4th International Symposium

FORMAL METHODS IN ARCHITECTURE

2-6 April 2018

BOOK

OF ABSTRACTS

FORMAL METHODS IN ARCHITECTURE

David Leite Viana, Franklim Morais, Jorge Vieira Vaz (Coords.)

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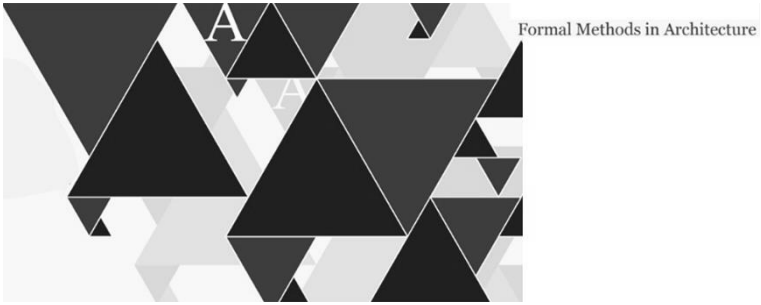

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Purpose

The main purpose of this symposium is a contribution to the debate about the application, in the disciplines of Architecture and Urbanism, of new formal methods - new methodological advances based on new developments coming from Mathematics. From the millennial geometry to current shape grammars, several formal approaches to Architecture and Urbanism will be presented, with their different points of view, different fields of application, different grades of abstraction and formalization. The aim is to look at the potentials and objectives of these formal methods, both those on the horizon as well as those already accomplished, their successes but also their problems. The intention is to promote the use of formal methods in the creation of new explicit languages for problem-solving in Architecture. These problems range from representation, to theory, critique, production, communication, etc., never ceasing to see Architecture and Urbanism as technological activities and well as artistic ones. The more historically established areas of application of mathematical sciences, such as traditional geometries or mathematical developments connected to engineering, are left somewhat outside the focus, without however forgetting the deep connections these establish with the new formal methods. Many of these have a level of development that requires the existence of established academic communities, with their own specialized forums. These symposia, more than an attempt to deepen each specific field, are above all about finding points of convergence. This is not limited to a possibly interesting abstract integration of different areas of research, but mainly to advance the multiple crossings between several methods, which fertility has already been proven. A dialogue with semi-formal and even informal methods in current use is to be stimulated as well, as a way to deepen the discussion on aesthetics and ideologies controversies that surround the possibilities and reach of a formalization of Architecture and Art. As in previous symposia, some contributions will be made on the application of formal methods on fields other than architecture, like literature, music, and the fine arts, in as much as they may be useful for architectural application.

Scientific fields

ONTOLOGIES IN ARCHITECTURE

The development of ontologies applicable to Architecture and Urbanism emerged from the necessity of finding common linguistic bases for the multiplicity of languages used by the numerous agents in the constructed environment. This is all the more necessary nowadays, as artificial agents are more and more present. These ontologies have been used as a nuclear language in knowledge-bases of constructed environments, as well as logical assistants to design, participatory GIS, automatic acquisition of urban knowledge, and interoperability between several data processing artificial agents (CAD's, GIS, etc.). Several digital tools, such as OWL, Protégé or KLOne, with their origin in information technologies, are being used to create ontologies on the architectural domain.

BIM | VDC

BIM (Building Information Modelling) is an activity rather an object, is a human activity that involves logical thinking, digital entities and a large sort of specific software, with a strong impact in building design and construction activity. The transition to BIM, however, is not a natural progression from CAD (Computer Aided Design), because it involves a paradigm shift from "drawing" to "modelling"; a virtual model consisting of relationships between entities, organized into an object–based inheritance hierarchy. Technological and market trends are good predictors of the short–term future in this field, and it is opportune to analyse and discuss how BIM will be developed in different, yet correlated, aspects like VDC (Virtual Design to Construction) and the developments in peripheral hardware linked to building, prefabrication, assemblies, functions of construction management connected to ERP (Enterprise Resource Planning), ontological and semantic searching and compatibility of BEMs (Building Entity Models) to multiple platforms, IPD (Integrated Project Delivery), automated checking for code conformity and constructability to support Lean Construction, improved import and

export capabilities using protocols like IFC (Industry Foundation Classes) and parametric 3D technical catalogues from manufacture industry, the setting up and development of National Building Standards in connection with Green Building, LEED (Leadership in Energy and Environmental Design) or Breeam (Building Research Establishment Environmental Assessment Methodology) and expanding the scope and discipline-specific BIM tools or even "light" BIM for specific building types like low cost residential houses, or small area building facilities.

CAM COMPUTER AIDED MANUFACTURING

Advances in computation and its use to control production machines are being applied also to Architecture, allowing the automatic manufacture of complex geometries, hardly reachable in ancient techniques and at a fraction of the cost. Computer Aided Manufacturing and CNC (Computer Numerically Controlled) machines are enabling greater personalization, flexibility and innovation in architectural design and creative processes, providing society with new products and services.

CELLULAR AUTOMATA

´Cellular automata' is a term used to refer to a set of generative grammars, where multiple agents exist with identical or differentiated rules that act concurrently in the built space. The concept of Cellular Automata structures itself in dynamic mathematical models, with the goal of configuring processes capable of promoting self-replication. Originally it explored a set of quadrangular elements on a grid where, following a set of rules of proximity relative to each cell (cellular automaton) along the grid, growth processes were simulated, based on the logic of complex systems. Cellular Automata established itself as a process that started with small elements following simple rules (bottom-up approaches). Research has been revealing a great potential in the fields of architecture and urbanism, as it allowed the possibility of creating dynamic patterns, through reciprocal interaction and conditions of neighbourhood between cells. They constitute patterns from which architectural and urban formal hypotheses may appear, following mathematical approaches free from traditional deterministic constraints.

GIS GEOGRAPHIC INFORMATION SYSTEMS

Since their emergence, in the 60's of the 20th century, these territory analysis and planning digital tools - the Geographic Information Systems (GIS) - are evolving to adapt to the new and diffuse means in which territory is appropriated by the information based society. Together with the traditional interlacement of diverse layers of territorial information, the contemporary information practices of geo-spatialization almost allow their complete mapping on-line, dramatically reducing the gap between production and data visualization. Furthermore, the recent 3D presentations enable a friendly visualization of complex data, approaching the common citizen to urban participatory processes. The GIS experimentation field is nowadays exploring crossings with other tools of spatial analysis, such as space syntax. Other new emergent tools, as processing, will be able to connect to GIS in a near future.

PARAMETRIC PROCESSES

Research on parametric processes has been tackling the evolution of different methods and technological processes, which lies in the possibility of quick visualization, construction, and modification of concepts associated with design. These systems establish a complementary relationship with generative design, where different parameters from several different components are intrinsically connected through an algorithm – in which the variables are then verified so as to be adjusted to the needs of specific results. From the initial analysis to the execution and production of final components, through the (no less important) phase of form-finding, parametric processes enable singular approaches to the set of conditions of each context. These conditions are formally framed via top-down strategies, or, conversely, using informal combinations of less structuring components as a way to promote results generated through bottom-up approaches.

PROCESSING

Processing is a creative programming platform (IDE / Integrated Development Environment) supported by the Java language, which assumes the purpose of combining the different programming (and

increasingly diverse) areas of digital arts, through structuring of visual media applications and interactive. Having had originally educational purpose - as a tool focused on teaching the graphical component that language, open source condition - quickly encouraged the participation of growing communities, increasing its development in areas such as performing arts, kinetic arts, data visualization interactive real-time experimental architecture, among other fields of artistic creation and applied research. Particularly in the architectural perspective, there is the in-depth research to the generative level design and implementation of limitations associated with "traditional" methods - where the Processing demonstrates its greatest potential, allowing the user (architect-developer) define specific dynamic applications that allow putting into practice the processing conditions and complex rules in creating certain architectural objects.

SHAPE GRAMMARS

Shape grammars are technologies belonging to the broader field of generative grammars, dedicated to the production of geometric shapes. A shape grammar includes a generative algebra applied to a set of production rules. These grammars have been used in diverse areas, from technologies to the visual arts, as identifying styles of composition or as a means to refine structural elements. In architecture and urbanism this tool is used in history, theory, and critique (with examples like the definition of a grammar of Palladio's villas, or the formalization of Alberti's production rules), as well as on automated design, based on rules defined by the architect, or according to rules or patterns identified from case studies or established practices.

SPACE SYNTAXES

Space syntaxes consist of a set of theories and methodologies used for the study and treatment of building and urban space. Spaces can be geometrically defined through more or less abstract concepts: either geographic, (volumes, surfaces, axial lines, nodes), or topological (graphs and connections). These spatial elements establish simple relationships between themselves, like visibility or connectivity. It is possible to build a

whole set of concepts based on this basic proprieties, which are usually quantifiable, like integration, depth or controllability. These quantities represent architectural and urban realities, at a physical level (such as accessibility, connectivity), at the level of cognitive psychology (intelligibility, entropy) and of sociology (privacy, control, segregation). The space syntaxes have been extensively used on multiple fields of architectural analysis, especially at an urban scale, such as traffic studies, distribution of facilities or even the prediction of geo-localized demand.

TRACKING | MAPPING

Tracking and mapping constitute a set of methods and processes based on digital tools and technological procedures that aims to deepen the correlation between cities/buildings socio-spatial dynamics and appropriation and its configuration and organization, combining different typological, topological and morphological approaches arranged on qualitative and quantitative standards. It explores the relationships between space users and different elements within architectural layouts and/or urban spaces (street network, building fabric, urban activities) tracking flows, collective urban dynamics and individual appropriations (using tacking devices, mobile communication devices – smartphone and tablet – and video tracking, for instance). The availability of online open source collaborative software, tracking and map apps, internet access and digital connection and platforms contributes to increase the ways to produce and to collect a wide variety of individual and collective data (big data, small data), georeferenced in real time. The goal is to track space experiences, mapping them. These topics' arguments the convergence between tracking spaces' dynamics and the development of social appropriation' mapping.

Table of contents

Abstracts

Welcoming

Jorge Vieira Vaz, David Leite Viana, Franklim Morais

Distinguished Guests, Speakers, Participants and Friends
Good afternoon to everyone.

Thank you for joining us here at the 4th International Symposium Formal Methods in Architecture. It is a great honour for me to welcome you all to Porto. On behalf of the organizers of this Symposium, I would like to express my most sincere gratitude for your presence at this short Opening Ceremony - the start of our Scientific Program.

The exchange of ideas is one of the three fundamental pillars of the research community… together with theory and critical thinking, of course.

The implementation of this 4th Symposium became, now, a tradition for us and a fundamental part of our success. Every two years we met together for one week, three full days of work presentations, sharing ideas, scientific discussing, networking, with new questions and thoughts about Architecture and Urbanism and the contribution that Formal Methods can provide, which, we believe, can be very important. Back to two thousand and ten, we assumed the intention of crossing a group of scientific fields that use the computerized calculation and have an increasing importance in the areas of the urban and architectonic analysis.

Ontologies, Building Information Modelling, Virtual Design to Construction, Computer Aided Manufacturing, Cellular Automata, Geographic Information Systems, Parametric Processes, Processing, Shape Grammars, Space Syntax, Tracking and Mapping are the scientific fields of our Symposium. Some are more theoretical, others more empirical and, together, they cover a wide spectrum of knowledge with application in built environment and in peoples life.

The topics which will be presented by participants are crucial for the intensification of the exchange of ideas but we wish:
- To have the most important subjects presented by keynote speakers,
- To have time to discuss the subjects presented, and
- Don't have parallel sessions which can difficult the cross - fertilization factor, for us, a very important strategy.

These are the main reasons why it is not possible for us to accept all the announced contributions for oral presentation.

The quality of the submitted papers forced rigorous selection criteria; this inevitably led to the rejection of good and valid works; we know that and hope that the authors will kindly understand this situation. We believe that the quality of the technical program is high and the spectrum of topics to be debated is very broad.

I would like to take this opportunity to thank our team of reviewers for their effort and expertise in reviewing the selected papers, in a so short time, without whom it would have been impossible to successfully conduct an efficient peer review process and guarantee the standards that are necessary for ensuring the scientific relevance of this symposium.

Before closing this open ceremony, I should also like to extend further thanks to those who made valuable contributions to the organization of the Symposium:
To CESAP (Cooperativa de Ensino Superior Artístico do Porto, CRL), to ESAP (Escola Superior Artística do Porto) and its Master Program in Architecture and to LIAU (Laboratório de Investigação em Arquitectura e Design) – for the institutional support; To "NORTE2020 Program" and the "Opo'Arch Formal Methods Project Team" which allowed to fit in our activities the support of the European Regional Development Found, from European Union;

To the predecessor organization who provide us with a great deal of extremely useful information about the pitfalls associated with such undertaking and who so kindly shared their experiences with us;

To the Scientific Committee which was always available and which was tireless, even with such tight deadlines;

To my colleagues of the Organizing Committee, with a special thanks to "Concinnitas Team" without whom it will be impossible carry out this task;
To the trainers and the trainees of the workshops;

To Cambridge Scholars Book Publisher for the patience and technical care always shown;

To the dedicated team of volunteers and to the Meeting Point Staff, for their generosity;

To Casa Diocesana de Vilar, for its kind hospitality in allowing us to use these conference facilities;

To the Exposition Team, that graciously set up the exhibition;

To our colleagues and friends for their untiring help, support and advice in planning and arranging this Symposium.

My personal gratitude and thanks goes out to all of you, who have gently responded to the call and have now moved to Porto to present their communications. I'm confident that this symposium will be a memorable event.

What sets a symposium apart from other similar is:
- The excellence of speakers,
- The relevance of the knowledge being present, and
- The opportune nature of the topic under discussion.

But the most important thing of all, however, is the dynamics generated by participants. It is the "after – program" discussions and the networking that makes such a valuable difference and will certainly guide a new cycle of innovation in Formal Methods in Architecture research.

So, let me conclude by asking you to stay committed, keep proactive and help us shape the future of Formal Methods into Architectural practice.

Thank you for your attention. The 4th International Symposium Formal Methods in Architecture, two thousand and eighteen, is formally open.

What if architecture could change the world?

Aryanour Djalali

DNA believes inspiration is everywhere, and sometimes comes from a change, a change in people's lifestyle with our inspirational living spaces where NATURE becomes our main inspiration bringing an emotional approach to our nowadays urban cities. Thus, our main theme and the basis of all our projects is DNA "ENHACED BY NATURE", where the architectural expression combines elements of movement, landscape, technology and innovation in construction. DNA also believes that Architecture is the mother of the arts. We think that architecture connects the present with the past and the tangible with the intangible. For us architecture represents a power to inspire, to elevate the spirit, to feed both the mind and the body. During the lecture "*What if architecture could change the world?"* we would like to share how DNA inspires from nature and its elements and translates the ideas into real projects offering an impeccably contemporary design with comfort & luxury amenities to every guest. M. Djalali will present selected projects of DNA and explain the history and philosophy of each one referring to architecture and design details including shapes, materials, colours, main source of inspiration and concepts.

Alexander's theories applied to urban design

Alice Rauber, Romulo Krafta

Christopher Alexander has presented some key concepts, such as wholeness, centres and harmony-seeking computations, related to the harmony reached by a system, that is to say, the coherence of a given configuration. Wholeness is the global structural character of a given configuration, existing in space. Centres are the primary entities which compose wholeness, and harmony can be achieved by the use of fifteen properties, which describes the relationship among centres. According to Alexander, wholeness is measurable and thereby he proposes a new research agenda based on harmony-seeking computations. In the present exploratory study, we discuss an urban configurational approach to explore Alexander's insights. The main purpose is to investigate the possibility of using those insights as analytical methods for urban planning and design. The literature review shows that wholeness has already been defined as a hierarchical graph, in which centres are represented as nodes and their relationships as links. We argue that a key point to move forward is a deeper investigation on how to describe the urban system. Thus, we check out different descriptive system and different centrality measures, which can be used to reveal the spatial relationship between urban entities. Such approach is supported by spatial network studies and by Geographical Information Systems (GIS). The former provides descriptive systems to model the relationship between urban spatial entities, and the latter provides tools for different types of visualization. Crossing GIS with network spatial analysis seems to be helpful to bring Alexander theories closer to urban design, since the descriptive system has a central role, as well as the way we analyse and visualize the results. The value of this paper is to contribute to the debate on how to operationalize Alexander's theories, suggesting new possibilities for future investigation.

Potentiality analysis for urban planning

Rudi Stouffs, Patrick Janssen, Ye Zhang

We report on a methodology for computational analysis of the potential for the development of urban nodes within an industrial estate in order to transform the estate from an almost mono-functional, segregated and fragmented, highly polluted industrial area into a major catchment area for future population growth that integrates clean(ed) industrial plants with green lungs, attractive housing and vibrant urbanity for up to one million people to live, work and play by 2050. We adopt a location choice approach, considering land availability, accessibility to transit, presence of parks and traffic noise exposure as influencing factors. Our selection is partially driven by data availability and partially by existing scenario planning processes that we aim to support by generating alternative scenarios or providing arguments in support of such scenarios. Land availability is mainly affected by land leases and safety buffers. We adopt a sigmoid curve to normalise land lease end dates between 0 and 1, apply this curve to both land leases and safety buffers, and consider the minimum of both as land availability analysis value. For accessibility to transit, we consider a proximity analysis based on walkable distances to different modes of public transportation. Distances are normalized and additionally weighted by transit mode. For parks, we consider both the accessibility and the area of green spaces in the analysis. We discount waterbodies from the analysis as few are accessible or are otherwise part of a park or green space. Similarly, we discount the presence of industry because this is already taken into account indirectly via the land availability analysis and the final cumulative, aggregate urban potential analysis. We do take into account exposure to traffic noise for the main expressway passing through the estate area. The final analysis outcome is a weighted aggregation of these four analyses and we consider the weights as parameters for the urban planner to play with. A normalized accumulation of analysis values illustrates urban potential over the area of a neighbourhood or catchment area. The actual selection of urban nodes remains as a task for the urban planners, with the individual, aggregate and cumulative analyses serving both the selection and their argumentation.

3D Space Syntax analyses:
attributes to be applied in Landscape Architecture projects

António Ascensão, Cláudia Fernandes, Laura Roldão Costa, Catarina Ruivo

The paper explores the potential of the application of Space Syntax methodology to Landscape Architecture. Dealing with the landscape architectural design process, the use of 3D Space Syntax analysis allowed for a better understanding of the relations between the urban space shapes (spatial configuration, visibility and accessibility) and functions (physical, social and psychic). The implementation of an iterative process of project improvement optimizes the fulfilment of the landscape architect's vision, through mastered changes in ground shaping, selection of the species and spatial distribution of trees. A research was endeavoured regarding the digital modelling of the vegetation. To concretize this goal it was necessary to define the attributes to insert in the software. The main attributes of vegetation that can be used in landscape projects are: form and dimension, growth speed and visual permeability (transparency/opacity) of the crown in winter and summer. This paper explores, in the context of the DepthSpace3D software, the attributes of vegetation that are necessary to consider in landscape projects using an urban park in Maia (Porto) as case study.

Measuring urban renewal:
a dual kernel density estimation to assess the intensity of building renovation

Filipe Brandão, Ricardo Correia, Alexandra Paio

In the cities of post-industrialized countries, building renovation is the main part of building construction activity. Measuring that ongoing phenomenon is a problem of visualization and representation at which traditional representation tools and processes have some limitations. Databases are resources open to architectural research that provide new possibilities to develop design practice and theory. Methods related to data-driven tools can improve the analysis of the urban renovation phenomena and its distribution throughout urban areas and be of great usefulness for urban planning and public policies. To support these processes, Kernel Density Estimation (KDE) is an efficient tool that overcomes incomplete data, as not all renovation is reported to city halls. This article aims to provide a vision of the possibilities of integrating dispersed datasets. Using the city of Lisbon building permit alphanumerical and spatial database as a case study, we present preliminary work on a method of measuring building renovation intensity. Using Dual KDE we determine the intensity of building renovation across the city and along the time period, comparing the density of two different variables, the density of building renovation and the density of the city. We further provide two implementations of this methodology, using a parametric modelling environment and a GIS software.

Generating forms via informed motion, a flight inspired method based on wind and topography data

Demircan Tas, Osman Sumer

Generative systems are becoming a crucial part of current design practice. There exist gaps however, between the digital processes, field data and designer's input. To solve this problem, multiple processes were developed in order to generate emergent and self-organizing design solutions that combine the designer's input with surface models acquired via photogrammetry and generative design tools. Different generative design methods were utilized for trials, including surface scattering based on UV coordinates, animation snapshots (similar to long exposure photography) and a particle swarm algorithm on arbitrary data, interpolated within GIS software. A large volume of adaptive forms that are complex, yet responsive to changes in parameters, user input, topography and/or various spatial data were acquired. Resulting outputs were rendered and projection mapped onto the original physical model and evaluated for further iterations.

Shapes and attributes

Rudi Stouffs

We consider shapes that are imbued with visual attributes, for instance, colour, thickness, texture, labels, etc., and examine how such augmented shapes can be uniformly characterised so as to lend themselves amenable to computation. Specifically, we present a uniform characterisation of the behaviour of shapes augmented with non-geometric attributes for the operations of sum, product and difference and the subshape relationship. We demonstrate this uniform behavioural expression for shapes augmented with labels and weights, two more common kinds of attributes in shape grammar development. Hereby, we distinguish between attributes that may have a zero or empty value, e.g., functional labels, and attributes that may not have a zero or empty value, e.g., layer labels and line thicknesses. Next, we explore the behavioural expression for colours as a less common kind of shape attribute. Initially, we refer to the existing literature and consider a 'ranking' of enumerative colours and materials. Subsequently, we consider three novel behavioural expressions for colours defined within a three-dimensional RGB or HSV (Hue, Saturation, Value) space. Specifically, we consider a behaviour similar to weights, where the combination under sum of two component values yields the maximum of both values and the common value (under product) equals the minimum of both component values. We also consider an alternative behaviour that may apply when mixing colours as paints. Here, the combination under both sum and difference of two component values yields the average of both values. Finally, we consider colours to include an alpha, specifying a transparency value for the colour when added to an existing colour. In both this case and the ranking of colours, the operation of sum on two augmented shapes is non-commutative. We identify and discuss this and other special characteristics of specific behavioural expressions of augmented shapes in order to support interested parties in devising and formalising their own shape attribute propositions to support their shape grammar developments. As shape grammars deal with different kinds and aspects of design, these may require different kinds of non-geometrical information to be incorporated and encoded. It is this process of encoding that this paper attempts to support, on the one hand, by offering a template for this encoding within a uniform characterisation of augmented shapes and, on the other hand, by demonstrating a few different formalisations of coloured shapes using this template.

Generative biomorphism

Ricardo Massena Gago

This research is in the bio inspired design field, more precisely, it deals with the morphological gap between human and biological structures. The morphological divergences that exist between both come from a design problem. Despite their shape diversity, biological structures achieve their ecological performances by morphological coherence. They exist in profit to a common whole. So, it reveals that the ecological purpose follows a common geometrical pattern in order to allow the interaction and cooperation between structures. Most of the solutions developed by ecological design strategies do not reflect this integration ability. So, this research aims to decrease this morphological gap by proposing a design process that follows the geometric generation principles of the biological structures. The goal is the development of structures of architectural purpose that reveal a morphological identity closer to the biological ones. For that purpose a design tool of geometric essence is proposed. It is composed of a generative drawing tool (shape grammars) with a geometrical inventory. The generation process is composed of a main grammar that defines the structural configuration of the shape and two supplementary grammars that explore the roughness and texture patterns from biological morphology. The goal is to provide architects and designers the possibility to experience shape generation through a biological perspective. This experience allows exploring a geometrical pattern with which biological structures achieve their spontaneous integration in the environment and their self-supporting qualities.

RE:9²GRID –
fragmented parts and unified whole

Giacomo Pala

My presentation will focus on some work I've recently developed in the context of my PhD. The work is about the juxtaposition of the "nine square grid" and "fragmentation" in a kind of coherent whole. First, my presentation traces a history of these two concepts as formal methods in modern and contemporary architecture. To do so, I will refer to the work of architects such as Superstudio, Durand, Mies, Hejduk, Eisenman, Coop Himmelb(l)au and the ideas and analysis of theorists and historians such as Robin Evans and Jacques Lucan. Secondly, it is noted how the model of the "9 square grid" and the one of the "fragment" are usually interpreted as two different ideals in a conceptual dichotomy. On the one hand, the "nine square grid" is a method for the subdivision of a space starting by the internal relations of the parts constituting a given shape. On the other, "fragmentation" is a method used to break a whole and to produce an "explosion" of parts that are "external" to the original shape. Consequently, I will present my work as an attempt of conciliating the need of an internal formal logic and the one of fragmentation as a form of formal complexity. In fact, by considering the nine divisions of a square as an ensemble of parts, rather than just the internal diagram of a shape, in my work I have attempted - as a first step - the transformation of the "nine square grid" in an ensemble of fragments. To do so, I have imposed a simple mathematical rule: the rotation of the nine parts respect to the same origin using random values or scalar sequences of values. The result is, at first, a fragmentation of the "nine square grid", which, in turn, is considered as a figure rather than as a diagram. The second step has been the reconciliation of the parts that has involved the formal configuration of the connections between the different fragments. Finally, I have over-imposed the original "nine square grid", now interpreted as a diagram, in order to produce a seamless collage of the different logics of fragmentation and "whole". Finally, in the attempt of providing fertile ground for theoretical and historical development, I would show the final renderings in which material and colours play a major role in order to challenge the "strict" separation of the formal discourse of architecture from other theoretical narratives.

Circumstances generate the form: origin and evolution of the hospital pavilion typology

Sérgio Mendes

This paper is an analysis of the evolution of the typology of the hospital pavilion, starting from the circumstances in which it arose, following the fire in 1772 of the Hôtel-Dieu, the largest medieval hospital in Paris. We intend to demonstrate that this typology underwent several adaptations over time, depending on the context and the needs that prevailed when it was used. These adaptations generated, in some cases, buildings with forms different from the original, without compromising the basic principles that characterize it. The methodology to be used will consist of analysing variations in the typology shape, taking into account the relationship between the way the main circulation zones were organized and the pavilions positioned. The study will be organized in chronological order of the construction of the buildings. This is a study of great interest, since this typology seems to be extremely versatile, allowing its adoption in buildings or complexes of buildings, with functions quite different from those of hospitals.

Will drones have a role in building construction?

Nuno Pereira da Silva, Sara Eloy

This paper aims to explore the possibilities that robotic technologies, namely robotic arms and drones, bring to architecture and to the construction sector. The developed research was based in an extensive literature review, in the conceptualization of three experiments to be done with drones and in interviews with Fabio Gramazio, Tobias Bonwetsch (ETH Zurich) and José Pedro Sousa (FAUP). The paper starts by presenting a brief story of the introduction of robotic technologies in other industries and identifies the robotic technologies that are presently use, mainly in research, to assemble construction elements – drones and robotic arms. We then analyze the few case studies of construction performed with drones and robotic arms. Three experiments are idealized next in order to clarify the main difficulties of each action of construction performed by a robot. The advances in robotic construction are visible and growing every year. According to the experts robotic construction will be introduced in the construction industry in a hybrid way, where man and machine collaborate and not as total substitution of human labor.

Form finding and generative systems: a theoretical and applied research project

Gonçalo Castro Henriques

LAMO seminar/workshop *Em busca da forma, sistemas generativos* (Form finding & generative systems) sought to deepen the theoretical and practical development of generative algorithms in design. It pursued to explore the advances of mathematics at the end of the 20th century, namely information theory and general systems theory. These advances provided a new set of techniques to find design solutions. Although these techniques have already been applied in areas such as engineering, graphic design and urbanism — given their mathematical and computational nature — their application in architecture is still scarce. This event explored computational techniques, such as cellular automata, L-systems, genetic algorithms and shape grammars, to translate these techniques for design form finding tools. The idea was to understand through experimentation how these techniques can be applied to solve design problems. The event was preceded by a research and was supported by an international scientific committee, gathering a group of researchers experienced in the referred techniques. This article will describe the methodology used in the workshop and analyse the results. The event had many interested candidates that were selected to have a blend of undergraduate students, post-graduate with professionals/professors. All participants were introduced to generative design in a theoretical and practical experience about the mentioned form-finding techniques. The participants were then challenged to develop a project with the mentioned tools and were organized in groups of three (one undergraduate student, one post-graduate, one professor/professional). A heuristic helped to organize participants by interest and level of study, setting two groups for each theme, in a total of eight groups. The use of the tools in the design processes and their results are presented in this article, evaluating its potential and limitation. The results suggest that the tooling or computerization can coexist with the computation process, and this junction brings a new meaning to form in its formation process. Tools appear to be more tied to the context and to the project potential and the restrictions, albeit implicitly. But the learning process benefits from experience, to adjust the tools by trial and error. Even if the use of tools cannot be completely coded they work as heuristics to search the space of solutions. So tooling can rescue the design intuition prior to the use of computation. Tools influence the processes, the results and the final solution. So they are not neutral and need to be addressed.

Form and meaning in architecture and urbanism: principles of quality

Javier Poyatos Sebatián

Form is the perceivable external presence of a reality, in this sense, we can speak about form in architecture and urbanism. Architectural form must have a coherent sense, and it consists in its adaptation to the human inhabiting purposes according to the corresponding uses in each case. This adaptation depends on the intentions of the architect as an author, but only to a certain extent. According to hermeneutics, the meaning of a human work goes beyond the intentions of its own author, because it transmits additional aspects that were not originally expected by him. So, in one way or another, this form requires good quality in order to be in accordance with the ethical responsibility the architect has with society. It is common to ascertain the loss of quality in the urban form during the 20th and 21st centuries, especially in the current globalization scenario, and in comparison to the previous centuries. Relevant authors of the cultural and artistic critique such as Erwin Panofsky, Ernst Gombrich or Enrique Lafuente Ferrari have defended the identification of the quality in the works of creation as the fundamental objective of the critique. Due to this, the research and identification of the quality features in the urban form are pertinent in order to have useful instruments to correct this contemporary cultural loss. It is therefore proposed the identification of quality principles of urban form from a hermeneutic point of view. That is to say, each of these principles as capable of opening a certain horizon of comprehension of a specific perspective of quality. For example, we can aim at: beauty, scale, amenity, grace, order, etc. Each principle, offers then a horizon of understanding and also of urban creativity that assembles into this work from the analysis of operative subprinciples and their verification on specific expressive cases of urban form, in both, historical and current aspects. The principles in turn can intertwine offering cumulative and transverse quality options. Therefore, what is sought, is to offer a pertinent and structured hermeneutical tool for the analysis of urban form in its values of quality and excellence.

Urban challenges:
from regions to streets

José Nuno Beirão

The talk will give an overview of contemporary urban challenges at different scales – from regions to streets. Parallel to this overview, the presentation puts forward a set of tools and methods conceived to address the problems and inherent complexity found in the given challenges. The presented tools and methods start from understanding the world to informed ways of changing the world. Simultaneously, the presentation will start from problems at regional scale towards problems at local scale; neighbourhoods, streets and the public space.

ONTOARCHi –
an ontological framework for developing a semantically based new generation of automation tools for architectural design

Franklim Morais, David Leite Viana, Jorge Vieira Vaz, Catarina Ruivo, Isabel Cristina Carvalho

Architectural Design is a technological field where the use of Information Technologies are lagging behind the current state of the art of other human activities. Although CAD and related tools have been of invaluable interest, they are intended for drawing (first generation) and construction (second generation). Even recent developments of the 2nd, like BIM/IFC and others, are not directed to the creative work of the architect, dealing with such things as spaces, human needs or functions. ONTOARCHI project is a large framework of research efforts, trying a new path to develop o new paradigm in automation of Architectural Design. The core concept of the project is the natural association of a logical descriptive language (ontologies - OWL language in Protègé development environment) populated with architectural theories and/or methodologies and a set of operational languages reasoning over those defined ontologies. Those operational languages respond to the input of design requirements, querying the ontologies, and outputting the definitions of the likely and optimized projects that are as close as possible to the desired requirements and the most useful for the future commanding architect's work. This paper describes only one of the lines of R&D of the project. Its goal is to provide the architect with automated drafts and schemes of the sizes, shapes, distribution, interfaces and borders of the building spaces. It assumes that the most influential determinant of form is the set of human activities unfolding in the edifice. The created ontology encapsulates theories on relations between activities and spatial form. As this is a centennial field of interest of architectural studies, the ontology and its population could be defined heuristically, with an effort of logical formalization of a very extensive bibliography. The main concepts of the ontology deal with typified people, human activities, spatial requirements, equipment, environmental requirements, and construction elements. For now, the current outputs are schemes with the size of the spaces, their relative positioning considering attraction and repulsion factors, the material requirements of their mutual interfaces and with the exterior.

All bottles from one design semantics in design generation using ontologies to control shape generation

José Nuno Beirão, Rui de Klerk

The automated production of semantically sound designs may be obtained by combining a small number of parametric shape rules operating on a vocabulary of shapes taken from a structured design domain. The design domain is defined by a taxonomy and a meronomy of concepts, parametric shapes, parameters and descriptions where all part relations are made explicit – an ontology. The paper gives an example of a design system where some simple shape grammars operating on an ontology describing a design domain generates all possible and valid instances allowed in that domain. The design domain chosen is 'bottle design' where only the bottle shape is considered (stoppers, bottle labels or handles are not considered). The paper shows a design system developed in four different parts: • An ontology describing the bottle design domain. The ontology was developed at a workshop where the main goal was to learn how to implement an ontology using an ontology editor, in this case, Protégé. • An ontology describing simple geometric entities and their CAD representations, in RhinoCommon. This ontology was generated by a custom Python script using Owlready2 module and verified in Protégé. This ontology supports shape definitions in the previous ontology. • A parametric model generating all shape rules in the design system, outputting 3D models. • The fourth part integrates the previous, connecting the ontologies with the parametric implementation of the rules. Now rules pick shapes directly from the ontologies and generate all possible variations in the domain of bottle design. The ontology controls the relationships between all parts components of a bottle determining which shapes are allowed to be applied by a shape rule. The ontology also determines the relationships between rules, which provides control over the shape derivation process. Ontology rules stating specific relations between concepts associated to bottle parts, their shapes, parameters and descriptions, allows the automatic characterization of bottles being modelled under different (known) families of bottles or their distinctive parts. This allows the design interface to assist designers during a modelling session, enabling them to depart from a desirable type of bottle, instead of modelling everything from scratch. It also enables designers create models of based on bottle 1 properties. On another level, the ontology also provides additional support to the designer, providing analytical information regarding the bottle being designed. It relates it to existing bottles previously modelled in the ontology, such as iconic bottles.

SUPERGRID –
a grammar for a Kit-of -Parts Pedagogy

Pedro Engel

SUPERGRID is the product of an ongoing research project linked to a first year design studio in the Federal University of Rio de Janeiro which employs kit-of-parts exercises, a didactic method shares some key principles with the realm of generative grammars, since both rely on limited universes of elements and a set of combination rules. SUPERGRID is essentially a three-dimensional grammar developed as a computational algorithm based on the kit-of-parts employed in the studio. It is intended to both to stimulate experiments in compositional variations and to produce physical models that serve as didactic aids in the studio. The first generation of models, presented here, privilege structure and closing systems of buildings and aims at an understanding of the façade as a mediation device between inside and outside. Aside from such practical outcome, the development of the grammar also permits research development in the use of generative grammar. In this sense, the goals of this article are two-fold: on one hand it aims at describing the process of development of the SUPERGRID so far; on the other hand, and more importantly, it intends to outline specific topics for the further development of the algorithms, which will expectedly set out directions in terms of resources and computational technology to be brought in the research in its next phases. The paper begins by presenting the premises of the kit-of-parts pedagogy and the definition of the elements that compose the grammar, originated both on exemplars of Brazilian modern architecture and of ordinary buildings of the periphery of Rio de Janeiro. In the second part, the paper explains the development of the computational algorithm describing the types of elements that compose the models and the rules that govern their selection and positioning in the grid system. Considerations regarding further development will concentrate on different methods for selecting elements and their arrangements. Amongst these considerations is the need for coding that may establish (1) conditional relations amongst choices pertaining to different categories of architectural elements and (2) quantitative assessment of the compositional choices in terms of their performance regarding external factors such as direct sunlight intake and visual permeability. Finally, discussion regarding different approaches to selection methods will be held with the intention to bring up the issues are at stake when opting for either a more controlled choice system or a more automated one regarding the didactic purpose of the SUPERGRID.

A generative system using shape grammars and visual programming

Daniel Lenz

"Form Finding & Generative Systems" was a 10 day intensive workshop at LAMO/PROURB at Federal University of Rio de Janeiro. This workshop sought to explore techniques related to generative systems and their translation and/or application to architectural design. Four techniques were approached: L-systems, Automata Cellular, Genetic Algorithm and Shape Grammar, most of them born from the Information and General Systems theories. As preparations for the workshop, it was carried on some research regarding conceptual studies and pre-development of exercises. In this work we focus on the developments from the Shape Grammar research group. During the preparation period, we searched for previous existing computational implementations. We found few implementations and nonetheless decided to develop a new application using visual programming, namely the application Grasshopper. After reviewing seminar literature on this subject we thought to develop a three ordinate structure to be used to generate solutions for the workshop that would be easy to implement and use. During the workshop, participants were asked to develop a design solution for a space between 3x3x3m up to 10x10x10m using different techniques, in this case shape grammars using the application developed, that will be described in this paper. The structure of the Shape Grammar algorithm implemented will be described, together with the results of the experiences developed by the teams that worked with Shape Grammar. From this experience some observations are registered and are drawn some conclusions

The *galleria progressive* in the Solomon R. Guggenheim Museum and the Museum of Unlimited Growth

Ana Luísa Rolim, Luiz Amorim, Maria Júlia Jaborandy

The Solomon R. Guggenheim Museum, designed by Frank Lloyd Wright (1943-1959) and the Museum of Unlimited Growth (1939), by Le Corbusier, are examples of the *galleria progressiva*, a type of architectural configuration containing sequentially uninterrupted spaces, emerged after the French Revolution, that generates specific sets of linear events and has the potential to guide the visitor's experience relying more on the building geometry than on symbolic or guidance artifices. In Wright's design visitors would take the elevator up and descend, on a leisure mode drift, through a fixed journey on the sloping plane, from which they would sidestep into exhibition rooms and then return to the skewed plane of the spiral gallery in the rotunda. In a similarly deterministic configuration concept, Le Corbusier designed a museum to be accessed from an atrium in the mid-point of the structure, from where visitors would take a ramp to the upper floor, occupied by galleries, laid out in a square-shaped spiral overlaid with a 4-axis cross, that could grow endlessly as more exhibiting spaces were needed. As part of a broader PhD research on visitors' engagement in the *galleria progressiva* museum type, the interest of this paper relies on finding clues on the morphology of the concepts by two of the most iconic architects in the twentieth-century that might lead to their potential in facilitating engagement. To investigate morphological aspects, space syntax was used as the main theoretical ground, relying on justified graphs, convex, axial and visual analysis maps as topological representations of both spatial structures. Some of the key questions in future developments of this research are: Are both spiral-like configurations equally deterministic when it comes to route alternatives? Doe ones favor a more exploratory visit than the other? Which spatial system is easier to navigate? How does Le Corbusier's architectural promenade concept cope with an apparently very restrictive layout? By addressing these issues, we hope to revisit two important museum designs and, at the same time, bring light on the history of museum types by examining the *galleria progressiva*.

Partitioning indoor space using visibility graphs: investigating user behavior in office spaces

Petros Koutsolampros, Kerstin Sailer, Tasos Varoudis

An abstract representation of interior space is the foundation for any spatial analysis of human activity in such environments. It must capture high level concepts such as rooms, areas and corridors, but also allow for the discrete appearance of human behaviour (for example two people will not walk through the same corridor in the same way). Within the field of Space Syntax three such representations have been proposed, axial lines, convex spaces and visibility graphs. However none of these representations are both unambiguous and allow for aggregating results. Axial lines are reductions of the space into longest lines of sight and convex spaces are ”the largest and fattest convex spaces” possible. While both are meaningful abstractions, they are ambiguous and depend on the person creating them. Visibility Graphs on the other hand provide a uniform unit of analysis by dividing the space using a lattice grid into cells of equal size and connecting the cells if they are intervisible. This representation however does not allow for a meaningful aggregation of spatial human behaviour data, given its very precise nature. We propose a new representation, one which clusters adjacent cells of the visibility graph based on different metrics and thus provides both aggregatable areas and a robust method of creation. We explore how these various metrics and properties of the visibility graph create different types of clusters and specifically examine connectivity and Visual Mean Depth on various types of spaces, from simple shapes, to complex multi-floor buildings. Finally, we demonstrate how this aids the analysis of human activity in indoor spaces by focusing on a large sample of observed activity in office spaces. We argue that this new representation provides a robust but also meaningful foundation for the analysis of indoor space.

Complex buildings and cellular automata: a cellular automaton model for the centquatre Paris

Roberto D'Autilia, Janet Hetman

This paper explores the relational, dynamic elements of Complex Buildings (CB), a type of architecture designed to serve as incubators of uses and located in urban areas with a high housing density. The uses of CB deals with different elements, including the network of agents using or manage the buildings, the environment and the activities and functions that take place occasionally, temporally or permanently. The data was gathered through an ethnographic research that lasted 6 months and included a chronotopian approach to describe time and space. We further analyze and discuss the interaction of the elements of CB through the application of Cellular Automata, a computational method that simulates the process of growth of a given complex system. In particular, CA is used here to generate patterns that suggest the configuration of the uses within a CB that can optimize the management of the planning and therefore to increase in economic and social capital. Further, CA is applied to develop an abstraction model of the Centquatre, a cultural and artistic institute in Paris. This case study is a good example of CB because it is based on a public-private partnership and its architectural configuration is specially designed to host a diverse range of art, social and productive activities, which includes a wide central yard used as an urban public space open to different types of people. We state that the relevance of this case study lies precisely in its capacity to produce economic value through the combination of its different uses, and also by welcoming the presence of diverse people in what is rendered as public space. By considering the building a living organism, we develop a CA tool for revealing how determinant is the concepts of configurations and compatibility between uses and of economic value generated by people's presence. We argue that through this approach it is possible to show that the space-time designing and public space dimensions become determinant factors in CB.

Interaction between soil morphology and the technological landscape of Ave Valley

André Chaves

The present investigation consists of a counter-cultural methodological approach of the 1960s, 1970s and 1980s applied to a territorial sample of the Ave Valley, doubly characterized by a strong entrepreneurship from two agricultural devices and two industrial devices still existing today. The territorial sample corresponds to a Portuguese technological landscape that was developed with the industrialization of the Ave since 1845 and parallel to others like the Portuguese Douro Vinhateiro. The methodological counter-cultural reading referred to corresponds to the third computational wave, synthesized as an open rationalism and free sensorialism, culturally chaotic and fruit of the world hegemony domination of the United States of America since the end of World War II, commonly called postmodern. The identified methodological approach uses computational techniques aimed at the areas of architecture, industrial design and architectural heritage. These techniques were applied to procedures of spatial modelling applied to architecture, rapid object prototyping procedures applied to industrial design and in-loco field work procedures applied to architectural heritage. The soil morphology is defined by the relief, topography and local orography. The technological landscape is defined by human settlements, architecture and local construction. The temporal context is also limited to the 1960s, 1970s and 1980s. The spatial context is delimited to a case of territorial study, simultaneously of great vernacular and industrial patrimonial value in symbiosis with the contemporary urban dispersion, belonging to the parishes of Pousada de Saramagos, Mogege and Joane of the county of Vila Nova de Famalicão (Portugal). The conceptual description of the investigation consists of deconstructing, literally and existentially, the technological landscape of the Ave identified in the temporal and spatial context referred. It is considered, for this and as an initiation, the epistemological perspectivation of the territory of the case study from a possible natural and original reading before the intervention of man through the conceptualized soil morphology. Thus, this original epistemological perspectivation for soil morphology is a phenomenological innovation, through natural orography design, as an alternative to functionalist canonical studies, through the road network, as a support for an alternative interpretive reading of the diffuse urbanization of the Ave Valley. The procedural description of the investigation consists of two phases. The first phase is structuralist and is developed heuristically by computational logics through the elaboration of a functional diagram, seen as synthesis of the local genotype, from two rural devices and two industrial devices belonging to the case study. The second phase is post-structuralist and is developed heuristically by computational logic through the elaboration of a phenomenological diagram, seen as synthesis of the local phenotype, from two rural devices and two industrial devices belonging to the case study.

Spatial analysis in GIS environment: locational attractiveness assessment of the retail trade

Eliziéle Paroli, Clarice Maraschin

Retailing is a fundamental component of the structure of cities. The literature shows its importance in line with its influence in the generation of centralities, movement patterns, as well as in the revitalization of urban areas. A central topic in the retail analysis is store location, which is related to its attractiveness and even with its profitability. In order to determine the force of attraction of a given point of sale, methodologies based on gravitational models have been developed. One of the pioneers in this approach was William J. Reilly, in 1931, and later David L. Huff, in 1963. More recently, classic models such as Huff's have been integrated with Geographic Information Systems, granting prospects renovation and use expansion, along with the increasing data availability of urban georeferenced information. This paper explores a methodology for retail spatial analysis in a GIS environment, and it aims to: a) determine the degree of influence of different attributes in the consumer choice among a collection of retail options, and b) develop an empirical application for the clothing retail business sector in the central area of the city of Santa Maria, RS, Brazil. The study pinpoints three relevant attributes in the store choice: retail market clustering, topological accessibility of the street network and topographic slope of the terrain. We use an ArcGIS® environment in order to integrate the different analytic tools applied. For the determination of retail stores clustering, each shop was mapped using Google Earth®, and the point data was used as an input for the Kernel density map. The terrain slope was obtained with a Digital Elevation Model (SRTM data released by NASA) as an input. The street network was represented by streets segments (between two corners) and a topological Accessibility model was performed using UrbanMetrics®. These three features were taken as inputs for the attractiveness evaluation of each store, through the Huff model (ArcGIS Market Analysis Tools). As a result, it was identified the trading areas of each shop related to the selected attributes. The study provides confirmatory evidence that GIS are instruments capable of managing different types of data efficiently. The Huff model has been shown able of determine the attraction areas of the stores under study, and, lately, it can be used not only to verify empirically the attractiveness potential of existing shops, but also as location decision support for future markets.

Formal methods in social housing municipal management

David Leite Viana, Sara Eloy, Jorge Vieira Vaz, Isabel Cristina Carvalho, Catarina Ruivo

Scientific questions: 1. People's participation in community life, community engagement/empowerment, involving data tracking/mapping/visualization in open access digital platforms. 2. Integration of deprived communities in social innovation and improvement of social housing municipal policies and management through community-based solutions, e-governance and e-planning. 3. Inclusion of deprived communities in decision-making processes regarding social housing' maintenance and integration of municipal neighbourhood's data in public profiles allowing verifying, in a virtual and augmented environment, social housing dynamics in the urban metabolism. Objectives: 1. To engage stakeholders in knowledge sharing and e-participation in generating solutions. 2. To boost collective understanding and innovative capacity by developing a platform of design resources to help deprived communities to cohere and better empower them to address local problems through co-design and social innovation processes. 3. To develop a data integrated model using real-time and open access information to support community decision-making considering new visualisation patterns to communicate complex data to derive insights of value for more transparent and democratic decision-making. Description of the approach: Development of a 3D virtual interactive model to support planning consultation. The virtual model consists of a 3D point cloud data of the existing environment including the registration of the building information model of the future development. The model will be easily accessible from different devices such as laptop, tablet and smart phones. The model will be accessible by the community to visualise the concerned area to take informed decision in relation to planning and place making. Combined approaches involving data tracking/mapping/visualization will also be used. The methodology is systematized in formal methods and digital techniques in spatial analysis and statistics. In addition, it will be considered the data processing, its managing and transference between virtual and augmented environments. These procedures will be complemented with map tracking and three-dimensional modelling of the volumes concerning the neighbourhood used as study cases. Through community-visioning approaches, it will be envisioned the way community members think the neighbourhood and how they could change it for the better. This social action process will help to understand the neighbourhood, what needs to change, and ways in which change could be delivered. A Data Integrated Model (DIM) will be structured integrating a data model to support the community decision making, focusing municipal houses maintenance and retrofitting data management.

Four-dimensional objects, cellular automata and Virtual Reality – the Hypercocoon project

Victor Sardenberg, Isadora Tebaldi, Emilio Bier, Nicolle Prado

This research focuses on the problem of 4D objects generation and its representation. The hypothesis is that through the use of Cellular Automata and contemporary media like Virtual Reality, we can have ahistorically new way to generate and experience 4D objects (Hyper-objects). Methodology relies on the use of generative algorithms and Virtual reality Interaction, using Vr goggles to explore 3d and produce form. Cellular Automata (CA) systems are usually made by extrapolating one dimension. For instance a 1D CA is usually stacked to produce a 2D image. A 2D CA is stacked to produce a 3D Volume. Also, to produce a 3D CA systems are used 3D cubes, due to the inability to imagine a 4D reality and what would be a 4D object, called Hyper-object. Architecture has, in its core, representation tools that are enable reducing 3D objects to 2D drawings. From the Renaissance, especially through the work of Alberti and Dürer, plans and sections were instrumental to reduce one dimension to understand the architectural object and its disciplinary problems: mass x voids, parts x whole, inside x outside. This research enables a phenomenological experience of inhabiting a 4D object through Virtual Reality. Usually the 4D hyper-objects are represented as a succession of cubes that are connected by lines in its vertices. Following the tradition of architectural sections, a Virtual Reality environment was developed to experience a 3D slice of a 4D object. The project developed supports that it is possible to surpass previous representation limitation – by extending space to 4D – and that this extension can be used to generate form, in a form-finding process.

Urban morphology:
teaching different approaches

Vítor Oliveira

Why teaching urban morphology? What morphological contents should be taught? And, how to teach it? How to make an effective use of the different morphological approaches that have been proposed over the last decades? These are major questions of the debate in urban morphology studies. The 'Emerging Perspectives on Urban Morphology' / EPUM research project addresses these fundamental issues. Funded by the Erasmus + programme, this 28 months project brings together five partners (Sapienza Università di Roma, Space Syntax Ltd, TU Wien, Universidade do Porto, University of Cyprus) from different countries in South and Central Europe that have been promoting different morphological approaches, from the historico-geographical approach (Conzenian school) to the process-typological approach (Muratorian school) and to space syntax. Through a continuous learning process of meetings, teaching activities and workshops, that gathers a diverse set of teachers and learners, EPUM will: i) compare and improve the ways in which urban form and the agents and processes that are responsible for its transformation over time, are taught; ii) compare the theoretical, conceptual and methodological basis of the different approaches, identifying their main strengths and weaknesses, and exploring the possibilities to combine some of these different ways of describing, explaining and prescribing the physical form of cities. The paper presented to the 4th Formal Methods in Architecture will discuss not only the theoretical framework of the project, but also the process and the main intellectual outputs.

Complexity revival in architecture: building innovation

Alexandros Kallegias

There is a clear recognition of the benefits when bridging between computational design and digital fabrication techniques. The question then becomes, how can technology contribute in creating innovation within the field of architecture? Within an agenda that focuses on exploring generative techniques based on computation and inspired by biomimetics the presentation responds to the question through showcasing the research studies completed at the Architectural Association (AA) School of Architecture. The research behind the AA Sumer DLAB is embracing the notion of combining architecture, engineering, material and computer science as well as robotics in manufacturing. Computational form-finding techniques that are being explored in the recent digital era decades in architecture have enabled the creation of numerous geometrical assemblies. Coupled with the advancements in digital fabrication, the production of complex forms has been restricted to specific manufacturing methodologies. Recently the application of robotics such as the robotic arm from the automotive industry has introduced new possibilities for architectural design and manufacturing. The multi-axis freedom of an industrial robot arm, its speed, precision and repeatability has supported the rejuvenation of complexity found in volumetric formations allowing for an approach varied from practices of standardized, component-driven assemblies. The research work is framed around the definition of architecture as an open collaborative environment revisiting mediums of design and its processes of formation. By rethinking traditional fabrication processes the aim is to develop an innovative strategy for architectural design and construction. This strategy is then applied in the making of a 1:1 scale architectural prototype. The methodology here is divided into two stages and the work depicts how the outcome of the initial phase using computational techniques enables the progression to the second stage and the completion of the prototype. The presentation that describes the output of the architectural programme is an example of a series of output from the AA Summer DLAB, it sets the scene for the challenges and opportunities when combining computational design methodologies with digital fabrication techniques. The ongoing research moves across different media for design and production taking into account various variables while shifting the focus from the final result to an overall procedural approach and its benefits for architecture as we move towards a machine age evolution.

Z-Tolerance:
three-dimensional abstract representations of the migration issues in Europe

Canan Albayrak, Rui Colaço

Formal and computational methods are well suited for design aspects that are translatable into measurable dimensions and binary code. Some aspects of technical, social and human factors (including cognitive and phenomenological ones) of design can be translatable into a formal language. This paper and its related research is an inquiry into three-dimensional abstract representations of migration issues. Three installation pieces are designed and fabricated as a part of the Z-tolerance exhibition, which is a proposal to increase awareness to the current migration issues in Europe. Parametric design and three dimensional modelling are used for the process of transforming migration aspects that are normally represented by daily language into a visual abstract language. In addition to parametric design, the methodology of research makes use of Islamic geometric patterns and anamorphosis. The design of Z-Tolerance exhibition and installations contribute to research into abstraction of meaning and formalization of cognitive aspects of design specifically perception. Firstly, both form and the stages of the form finding process itself are investigated as a way of abstraction of meaning. Hence, different aspects of migration issues are represented through the design of form and of the design process itself. Secondly, the use of parametric modelling, manual mathematical calculations and photographic techniques constitute a way to formalize perception-based aspects of anamorphic perspective.

Urban segregation and socio-spatial interactions: a configurational approach

Ana Luisa Maffini, Clarice Maraschin

Urban segregation is an inherent feature of cities and becomes an urban problem when it excludes, or hinders, certain groups from accessing services, activities and spaces. Understanding segregation is of vital importance for the planning and management of cities. In Brazil, segregation by social classes is the one that dominates the structuring of cities, and public policies rarely address the urban configuration as part of the problem of segregation. Recent Brazilian housing programs have been a step forward in reducing the housing deficit; however they seem not having contributed to minimize the negative effects of socio-spatial segregation. The present work addresses segregation from a shift in emphasis from traditional territorial and housing segregation, to segregation as a restraint of socio-spatial interactions, thus including other facets of the phenomenon of segregation that have not yet been explored, and seeking new forms of evaluating and measuring this segregation in a spatially more relevant way. The socio-spatial interactions between different individuals allow various groups to use the same spaces and perceive the other, in that sense the co-presence in public spaces is of fundamental importance to reduce the effects of segregation. This paper aims to present a methodology of analysis of segregation based on configurational models, and develop an empirical application in a small Brazilian city, Ibirubá. In order to represent the probabilities of interaction between different socio-economic classes in public spaces, a configurational model (Weighted Centrality) was used, addressing the relationships between dwellings and places of retail supply. The city was represented by streets segments (between two corners) and the attributes of population size, household income and numbers of retail establishments in each segment were considered. The data come from the IBGE 2010 Census and from complementary field survey. The results allowed identifying the different potentials of interactions in the city, providing a first measure of this segregation. The conclusions seek to highlight the importance of configurational approaches in the study of segregation, as well as to show potentialities and limits of the presented methodology.

Design strategies and sexism in domestic spaces: a critical analysis of three modernist social housing icons

Larissa Gomes, Ana Luísa Rolim

Based on Dolores Hayden's concept that the house, as a reflection of the collective, mirrors the patriarchal structure of society by creating spaces that reinforce gender roles and stereotypes, we can argue that the service areas of a house is the spatial materialization of life support and family care activities. Considering that men and women should live and work equally, the feminist movement throughout the 20th century asserted that traditional constructions of gender relations should be destroyed and the house should function as a tool for social transformation. Domestic services in collective spaces then arise to enable the large-scale production of modernist housing and to dissociate women from domestic activities. Despite recognizing the plurality of genres, this study is limited to the binarism between men and women, and seeks to understand how gender relations are manifested in the domestic space and how spatial relations relate to the construction of gender. Based on Julienne Hanson's spatial syntax methodology the analysis investigates the importance of the implementation of collective domestic service systems during the modern movement as a tool to minimize the inequalities imposed by the sexual division of labor. Specific objectives include: (i) Analyze the spatial structure of three emblematic modernist housing complexes through the analytical variables proposed by Hanson - Narkomfin, in Moscow (Moisei Ginzburg, 1928-1932), Mendes de Moraes complex, known as Pedregulho, in Rio de Janeiro (Afonso Reidy, 1946-1950), and the Unité d'habitacion, in Marseille (Le Corbusier, 1947-1952) - which all contain collective spaces, such as laundries and kitchens; (ii) compare the spatial configuration of modern residences studied by Luiz Amorim and Hanson with these three cases to verify if these structures contribute to the perpetuation of gender roles and the sexual division of labor; and (iii) contextualize the socioeconomic and political scenarios involved in the three cases that might have favored minimization of such inequalities within the domestic sphere. The expected contribution is to show, under an analytical approach, aspects related to the influence of the domestic space on the social construction of the role of women and on the sexual division of labor in emblematic social housing complexes, bringing light to the importance of contemplating non-sexist architectural solutions which consider women both as an user of space and a transforming agent.

SCAVA – Space Configuration, Accessibility and Visibility Analysis: a 3D space syntax approach

Catarina Ruivo, Franklim Morais, David Leite Viana, Jorge Vieira Vaz

The analysis of spatial configuration through accessibility and visibility (SCAVA) has been conducted mostly with two-dimensional tools, relying on the capacity architectural plans often have of providing reliable and sufficient information. While forcibly three-dimensional problems are not the norm, these are often found in the literature, and frequently approached through adaptation of existing software. To tackle this question, we have developed DepthSpace3D, a dedicated software for the analysis of three-dimensional space. In this paper, we will back-up the hypothesis that some problems cannot be fully resolved with two-dimensional tools through the analysis of different case studies: i) a residential area where it is argued feelings of control and safety in the public areas may depend on its three-dimensional features, ii) a complex building (Casa da Música, in Porto, Portugal) and the surrounding public space, which architectural characteristics cannot be easily grasped through architectural drawings alone, iii) a hypothetical model of a large retail space. The case study analysis will be in some cases complemented with empirical data, as well as other theoretical models and digital tools for the understanding of spatial layouts, and intends to demonstrate the potentialities of three-dimensional analysis as part of an integrated approach.

The space between the formal and the informal city alongside the River Maranguapinho

Camila Santana, Ugo Santana

Fortaleza, with a population of 2,609,716 inhabitants, is a city marked by the contrast of planned and unplanned areas that reflects its social inequities at the urban space. The precarious settlements of the city are mostly located at environmentally degraded areas, such as the River Maranguapinho. This river passes alongside ten neighbourhoods, concentrating 302,675 inhabitants, with areas characterized by pollution, lack of sanitation and informal occupation. The objective of this paper is to analyse how the Fortaleza urban grid connects the formal and the informal settlements alongside the margins of the River Maranguapinho. The study considers as formal city the planned areas, designed following a conceived urban grid; and as informal city the self-produced space, where the concentration of precarious settlements defines the limits of the public space. The research is based on the analysis of the area located from the river's margins to the beginning of the planned grid of the city, aiming to identify how the formal and informal urban spaces connect. The analysis involved the development of maps in the software QGIS, associating with data collected from the municipal government institutions, such as location of the precarious settlements, population, urban infrastructure, per capita income and the number of dwellings. Subsequently, with the use of the software DepthmapX, axial and segment maps of Fortaleza urban grid were generated, with their respective data. These data were composed by values of normalised angular integration and choice, considering global and local scales, which were compared with the previously collected information. The study shows that the informal grid in this area was once generated by precarious settlements that mostly follows the river line. The public space is restricted and unplanned, without the separation between pedestrians' and vehicles' space, and without open spaces. This context is caused by the expansion of self-produced buildings with small built area and fragile materials. The government actions either adapt or destroy the informal grid, move the population to other areas and define public spaces alongside the river line, aiming to control the land use at its margins. In this region of the city, coexist three situations: the formal areas with planned grid and settlements; the informal adapted areas that were absorbed by the formal city through government actions; and the informal areas, marked by the discontinuity of the grid and the concentration of the precarious settlements

Made by architects, modified by people: a grammar for User Interventions

Amina Rezoug

This study aims to propose the application of shape grammar on the analysis of an existing building modified by its residents. Climat de France, a large housing ensemble designed by the French architect Fernand Pouillon in Algiers is today in a very different state according to its original design. Residents of the ensemble have highly modified the blocks according to their needs. This study questions the possibility of analysing residents' need using shape grammar and questions a grammar's ability to generate context-adapted solutions.

Collaborative mapping with smartphones – an artistic approach

Isabel Cristina Carvalho

The analysis of urban spaces using mobile communication devices, with the collaborative participation of the population, involves a hybridization of processes that allow adding individual perspectives in collaborative logics, expressed in dynamic mappings and promote increased readings of urban realities. This paper explores the contribution of locative media-art to urban co-design, through artistic practices where space is understood as an abstract manifestation of measurable urban flows. It will be discuss some examples of artistic interventions that exploit the instrumental potential of smartphones and tablets as participatory tools and instigators of multidimensional experiences in urban spaces. Through the smartphone, the capacity of the technological ubiquity is explored and the participation and/or interaction (of and) among public is increased, as a facilitating tool of the participative exercise of writing and inscribing information (subjective and objective) in the production of a sense of place. These artistic practices mediated by mobile communication devices classify, in a participatory and collaborative (and real-time) way, appropriations and experiences that generate and record information flows. These records result in collaborative maps that contribute to the understanding of urban flows, allowing urban space users to express opinions, also contributing to the definition and preservation of memory and identity of these locations.

Linking data mining, spatial analysis and algorithmic design: a review on a primer workshop based on Python

João V. Lopes

The field of data mining, the practical application of machine learning, has recently become a full flagged science known as Data Science. An interdisciplinary discipline in the intersection of A.I., computer science, statistics, data visualization and database management, its main objectives are pattern recognition/knowledge discovery in datasets and prediction/data modelling. The application of this latter objective has become recently the subject of intense debate following the case of its use outside the scientific research. From political campaigns to the first mortal accident involving a self-driven car, these events brought the field to the highlights and, although its tools are not new, the scale of their implementation raises important questions considering their application, the nature of personal digital data and free will.
In research its application is most relevant in data rich fields and quantitative analysis. Here we can include spatial and urban analysis, which nowadays deal with huge datasets, e.g. combining Big Data from the internet, time series or unstructured data fluxes with urban form and structure, helping to assess or construct new investigation hypotheses. Using case-based reasoning and optimization data mining becomes a predictive tool able to assist the design process, producing scenarios or helping to explore constrained design solution spaces. The presentation will (i) briefly introduce the topic of data mining; (ii) its usage in urban analysis and design, and, mainly, (iii) report on a preliminary evaluation of the related workshop carried out in the context of the present seminar. The workshop introduces data mining to participants in a hands-on approach, focusing in simple tasks so concepts are internalized by playing with tools and scripting. The focus is on python scripting using Anaconda python data analysis package and Jupyter interactive Notebooks. In this way participants get a glimpse on one of the most flexible and widely used programming languages across a variety of fields, from algorithm design to data analysis, that is able of customize the tools that sometimes customize our own investigation or practice.

Development of a permeability measure between private and public space

Patrícia Alonso, Meta Berghauser Pont, Luiz Amorim

This paper focus in the development of a frontage permeability measure, that is, a permeability measure of the border between private (the plot) and public (the street) urban space, as a way to complement metrics used to assess urban properties related to urban social performativity. There are methods of urban analysis already known and widely tested as indicators of intensities of people flows, as Spacematrix (BERGHAUSER PONT; HAUPT, 2009) and Space Syntax (HILLIER; HANSON, 1984), that respectively measure density and accessibility, two characteristics known to be related to urban vitality. However, in certain urban contexts, such as Latin American cities and, more specifically in this study case, Brazilian cities, urban developments with high densities and accessibility can present low intensities of people presence in the streets. The hypothesis is that this results from (1) bigger size of plots and (2) lower frontage permeability due to blind walls, both occurring after densification by a specific verticalization type - high-rise residential buildings. Therefore, the streets become less inviting for people and less safe. This paper introduces a method to measure frontage permeability both in qualitative and quantitative terms, by verifying: a) the frontage visibility and accessibility separately; b) the presence of setback, its depth and use; c) the type of space (referring to land use) there is permeability to. It also describes measuring procedures for density and plot size based on existing methods, besides syntactic measures of network centrality and accessibility. Then, it presents a pilot study, in order to evaluate the relation between permeability measure and density, plot size, frontage length and land use. The final part presents the test results and conclusions, as well as the research's next steps: expanding the test area and relating the results to socioeconomic data (people co-presence in the streets and land use).The results confirm the hypothesis that the increasing densification model in Brazilian cities with high-rise residential buildings generates a decrease in the frontages permeability, although this model does not appear to significantly change the plot sizes and the frontages lengths. The paper content is part of a doctoral research on the relations between density and urban form and its influence in the urban social performativity. The case studies are urban areas of João Pessoa, Brazil.

The centrality of (Vocational-Oriented) Knowledge: An Assessment of the Location of Polytechnic Institutes in Portugal

Mafalda Toscano, Luísa Cannas da Silva, Teresa Valsassina Heitor, Reem Shurush

Knowledge and creative businesses and industries have been in the core of discussion for urban renewal strategies worldwide. Educational facilities and the businesses they attract are key elements in urban dynamics, helping to promote urban diversity and contributing to enhance the areas where they are imbedded. In Portugal, the higher education system follows a binary structure, in which institutions are divided according to their mission into Universities and Polytechnics. The latter, whose mission is creating vocational-oriented knowledge, grounded on the specific needs of the regions they are inserted in, are key regional drivers, with the possibility of becoming developers and promotors at a regional scale, affecting education, mobility, health, and among other issues of urban life and urban quality. As such, and in view of the impact of polytechnic institutions in the Portuguese regional contexts, this paper aims at exploring the location of polytechnic institutions within their hosting cities, attempting to understand location patterns and similarities among different institutions, as well as envisaging the impact of such a location in the engagement with the hosting city. The research is developed at two scales: the first (a) focuses on the location of the institution in its hosting city, while the second (b) focuses on the depth of the spaces within the premises of the institution. The first scale of analysis (a) recurs to space syntax techniques – namely segment maps – in order to predict movement patterns and attraction levels based on the hosting city's street configuration. It focuses on variables related to the physical characteristics of the city, as well as related to the cognition and perception of its users. The second scale (b) implies analysing the internal spaces of the institution in order to understand the deepness of the most public areas (i.e. libraries, cafés, sports facilities...) and it recurs to justified graphs. For this study, two case studies are chosen according to their local importance - the Polytechnic Institutes of Beja and Bragança. This research aims at providing a methodology for general characterization of regionally oriented higher education institutions in terms of their location within urban systems, as well as exploring the spatial organization of the interior of the institutions analysed.

The *Digital Divide* as a determining factor in the geographical localization of the urban Quality of Life in the metropolitan area of Monterrey, México

Sofia Garza Vargas, Aida Escobar Ramirez

Those left out by the *digital divide*, with regard to access to, use of, or impact of information and communication technologies, are in a condition of inequality in the access to resources and the interpretation and understanding of information and knowledge, leading to disparities in education, income and social capital in the population. This paper proposes the main correlating variables of the *digital divide* as key factors in the study of the spatial differentiation of the urban quality of life between geographic areas. The variables of access to ICT excel as the principal components that explain the spatial dissemination of the urban phenomena as a result of the construction and application of a synthetic index that integrates indicators of a social nature, based on the evaluation of micro-economic characteristics and are conceived to take into account the systemic relations to the interior of the Latin American city. The approach is quantitative and the method to be used is the Principal Components Analysis with VARIMAX Rotation for the hierarchy of significant variables for the construction of a synthetic index of evaluation. The Kaiser-Meyer-Olkin test (KMO) and the Bartlett's sphericity test is used to check the feasibility of the factor analysis. The method for grouping geographic data is the stratification of Jenks natural breaks classification. Regression analysis is applied to know the degree of correlation between the factors. The study case is the Metropolitan Area of Monterrey, the 3rd-largest such area in Mexico. In addition, Geographic Information Systems are used to show the results of the statistical and spatial analyzes, namely, to visualize the means in which territory is appropriated. To show the geostatistical information, a specific map type is used, the thematic map, since it allows to show spatial information to indicate the location and the distribution of the phenomena in which this investigation deepens. The maps, together with the traditional interlacement of layers georeferenced data and information, allow to display a single thematic layer of data or group several layers to highlight patterns and relationships in space, allowing the mapping and “friendly” data visualization of complex urban phenomena such as the social differentiation of quality of life in space. Explorative experimentation with other tools of spatial analysis, such as cluster analysis, are involved.

Biographic notes

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Institutional support

Editorial support

urban science

an open access journal by MDPI

http://www.mdpi.com/journal/urbansci

A selected group of fifteen papers from 4FMA Symposium will be published within a Special Issue related to the topic "Urban Data Mining".

4th Symposium Formal Methods in Architecture

Book of Abstracts

Porto 2018

Coords.
David Leite Viana
Franklim Morais
Jorge Vieira Vaz

ISBN
978-972-8784-80-5

C. E. S. A. P. – Cooperativa de Ensino Superior Artístico do Porto
Portugal