The teaching of parametric modeling in the School of Architecture at the Politecnico di Torino

UAUIM | FACULTATEA DE ARHITECTURĂ DE INTERIOR | 20 DE ANI DE ARHITECTURĂ DE INTERIOR ȘI DESIGN

ARCHITECTURAL EXPERIENCES

PROCEEDINGS

INTERNATIONAL CONFERENCE OF ARCHITECTURE AND DESIGN

30-31/10/2023

COORDINATORS/EDITORS:
OANA DIACONESCU
DANIEL N. ARMENCIU
BOGDAN M. IONIȚĂ

PROIECT CO-FINANȚAT DE:
Administrația Fondului Cultural Național
UAUIM
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ACCADEMIA ADRIANEA EDIZIONI,
Roma, 2024

20 ARCHITECTURAL EXPERIENCES - Proceedings-
International Conference of Architecture and Design 30-31/10/2023

The publication presents the full paper of the scientific communications from the "20 Architectural Experiences" International Conference, aiming to disseminate architectural and design research studies.

Coordinators/Editors:
Oana DIACONESCU, Daniel N. ARMENCIU, Bogdan M. IONIȚĂ

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ISBN 978-88-99013-37-0

ARCHITECTURAL EXPERIENCES

DTP and cover:
Bogdan IONIȚĂ

The paper represents the authors' statement and their responsibility of its content and form.

INTERNATIONAL CONFERENCE OF ARCHITECTURE AND DESIGN - "20 ARCHITECTURAL EXPERIENCES"

The Faculty of Interior Architecture is celebrating its 20th anniversary this year. Due to this occasion, we had invited professors, alumni and abroad guests to join us for a special reunion conference.

Over the past two decades, the Faculty has grown and developed, producing some of the brightest design solutions in the interior architecture and product design field in Romania. This conference allows professors and professionals to connect, network, and share their experiences.

The conference was held on the 30th-31st of October at "Ion Mincu" University of Architecture and Urban Planning and featured some prominent figures in the field as keynote speakers. Breakout sessions also covered various topics related to the Faculty's areas of research.

In addition to the conference, the agenda includes five special reunion events, organized as Round tables, which have allowed all the speakers to share their knowledge and provide new perspectives for architectural education.

All these researched areas played a crucial role in shaping the future of our built environment. By bringing together people from diverse cultures, the conference created a platform for sharing ideas and perspectives that enriched the field of architecture. Through research, architects can develop innovative solutions to complex challenges while focusing on new visions, enabling us to push beyond established norms and explore exciting new possibilities. Ultimately, investment in architectural education and research can help create a built environment that is sustainable, equitable and inspiring for all.

The "20 Architectural Experiences" event aimed to help members of universities and professionals find innovative solutions in imagining the entire design process and analyzing its long-term effects and consequences.

Architecture acts as a bridge connecting different aspects of thought processes, ideologies, and perspectives that shape our society. It represents a tangible manifestation of cultures, traditions, and beliefs, giving physical form to the intangible. The structural design, building materials, and overall aesthetics of architecture reflect the values and principles of a specific period or community, presented in the five main conference topics. The event underlined the fusion of art and science to create spaces that serve as a canvas for human interaction and creativity, influencing our behaviour and leaving a lasting impact on future generations.

MAIN COORDINATOR:
Assoc. prof. arch. **Oana DIACONESCU**
Dean of the Faculty of Interior Architecture

The “20 Architectural Experiences” conference has been carefully crafted, encompassing five comprehensive sections that explore crucial facets of modern architecture and design.

Section One: Architectural Education confronts the complexities of architectural education, a domain characterized by its malleability and intricacies. As we embark on this section, we aim to tackle pressing issues, including the evolving roles of curricula, the challenges posed by artificial intelligence (AI), innovative teaching methodologies, emerging trends in the architectural profession, and the importance of interdisciplinary approaches. The overarching objective is to create a global network of strategic significance, fostering the exchange of educational research methodologies and engaging in thoughtful discourse on the future development of academic fields in architecture, urban planning, and design.

Section Two: Perception on Architecture can be decoded through senses emphasizes the profound connections between human beings, their needs, and the built environment. It is our belief that research in this realm is indispensable, and thus, we explore topics such as universal design, healing architecture, the sensory aspects of understanding architecture, and arguments surrounding bio-architecture. Our primary aim is to integrate the human perspective into the narrative of architectural and urban design, emphasizing themes such as well-being, biophilia, eco-design, and the cultural approach to sustainability.

Section Three: Techniques and Technology in Architecture invites extensive discussions on the threats and opportunities associated with the rapid evolution of technology in building design. This section delves into smart cities, urban resilience, the limits of technology in architecture, architectural vulnerabilities, architecture at risk, and the importance of technology in building design, including sustainability, circular economy concepts, BIM technologies, VR, and digitalization. Our mission is to foster a balanced negotiation between the latest technological developments and their seamless integration into the creative architectural design process.

Section Four: Monuments and Historical Traces recognizes the fragility of our built heritage and the pressing need for knowledge, interest, and preservation. With a focus on urban regeneration and the restoration of lost identities, this section explores topics such as archaeological remains, heritage preservation, vanished artifacts, war remnants, reuse, restoration and conservation, urban archaeology, archaeological risk assessments, landscape heritage, and urban transformations. Our purpose is to deepen our understanding of heritage and its integration into the collective knowledge of our cities.

Section Five: Re-Imagining Design unveils the complexity inherent in the world of design, which involves art, engineering, and architecture. We examine topics such as design interdisciplinarity, design history, product and industrial design, graphic design, design methodologies, design thinking, social innovation through design, democratic design, human -centered design, universal design, inclusive design, BIM modeling, and GIS. This section aims to redefine the role of designers and reinvigorate the profession with cutting-edge tools, techniques, and knowledge

Assist. designer **Bogdan IONIȚĂ**

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The forthcoming conference is organized with the principal objective of commemorating the two-decade milestone since the establishment of the Faculty of Interior Architecture. This auspicious event is poised to convene a distinguished assembly of scholars, seasoned practitioners, and prominent institutions, all with the purpose of engaging in a rigorous discourse pertaining to the emerging architectural, urban planning, and design paradigms. The deliberations are anticipated to foster a comprehensive and interconnected outlook, emphasizing the interdisciplinarity that characterizes contemporary endeavors in these domains.

01

SECTIONS:

ARCHITECTURAL EDUCATION

Architectural education is a flexible yet complex field of study, therefore defining its limits and methods represents a challenge for academics and researchers alike.

TOPICS: the roles of curricula, artificial intelligence (AI) challenges, teaching methodologies, tendencies of the architectural profession and interdisciplinarity.

PURPOSES: creating an international strategic network, encouraging the exchange of methodologies and educational research, and debating visions on the further development of the academic field in architecture, urban planning and design.

CONFERENCE MODERATORS:
Lecturer arch. **Daniel N. ARMENCIU**
(**Faculty of Interior Architecture**)

Prof.arch. **Angelica STAN**
(**Faculty of Urban Planning**)

SECRETARY:
Lecturer. arch. **Cristina Maria CHIRA**

02

PERCEPTION ON ARCHITECTURE

Space can be decoded through senses, generating connections between human beings, their needs, uses and the built environment, therefore research on this topic is indispensable.

TOPICS: universal design, healing architecture, the use of senses in understanding architecture, arguments on bio-architecture (wellbeing, biophilia, eco-design, etc.) and a cultural approach to sustainability.

PURPOSES: integrating the human being in the narrative of the architectural and urban design process.

CONFERENCE MODERATORS:
Lecturer arch. **Codruța IANA**
(**Faculty of Interior Architecture**)

Lecturer arch. **Mihaela ZAMFIR**
(**Faculty of Architecture**)

Prof. arch. **Augustin IOAN**
(**Faculty of Architecture**)

SECRETARY:
Assist. arch. **Alexandra STAN**

03

TECHNIQUES AND TECHNOLOGY IN ARCHITECTURE

This section encourages discussions on threats and opportunities arising along with the fast development of technology applied in buildings' design.

TOPICS: smart cities, urban resilience, limits of technology in architecture, architectural vulnerabilities, architecture at risk and the importance of technology applied on buildings' design (sustainability, circular economy concepts, BIM technologies, VR and digitalization, etc.), technical details integration.

PURPOSES: negotiating the balance between the latest technological developments and their integration into the creative architectural design process.

CONFERENCE MODERATORS:

Assoc. Prof. arch. **Codina DUȘOIU**
(**Faculty of Interior Architecture**)

Lecturer arch. **Monica MUREȘANU**
(**Faculty of Architecture**)

Assoc. Prof. arch. **Claudiu RUNCEANU**
(**Faculty of Urban Planning**)

SECRETARY:

Assist. int. arch. **Roxana MITARCĂ**

04

MONUMENTS AND HISTORICAL TRACES

Given the fact that the built heritage is at risk due to a lack of knowledge, interest and preservation, this section wants to highlight studies, research and design projects which are looking not only into the regeneration of the urban tissue but also into regaining the lost identity of the place.

TOPICS: archaeological remains, heritage, disappeared artifacts, traces of war, reuse, restoration and conservation, urban archaeology, archaeological risk charts, landscape heritage, urban transformations.

PURPOSES: understanding and integrating heritage in the collective knowledge of the city, the use of memory in recreating the dialogue between built remains, communities and landscapes.

CONFERENCE MODERATORS:

Assoc. Prof. arch. **Oana DIACONESCU**
(**Faculty of Interior Architecture**)

Assoc. Prof. arch. **Horia MOLDOVAN**
(**Faculty of Architecture**)

Assoc.Prof. arch. **Mihaela HĂRMĂNESCU**
(**Faculty of Urban Planning**)

SECRETARY:

Assist. int. arch. **Mihaela Cecilia LAZĂR**

05

RE-IMAGINING DESIGN

Design has always been a complex phenomenon encompassing not only a diverse intersection of art, engineering, and architecture but also highlighting the need of constantly redefining the profession of the designer.

TOPICS: design interdisciplinarity, design history, product and industrial design, graphic design, design methodologies, design thinking, social innovation through design, democratic design, Human centered design, universal design, inclusive design, BIM modelling, GIS.

PURPOSES: redefine the role of the designer and the way this profession can shape the future through the use tools, techniques and knowledge.

CONFERENCE MODERATORS:

Lecturer arch. **Mihnea SIMIRAȘ**
(**Faculty of Architecture**)

Lecturer urb. **Ana OPRIȘ**
(**Faculty of Urban Planning**)

Assist. designer **Bogdan M. IONIȚĂ**
(**Faculty of Interior Architecture**)

SECRETARY:

Assist. arch. **Alexandra DUNEL**

CONFERENCE KEYNOTE SPEAKERS

Arch. **Lukas BOBOTIS** –
BOBOTIS+BOBOTIS ARCHITECTS, Athens, Greece;

Arch. **Vadim BABIJ** –
DO ARCHITECTS, Vilnius, Lithuania;

Product Designer **Michael SANS** –
SANS, Berlin, Germany.

ROUND TABLE

The panels will be followed by a round table associated to each section, moderated by:

Asoc. Prof. arch. **Oana DIACONESCU**
/ARCHITECTURAL EDUCATION

Prof. arch. **Augustin IOAN**
/PERCEPTION ON ARCHITECTURE

Prof. arch. **Rodica CRIȘAN**
/TECHNIQUES AND TECHNOLOGY IN ARCHITECTURE

Prof. arch. **Mihaela CRITICOS**
/MONUMENTS AND HISTORICAL TRACES

Assoc. Prof. arch. **Ionuț ANTON**
/RE-IMAGINING DESIGN

CONFERENCE GUESTS

Prof. arch. **Marian MOICEANU** –
Rector of ”Ion Mincu” University of Architecture and Urban Planning;

Assoc. Prof. arch. **Mariana CROITORU** –
Head of Interior Design and Design Department;

Lecturer arch. **Valerica POTENCHI** –
Head of Study of Form and Ambience Department.

Faculty of Interior Architecture administrative:
Prof. arch. **Iulius IONESCU** –
Dean of the Faculty of Interior Architecture 2003-2012;

Prof. arch. **Marius Marcu LAPADAT** –
Dean of the Faculty of Interior Architecture 2012-2016;

Prof. arch. **Beatrice JOGER** –
Dean of the Faculty of Interior Architecture 2016-2020.

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Dean of the Faculty of Interior Architecture

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Vice-Dean of the Faculty of Interior Architecture

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Assist. int. arch. **Roxana MITARCĂ**
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THE TEACHING OF PARAMETRIC MODELING IN THE SCHOOL OF ARCHITECTURE AT THE POLITECNICO DI TORINO/

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Abstract. Almost 15 years ago the first course dedicated to the Building Information Modeling (BIM) methodology was included in the Master of Science (MSc) in Architecture at the Politecnico di Torino. At the same time, the job's world in Italy has changed, thanks also to the publication of legislation that now makes the adoption of BIM mandatory for public works with an amount over 1 million euros. This course is proposed by the Drawing discipline (ICAR/17), whose declaratory clearly states that the sector deals with the generation, construction and analysis of drawings, images and models, as outcomes of scalar representations of existing or planned realities. By the way, the parametric approach can take on multiple forms, favoring multidisciplinary collaborations that allow for in-depth study of specific themes proposed by the design disciplines. In this regard, according to the recent reform of the Master's Degrees, the theme of Parametric Modelling has been appropriately declined on the different programmes.

In the MSc in Architecture Construction and City, the *Parametric Digital Modelling* course (6 ECTS ICAR/17) provides the necessary cultural, critical and operational tools to introduce students to the BIM modeling applied to the design, construction and management process. Alternatively, the *Architecture and Computational Design* atelier (6 ECTS for: ICAR/14-Architectural Design; ICAR/17), considers parametric design as an ideational and compositional process, through the explicitation of a conception process inextricably linked to the representation process. The design process is linked to the investigation of drawing methods and tools used today for the prefiguration of the architectural project: modeling supported by Visual Programming Language (VPL) enables the management of morphological/functional complexity in the compositional phase, the BIM approach anticipates and resolves the building's construction issues.

In the MSc in Architecture for Sustainability the *Parametric and Algorithmic Digital Modelling* course (6 ETCS ICAR/17) allows the acquisition of new methodologies for the control of complexity, specially intended in the integration of the different systems (spatial, structural, cladding, etc.) that make up the architectural object; we work on the application of constructive logic to parametric modeling, emphasizing the role of efficiency, legibility and generalization of the compositional process of the algorithms. In the *Parametric and algorithmic modeling* atelier (4 ECTS for: ICAR/14; ICAR/17; ING-IND11 - Building Physics), forms and elements are designed by defining their performance standards and verifying their construction and production methods. In this sense, the parametric approach enables the management different information systems, allowing changes to the project to be made quickly and precisely or to investigate a range of possibilities/alternatives, starting from numerical (dimensional, quantitative, performance) or formal hypotheses assigned.

In the MSc in Architecture for Heritage, the *Point Clouds and HBIM* course (4 ECTS ICAR/17; 2 ECTS ICAR/06-Geomatics), explores the potential of BIM for Cultural Heritage. The H-BIM (Historical-Heritage) approach encourages a multidisciplinary collaboration that critically analyzes the integrated 3D metric survey products and their subsequent transformation into graphical/numerical representations.

Introduction. Over the past 30 years, the profession of architecture has changed profoundly: In this regard, the role of parametric modeling, in its many forms and declinations, has now established itself as a solid reality within the most widespread operational practices. In parallel, national and international standards have incorporated these technological advances, considering the parametric approach as a fundamental element of integrated, multidisciplinary design. In this context, the role of the university is to anticipate what will be the operational practices of the coming years, so as to train professionals who are prepared and in step with the times. This paper aims to critically examine the various opportunities that the School of Architecture of the Politecnico di Torino offers to its students on the topic of parametric design, describing some training proposals that refer mainly to the Master's degree courses.

The multiple meaning of the "parametric" term. The term parameter, from which some of the considerations in this book are derived, assumes different connotations depending on the context in which it is applied. Whereas in mathematics it represents an arbitrary constant used in systems, formulae and equations,in a design environment it can take on other, different shades of meaning.

This is a good opportunity, then, to unravel this terminological tangle: unlike parametric software, object-based software has more in common with architectural design, where the internal libraries available are actually classified by building element type. So there are software applications in which the parameter is central to a system of associated dimensional relations and is given flexibility by procedures that facilitate not only the formal conception but also the changes occurring in the subsequent construction stages, which is fertile ground for experimenting with programming code. In other contexts, the same term refers to the control of a certain number of variables (geometrical, relational and other ones) that enable a particular process (design, construction, management, etc.) to be managed. In IT, a parameter is a value that a function expects to receive in order to do its job.

In other words, the function, the program itself and the operating system expect (values) and want to know (what to do), because the programmer has expressly envisaged that information be supplied for those purposes, i.e. by requiring that parameters be passed [1].

The innovation of the last years involves the upgrading of procedures strengthened with propositions deriving from the latest operational methods that have reinforced not only modeling procedures, but also the possibility to use common formats for sharing information. The objective of this operation is to enable interoperability within each single product, with the purpose of reducing entry obstacles for potential clients and enhancing potential output. Both parametric and object software systems are inclined to this common objective as they follow analogous paths. For the first ones, which can also be defined as rule based software, we can see (with reference to the names of the most distinguished international designers) the definition of new operation procedures where the professional expert works in close contact with programmers, creating customized programs from time to time [2].

Parameters, algortithms and scripts. Scripting functions, in their various declinations, can constitute a possible balance between functions programmed from scratch by dedicated staff and an equally skillful use of existing functions that can be customized. Relative to the software object based, the main software houses, possessing a wide range of applications, are equipping themselves by implementing policies of convergence of different products within a single commercial line. We are seeing home-made interoperability procedures consisting of the adoption of a single common platform that branches out into the specific domains through the preparation of appropriate programming strings by IT experts (this is the case with the firm of Gehry & Partners, Greg Lynn, Arup to name a few, but by now all major designers contemplate several figures); and it could not be otherwise, both because not many professionals have these skills and because they would find themselves working unnaturally, forced to jump constantly from the (slight) poetic freedom of intuition to the rigid force of binary deduction. There is no clear boundary between the two approaches, much less is it correct to think of a rigid separation between applications structured on the basis of dedicated programming codes and applications that are distinguished by a rational and advanced organization of the computer tool.

Jeffrey Kipnis, in an article dated 1993, "Towards a New Architecture" hypothesized that there could be two possible approaches for graphical information technology applied to the construction industry, which are the same highlighted in the previous chapter; as tribute to the vitruvian category of shape, he identifies two possible arrays: *"One to privilege formal explorations focused on the use of topological distortions of surfaces, by him defined as Deformation, and another one where the formal image is almost completely nullified for the advantage of an experimentation focused on functional-programmatic aspects, named inFormation"*(a).

However, the double definition proposed by Kipnis shows a disapproval of his reasons with the setting-in of BIM instruments. If initially there was a real distinction between the complex geometry drawn by three-dimensional modelers of the new generation and the comforting safety of the Euclidean geometry, the situation slowly shows a hybridization of the functions competing in the achievement of a summa of performance. A high performance order, and therefore capable of "doing anything", now left completely bare of iconic meanings and, instead, continuously under test process. This implies, to all intents and purposes, a link with the initial dichotomy, developed with the division between DeFormation and InFormation, in the name of a new category of concept design: Performance [3].

In a purely operative perspective, concerning aspects relating to practice, the innovation of the design process, introduced with the most recent software, consists of the possibility to organize a constructive simulation already widely identified with the metaphor Building Information Modeling. A new time has perhaps arrived when the nature of buildings will be partly also due to the designing process, by virtue of an updated way of drawing proposed by Information Technologies: implemented with the preparation of an interactive graphical model, of an out-and-out decisional model.

BIM systems give the three-dimensional model of the object the role of process/control of the congruence among the different formal, plant, structural, technological, and construction components from the very first design phases, conceptually overturning the consolidated design routine mainly set-up based on the use and the congruence verifications among the different two-dimensional drawings.

The Heuristic term, as known by the majority, comes from the Greek verb eurisko and its meaning is not so much to invent, but instead to find, to discover. In the Greek world, an invention is not to be linked to the introduction of the new but, more precisely, to bring to light those aspects that already exist but are still hidden in things.

It should therefore be noted how the traditional Heuristic process of building design, through a representation that goes way past the sole graphical expression, is further reinforced with the use of information technology. A parametric drawing "already contains everything", in view of the clear hermeneutic route previously taken. It is only a matter of searching for its productive capacity, encouraged by the desire of exploring its various nature.

Thus, it can be agreed that contemporary project design is the place that encompasses in one environment the multiplicity of languages. It is a design forced to continuous leaps in scientific status by having to contemplate knowledge from different disciplinary paradigms, marked by a permanent condition of becoming of knowledge. And this is one of the assumptions that has guided us in structuring the educational offerings of our School of Architecture.

The contribution of parametric modeling in the architectural education. Almost 15 years ago the first course dedicated to the Building Information Modeling (BIM) methodology was included in the Master of Science (MSc) in Architecture at the Politecnico di Torino. At the same time, the job's world in Italy has changed, thanks also to the publication of legislation that now makes the adoption of BIM mandatory for public works with an amount over 1 million euros. This course is proposed by the Drawing discipline (ICAR/17 - Drawing), whose declaratory clearly states that the sector deals with the generation, construction and analysis of drawings, images and models, as outcomes of scalar representations of existing or planned realities. By the way, the parametric approach can take on multiple forms, favoring multidisciplinary collaborations that allow for in-depth study of specific themes proposed by the design disciplines. In this regard, according to the recent reform of the Master's Degrees, the theme of Parametric Modelling has been appropriately declined on the different programmes.

In the Master's Degree in *Architecture Construction and City*, the *Parametric Digital Modeling* course (6 ECTS - European Credit Transfer and Accumulation System in ICAR/17-Drawing) provides the cultural, critical, and operational tools necessary to introduce students to BIM modeling issue applied to the design, construction, and management process. For the achievement of the objective, students are provided with the necessary operational tools for parametric modeling applied to different representation scales, congruent with the different phases of the design process: the conscious use of geometric levels (Level of Geometry) and information levels (Level of Information) allows the student to deal with national regulations and with directives, guidelines and international standards. The theoretical treatment referring to the most up-to-date international research and case studies is combined with the application activities. The aim is to develop students' ability to critically and consciously use BIM starting from the essential concept of interoperability between software for optimal information management, thus applicable to different disciplinary areas effectively and efficiently.

Alternatively, students enrolled to the same Master's Degree course may choose the *Architecture and Computational Design* atelier (6 ECTS in ICAR/17-Drawing; 6 ECTS in ICAR/14 - Architectural and Urban Design). In this didactic proposal the parametric design is more understood as a process of conception and composition, through the explanation of the process of conception closely and indissolubly linked to the process of representation. The design process is linked to the investigation of drawing methods and tools used today for the prefiguration of architectural design: the modeling activity is supported by Visual Programming Language (VPL) allows the management of morphological/functional complexity in the compositional phase, the BIM approach allows to foresee and solve the construction issues of the building in relation to the adopted level of representation detail.

The Atelier thus enables the student/designer to acquire new methodologies that can be employed as valuable tools for analyzing and generating urban morphological systems.

In the Master's Degree in *Architecture for Sustainability*, the *Parametric and Algorithmic Digital Modeling* course (6 ECTS in ICAR/17) allows the acquisition of new methodologies for the control of complexity, understood not only in the purely formal aspects (double curved surfaces, the engineering process applied to the façade skins, ...) but also in the integration of the different systems (spatial, structural, cladding, etc..) that make up the architectural object; we work on learning algorithmic procedures through a process of deconstruction of design thinking, for subsequent efficient reconstruction of codes, supported by computational processes; together with the students, we apply the constructive logic to the parametric modeling, emphasizing the role of efficiency, readability and generalization of the compositional process of algorithms.

In line with the characterization of the Master's degree course in *Architecture for Sustainability*, the *Advanced Parametric Design* atelier (4 ECTS in ICAR/17-Drawing, 4 ETCS in ICAR/14 - Architectural and Urban Design; 4 ECTS in ING-IND/11 - Building Physics) intends to explore the topic of parametric design through the adoption of computational strategies: on the one hand, it involves designing forms and elements by defining their performance standards and verifying their construction and production methods, in line with the most innovative professional practices. The connection of parametric definition with the possibility of evaluating the effect of geometric, compositional and technological parameters on the physical performance of the building in real-time, allowing the design project to be informed and optimized from a performance point of view during the entire design process, and not only as a final verification.

The workshop also focuses on the quantity and quality of information, the discretization needed to support physical-technical simulations, and how to evaluate the results of these simulations to reinform and improve the design. In this regard, some performance parameters are used, such as energy performance management and indoor and outdoor environmental comfort, setting the relevant parameters according to local legislative requirements.

To achieve these goals, parametric modeling applications are used: the mathematical algorithms allow the description of processes and actions that will be translated into 3D models. From a building physics perspective, parametric modeling software is integrated with parametric tools for calculating energy and environmental performance.

In the Master's Degree in *Architecture for Heritage*, the *Point Clouds* and *HBIM* course (4 ECTS ICAR/17-Drawing; 2 ECTS ICAR/06-Geomatics), thanks to the coordinated contribution of the disciplines of Drawing and Geomatics, explores the potential of Building Information Modeling applied to the built heritage field. While in its early days, BIM was primarily associated with the design and construction activities of new buildings, in recent years, this methodology has also begun to be applied in the built environment. Implementing BIM to the existing heritage offers numerous opportunities to optimize building work's management, maintenance and protection. The Historical/Heritage BIM (H-BIM) approach involves close disciplinary collaboration to critically analyze products related to the integrated 3D metric survey (point clouds) and the subsequent transformation of the acquired data into graphical and alphanumeric representations based on parametric modeling in the BIM environment, including with the use of Visual Programming Language tools (VPL).

Open conclusions. Until the first half of the twentieth century, scientific thought was guided by inductive cognitive principles. Science gathered observations and set them in relation to each other. True and genuine theories were formulated, working by degrees and using the Galilean method. In this manner, reasoning, in any field you might choose and comforted by repeated experiments, proceeded from the bottom up using an *if ... then* approach: once a condition had been verified a logical consequence was derived from it in a linear sequence. This way of working, widespread for centuries, went hand in hand, on the basis of the process of knowledge formation in those periods, with the possibility of building a strong theoretical framework.

The method was applied not just in the field of science, but also, as history demonstrates, in the fields of philosophy, art and sociology. And the same occurred in the world of construction. For example functionalism showed how to proceed in the first half of the twentieth century: consider the decision chart followed by Le Corbusier or other masters, where a general approach, considered universally valid, springs from the sum of singe facts and demands.

Today the picture has changed radically. After Einstein science no longer proceeds on the basis of predetermined theoretical systems by means of a series of questions and hypotheses that are first posed and then tested. The contemporary horizon is that of complexity (where complex does not mean complicated but many-sided), not to be interpreted in terms of some theory or other, but at the level of the tests, formulated on the basis of the scientific knowledge of a research team, which are passed from time to time. It happens in the same way in the field of building. For example in the case of technological design, the more complex a system is, the more the cognitive process is performed with the formulation of hypotheses that are then compared with a set of elements and tools to test them. We have therefore changed from an inductive to a deductive method.

The process in this case is "from the top down" and is based on questions of the type "*what ... if*"(b). Clearly an approach of this type requires adequate conceptual, formal and above all technological tools, because in a knowledge system of this type it is above all the contemporary technology (that supported by computers), with its capacity to organize systems with multiple relations, that constitutes the principal factor.

In this context, the training offered by the School of Architecture of the Politecnico di Torino aims to propose the most appropriate solutions to contemporary professional practice, declining the theme of parametric in its different meanings, according to the different Master's Degrees chosen by the students and enabling them to master the theoretical framework and practical skills related to the most modern operational practices.

Acknowledgements. Although the contribution was conceived jointly, M. Lo Turco is author of paragraph "The multiple meaning of the "parametric" term"; A. Tomalini of paragraphs "Introduction" and "The contribution of parametric modeling in the architectural education"; J. Bono of paragraphs "Parameters, algortithms and scripts" and "Open conclusions".

Notes.
a. Kipnis 1993, p. 63.
b. Saggio 2007, p.81.

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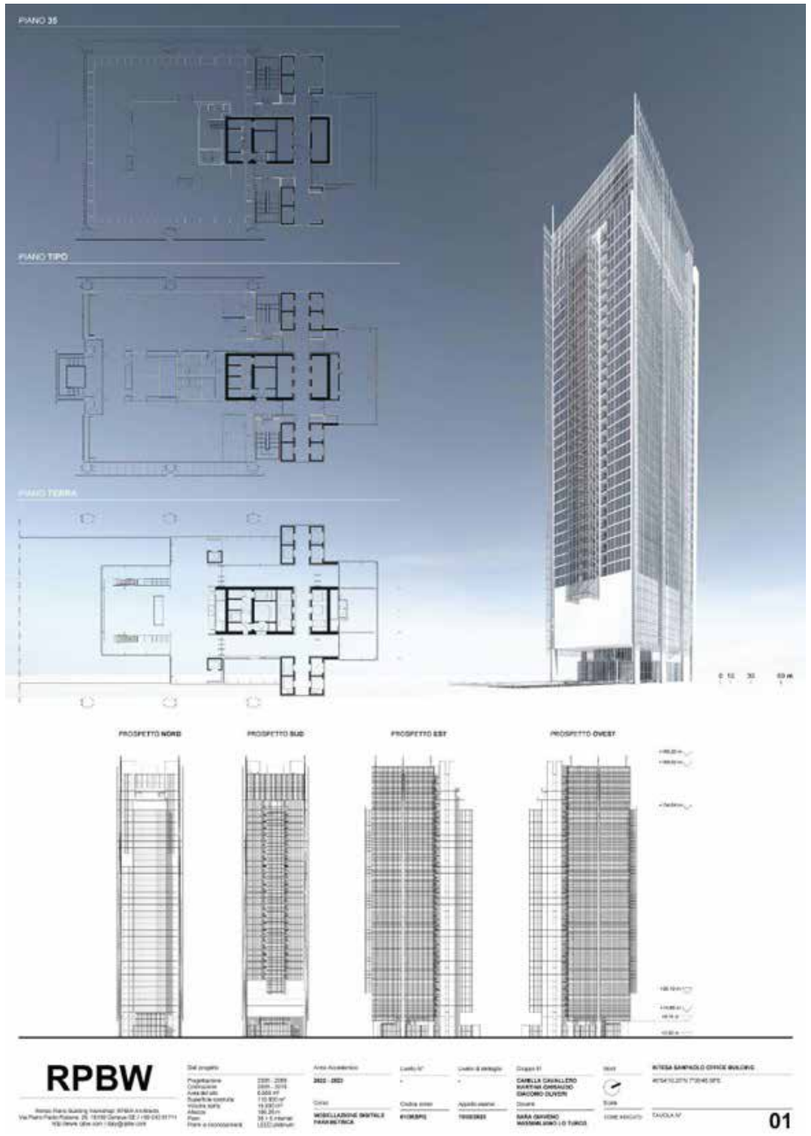
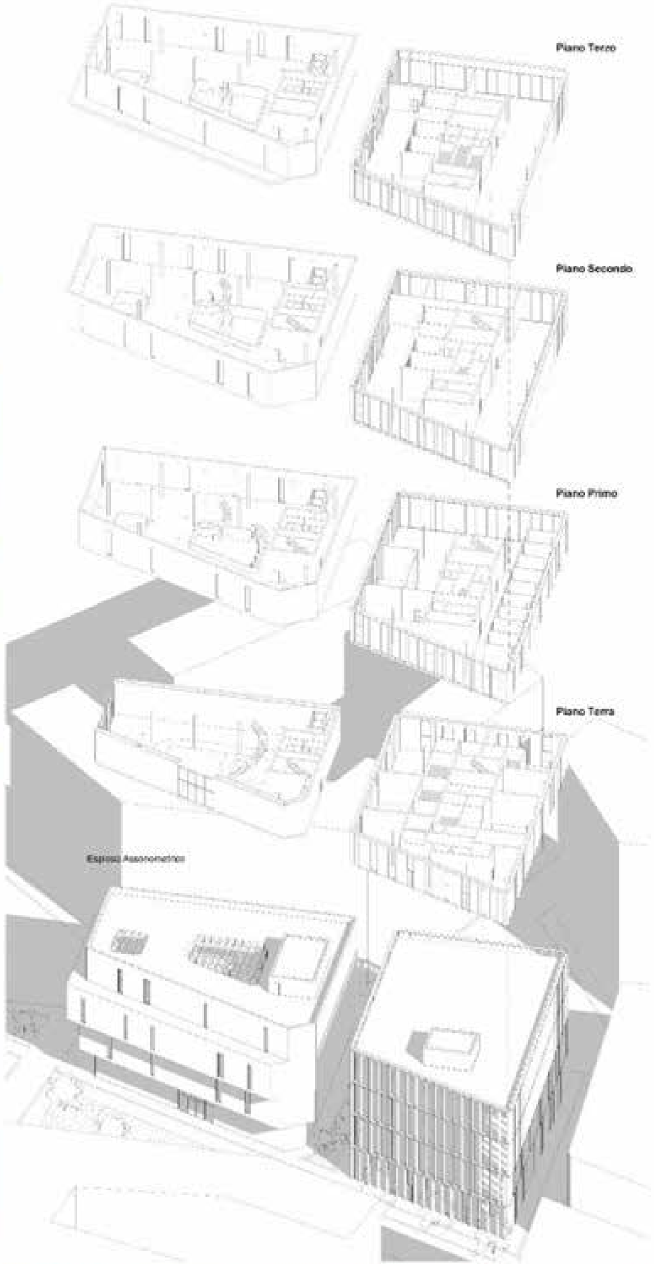
Figures.
FIGURE 1 - One of the students' outcomes in the *Parametric Digital Modeling* course: the development and communication of the assigned case study through the use of BIM methodology (technical drawings in orthogonal projections, 3D views, axonometric cutaways, exploded views, renders, schedules, thematic views).
FIGURE 2 - One of the students' outcomes in the *Architecture and Computational Design* atelier: the definition of responsive digital models composed through algorithms (VPL) and parametric elements (BIM).
FIGURE 3 - One of the students' outcomes in the *Parametric and Algorithmic Digital Modeling* course: parametric and algorithmic logic are used to analyze and reinterpret the fundamental elements of an architectural project. This coding and reinterpretation process allows for a deeper and more creative perspective on architectural structure and design.
FIGURE 4 - One of the students' outcomes of the *Advanced Parametric Design* atelier: parametric and algorithmic methodology application to investigate and facilitate the physical-technical simulations essential to creating a design that meets regulatory requirements and user comfort.
FIGURE 5 - One of the students' outcomes of the *Point Clouds* and *HBIM* course: the use of BIM methodology for managing and interacting with the existing heritage, including manipulating the point cloud and information and geometric data related to the model and its parametric components.



1.

THE CITY LINE

Gli edifici ospitano funzioni miste determinate tramite un algoritmo che, a seconda della distanza rispetto a punti focali del nostro progetto urbano, passano gradualmente da un uso più pubblico a privato.
Il primo edificio è adibito ad uso completamente commerciale ed è stato destinato ad ospitare un DEPARTMENT STORE. All'interno la circolazione è libera e personale secondo le intenzioni dei clienti, poiché non sono inserite partizioni a delimitare lo spazio interno saranno gli stand dei marchi. Il primo edificio rappresenta un punto di riferimento per l'asse pedonale e le zone residenziali, soddisfacendone le necessità.
Il secondo, aderendo alle logiche parametriche stabilite, prevede l'intero pian terreno a destinazione commerciale, e lo sviluppo di spazi per uffici e co-working nei tre piani soprastanti.



2.

Politecnico di Torino

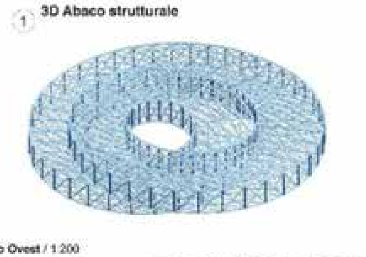
Atelier Architettura e progettazione computazionale
Corso di Laurea Magistrale in Architettura Costruzione Città

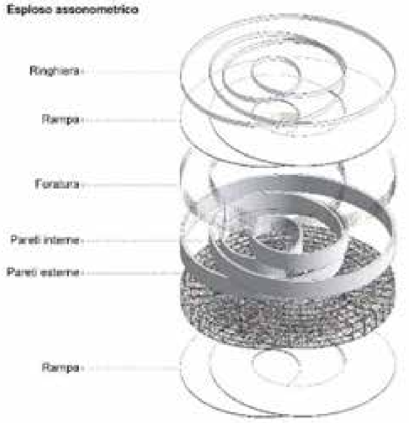
01

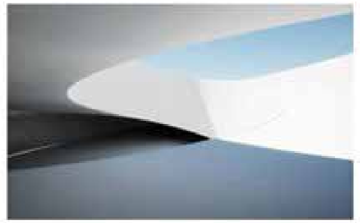
Denmark Pavilion

EXPO 2010 | Shanghai

BIG





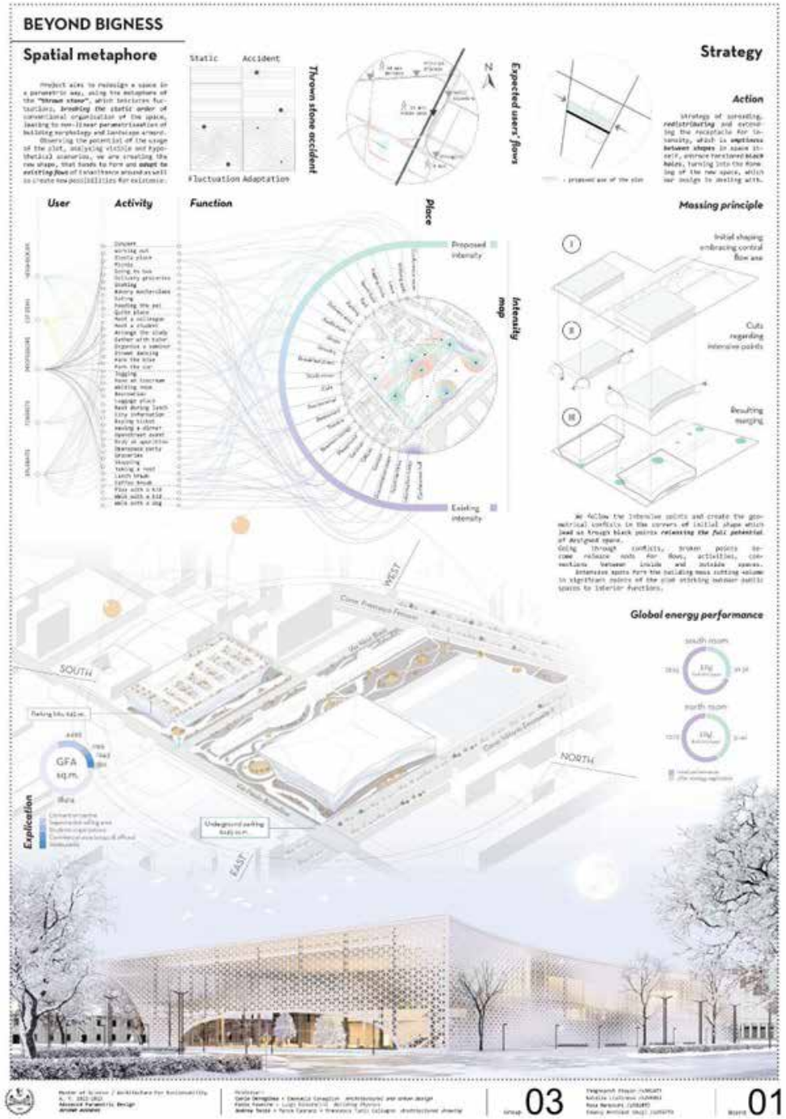


LM - Architettura per la Sostenibilità
Modellazione parametrica e algoritmica - A.A. 2020/21

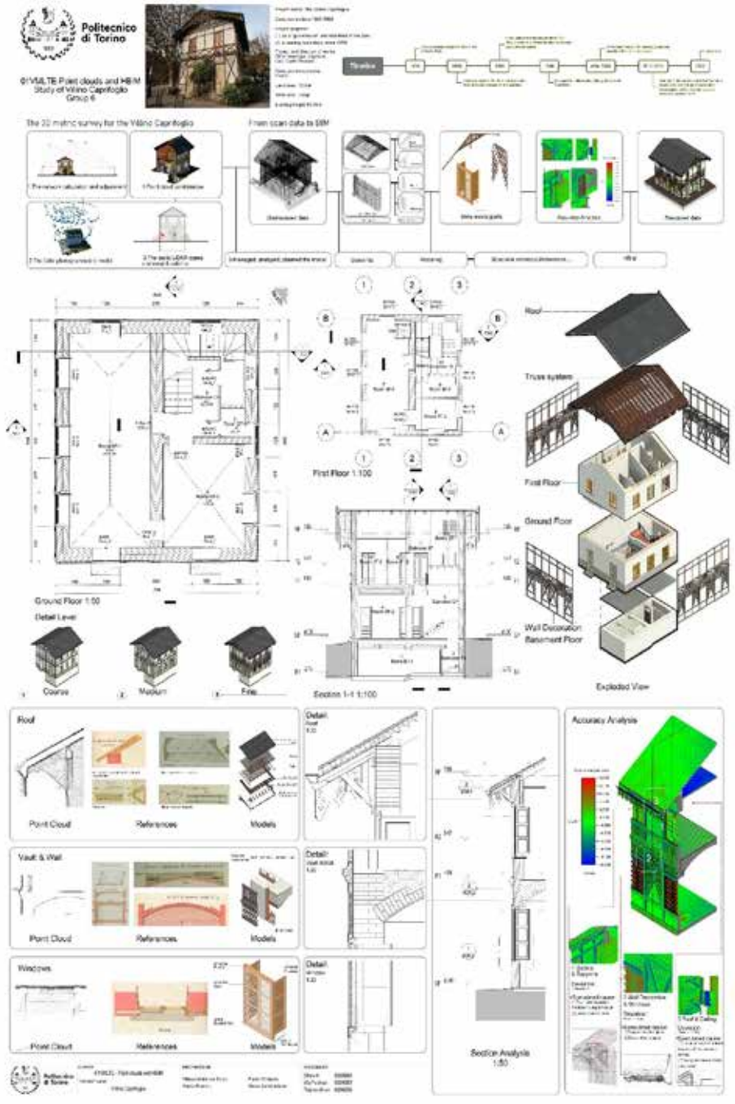
Denmark Pavilion, BIG
Shanghai Expo, 2010

Gruppo 15

3.


BEYOND BIGNESS
Spatial metaphore
Static
Accident
Thrown stone accident
Fluctuation Adaptation
Expected users flows
Strategy
Action
User
Activity
Function
Place
Intensity map
Proposed intensity
Existing intensity
Massing principle
Initial shaping embracing central flow axe
Cuts regarding intensive points
Resulting merging
Global energy performance
south room
north room
SOUTH
NORTH
WEST
EAST
GFA sq.m.
Explication
Underground parking
Group 03
Board 01

4.


Politecnico di Torino
©VISILTE Point clouds and HBIM
Study of Villino Capriglio
Group 6
The 3D metric survey for the Villino Capriglio
From scan data to BIM
Ground Floor 1:50
Detail Level
Coarse
Medium
First Floor 1:100
Section 1-1 1:100
Roof
Truss system
First Floor
Ground Floor
Wall Decoration
Basement Floor
Exploded View
Point Cloud
References
Models
Vault & Wall
Windows
Section Analysis 1:50
Accuracy Analysis

5.