-line chat facility, and finally, breaks to relax and watch stimulating video material.

Unlike most traditional conferences, for Nexus 20/21 the printed conference book was sent to all participants in advance. Coupled with this, preview videos of the presentations—created by the authors with the conference organisers’ support—allowed participants to familiarise themselves with the topics before the event commenced (Fig. 3). The videos were made available on the internal website (prepared with the help of the company ITYOU) for all presentations, and structured according the program. The website was also crucial for the successful online mode. This allowed the conference to host live presentations, typically 10 min for each presentation, and with 20 min of discussion at the end of each session (Fig. 4).

In addition to the main “presentation room” in the Zoom video conferencing tool, two “breakout rooms” were offered. The participants could go to these and return to the main room at any time. One breakout room was intended for technical and organizational questions and a second one for social contacts, a so-called “coffee break room”, where the participants could also make appointments with others and exchange information, which is usually so important at conferences. These breakout rooms were supervised by the support team. In the presentation room members of the support team were always available in the chat to answer questions or provide assistance, as well as to resolve screen-sharing problems. The members of the support team, who were critical to the success of the online mode, were Abinandh Ananthakrishnan, Benedikt Blumenröder, Eva Hagen, Jonny Klein, Pallabi Kundu, Florian Miethe, Andja Stober, Lukas Wasem, Morgane Zimmer, and Viyaleta Zhurava.
During the breaks, the presentation room projected videos about the host department and university, cultural events in the city of Kaiserslautern as well as videos on relevant projects from the department of Descriptive Geometry. The participants were thus able to take away impressions of the department, its work, and the culture in the city. These sought to counter the arbitrariness of an online event, creating a connection to a particular place and group of people. The participants confirmed the intended effect in their very positive reactions to the whole event.

**Papers in this Special Issue**

Following review of the extended abstracts and presentations at the conference, the Scientific Committee short-listed a series of the most original works, and invited the authors to develop full research papers for refereeing and possible inclusion in the *Nexus Network Journal*. Ten of these research papers are organised in this issue into three broad themes—Palladian Language, Measuring and Comparing Architecture, Perception, Inhabitation and Movement—and an eleventh paper is included in the Didactics section of the journal.
The first of the three Palladian papers is “Parametric Experiments on Palladio’s 5 by 3 Villas” by Roberta Spallone and Michele Calvano. This paper proposes a parametric reconstruction of Palladian proportional schemas, with a focus on three villas: Villa Poiana, Villa Zeno, and Villa Thiene in Cicogna. The following paper, by Ju Hyun Lee, Michael J. Ostwald and Michael J. Dawes, is “Examining Visitor-Inhabitant Relations in Palladian Villas”. In this paper a new variation of the classic spatial analysis method, the justified plan graph (JPG), is proposed, which considers both weighted and directed spatial experiences in five of Palladio’s villas. The final paper in this section, “Partitioning Sites for Invention in Serlio’s and Palladio’s Palazzi” by Nick Mols, examines the division of space in architectural planning. Using works by Serlio and Palladio as examples, Mols demonstrates a process for developing and ordering spatial hierarchies.
Measuring and Comparing Architecture

This section commences with Peter Wilson’s “Irrational Numbers in Vitruvius’s Fanum Basilica”, which revisits translations of Vitruvius’s treatise, for the purpose of examining various modules and ratios in the Fanum Basilica. In the second paper, “The Imperfect Geometries of the Basilica S. Peter and Paul in Casalvecchio, Messina” by Marinella Arena, a protocol is outlined for the analysis of Sicilian Arab-Norman architecture. This involves an instrumental survey coupled with geometric and morphological analysis. The next paper in this section is Robert Bork’s “A Geometrical Perspective on Otto von Simson’s Gothic Cathedral”. Using five case studies—Saint-Denis Abbey and the cathedrals of Sens, Bourges, Chartres, and Reims—Bork examines Otto von Simson’s claims about the use of idealised geometric figures in twelfth- and thirteenth-century architecture. The final paper in this section is “Geometric Characterization of Late-Baroque Domes in Sicily” by Laura Floriano, Mariangela Liuzzo and Giuseppe Margani. This paper uses three-dimensional survey data to examine the geometry, both measured and idealised, of seven Sicilian domes built between the eighteenth and nineteenth centuries.

Perception, Inhabitation and Movement

The first paper in this section is Luigi Cocchiarella’s “Orthographic Anamnhesis on Piero’s Perspectival Treatise”. This paper undertakes an analysis of three perspective methods proposed by Piero della Francesca in De Prospectiva Pingendi. The second paper, “Geometry and proportions in Anne Tyng’s architecture” by Cristina Cândito and Alessandro Meloni, uses digital reconstructions to two of Tyng’s works to investigate aspects of geometry, three-dimensional tiling and inhabitation. The last paper in this section is “Computationally Evaluating Street Retrofitting Interventions” by Marcela Noronha, Gabriela Celani and José Pinto Duarte. This paper describes the use of an evaluation model for street retrofitting capacity, which takes into account principles developed in previous Pedestrian Level of Service (PLOS) instruments.

Didactics

The final paper in this issue is “Form Follows Parameter: Algorithmic-Thinking-Oriented Course for Early-Stage Architectural Education” by Karolina Ostrowska-Wawryniuk, Marcin Strzała and Jan Słyk. This Didactics paper describes a course at the Warsaw University of Technology’s Faculty of Architecture, which seeks to support teaching of parametric methods, linking architecture to mathematics.

Conclusion

While there is no substitute for meeting face-to-face, the Nexus 20/21 conference showed that our scholarly society can effectively adapt to major challenges, pivoting to host its first successful international conference in online mode. The quality of
the work was once again exceptional, reinforcing the value of this network, which is now in its 26th year. The next conference in this series, Nexus 2023, is planned to take place in June 2023 in Torino, Italy. We hope to see you there in person!

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Michael J. Ostwald is Professor of Architectural Analytics and Associate Dean of Research at UNSW, Sydney (Australia). He has previously been a Professorial Research Fellow at Victoria University Wellington, a visiting Professor and Research Fellow at RMIT University, an ARC Future Fellow at the University of Newcastle and a visiting fellow at ANU, MIT, HKU and UCLA. He completed postdoctoral research on geometry at the CCA (Montreal), UCLA (Calif.) and Harvard (Mass.). Michael is Co-Editor-in-Chief of the Nexus Network Journal: Architecture and Mathematics (Springer) and on the editorial boards of ARQ (Cambridge) and Architectural Theory Review (Taylor and Francis).