

Preface

Since 1985 the Computer-Aided Architectural Design Futures Foundation has fostered high level discussions about the search for excellence in the built environment through the use of new technologies with an exploratory and critical perspective. In 2015, the 16th CAAD Futures Conference was held, for the first time, in South America, in the lively megalopolis of Sao Paulo, Brazil. In order to establish a connection to local issues, the theme of the conference was "The next city". The city of Sao Paulo was torn down and almost completely rebuilt twice, from the mid 1800s to the mid 1900s, evolving from a city built in rammed-earth to a city built in bricks and then from a city built in bricks to a city built in concrete. In the 21st century, with the widespread use of digital technologies both in the design and production of buildings, cities are changing even faster, in terms of layout, materials, shapes, textures, production methods and, above all, in terms of the information that is now embedded in built systems.

Among the 200 abstracts received in the first phase, 64 were selected for presentation in the conference and publication in the Electronic Proceedings, either as long or short papers, after 3 tough evaluation stages. Each paper was reviewed by at least three different experts from an international committee of more than 80 highly experienced researchers. The authors come from 23 different countries. Among all papers, 10 come from Latin-American institutions, which have been usually under-represented in CAAD Futures. The 33 highest rated long papers are also being published in a printed book by Springer. For this reason, only their abstracts were included in this Electronic Proceedings, at the end of each chapter.

The papers in this book have been organized under the following topics: (1) modeling, analyzing and simulating the city, (2) sustainability and performance of the built environment, (3) automated and parametric design, (4) building information modeling (BIM), (5) fabrication and materiality, and (6) shape studies. The first topic includes papers describing different uses of computation applied to the study of the urban environment. The second one represents one of the most important current issues in the study and design of the built environment. The third topic, automated and parametric design, is an established field of research that is finally becoming more available to practitioners. Fabrication has been a hot topic in CAAD conferences, and is becoming ever more popular. This new way of making design and buildings will soon start affecting the way cities look like. Finally, shape studies are an established and respected field in design computing that is traditionally discussed in CAAD conferences.

Hosting CAAD Futures conference was a great honor to us. Enjoy this great selection of papers.

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Keynote speakers

The papers in this book cover three aspects of design computing: its origins, new research frontiers and applications in practice. In a similar way, the conference keynote lectures were grouped under the following topics: “CAAD in History”, with Arivaldo Leão de Amorim (Brazil) and João Magalhães Rocha (Portugal), “CAAD in Research”, with Axel Kilian (Germany/USA) and Jane Burry (UK/Australia), and “CAAD in Practice”, with Milos Dimcic (Serbia/Germany) and Caroline Bos (Netherlands). When selecting the speakers we tried to be as inclusive as possible, with young and experienced men and women from academia and practice, representing institutions from South and North America, Europe and Asia/Pacific

Day 1: CAAD in History



Arivaldo Leão de Amorim

Federal University of Bahia

Arivaldo Leão de Amorim has graduated in civil engineering (1977) and architecture (1982) at the Polytechnic School and at the Faculty of Architecture of Federal University of Bahia (UFBA), respectively. He did his Master (1990) and PhD (1997) courses on transportation engineering at the Polytechnic School of Sao Paulo University (USP). Presently, he is full professor at the Faculty of Architecture of UFBA, and he has worked on applications of digital technologies for Architecture, Urbanism and Construction. In 1992, together with Prof. Gilberto Corso, they created LCAD – Laboratory of Advanced Studies on Architecture, City and Digital Technologies (since 2014), an important national reference in this area. His works and interest cover Computer Aided Architectural Design (CAAD), Building Information Modeling (BIM), Cultural Heritage Documentation, and Urban Planning on education. He has organized a set of conferences related to these subjects and produced some related papers. Besides, his collaborative work with several national universities, he also has collaborative agreements with the Institute of Photogrammetry and Remote Sensing (IPF) of Karlsruhe Institute of Technology (KIT), in Germany, and with the Dipartimento di Ingegneria Civile Edile e Architettura (DICEA), of the Università Politecnica della Marche (UNIVPM), in Italy.

CAAD History in Brazil

Arivaldo Amorim's lecture will be titled "CAAD History in Brazil". He will present the evolution of use of the computers in the AEC area to the current CAAD applications, starting with the context of the contested national law of market reserve of information technology that contributed to the delay of the popularization of computers in the country, especially its use in architecture; the first experiments and uses with CAD and the conferences in the 1980s; a panorama of the 1990s covering the first teaching experiences facing architecture; the compulsory computer education in architecture by law; the events and the emergence of the first research groups; the popularization and universalization of CAD use in offices and schools of architecture in the 2000s, as well as the consolidation of research groups; and finally the maturity of the area with the diversification of subject research and strengthening of the research groups from 2010 on. He will conclude with an assessment of the panorama of the national production from papers presented at conferences, thesis and dissertations, and the research groups registered in CNPq's directory.

Day 1: CAAD in History



João Magalhães Rocha

University of Evora

João Magalhães Rocha teaches at the Department of Architecture at the University of Évora (UE), Portugal. He earned a M.Sc from Columbia University (GSAPP) New York (1995) and completed his PhD at the Massachusetts Institute of Technology (MIT) at the Design and Computation Group. He taught at the Pontificia Universidad Católica (PUC) at Santiago, Chile (1996), at MIT as a teaching assistant (1998-2002) and received a Post-doc Fellowship from the Paul Mellon Centre for Studies in British Art in London (2008). He was recipient of a Harold Horowitz Student Research Award (MIT) and was a research Fellow at Cambridge University, UK. In addition he holds a professional degree in architecture from the Technical University of Lisbon (FAUTL). Currently is Adjunct Director of the Department of Architecture at Évora University, he has lectured widely and published broadly and his research deals primarily with the development of computation in relation to architecture both from a historical and practical perspective. As member of the UNESCO Chair for Intangible Heritage and Traditional Know-how (UE) he pursues work regarding Portuguese heritage at the Maghreb area. His book, *War Science Architecture: From World War II to Architecture Computing* will be released during Spring 2015.

War Science Architecture From World War II to Architecture Computing

João Rocha's lecture addresses the development of computer technology from the dawn of World War II till the inception of the first research Centers on Design Computing. In an era where the term Digital Architecture emerges globally with impacts on every field of the architectural discipline it urge to draw a map that enlighten the origins of this new thrilling endeavor. The lecture depicts on research investigating the foundation, development and advances of computing technology when applied to architecture. Deriving from theoretical, practical an archival research the author provides a new cultural and historical framework, which contextualizes the birth of architecture computing initially in the UK and later in the USA.

Day 2: CAAD in Research



Axel Kilian

Princeton University

Axel Kilian is an Assistant Professor at the Princeton University School of Architecture. He previously taught Computational Design at the Department of Architecture at MIT and at TU Delft. In 2006 he completed a PhD in Design and Computation at MIT on design exploration. In addition he holds a Master of Science from MIT and a professional degree in architecture from the University of the Arts Berlin. Axel Kilian has lectured widely and published extensively. His publications include the Architectural Geometry book from 2007 with coauthors H. Pottmann, A. Asperl, M. Hofer. Axel Kilian was a longtime contributor to the Smart Geometry event series from 2003-2010 as well as co-chair of the inaugural Advances in Architectural Geometry conference in 2008, and member of the advisory committee for the Design Modelling Symposium in 2011 and 2013, as well as frequent reviewer for journals and conferences in the field of computational design. He contributed to the concept car design studio of William Mitchell in the Media Lab's Smart cities group from 2003-2006. In addition he is the founder of the design consultancy designexplorer.net. His latest research focus is on embodied computation, the continuation of computation in the physical realm.

Embodied Computation

Axel Kilian's lecture is titled Embodied Computation. In some engineering systems such as quad copters there is a shift from systems with mechanical complexity for control towards algorithmic complexity paired with simpler mechanics. This allows for greater flexibility and a continued adaptation of the systems post deployment and therefore a chance for the design process to continue into the artifact itself. In parallel in robotics sensor feedback and open loop controls are slowly being integrated into the fabrication process that offers the opportunity to assign material more agency in the process of fabrication. To understand materials as the embodiment of computational processes and to link these physical processes more with the computational processes of design and view define the design process as open ended process beyond the completion of the physical artifact is the challenge that will be discussed on an experimental scale. The implications of these changes are particularly fascinating at an architectural and urban scale both for the creation of future constructs and the refurbishing of existing structures as networked and computationally enabled entities.

Day 2: CAAD in Research



Jane Burry

Royal Melbourne Institute of Technology

Jane Burry is an architect and Associate Professor of Architecture and Design in the School of Architecture and Design, RMIT, where she directs the Spatial Information Architecture Laboratory, SIAL. Set up to foster transdisciplinary research and education, SIAL is home to twenty PhD candidates pursuing design practice-led research, many in association with government and industry-funded projects. Jane also established and coordinates RMIT's Master of Design Innovation and Technology program. She has practiced, taught and researched internationally, including involvement as a project architect in the technical office at Antoni Gaudi's Sagrada Familia church in Barcelona and the design of many less prominent built works. She has over sixty publications. Her research focuses on mathematics in contemporary design. Jane is lead author of *The New Mathematics of Architecture*, 2010. Within SIAL she is currently engaged in research into advanced design and construction and the enfolding of analysis feedback into early, responsive and interactive design and prototyping. Related to this work, she edited the book *Designing the Dynamic*, 2013, and is currently investigating the Integration of Architectural, Mathematical and Computing Knowledge to Capture the Dynamics of Air with colleagues in architecture, mathematics, computing and engineering.

Researching the Sensate City

Jane Burry's lecture will be titled *Researching the Sensate City*. As a theatre for collective human life, the city is both an expression of permanence and solidity and an ever-transforming environment. Increasingly, the boundaries between the fabric of the city and the animate are blurring. The built environment sees, it knows and communicates where we are, can sense where we are going. It has the potential to feel and respond usefully to changes in the ambient environment. Although built architecture remains largely static, or only subtly dynamic, the city fabric nevertheless encounters and interacts with some of the most complex and unpredictable dynamic data and information streams. The very stasis of buildings can make their interaction with ambient flows more unpredictable. Design research for the "next city" calls for a phenomenal approach to the qualities of atmosphere, sound, heat, air movement, humidity and human interaction that acknowledges the subtlety of the feedback cycles informing an increasingly sensate and responsive city. The presentation will explore novel ways to collect and process real time data or simulate behaviour to create design feedback environments in which designers can build their own intuition while designing.

Day 3: CAAD in Practice



Milos Dimcic

Programming Architecture

Milos Dimcic graduated from the Faculty of Architecture, Belgrade, in 2006. He continued his studies in Stuttgart, Germany, where he finished his PhD in 2011, under the guidance of Prof. Dr.-Ing. Jan Knippers. During the studies he also worked at the Knippers Helbig office in Stuttgart. He has more than 8 years of experience in combining architecture, structural engineering and programming. Since 2007 he has been developing automation methods used in some of the world's famous large scale projects. In 2009 he programmed the largest parametrically generated facade and structure in the world. In 2011 he founded Programming Architecture and he has been developing different types of software (including free plug-ins) for very diverse and interesting projects all around the world. Some of the projects he contributed to since 2007 are: Bao'an Airport – Shenzhen, China (M.Fuksas), EXPO Axis - Shanghai, China (SBA Architects), Institute of Peace, Washington D.C, USA (Moshe Safdie), KAPSARC Research Center, Riyadh, Saudi Arabia (Zaha Hadid), Crystal Hall, Baku, Azerbaijan (GMP), and many others.

Artificial Intelligence in Architectural Praxis

Milos Dimcic's lecture will be titled Artificial Intelligence in Architectural Praxis. In this day and age, in architectural and engineering offices, we are using computers as automation tools. We write algorithms and use machines that make our work more efficient in terms of speed and strength. Recently, there has been a lot of discussion about technological singularity - the moment when artificial intelligence (AI) surpasses human intelligence. This is known as strong AI. We are still far away from that moment, but on our way there we are creating software that goes beyond a tool, and slowly becomes something known as weak AI. We are entering an era in which highly specialized software is not our servant; it is our co-worker, our advisor. The lecture will focus on practical applications of algorithms that give answers to questions you cannot answer yourself, thus helping you reach creative and optimal design. On the examples of some of the largest and most complex projects in the world, methods of simple automation will be demonstrated, but also techniques already describable as weak AI. After discussing the power of such algorithms, the focus will be shifted on their future, which is already being written (coded).

Day 3: CAAD in Practice



Caroline Bos

UN Studio

Caroline Bos studied History of Art at Birkbeck College of the University of London and Urban and Regional Planning at the Faculty of Geosciences, University of Utrecht. In 1988 she co-founded Van Berkel & Bos Architectuurbureau with the architect Ben van Berkel, extending her theoretical and writing projects to the practice of architecture. Realized projects include the Erasmus Bridge in Rotterdam, museum Het Valkhof in Nijmegen and the Moebius house. In 1998 Caroline Bos co-founded UNStudio (United Net). UNStudio presents itself as a network of specialists in architecture, urban development and infrastructure. Current urban development projects include the restructuring of the station area of Arnhem, the mixed-use Raffles City in Hangzhou, a masterplan for Basauri, and the design and restructuring of the Harbour Ponte Parodi in Genoa. Caroline Bos has taught as a guest lecturer at Princeton University, the Berlage Institute in Rotterdam, The Academy of Fine Arts in Vienna and the Academy of Architecture in Arnhem. In 2012 she was awarded an Honorary Professorship at the University of Melbourne's Faculty of Architecture, Building and Planning. Central to her teaching is the inclusive approach of architectural works integrating virtual and material organization and engineering constructions.

Next City, next Stop: Doha

Design strategies for the Qatar Integrated Railway Project

Caroline Bos's lecture will be titled Next City, next Stop: Doha - Design strategies for the Qatar Integrated Railway Project. In 1999 UNStudio launched the notion of deep planning, an exploration of the relation between architecture, urbanism and infrastructure, noting: 'The new architect faces a new assignment. Increasingly involved as the architect is in the realisation of bridges, motorways and urban revitalisation plans, alongside houses, offices and public buildings, the traditional procedures of practice are becoming inadequate. Urban nodes and infrastructure are some of the most important questions facing architecture at the moment.' ('Move', Van Berkel, Bos, 1999). For UNStudio, then, the blurring of the traditional distinctions between categories, typologies, and scales (city-nature, public-private, and global-local), is essentially connected to the real and concrete places that facilitate the increased mobility and access that characterizes our time.

While the network society, spaces of flow, the axes of mobility and access have been charted extensively by theorists, such as Castells, Harvey, and Sassen, which has had a profound influence on the architectural understanding of such places, it could be questioned if radically new and different design approaches have been developed. As Graham and Marvin argue, urbanists and architects have ‘tended to focus overwhelmingly on the designed spaces within building envelopes, rather than the networked infrastructures that knit buildings together.’ (‘Splintering Urbanism’, Graham, Marvin, 2001) Alternatively, they point to the occasional glorification of infrastructure as ‘iconic landmark’.

For UNStudio, the next stop in the next city is a node in the networked city, and designing an infrastructure network requires a network approach to designing and building. The realization of a contemporary space of flows thus necessitates a policy-aware, flexible, spatially-technical innovative, networked approach. This talk will use the design process of the Qatar Integrated Railway Project (QIRP) to focus on the question which are the instruments and design tools that allow the profession to effectively respond to ‘networked infrastructures, technological and the urban condition’? For UNStudioThe Qatar Integrated Railway Project (QIRP) comprises around 35 stations in phase 1 and around 60 stations in phase 2 for the new Doha Metro Network (planned to comprise 4 lines) and will serve as the backbone of the public transport system in the Greater Doha Area.

The design further aims to incorporate and integrate all functional and technical aspects of the network and stations into a coherent architectural expression. A key concept within the design is one of creating varying scales of identity for the user - network identity, line identity and station identity. We developed an ‘Architectural Branding Manual’, a set of design guidelines, architectural details and material outlines that will assure the spatial quality and clarity of the network. The manual will be used by the appointed D&B contractors to implement and deliver the individual stations in the first phase.