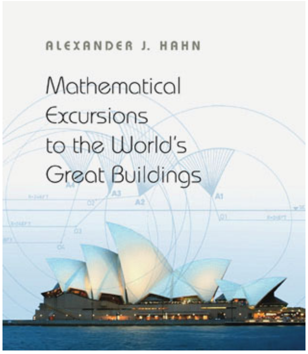

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Book Review

Alexander J. Hahn

Mathematical Excursions to the World's Great Buildings

Princeton and Oxford, Princeton University Press, 2012

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A conversation between a mathematician (Jesper Matthiassen) and an architect (Sylvie Duvernoy) about Alexander Hahn's new book

Alexander Hahn is a professor of mathematics at the University of Notre Dame, in South Bend-Indiana, and his new book *Mathematical Excursions in the World's Great Building* is obviously an outcome of his teaching experience.

The book is divided into seven sections:

– Humanity awakening: sensing form and creating structures;
– Greek geometry and Roman engineering;
– Architecture inspired by faith;
– Transmission of mathematics and transition in architecture;
– The Renaissance: architecture and the human spirit;
– A new architecture: materials, structural analysis, computers and design;
– Basic calculus and its application to the analysis of structure.

J.M.: It's not often that books fully dedicated to both mathematics *and* architecture are published. And usually these inspiring publications are written by architects and therefore primarily based on an architectural point of view. But Alexander Hahn's book is of another kind. It is written by a professional mathematician exploring architecture and architectural topics. It is thus very interesting and intriguing because it presents the reader with another way to approach and "read" architecture, that is, from a mainly mathematical perspective. For a mathematician it is an immediate pleasure both to follow Alexander Hahn on his journey to the world's great buildings as well as to re-explore basic and more advanced mathematical topics used to analyze the buildings.

S.D.: A historical overview of the world's architecture written by a mathematician is not going to be appreciated by the community of scholars in architecture history. Incursions in the field on behalf of "non-specialists" are not welcome. But since historians rarely address topics such as the relationship between theoretical mathematics and innovation in architectural design and/or building technology, *Excursions* (which focuses on this

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very question) sheds new light on the study of historical architecture, inquiring into aspects that are too often hastily dismissed. This is not just another history of architecture: it is meant for students and scholars interested in the reciprocal influences between several disciplines belonging to both art and sciences, namely architecture, mathematics and engineering.

J.M.: The presentation of the world's great buildings is based on Hahn's own studies and from his personal standpoint as a contemporary scientist. He is aware of the fact that the mathematical comments about the buildings studied are standard by today's criteria. Further – as he states himself – such notions would (most often) have been beyond the reach of the architects who built the buildings. Often Hahn seizes the opportunity to present a bit more mathematics than actually needed to analyze the buildings or their construction. This is splendid seen from the point of view of a mathematics teacher, and it might help fellow teachers to be aware of how often architecture as a theme can be combined with most ordinary mathematical topics.

S.D.: The criticism about the volume may comprise some of the usual negative comments that any historical overview is likely to receive: some chapters are much more superficial than others; some historical periods are studied less in depth than others, and some thematic bibliographic references are weak and few (for instance, the bibliography of chapter 2). Of course, any section could be the subject of a full treatise, comprising many chapters, and giving a much broader and comprehensive analysis of the specific topic. But this criticism fades away if instead of considering the volume as a historical overview of the world's architecture we view it as a collection of some significant case-studies arranged in chronological order.

The positive aspect of the book is that, just like any other thematic collection of case-studies, it sums up and gathers in a single volume various research results that would otherwise be long and tiresome to collect by reading the many scattered publications in which they are discussed.

J.M.: Chapter 7 and two sections of chapter 5 (on Linear Perspective) are generally more based on geometry and calculus but these chapters can be (partly) omitted in a more non-mathematical reading of the book. Chapter 6 is somewhat technical (about statics) and focuses on an icon of modern architecture, the Sydney Opera House. To fully understand the huge difficulties involving the construction of the shells and the simplicity of the solution, this chapter is a "must" for the reader.

S.D.: Throughout his book Hahn addresses the two main aspects of the relationship between architecture and mathematics: the question of the shape design (geometry and form-finding) and the question of statics (the structural calculations). The question of innovation also subtends all studies. Art and sciences continuously and simultaneously progress and innovate throughout the ages. What tricky computational problems were prompted by the desire for new forms, for monumentality, and what scientific progress were achieved thanks to the obstinacy of architectural designers?

Both aspects, aesthetical and practical, meet where and when the question of feasibility arises. An architectural design has neither value nor meaning if it cannot be transformed into an actual building, and any practising architect knows how difficult it is to control the precision of the building operations, avoiding alterations being made to the design by collaborators or other partners involved in the construction. The feasibility of the design is a goal that is sometimes hard to reach. Hahn insists that most often mathematical notions are beyond the reach of architects, but they are always a challenge to engineers and mathematicians themselves, when innovation is concerned. Answers to problems, progress in knowledge and cultural growth stem from the collaboration between parts. It took five years to Jørn Utzon and Ove Arup to define the geometrical shape of the sails of the Sidney Opera House. The paragraphs dedicated to the history of this building beautifully conclude the architectural pages of Hahn's book. They illustrate in a brilliant way the relationships between technology, art and science, showing how geometrical insight gave life to a creative design. The answer to technological problems does not alway lie in the finding a new or innovative mathematical object, but rather in the innovative use of classical geometry.

J.M.: Each chapter ends with a section called "Problems and Discussions". From a mathematical and didactical point of view these are some of the most welcome parts of the book. All teachers of mathematics know that exercises are important for getting a profound understanding of mathematical theories and facts, and that exercises are a necessity for becoming familiar with the strategies for problem-solving in general. In *Mathematical Excursions to the World's Great Buildings* an extra dimension is added to this. The mathematics behind the problems and exercises in the book can be divided into three different types; 1) mathematics used for the actual construction of buildings, 2) mathematics useful for analyzing buildings and finally 3) the mathematics for the mathematics itself, that is, without any relationship to architecture at all. The problems of type 1 and 2 and the outlined discussions in the end of each chapter really help the reader to develop the ability to view architecture in another way: from a mathematical viewpoint. Besides becoming trained mathematically the students can acquire a new skill: viewing architecture from a mathematical standpoint might add something extra to the experience and understanding of the esthetics.

About the reviewers

Sylvie Duvernoy is an architect, graduated from 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. After having taught architectural drawing for several years at the engineering and architecture faculties of the University of Florence, she now teaches at the Politecnico di Milano. The research carried forth since the beginning of the post-graduate studies mainly focus 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 Journals. She is the Book Review Editor for the *Nexus Network Journal.*

Jesper Matthiasen received a M.Sc. in mathematics and physics from Aarhus University, Denmark, in 1988. He has afterwards made supplementary studies in history of arts at Aarhus University due to an interest in mathematics combined with both architecture and visual arts. Since 1989 he has been teaching mathematics at upper secondary school level at Aarhus Akademi, and during 1998-2000 he was a lecturer in History of Arts at the University of Copenhagen. Since 2002 he has been engaged in the training and education of new math teachers at the upper secondary schools, and he is an external examiner for both universities and schools of engineering throughout Denmark. He is a member of the 2012-2013 editorial board of the *Nexus Network Journal.*