Sylvie Duvernoy

Conference Report

***Nexus 2004: Relationships Between
Architecture and Mathematics***

19-23 June 2004, Mexico City

Nexus 2004, the fifth biennial international conference on architecture and mathematics organized by the *Nexus Network Journal* was held in Mexico City this year from June 19 to June 23, on the Mexico City campus of the Tecnológico (TEC) de Monterrey. The scientific organizing committee included Kim Williams, director of Nexus, Professor Francisco Javier Delgado Cepeda and Professor Carlos Román Chávez García from the TEC of Monterrey, and Sylvie Duvernoy. The local organizing committee included José Luis Gómez Muñoz, who introduced each speaker, and the staff and teachers of the TEC of Monterrey.

The choice of papers for Nexus 2004 was made by the scientific committee in accordance with the usual objective of the Nexus conference, which is to bring together scholars from different countries, and studies on architecture from different cultures and different times. In honour of our host country and host institution, a full session was dedicated to studies on Hispanic architecture, from ancient to contemporary. Themes of the other sessions were non-Western architecture, Western architecture, technology, and miscellaneous studies. As always, we wanted to approach the study of relationships between architecture and mathematics from different point of views: scientific, artistic, theoretical and practical. The group of speakers was thus very international and its pluri-disciplinarity was echoed in the diversity of the participants to the meeting.

The TEC of Monterrey also invited four keynote speakers from four different countries: Kivi Sotamaa from Finland, Hernán Díaz Alonso from the United States, Mark Burry from Australia, and Branko Mitrović from New Zealand.

Unlike during the previous meeting, Nexus 2002, which was held in Óbidos, Portugal, discussion did not take place during a round table at the end of the meeting, but occurred spontaneously at the end of the sessions or during intervals between speeches. Several important questions were raised and debated concerning the various aspects of architectural research and design. Modern mathematics provide the architect with new professional work tools for either the scientific investigation of ancient buildings, or design work in planning and creating new buildings. The questions that were raised related to the appropriateness and the limits of these tools. Analytical methodologies were discussed with regards to research: what kind of investigation is suitable to the study of ancient architecture and how can it be done? Regarding architectural design process, a second point of discussion concerned the role and influence of digital tools on design.

As regards the possibility of applying modern mathematical theories to the analysis of ancient architecture, two examples were shown at the meeting. The first one concerned fractal geometry applied to the study of a wide range of Mayan pyramids ("Geometric and Complex Analyses of Maya Architecture: Some Examples" by Gerardo Burkle-Elizondo, Nicoletta Sala, Ricardo Valdez-Cepeda). The second one concerned graph theory applied to understanding the design of traditional Islamic muqarnas ("Muqarnas, Construction and Reconstruction" by Yvonne Dold-

Samplonius and Silvia Harmsen). The conclusions reached in the case of the muqarnas were indeed more convincing than in the case of the pyramids. The risk of such an approach is that the study of some ancient architecture becomes a mere pretext for testing the potentiality of a new mathematical theory, and verifying its validity as a research tool. This deviation is especially evident in a paper where three different procedures for analysis are experimented on the same object, with results that do not converge towards undisputable conclusions regards to the architecture itself. Nothing is thus proved concerning either the methodological tool or the object of the analysis.

Nexus 2004 group photo

The purpose of research in ancient architecture, or ancient urban design, is usually to unveil a hidden theoretical knowledge, or at least an intentional geometric and/or arithmetic order. This knowledge may be proved either by using the same procedures that ancient designers probably used themselves: diagrams drawn with some kind of manual graphic device, or applying modern procedures provided by contemporary mathematics. These modern approaches may be adopted on the condition that the researcher does not assume that the ancient designers were aware of them; the objective is to demonstrate a knowledge, but not the knowledge of the analytical tool itself.

A more traditional approach using classical geometry and arithmetic was adopted in the analysis of the urban design of the monumental axis of the ancient Aztec city of Teotihuacan ("A New Geometric Analysis of the Plan of the Teotihuacan Complex in Mexico" by Mark Reynolds); the design of Palazzo della Signoria in Florence ("The Sequence of Fibonacci and the Palazzo della Signoria in Florence" by Maria Teresa Bartoli); and the Packard House by Rudolph Schindler ("Triangular Geometry in Rudolph Schindler's Packard House of 1924" by Jin-Ho Park). The classicism of the methodology is not, of course, in itself a guarantee of the reliability of

the results, which have to be supported in any case by some other kind of evidence in order to be proven. This is why, in the absence of any contemporary documentation or written source, we still cannot draw definite conclusions with regards to the Aztec architectural and urbanistic theories—as Mark Reynolds himself honestly admits—even if some surprising coincidences between the outlines of the plan of the survey, and attempts at finding a geometrical order may be more than simple random effects.

Conference organizers (left to right) Sylvie Duvernoy, Francisco Delgado, Kim Williams

A second discussion was suggested by the presentations of Kivi Sotamaa (“Driven by the Sublime”), Hernán Díaz Alonso (“Topologies of Beauty: From the Ugly to the Horrific”), and Carol Hermann (“Architecture and Programming: Generative Design”) about the role of the digital tool in the design. Again we were interested in methodology, but for artistic creation rather than for research purposes. Computer technology is the most sophisticated tool that modern mathematics has offered to designers, and reflections about its potentialities are a recurrent field of interest in Nexus conferences. The questions are: how did the digital computation influence the creative process of design, and what changes did it bring to our professional work? The general use of CAD (Computer-Aided Drafting) blossomed in the eighties and its success is undeniable. On the other hand, in the same time frame, CAAD (Computer-Aided Architectural Design) did not meet the original expectation of being able to solve problems from a qualitative point of view, rather than from a mere quantitative one. Nevertheless, in twenty years, digital representation has improved so much, especially in the 3D field, that it has certainly facilitated the modeling of complex 3D geometrical shapes, thanks mainly to the powerful instant visualization, on the screen of the computer, of the shapes themselves. Thus the question of the relationship between computers and design brings out the delicate question—one whose answer is far from immediate—of the influence of the representation techniques upon the design process: can we imagine shapes that we cannot represent? Shapes can be manipulated and engendered by algorithms, or specific

software products, which—architects repeatedly claim—are totally driven (and chosen) by the human brain. For instance, mathematical models for liquid phenomena inspired Kivi Sotamaa's design research. The final result will look the way its designer expects it to look—either sublime... or horrific—so the real question might be: what are the links between CAD and CAAD? Does computer technology only make the proliferation of free-form architecture possible, examples of which were few and exceptional in the pre-digital era? A definite conclusion has yet to be drawn, and the question needs to be discussed further—maybe at the next Nexus conference!

A fascinating example of relationship between representation and design, mathematics, and architecture was given by Mark Burry, who explaining the process of carrying out the construction of the Sagrada Familia in Barcelona. Burry showed how the complex shapes of the building elements, readable on what is left of Gaudi's hand sketches, are reproduced on the digital tool and expressed in mathematical terms, in order to be manufactured and assembled. First drawn on paper, the fantastic vision of the architect comes true thanks to an accurate computational analysis and 3D modeling, the purpose of which is to express the original passion for form.

The next Nexus conference will take place in Genoa, Italy, in June 2006, and we all look forward to this important appointment. Shared reflections and discussions always are an occasion for growth and progress in personal knowledge and science.

About the Author

Sylvie Duvernoy is an architect, graduated at Paris University in 1982. She later participated in the Ph.D. program of the Architecture School of Florence University and was awarded the Italian degree of "Dottore di Ricerca" in 1998. She presently teaches architectural drawing at the engineering and architecture faculties of Florence University. The research carried forth since the beginning of the post-graduate studies mainly focuses on the reciprocal influences between graphic mathematics and architecture. Architecture history shows that geometry and its related aesthetic symbolism were always present, hidden in architectural and urban design from antiquity to modern times. The way they were involved and the strength with which they were claimed, vary according to historical periods. These relationships have always been expressed by the means of the drawing: the major and unavoidable tool of the design process. The results of her studies were published and communicated in several international meetings and reviews.

Beside the research and teaching, she always had a private professional activity. After having worked for a few years in the Parisian office of an international Swiss architecture firm, she is now partner of an associate office in Florence, the design projects of which cover a wide range of design problems, from remodeling and restoration to new constructions, in Italy and abroad.