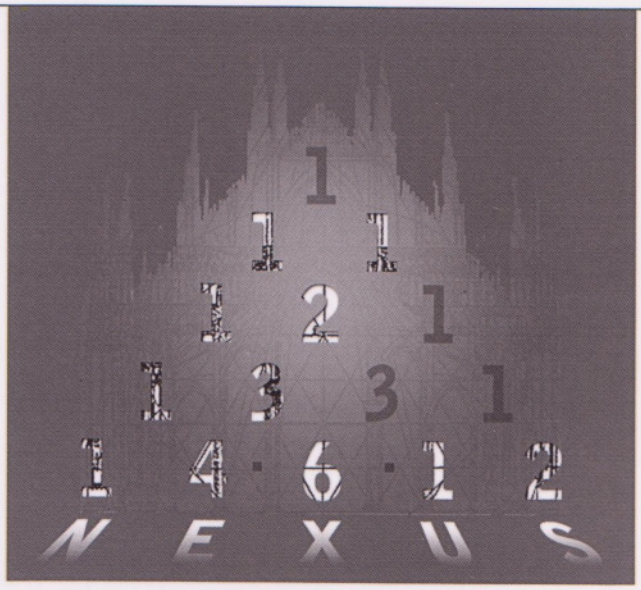
Michela Rossi (editor)

Nexus Ph.D. Day. Relationships between Architecture and Mathematics



Proceedings of the
Nexus 2012
Relationships between Architecture and Mathematics
Ph.D. Day and Poster Session

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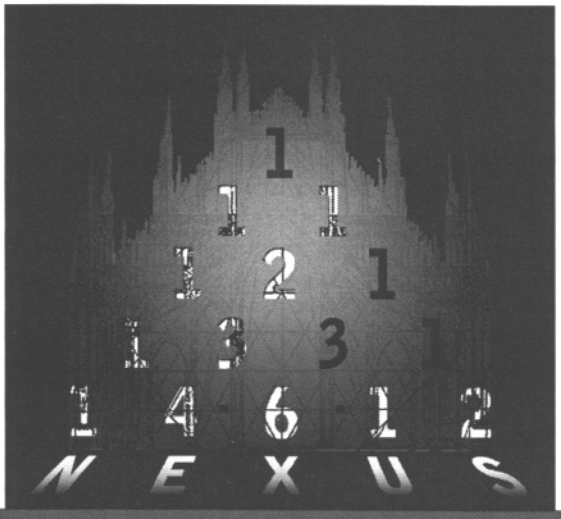

Nexus Ph.D. Day

Relationships between Architecture and Mathematics

and Poster Session

Politecnico di Milano
11-14 June 2012

edited by Michela Rossi

Nexus: Relationships between Architecture and Mathematics

1996 - Fucecchio (Florence) Italy
1998 - Mantua, Italy
2000 - Ferrara, Italy
2002 - Óbidos, Portugal
2004 - Mexico City, Mexico
2006 - Genoa, Italy
2008 - San Diego, California, USA
2010 - Porto, Portugal
2012 - Milan, Italy

The Nexus conferences were created by Kim Williams, with the first edition held in 1996, with Nexus '96 held in Fucecchio (Florence) Italy, sponsored by the Fondazione Montanelli-Bassi, under the direction of Kim Williams. The second conference, Nexus '98, took place in Mantua, Italy, under the auspices of the Accademia Nazionale Virgiliana and the Centro Studi Leon Battista Alberti di Mantua, directed by Kim Williams and Livio Volpi Ghirardini. It was at the second conference that the decision was made to begin the Nexus Network Journal. The founding of the NNJ made possible communication and diffusion of research between the biennial Nexus conferences. Nexus 2000 took place in Ferrara, Italy, directed by Kim Williams, with the support of the Dipartimento di Matematica and the Dipartimento di Architettura of the University of Ferrara. It was at this conference that the first Round Table Discussion was held, providing an important forum for interdisciplinary discussion. Nexus 2002 was held in Óbidos, Portugal, sponsored by the Centro de Matemáteca e Aplicações Fundamentais (CMAF) of the University of Lisbon. Co-directed by Kim Williams and José Francisco Rodrigues, it was the first Nexus conference held outside Italy. Nexus 2004, co-directed by Kim Williams and Francisco Delgado Cepeda, took place in Mexico City, with the support of the Instituto Tecnolólogico de Estudios Superiores de Monterrey, Campus Estado de México. Nexus returned to Italy with Nexus 2006 in Genoa, co-directed by Kim Williams, Orietta Pedemonte and Sylvie Duvernoy, sponsored by the Dipartimento per la Scienza dell'Architettura of the University of Genova. Nexus 2008 was hosted by Point Loma Nazarene University in San Diego, California, and was co-directed by Kim Williams, Maria Zack, and Sylvie Duvernoy. The 2010 edition of Nexus took place in June 2010 in Porto, Portugal, sponsored by the Faculty of Sciences, the Faculty of Architecture, and the Centro de Matemáteca of the University of Porto and the FCT – Fondação para a Ciência e a Tecnologia, and was co-directed by Kim Williams, João Pedro Xavier, and João Nunes Tavares.

The aim of the Nexus Conferences
There are many connections between architecture and mathematics: mathematic principles may be used as a basis for an architectural design, or as a tool for analyzing an existing monument; architecture may be a concrete expression of mathematical ideas, becoming, in a sense, "visual mathematics". The purpose of the Nexus conference series is to bring together all those working with ideas related to both architecture and mathematics, and to allow researchers to exchange ideas first-hand. Papers presented at the conference are subsequently published, providing a permanent archive of studies in architecture and mathematics.

The Nexus Network Journal
The *NNJ* is a peer-reviewed research resource for studies in architecture and mathematics published three times a year in print by Kim Williams Books and Birkhäuser Publishers and is available online at SpringerLink. In 2010 the *NNJ* was accepted into the Thomson-Reuters ISI database. The purpose of the *NNJ* is to publish research in architecture and mathematics that present the subject in the widest possible panorama. Thus, like the Nexus conferences, the *NNJ* is interdisciplinary and multicultural. Topics explored include proportion, geometry, algebra, topology, symbolism, fuzzy logic, complexity theory, fractals and chaos, tessellation, modularity, perspective, metrology, symmetry, music, astronomy, construction history and mechanics, and the application of these in architecture, landscape architecture and urban planning in all cultures and all epochs.

www.nexusjournal.com

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Authors (papers and abstracts)

ARCHITECTURE IN THE DIGITAL AGE
Evolution of the language and contemporary design

Alessia Riccobono
University of Palermo, Dipartimento di Architettura
Ph. D. course in Recovery of Ancient Contexts and Innovative Processes in Architecture - XXIV cicle

Abstract
The 'computer revolution' is the most obvious phenomenon of our time. The new capabilities introduced by the digital drafting have triggered a substantial evolution of the relationship between representation and design. The diffusion of digital technologies in Architecture has opened new frontiers in the design field, stimulating the development of a new expressive language that promotes generating complex shapes. On the other hand, the shape often becomes the main interest of the designers. Then, is the project only a formal question? Are the glamour images become the main target to which the 'New Architecture' aims?

Key words
Design Process, Digital Tools, New Trends, Criticism, Architectural Quality.

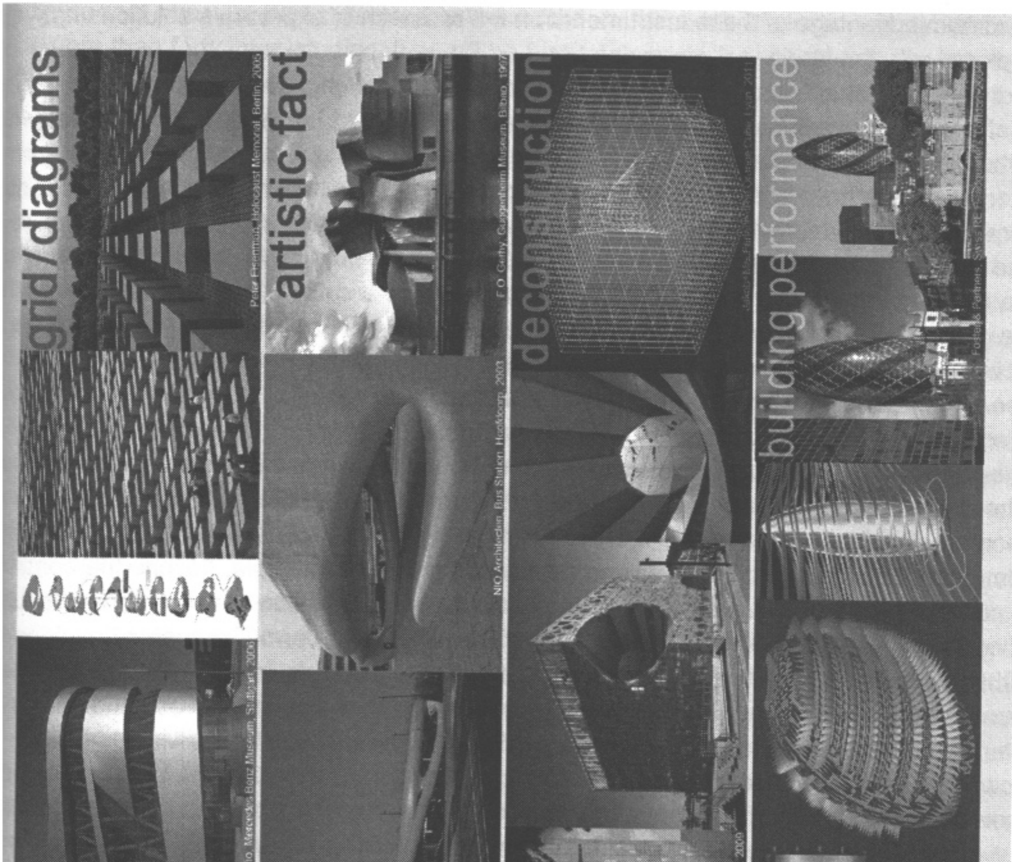
1. Introduction

Through the centuries, the Architecture has always reflected the historical period, the innovations, technological or not, the social and cultural progress that have generated it. In the age of globalization and cyber-culture, the Architecture has used various disciplines and tools belonging to other fields of knowledge and has introduced them into the design conception, creating new expressive languages. The innovation that changed the background of contemporary architecture is undoubtedly related to the birth of the computer technologies. In fact, the use of CAD/CAAD software has certainly expanded the possibility of representation the architectural objects. But it has also triggered a revolution in design methodology linked to the endless possible spatial variations of the architectural shape.
The PhD research arises by the desire to understand the influence of the digital tools in architecture, valuating the critical aspects and the limits imposed by them.

2. The research

Before the advent of digital technologies the conception of architectural form was mainly based on the principles of Euclidean Geometry. The design could arise by composition and synthesis of basic geometrical shapes, because they were easily controlled by whole knowledge possessed at that time. The actual modeling software offers the ability to handle complex shapes in three dimensional space, a place where we can virtually represent the real physical space. Many architects have introduced the new software in their design practice, trying to exploit the instrumental opportunities offered to improve the productivity of their work and using the digital tools only as a virtual sheet. The others have taken

NEWTRENDS in the contemporary Architecture
mathematical
derivation
Ron Arad, Design Museum in Holon, 2010
fluidity / fluxes
blob
folded surfaces


grid / diagrams
Peter Eisenman, Holocaust Memorial, Berlin, 2005
UNStudio, Mercedes Benz Museum, Stuttgart, 2006
Zaha Hadid, maXXI, Rome, 2010
artistic fact
F.O. Gehry, Guggenheim Museum, Bilbao 1997
NIO Architecten, Bus Station, Hoofddorp, 2003
Vito Acconci, Mur Island, Graz, 2003
deconstruction
Morphosis, Cooper Union Building, New York, 2009
building performance
Foster & Partners
Foster & Partners, City Hall, London, 2002
NEWTRENDS in the contemporary Architecture

maximum advantage of these instruments on the research of expressive solutions not yet explored with the traditional representation.

In the history, the Geometry has had constant relationship with the Architecture. This relationship was fruitful, until the concepts were translated into real-world applications rather than in physical objects[1] unrelated to the surrounding environment. The current interest seems have a different character. Some geometrical concepts are abstract and conventional, the mathematics becomes a presumed property of the architectural space. The use of the software controlling architectural shape may have indirectly reinforced the feeling of some architects to be the protagonists of a cultural environment, in which the geometry, science and philosophy are the fundament of new expressive avant-garde. Several projects suffers from excessive solipsism and they are often self-referenced. Then, it is natural to ask if the relationship between digital modeling tools and some trends in contemporary architecture is become only a formal fact.

The keywords employed by this new Architecture use a lexicon traditionally belonging to other fields of knowledge in order to legitimize some projects. We talk of non-Euclidean geometry, topology, dynamism, morphing, unpredictability, non-formal, fluidity, etc, but some concepts are often banally interpreted and used. For example, despite the control of complex surfaces, in reality all software works in the Cartesian space. The existence of non-Euclidean spaces is solely an illusion. Some projects borrow concepts developed within scientific and mathematical theories and translate them into formal results, like in the paradigmatic case of the Möbius House by UNStudio, where the shape was generated by the manipulation of one of the classical topological surfaces, such as the Möbius Strip.

Nowadays we can talk of Post-Digital Age, because for many years the buildings have showed marked signs of undoubted use of the new media. The architecture is very much a synthesis between the virtual, the actual, the biological, the cyborgian, the augmented and the mixed[2]. Today it is necessary to reflect about the changes that architecture has undergone and is undergoing, to understand the real results and meanings of more than ten years of digital experimentation in the construction industry. We are past the initial doubtful phase, with the first reactions of enthusiasm or concern. The problem is no longer whether digital technology is a good or bad thing for design, but it is rather about the direction architecture is taking under its influence[3].

The first phase of the research was dedicated to the description and the analysis of the status questionis with updated and appropriate bibliography and with a selection of examples of built architectures. The second step was necessarily dedicated to a short but necessary historical digression on the concept of shape in contemporary Architecture and on the evolution of the language in the last years, and to the analysis of the various trends about the digital design process, such as Generative Design, Performative Architecture, Digital City Planning, BIM. In addition, it was necessary to study the influence of intrinsic and extrinsic disciplines on contemporary architecture, such as topology, natural sciences, contemporary philosophy, industrial design and technological innovations to understand the architectural language evolution.

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1 PELLITTERI, Giuseppe, (2010), *L'involucro architettonico. Declinazioni digitali e nuovi linguaggi*, Fotograf, Palermo.

2 SPILLER, Neil, (2009), Plectic architecture: towards a theory of the post-digital in architecture, in TECHNOETIC ARTS, 7 (2), Intellect, 95-104.

3 PICON, Antoine, (2010), Digital Culture in Architecture, Birkhäuser, Basel.

The current phase is being devoted to the selection, the evaluation and the classification of more than forty case-studies, that will be further increased up to at least one hundred. The cases chosen are high-quality built architectures strongly influenced by digital tools and culture, over a period that covers the last fifteen years. Furthermore, they are not into a specific geographical area, because the effects of digitization on the evolution of architectural shape are evident on global scale.
Understanding the new directions in the architectural contemporary design it is a complex issue and a historical-typological approach is useful to evaluate the real quality of the built works. Assessing the quality of architecture is certainly a task that requires a vast knowledge, not only limited to our discipline, but it implies a logical and conscious process. Therefore, the main operation was to define the parameters and after to assign a scale of evaluation to each one. We choose several parameters, such as functional features, internal spatiality, relationship with the urban context, needs of the user, response to the needs of the clients, consistency with the structure, conformative features of the envelope, generative features, environmental performances, expressiveness, figurativeness, semantic/symbolic communication, rules and code, etc.
The case-studies were then categorized and evaluated according with the quality standards. We have seen that several realizations suffer from an excessive partiality, due to the software used and the theories - Mathematical, philosophical, genetic - to which the project was inspired have prevailed on other intentions. Very often, these projects have considered only few of these parameters, sacrificing all the others, and were characterized by a little attention to the urban context and landscape o to the spatial properties. In turn, the best works are the result of a masterly design synthesis, combining aesthetic values and design intents, functional requirements and formal features, respect of environment and generative rules, etc. The case-studies were then categorized and evaluated according to the quality standards. In parallel, we have defined a lexicon of the current architectural trends due to the use of digital technologies. Each architecture was then classified according with many categories, such as blob, grid, diagrams, fluidity, fluxes, pattern, artistic fact, deconstruction, mathematical derivation (topology, fractal, mathematical theories, evolutionary algorithm), natural derivation (genetic code, biological systems), folded surfaces, etc. Some buildings may have more than one classification. The aim was to understand which are the most common trends, if several ways of designing are recurrent in the architectural practise, if they interact each other and with which results.

3. Conclusion

We have seen that many cases studied, whose architectural quality is high, fall into the cases in which are prevalent, among the criteria assigned, fluidity, flows, patterns (40%). It is evident that the prevailing trend seems to be almost a New Expressionism or a New Baroque, privileging curved lines and complex geometries. These derive both from Mathematical, philosophical, genetic theories (Topology, folded surfaces, genetic code), both form the values of a society increasingly interconnected and dynamic, dominated by a constant flux of information, people, pictures, objects. The projects of some architects like Zaha Hadid, Coop Himmelb(l)au, Frank O. Gehry are emblematic of such language and figurativeness. Their architecture is the result of a complete spatial and theoretical

research and the computer is only the media that allows to give form to an idea. In turn, other projects seem to be derived only from the great potential of the 3D modeling and scripting software, with contrasting results, as much new interesting expressive languages, as only formal and stylistic drifts. The image seems now the true aim of many architects, with all its consequences, such as fashions and styles. Certainly the image, when it is perceived, has the value of the sign. But a sign with that meaning? It is often a stereotype meaning, extracted from a set of declared positive values. It seems that the problem, as it often happens, is put in terms of novelty: new shapes, or rather, shapes before not seen and not experienced, which can be translated into pictures to be taken for glossy magazines.

As the invention of perspective in the fifteenth Century radically changed the conception of architectural space, there is no doubt that digital technologies have introduced a revolution in architectural design. But, up to now, the Digital Age gave us only these products. Expressive languages seem to emerge from instrumental, procedural and artistic facts, with considerations primarily limited to the shape, without attention to the needs of the space in all its existential articulations. The form, expression of an incomplete spatial research, very often remains or becomes only the image, in the continuing search for a visibility at all costs.

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[3] TSCHUMI, Bernard, CHENG, Irene, (2003), *The State of Architecture at the Beginning of the 21st Century*, The Monacelli Press, New York.

Michela Rossi (editor)

Nexus Ph.D. Day. Relationships between Architecture and Mathematics

The IX edition of the International Conference Nexus-Relationships between Architecture and Mathematics at Politecnico di Milano, sponsored by Department of Industrial Design and Department of Mathematics comprises a workshop dedicated to Ph.D. students.

The event is sponsored by the Politecnico Ph.D. School and the Design Ph.D. program of Department INDACO and by the National (Italian) Ph.D. School in "Science of Represen tation and Architectural Survey".

The "Nexus Ph.D. Day" is meant to be an international and multi-disciplinary meeting between Ph.D. students involved in scientific researches in the fields that are connected to the topic of the Conference. It intends to promote didactic and research exchanges trough interactions between various schools from different countries.

This will give the opportunity to Ph.D. students and young Ph.D. fellow, who have di fensed their thesis in 2010 or later, to show their work to a large international academic community, by the oral presentation of selected lecture and a poster session related to the conference one, to improve a meeting among people working on similar issues, generally concerning the relationships between Architecture and Mathematics in all the different scales of design.

The papers that are presented in the Ph.D. Day and those only published in the printed proceedings were selected with double blind review from anonimous revisers.

General topics:

- Theory and analysis of design in architecture, landscape and artefacts
- Design grammars, morphology, parametrical transformation
- Complex shapes and structures in architecture and industrial design
- Harmony and architecture (music and proportions)
- The digital 'lecture': a syntesis of history, science and architetcture
- The digital model: innovative methods of survey and representation
- Real-world data shape representation: from mathematics to visualization

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