# eCAADe 2017 Sh<sup>o</sup>CK!

Volume 1

#### Editors

Antonio Fioravanti, Stefano Cursi, Salma Elahmar, Silvia Gargaro Gianluigi Loffreda, Gabriele Novembri and Armando Trento Faculty of Civil and Industrial Engineering *Sapienza* University of Rome

1<sup>st</sup> Edition, September 2017

ShoCK! – Sharing of Computable Knowledge! - Proceedings of the 35<sup>th</sup> International Conference on Education and Research in Computer Aided Architectural Design in Europe, Rome, Italy, 20<sup>th</sup>-22<sup>nd</sup> September 2017, Volume 1. Edited by Antonio Fioravanti, Stefano Cursi, Salma Elahmar, Silvia Gargaro, Gianluigi Loffreda, Gabriele Novembri, Armando Trento. Brussels: Education and Research in Computer Aided Architectural Design in Europe; Rome: Dep. of Civil, Building and Environmental Engineering, Faculty of Civil and Industrial Engineering, Sapienza University of Rome.

ISBN 9789491207129 978-94-91207-12-9

Copyright © 2017

Publisher: eCAADe (Education and Research in Computer Aided Architectural Design in Europe) and Dep. of Civil, Building and Environmental Engineering, Faculty of Civil and Industrial Engineering, *Sapienza* University of Rome.

Cover Design: Ugo Maria Coraglia, Kareem Elsayed and Antonio Fioravanti. eCAADe2017 Logo Contest winners: Mohamed Elgendy and Omar Hadid (1<sup>st</sup> prize); Valerio Perna (2<sup>nd</sup> prize).

All rights reserved. Nothing from this publication may be produced, stored in computerised system or published in any form or in any manner, including electronic, mechanical, reprographic or photographic, without prior written permission from the publisher. Authors are responsible for all pictures, contents and copyright-related issues in their own paper(s).

# eCAADe 2017

# Sh<sup>o</sup>CK!

# Sharing of Computable Knowledge!

Volume 1

Proceedings of the 35<sup>th</sup> International Conference on Education and Research in Computer Aided Architectural Design in Europe

> 20<sup>th</sup>-22<sup>nd</sup> September 2017 Rome, Italy Dep. of Civil, Building and Environmental Engineering Faculty of Civil and Industrial Engineering *Sapienza* University of Rome

Edited by Antonio Fioravanti Stefano Cursi, Salma Elahmar, Silvia Gargaro, Gianluigi Loffreda, Gabriele Novembri, Armando Trento

# Theme

# Sh<sup>o</sup>CK! – Sharing of Computable Knowledge!

The theme of the 35<sup>th</sup> eCAADe Conference is *Sharing of Computable Knowledge! – ShoCK!* so, we have invited eCAADe community, members of Sibling Organizations and CAADFuture friends to face this exciting theme.

Why such a strong theme? Mainly for three reasons.

The first one, is that we live in a city that has been witness of several revolutions of the conceptions of architectural space: most turning points of space perception are present here by means of architectural masterpieces as Bruno Zevi stated. I like to quote Rem Koolhaas: "It is a platitude that the presence of history in Rome is detriment to the development and display of modern art. But if that were true, Rome – *a city of successive modernities* – would never happened.".

Secondly, as my DaaD research group states "Rome is an open-air museum of architectural avant-garde masterpieces of an *uninterrupted history* where styles are juxtaposed, intertwined and *stratified* other than culturally also physically..." This concept is very close to the modern concept of cognitive sciences: to think by means of several abstraction levels of intelligence. And the third reason is that we live in a Faculty founded in 1817 – right two centuries ago - has always had a multidisciplinary approach to understand and solve problems: from the outset Architecture, Civil engineering, Bridge construction, Topography, Geometry and Mathematics subjects were present. As a matter of facts this approach it is not limited to technical aspects as – most importantly – the Faculty, now Civil and Industrial Engineering, lives in *Sapienza* University of Rome – established in 1303 – a university that pursuits the "universal" approach where each discipline enhances the others.

Going back to the theme, it involves in turn several subjects: Internet of Things, pervasive nets, Knowledge 'on tap', Big Data, Wearable devices and the 'Third wave' of AI, ... All of these disruptive technologies are upsetting our globalised world as far as it can be predicted henceforth.

So, academicians, professionals, researchers, students and innovation factories... are warmly invited to further shake up and boost our innovative and beloved CAAD world – we already are in the post-digital era – with new ideas, paradigms and points of view.

I said "CAAD world" as I think that it contains and involves several disciplines but it is a new subject it its own that overcomes the former ones.

The underlain idea of this International Conference is that as a catalyst of creative energy it pursuits with determination founders' purposes and to be a shocking vanguard, a melting

pot of novelties, in words: to become an "incubator" of innovative and seminal ideas, to generate enthusiasm, to be an occasion for new friendships and to facilitate the establishment of effective researches' networks. The title of the conference reflects well these intentions:

## ShoCK! – Sharing of Computable Knowledge!

So the aim of the Conference was to knock our habitual design activities out, to compare the various methodological and technological trends and to disseminate the latest research advances in our community. Will our fine buildings and design traditions survive? Or, will they 'simply' be hybridized and enhanced by methods, techniques and CAAD tools? Obviously, computation is needed to match the ever-growing performance requirements, but this is not enough to answer all these questions we have to deal with the essence of problems: *improve design solutions for a better life*!

Obviously, *computation* is needed to match the ever-growing performance requirements, but this is not enough... As life is not a matter of single individuals, we need to increase collaboration and to improve *knowledge* and *sharing*. This means going back to focusing on human beings, and involves the humanistic approach, and the long history of architecture... from handicrafts to thinking to technology... to handicrafts again.

A large spiral of the *architectura* as *eternal* as our city.

## Α.

#### Antonio Fioravanti eCAADe 2017 Conference Chair

\* This first volume of the conference proceedings of the 35<sup>th</sup> eCAADe conference contains 74 papers grouped under 13 sub-themes; both volumes contain altogether 155 accepted papers. The Conference was held at the Faculty of Civil and Industrial Engineering, *Sapienza* University of Rome, Rome, Italy, in via Eudossiana 18, Rome, on 20<sup>th</sup> – 22<sup>nd</sup> September 2017.

In addition to the accepted papers, the first volume contains *Keynote* speakers' contributions concerning the themes of their keynote lectures and the *Workshop Contributions* including the contents of workshops given; the second volume furthermore includes the *Poster Session* contents.

All the papers of these proceedings will be accessible via CuminCAD - Cumulative Index of Computer Aided Architectural Design, http://cumincad.scix.net

# Acknowledgements

Authorities, colleagues, researchers, professors, students, professionals all of you are welcomed to the 35th eCAADe conference, in Rome the *eternal city*.

It has been a long time ago – 31 years – since the previous eCAADe conference was held in this Faculty, hosted by our University - "La Sapienza".

That time, Gianfranco Carrara, one of the eCAADe founders, chaired the 4<sup>th</sup> eCAADe conference in 1986. That time on, there was only one eCAADe conference in Italy precisely in Palermo in 1995 chaired by Benedetto Colajanni and Giuseppe Pellitteri. This Faculty – now Faculty of Civil and Industrial Engineering – inspired by Parisian and Austrian academic models, is quite old as it was funded by Pope Pius VII in 1817, so now it celebrates its Bicentennial!

But it is quite young compared to our mother University "La Sapienza" that was established by the Pope Bonifacius VIII in 1303.

The original idea of bringing the eCAADe conference back to Rome goes rather back in times, I remember it was in 2009 at eCAADe conference in Istanbul. You know things take their time in Italy, so only in 2013 my Faculty approved and on 21<sup>st</sup> March 2015 eCAADe Council granted us the permission to organize the 35<sup>th</sup> conference. Over the last years several people have helped us to make this conference happen. We thank the former Dean of Civil and Industrial Engineering Faculty, Prof. Fabrizio Vestroni and especially the present Dean, Prof. Antonio D'Andrea for their supports.

During the process of organizing the eCAADe 2017 we have had the privilege to experience the supportive, collaborative and frank atmosphere of eCAADe Council, whose members, no one excluded, have helped us with all organizational aspects.

Let us be touched in remembering for his humanity the former eCAADe President, Johan Verbeke, who recently passed away. We all are sad in this moment thinking is no more physically with us now, but at the same time we are grateful to have met him and exchanged ideas on equal terms as his habit. In spirit, he is present so we can tell him: Johan, special thanks for your open-minded support, we warmly thank you! We miss you, and we do not forget you!

How cannot we mention Joachim Kieferle a friend, who is also the eCAADe President, for his encouragement and unswerving support during the last years and his ability to cut up dead-

locks into pieces? A special thanks to the great Bob Martens for his ability in organizing complex tasks and simplifying processes – Dutch origin helps – his daily support was precious and helped us relentlessly. And a "suuppper" thanks to a "super" friend as Gabriel Wurzer for his optimism and silent help in difficult issues.

Also, we wish to thank all the other previous conference organizers, Henri Achten, Rudi Stouffs and Emine Mine Thompson, for sharing their experience and knowledge. A special thanks to more recent conference organisers Bob Martens, Gabriel Wurzer, Thomas Grasl, Wolfgang E. Lorenz and Richard Schaffranek together with Aulikki Herneoja, Toni Österlund and Piia Markkanen!

Quality is the vital issue concerning conference proceedings.

To improve it we used different means: *OpenConf* conference management system that easily ensured that none of the reviewers came from the same institution as the authors; through special relationships between Liverpool University and eCAADe thank to Martin Winchester's support we were able to overcome program bugs; a second and handcraft check of interest conflicts among authors and reviewers was made during the reviewing phase; a double-blind peer review process; and an accurate reviewers' selection. The selection was fair, and only extended abstracts with high grades were admitted to full paper phase.

Quality means also typographic quality control in two ways: for printing results and for respecting author's layout; so, thanks to the well-known *ProceeDings* formatting management system eCAADe could fulfil these two needs.

Authors uploaded their extended abstracts (length of 1000 to 1500 words, two optional images, 5 to 10 references) by 1st of February 2017; each abstract was evaluated anonymously.

Altogether, we received 309 extended abstracts from 46 different authors' countries, shortly after 5 were withdrawn. Each extended abstract had three blinded peer reviews so 912 reviews were accomplished in a short time and 188 papers were accepted for full paper submission. After a while 11 of these ones were withdrawn and eventually 155 papers were published in the eCAADe 2017 Proceedings.

Let us express our very grateful appreciations for all the 132 reviewers from all over the world for their constructive and thorough comments for each author. A special thanks to reviewers who spent their time to review more than 8 extended abstracts – Joachim Kieferle and Anand Bhatt - not to mention members of "Joker Reviewers' Team": Stefano Cursi, Salma Elahmar,

Paolo Fiamma, Silvia Gargaro, Gianluigi Loffreda, Wolfgang E. Lorenz, Davide Simeone, Gabriel Wurzer and me that were able to review abstracts during the last days to accomplish missing reviews on time.

We thank and congratulate all authors for their hard work and support on using the ProceeDings tool and finalizing their full papers carefully in time. In this last phase of editing full papers we want to thank for his "extra-ordinary" work Gabriel Wurzer, the Master of the ProceeDings and Wolfgang E. Lorenz and Ugo Maria Coraglia, who with high sense of responsibility worked with us and to successfully produce high quality proceedings.

We also continued the practice started in eCAADe 2015 conference in Vienna of having all the session chairs to give prospective comments of the papers and to evoke the discourse at early stage between the author and session chair for the 27 sessions of the conference. All the session chairs also participated the peer review process of the extended abstracts.

We owe great gratitude to the session chairs for their commitment and their long-term contribution to the process until the final paper presentations.

We thank the keynote speakers and their contribution of writing the keynote papers concerning their lecture themes: Gianluca Peluffo, Chair in *Exhibition Design* and *Art & Architecture*, IULM - International University of Language and Media; John Gero, Research Prof. in *Computer Science and Architecture*, University of North Carolina at Charlotte and Krasnow Institute for Advanced Study George Mason University; and Gernot Riether, Director of *School of Architecture*, NJIT – New Jersey Institute of Technology, Editor of *DCA Journal*.

Workshops are part of eCAADe conferences, so we thank all the organizers for their workshop and for their contribution of short papers (non-peer reviewed) about the contents of their own workshop.

We are also grateful to Wolfgang Dokonal and the eCAADe Council for organizing the traditional PhD workshop for young researchers and supporting the grant winners with a subsidy for traveling to Rome.

We recovered an old tradition of previous eCAADe Conferences bringing poster session to life again, so during the conference we had 4 free lectures on interesting themes.

This year for the first time we launch an international competition linked to the Conference, the "eCAADe2017 Logo Contest" that helped in disseminate the spirit and values of eCAADe in new areas. We thank the International Jury that was made up by Antonino Saggio (President, Chair in *Information Technology applied to Architecture and Urban and Architectural design*), Eleonora Fiorani (Vice president, Chair in *Cultural Anthropology and Sociology of Innovation*),

Henri Achten (former eCAADe President, Chair in *Computer Aided Architectural Design*), Maria Argenti (Chair in *Architectural Composition* and Editor in chief of *Rassegna di Architettura e Urbanistica*), and Antonio Fioravanti (Chair in *Architectural Engineering*). Two Winners and three Honourable mentions were awarded (see on website https://www.daadgroup.org/result/). We would like to express our gratitude for the administrative help in organizing this conference to eCAADe council and especially Nele De Meyere that has provided us valuable input and lessons learned from past conferences.

We have also had support from DaaD*group* for managing the conference services, ranging from the registration process to the actual on-site registration services. A big thank you goes to PhD students Ugo Maria Coraglia and Francesco Rossini for their extra-work in critical situations.

Thanks to the sponsors we were enabled to organize an international conference as eCAADe is. Financial supports, apart Sapienza University of Rome, was generously provided by A-Sapiens, AT Advanced Technologies, Autodesk; 3TI Progetti and Bentley Systems International Ltd. Technical support was provided by Epson Italia, Gangemi Editore, Geores, it solution, Noumena and ProceeDings.

We wish to also thank Gangemi Editore in person of Giuseppe and Fabio Gangemi for their very fast and accurate printing process and the high quality of both volumes.

As a special form of sponsorship, all members of the Organizing Team and students of Architecture-Building Engineering M. Course that donated their time to help prepare and organize this conference. Thank you all !!!

Rome, 1<sup>st</sup> September 2017

Antonio Fioravanti

#### **Conference Chair**

Angelo L.C. Ciribini, Gabriele Novembri and Armando Trento

#### **Conference Vice-chairs**

# **Organizing Committee**

#### **Conference Chair**

Antonio Fioravanti

# Conference Vice Chairs

Angelo L.C. Ciribini, Gabriele Novembri, Armando Trento

#### Web

Gianluigi Loffreda, Ugo Maria Coraglia, Antonio Alfieri (IT Solution)

**Media & Communications** Ugo Maria Coraglia, Ludovica Di Martino, Isabella Calderaro

#### **Technical Support** Claudio Nardi, Marco Di Bonifaco, Francesco Furia

**Publication and Proceedings Editing** Ugo Maria Coraglia, Wolfgang Lorenz, Gabriel Wurzer, Stefano Cursi, Kareem Elsayed, Francesco Livio Rossini

#### **Reviewing Process Management** Salma Elahmar, Ludovica Di Martino

Secretary and Stationery Roberta Cannata, Anastasia Fratangelo

#### Installations and Mounting

Alireza Jahanara Francesco Livio Rossini Kareem Elsayed

# **List of Reviewers**

- Sherif Abdelmohsen American University in Cairo, Egypt
- Henri Achten Czech Technical University in Prague, Czech Republic
- Asterios Agkathidis University of Liverpool, United Kingdom
- Hasim Altan University of Sharjah, United Arab Emirates
- Aleksander Asanowicz Bialystok University of Technology, Poland
- Gideon Aschwanden The University of Melbourne, Australia
- Phil Ayres Centre for Information Technology and Architecture (CITA), Denmark
- Guenter Barczik Erfurt School of Architecture / HMGB Architects, Germany
- Joo H Pbilip Bay Curtin University, Australia
- José Beirão University of Lisbon, Portugal
- Anand Bhatt Architexturez Imprints, India
- Henriette Bier TU Delft, Netherlands
- Nimish Biloria University of Technology Sydney (UTS), Australia
- Stefan Boeykens KU Leuven University of Leuven, Belgium
- Johannes Braumann Association for Robots in Architecture & University for Arts and Design Linz, Austria
- Peter Buš Faculty of Architecture, Czech Technical University in Prague, Czech Republic
- Gulen Cagdas Istanbul Technical University, Faculty of Architecture, Turkey
- Erik Champion Curtin University, Australia
- Teng-Wen Chang National Yunlin University of Science and Technology, Taiwan
- Sheng-Fen Chien National Cheng Kung University, Taiwan
- Benny Chow AEDAS Architects, Hong Kong
- Mark Clayton Texas A&M University, United States
- Birgul Colakoglu İstanbul Technical University, Turkey
- Stefano Cursi Sapienza University of Rome, Italy

- Bauke de Vries Eindhoven University of Technology, Netherlands
- Marcella Del signore Tulane University, United States
- Wolfgang Dokonal University of Technology Graz, Austria
- Dirk Donath Bauhaus University, Germany
- Theodoros Dounas Xian Jiaotong Liverpool University, China
- Jose Duarte Faculty of Architecture, University of Lisbon, Portugal
- Athanassios Economou Georgia Insitute of Technology, United States
- Salma El Ahmar Sapienza University of Rome, Italy
- Ahmed El Antably Arab Academy for Science, Technology and Maritime Transport, Egypt
- Sara Eloy Instituto Universitario de Lisboa, Portugal
- Halil Erhan Simon Fraser University Canada
- Alessio Erioli Alma Mater Studiorum Università di Bologna, Italy
- Paolo Fiamma University of Pisa, Italy
- Antonio Fioravanti Sapienza University of Rome, Italy
- Pia Fricker Aalto University, Finland / ETH Zurich, Switzerland
- Tomohiro Fukuda Osaka University, Japan
- Silvia Gargaro Sapienza University of Rome, Italy
- Harald Gatermann Hochschule Bochum University, Germany
- David Gerber University of Southern California, United States
- John Gero UNC Charlotte, United States
- Ipek Gursel Dino Middle East Technical University (METU), Turkey
- Jeremy Ham RMIT University, Australia
- Malgorzata Hanzl Lodz University of Technology, Poland
- Jie He School of Architecture, Tianjin University, China

- Pablo C. Herrera Universidad Peruana de Ciencias Aplicadas, Peru
- Urs Hirschberg TU Graz, Austria
- Jia Hu Independent Researcher
- Tim Ireland Kent School of Architecture, United Kingdom
- Patrick Janssen National University of Singapore, Singapore
- lestyn Jowers The Open University, United Kingdom
- Anja Jutraz University of Ljubljana, Slovenia
- Matevz Juvancic University of Ljubljana, Slovenia
- Anetta Kepczynska-Walczak Lodz University of Technology, Poland
- Sora Key Independent Researcher
- Joachim Kieferle Hochschule RheinMain, Germany
- Arto Kiviniemi University of Liverpool, United Kingdom
- Erik Kjems Aalborg University, Denmark
- Robert Klinc University of Ljubljana, Slovenia
- Michael Knight University of Liverpool, United Kingdom
- Tuba Kocaturk University of Liverpool, United Kingdom
- Volker Koch Karlsruhe Institute of Technology, Germany
- Reinhard Koenig Bauhaus-University Weimar, Germany / Austrian Institute of Technology, Austria
- Odysseas Kontovourkis University of Cyprus, Cyprus
- Jose Kos Federal University of Santa Catarina, Brazil
- Toni Kotnik Aalto University, Finland
- Sylvain Kubicki Luxembourg Institute of Science and Technology, Luxembourg
- Matthias Kulcke Hamburg University of Technology, Germany / HafenCity University Hamburg, Germany

Hyunsoo Lee - Yonsei University, Korea

Ji-Hyun Lee - Graduate School of Culture Technology (GSCT), Korea / Korea Advanced Institute of Science and Technology (KAIST), Korea

- Jos van Leeuwen The Hague University of Applied Sciences, Netherlands
- Andrew Li Kyoto Institute of Technology, Japan
- Biao Li Southeast University, China
- Katherine Liapi University of Patras, Greece
- Gianluigi Loffreda Sapienza University of Rome, Italy
- Thorsten Lomker Zayed University, United Arab Emirates
- Werner Lonsing Independent Researcher
- Wolfgang Lorenz TU Wien, Austria
- Russell Loveridge NCCR Digital Fabrication / ETH Zürich, Switzerland
- Mark Luther Deakin Uviversity, Australia
- Carlos L. Marcos Universidad de Alicante, Portugal
- Earl Mark University of Virginia, United States

Bob Martens - TU Wien, Austria

- Tom Maver Glasgow School of Art, United Kingdom
- Benachir Medjdoub Nottingham Trent University, United Kingdom
- AnnaLisa Meyboom The University of British Columbia, Canada
- Jules Moloney Deakin University, Australia
- Volker Mueller Bentley Systems, United States
- Michael Mullins Aalborg University, Denmark
- Walaiporn Nakapan Rangsit University, Thailand
- Taro Narahara New Jersey Institute of Technology, United States
- Katerina Nováková Czech Technical University in Prague, Czech Republic
- Yeonjoo Oh Hyundai Construction and Engineering, South Korea
- Konstantinos-Alketas Oungrinis Technical University of Crete, Greece
- Rivka Oxman Technion University, Israel
- Burak Pak KU Leuven, Belgium
- Hyoung-June Park University of Hawaii, United States
- Sule Tasli Pektas Bilkent University, Turkey
- Giuseppe Pellitteri Università degli Studi di Palermo, Italy
- Chengzhi Peng University of Sheffield, United Kingdom
- Frank Petzold TU Munich, Germany

Henrika Pihlajaniemi - University of Oulu, Finland Ulrich Pont - TU Wien, Austria Rabee Reffat - Assiut University, Egypt Dagmar Reinhardt - The University of Sydney, Australia Joao Rocha - University of Évora, Portugal Luís Romão - University of Lisbon, Portugal Blair Satterfield - University of British Columbia, Canada Marc Aurel Schnabel - Victoria University of Wellington, New Zealand Sven Schneider - Bauhaus-University Weimar, Germany Davide Simeone - Sapienza University of Rome, Italy Martijn Stellingwerff - TU Delft, Netherlands Rudi Stouffs - National University of Singapore, Singapore Kjeld Svidt - Aalborg University, Denmark Dina Taha - Alexandria University, Egypt Martin Tamke - The Royal Danish Academy of Fine Arts, Denmark Emine Mine Thompson - Northumbria University, United Kingdom / Independent Researcher Christian Tonn - FARO 3D Software GmbH, Germany Armando Trento - Sapienza University of Rome, Italv Bige Tuncer - Singapore University of Technology and Design, Singaore Žiga Turk - University of Ljubljana (UL-FGG), Slovenia Emrah Turkyilmaz - Istanbul Kultur University, Turkey Johan Verbeke - KULeuven, Belgium / Aarhus School of Architecture, Denmark Spela Verovsek - University of Ljubljana, Slovenia Maria Voyatzaki - Aristotle University of Thessaloniki, Greece Albert Wiltsche - TU Graz, Austria Jerzy Wojtowicz - Warsaw University of Technology, Poland

Gabriel Wurzer - TU Wien, Austria

# Contents

- 5 Theme
- 7 Acknowledgements
- 13 List of Reviewers
- 17 Dedication

#### 27 KEYNOTES

- 29 Keynote Speakers
- 31 The Digital Design Build Studio Gernot Riether
- **37 Cognitive Design Computing** John S. Gero
- 41 The navel of the world Gianluca Peluffo

## 43 WORKSHOPS

#### **45** Internet of Homes (IoH) Eiman Elbanhawy, Daniel Gooch, Theodoros Georgiou, Aikaterini Chatzivasileiadi

#### 49 CoOptimise Kristjan Nielsen, Mariam Khademi

#### 51 Co-Design using HYVE-3D Tomás Dorta, Emmanuel Beaudry Marchand

53 Wall.4.all Bojan Tepavčević

#### 55 LightWIRE Eugenio Bettucchi, Iacopo Neri

- 57 Parametric Design of Street Profiles Rui de Klerk, José Nuno Beirão
- 59 Structuring of Teaching and Learning Situations in Architectural Education Matthias Kulcke, Wolfgang E. Lorenz, Gabriel Wurzer
- 63 Dynamo: Applications for Design and Optimization Philipp Müller, Colin McCrone

## 65 AGENT-BASED SYSTEMS

# 67 Extended modelling

Yannis Zavoleas, M. Hank Haeusler

- 75 Emergent order through swarm fluctuations Evangelos Pantazis, David Gerber
- 85 Modelling Buildings and their Use as Systems of Agents Davide Simeone, Stefano Cursi, Ugo Maria Coraglia
- 93 Saving Lives with Generative Design and Agent-based Modeling Sofia Sousa, Inês Caetano, António Leitão
- 103 Improving Proactive Collaborative Design Through the Integration of BIM and Agent-Based Simulations Antonio Fioravanti, Gabriele Novembri, Francesco Livio Rossini
- 109 BIM
- 111 BIM-based Multiuser Collaborative Virtual Environments for end user involvement Jesper Bendix Sørensen, Kjeld Svidt
- 119 H-BIM and web-database to deal with the loss of information due to catastrophic events

Vincenzo Donato, Stefano Giannetti, Maurizio Marco Bocconcino

- 129 Spatial Typology for BIM Takehiko Nagakura, Woongki Sung
- **137 BIM Tools Overview** Steffen Wallner, Petra von Both
- 147 The uptake of BIM Dana Matejovska, Ivana Vinsova, Michal Jirat, Henri Achten
- **153** An Automated Code Compliance system within a BIM environment Panagiotis Patlakas, Andrew Livingstone, Robert Hairstans
- 161 Theory of Games and Contracts to define the Client role in Building Information Modeling Giuseppe Martino Di Giuda, Valentina Villa, Angelo Luigi Camillo Ciribini, Lavinia

Chiara Tagliabue

### **169 BIOMIMICRY**

- **171 Biofilm-inspired Formation of Artificial Adaptive Structures** Mohammad Hassan Saleh Tabari, Saleh Kalantari, Nooshin Ahmadi
- 181 Feather-inspired social media data processing for generating developable surfaces: Prototyping an affective architecture Chenjun Liu, Tsung-Hsien Wang, Mark Meagher, Chengzhi Peng
- **191 Optimization of Facade Design for Daylighting and View-to-Outside** Mohamed Adel Wageh, Mahmoud Gadelhak
- **199 Sun Shades** Timo Carl, Markus Schein, Frank Stepper
- 209 Thermal and Daylighting Optimization of Complex 3D Faceted Façade for Office Building

Amartuvshin Narangerel, Ji-Hyun Lee, Rudi Stouffs

219 Daylight Optimization Mohammed Ayoub, Magdi Wissa

### 229 CAAD EDUCATION - HISTORY

- 231 Reinventing Design-Build projects with the use of digital media for design and construction loanna Symeonidou
- 241 Optical Integrity of Diminished Reality Using Deep Learning Tomohiro Fukuda, Yasuyuki Kuwamuro, Nobuyoshi Yabuki
- 251 New digital trends in current architecture Giuseppe Pellitteri, Alessia Riccobono
- 261 Learning Space Augustus Wendell, Ersin Altin
- 267 Tradition and Innovation in Digital Architecture Daniel Almeida, José Pedro Sousa

## 277 CAAD EDUCATION - PHILOSOPHY

- 279 Computation As Design Logic Indicator Anetta Kepczynska-Walczak
- **289 Competences for Digital Leadership in Architecture** Tadeja Zupancic, Johan Verbeke, Aulikki Herneoja, Henri Achten

297 Unfolding the design of architecture as a strategy to assess intellectual property Domenico D'Uva

303 Digital Design Hermeneutics Anthony Papamanolis, Katherine Liapi

313 Why Immersive? Hadas Sopher, Yehuda E. Kalay, Dafna Fisher-Gewirtzman

## 323 CAAD EDUCATION - TEACHING

- **325 The Use of Simulation for Creating Folding Structures** Asli Agirbas
- 333 Digital Fabrication in Education Philipp Eversmann
- **343** Adaptive Lighting for Knowledge Work Environments Piia Markkanen, Henrika Pihlajaniemi, Aulikki Herneoja
- **353 Learning by Merging 3D Modeling for CAAD with the Interactive Applications** Mohamed Hassan Khalil
- **363 Teaching architecture students to code** Tim Ireland
- 373 Early design stage automation in Architecture-Engineering-Construction (AEC) projects

Ivan Renev, Leonid Chechurin, Elena Perlova

# 383 CAAD EDUCATION - TOOLS

- **385 Contrasting Publications in Design and Scientific Research** Gabriel Wurzer, Wolfgang E. Lorenz, Tomo Cerovsek, Bob Martens
- **395 The architectural gadget factory** Volker Koch, Matthias Leschok, Petra von Both
- **401 The Role of VR as a New Game Changer in Computational Design Education** Arzu Gönenç Sorguç, Müge Kruşa Yemişcioğlu, Çağlar Fırat Özgenel, Mert Ozan Katipoğlu, Ramin Rasulzade
- **409 Computational and Modeling Tools** Firas Al-Douri, Ph.D.
- 419 Development of parametric CAAD models for the additive manufacturing of scalable architectural models Stefan Junk, Philipp Gawron

4 eCAADe 35 - Contents

## 427 CITY MODELLING AND GIS

**429 Parametric master planning via topological analysis using GIS data** Kuai Yu, M. Hank Haeusler, Alessandra Fabbri

#### **439 Urban Pinboard** M. Hank Haeusler, Rob Asher, Lucy Booth

- **449 Rethinking the Urban Design Process from a Data Perspective** Yuezhong Liu, Rudi Stouffs, Abel Tablada
- **461 Advanced tools and algorithms for parametric landscape urbanism** Attilio Pizzigoni, Vittorio Paris, Andrea Micheletti, Giuseppe Ruscica
- **471** Merging the Physical and Digital Layer of Public Space Chiara Farinea, Areti Markopoulou, Aldo Sollazzo, Angelos Chronis, Mathilde Marengo
- **477** Generative computational tools for the design of Urban Morphology Mateos Shehu, Anna Yunitsyna

# 483 CITY MODELLING TOOLS

- **485 Towards a modular design strategy for urban masterplanning** Martin Dennemark, Sven Schneider, Reinhard Koenig, Abdulmalik Abdulmawla, Dirk Donath
- 495 The role of Open Data in identifying and evaluating the Livability of Urban Space

Eleanna Panagoulia

- 505 Human-driven and machine-driven decisions in urban design and architecture Jacek Markusiewicz, Adrian Kreżlik
- 515 Visual Programming meets Tangible Interfaces Gerhard Schubert, Ivan Bratoev, Frank Petzold
- 523 The city as an element of architecture Daniel Koehler
- 533 Visualizing and Analising Urban Leisure Runs by Using Sports Tracking Data Özgün Balaban, Bige Tunçer

# 541 COLLABORATIVE AND PARTICIPATIVE DESIGN

**543 On-site participation linking idea sketches and information technologies** Peter Buš, Tanja Hess, Lukas Treyer, Katja Knecht, Hangxin Lu

551	<b>Learning Participatory Urban Research</b> Dieter Michielsen, Tonia Dalle, Mara Usai, Rosaura Romero, Burak Pak
561	SenCity City Monitor as a platform for user involvement, innovation and service development Henrika Pihlajaniemi, Anna Luusua, Esa-Matti Sarjanoja, Risto Vääräniemi, Eveliina Juntunen, Sini Kourunen
571	<b>DSA - Digital Support for Art</b> Armando Trento, Uwe Woessner, Joachim B. Kieferle, Andrea Cataldo
581	<b>Data-responsive Architectural Design Processes</b> Saleh Kalantari, Mona Ghandi
591	DESIGN TOOLS - PROGRAMS
593	Collective Construction Modeling and Machine Learning: Potential for Architectural Design Taro Narahara
601	<b>Integration of CFD in Computational Design</b> Angelos Chronis, Alexandre Dubor, Edouard Cabay, Mostapha Sadeghipour Roudsari
611	<b>Performative Materiality</b> Mercedes Peralta, Mauricio Loyola
619	Integrated Adaptive and Tangible Architecture Design Tool Qinying Li, Teng Teng
629	<b>The Application of Daylighting Software for Case-study Design in Buildings</b> Mark B. Luther
639	<b>APART but TOGETHER</b> Alireza Borhani, Negar Kalantar
649	DESIGN TOOLS - ROBOTICS
651	ROBOTRACK Renate Weissenböck
661	<b>Hydroassemblies</b> Dario Castellari, Alessio Erioli
671	Elements   robotic interventions II Christian J. Lange
679	<b>tOpos</b> Sebastian Bialkowski

689 Fibrous Aerial Robotics

Samuel Pietri, Alessio Erioli

699 A cloud recycling light Liss C. Werner

## 709 DESIGN TOOLS - THEORY

#### 711 ARch4models Fábio Costa, Sara Eloy, Miguel Sales Dias, Mariana Lopes

- 719 A Visualization Dashboard and Decision Support Tool for Building Integrated Performance Optimization Mahmoud Gadelhak, Werner Lang, Frank Petzold
- 729 Integrated Algorithmic Design Renata Castelo Branco, António Leitão
- 739 Contemporary Stereotomic Trait, an Opportunity for the Development of the Volumetric Digital Architecture Irina Miodragovic Vella, Toni Kotnik
- 747 Free-form Transformation Of Spatial Bar Structures Hussein Hussein, Asterios Agkathidis, Robert Kronenburg
- 757 Evaluating the capability of EnergyPlus in simulating geometrically complex Double-Skin Facades through CFD modelling Salma El Ahmar, Antonio Fioravanti

# eCAADe 2017 Sh<sup>o</sup>CK!

Volume 2

#### Editors

Antonio Fioravanti, Stefano Cursi, Salma Elahmar, Silvia Gargaro Gianluigi Loffreda, Gabriele Novembri and Armando Trento Faculty of Civil and Industrial Engineering *Sapienza* University of Rome

1<sup>st</sup> Edition, September 2017

ShoCK – Sharing of Computable Knowledge - Proceedings of the 35<sup>th</sup> International Conference on Education and Research in Computer Aided Architectural Design in Europe, Rome, Italy, 20<sup>th</sup>-22<sup>nd</sup> September 2017, Volume 2. Edited by Antonio Fioravanti, Stefano Cursi, Salma Elahmar, Silvia Gargaro, Gianluigi Loffreda, Gabriele Novembri, Armando Trento. Brussels: Education and Research in Computer Aided Architectural Design in Europe; Rome: Dep. of Civil, Building and Environmental Engineering, Faculty of Civil and Industrial Engineering, Sapienza University of Rome.

ISBN 9789491207136 978-94-91207-13-6

Copyright © 2017

Publisher: eCAADe (Education and Research in Computer Aided Architectural Design in Europe) and Dep. of Civil, Building and Environmental Engineering, Faculty of Civil and Industrial Engineering, *Sapienza* University of Rome.

Cover Design: Ugo Maria Coraglia, Kareem Elsayed and Antonio Fioravanti. eCAADe2017 Logo Contest winners: Mohamed Elgendy and Omar Hadid (1<sup>st</sup> prize); Valerio Perna (2<sup>nd</sup> prize).

All rights reserved. Nothing from this publication may be produced, stored in computerised system or published in any form or in any manner, including electronic, mechanical, reprographic or photographic, without prior written permission from the publisher. Authors are responsible for all pictures, contents and copyright-related issues in their own paper(s).

# eCAADe 2017

# Sh<sup>o</sup>CK!

# Sharing of Computable Knowledge!

Volume 2

Proceedings of the 35<sup>th</sup> International Conference on Education and Research in Computer Aided Architectural Design in Europe

> 20<sup>th</sup>-22<sup>nd</sup> September 2017 Rome, Italy Dep. of Civil, Building and Environmental Engineering Faculty of Civil and Industrial Engineering *Sapienza* University of Rome

Edited by Antonio Fioravanti Stefano Cursi, Salma Elahmar, Silvia Gargaro, Gianluigi Loffreda, Gabriele Novembri, Armando Trento

# Theme

# Sh<sup>o</sup>CK! – Sharing of Computable Knowledge!

The theme of the 35<sup>th</sup> eCAADe Conference is *Sharing of Computable Knowledge! – ShoCK!* so, we have invited eCAADe community, members of Sibling Organizations and CAADFuture friends to face this exciting theme.

Why such a strong theme? Mainly for three reasons.

The first one, is that we live in a city that has been witness of several revolutions of the conceptions of architectural space: most turning points of space perception are present here by means of architectural masterpieces as Bruno Zevi stated. I like to quote Rem Koolhaas: "It is a platitude that the presence of history in Rome is detriment to the development and display of modern art. But if that were true, Rome – *a city of successive modernities* – would never happened.".

Secondly, as my DaaD research group states "Rome is an open-air museum of architectural avant-garde masterpieces of an *uninterrupted history* where styles are juxtaposed, intertwined and *stratified* other than culturally also physically..." This concept is very close to the modern concept of cognitive sciences: to think by means of several abstraction levels of intelligence. And the third reason is that we live in a Faculty founded in 1817 – right two centuries ago - has always had a multidisciplinary approach to understand and solve problems: from the outset Architecture, Civil engineering, Bridge construction, Topography, Geometry and Mathematics subjects were present. As a matter of facts this approach it is not limited to technical aspects as – most importantly – the Faculty, now Civil and Industrial Engineering, lives in *Sapienza* University of Rome – established in 1303 – a university that pursuits the "universal" approach where each discipline enhances the others.

Going back to the theme, it involves in turn several subjects: Internet of Things, pervasive nets, Knowledge 'on tap', Big Data, Wearable devices and the 'Third wave' of AI, ... All of these disruptive technologies are upsetting our globalised world as far as it can be predicted henceforth.

So, academicians, professionals, researchers, students and innovation factories... are warmly invited to further shake up and boost our innovative and beloved CAAD world – we already are in the post-digital era – with new ideas, paradigms and points of view.

I said "CAAD world" as I think that it contains and involves several disciplines but it is a new subject it its own that overcomes the former ones.

The underlain idea of this International Conference is that as a catalyst of creative energy it pursuits with determination founders' purposes and to be a shocking vanguard, a melting

pot of novelties, in words: to become an "incubator" of innovative and seminal ideas, to generate enthusiasm, to be an occasion for new friendships and to facilitate the establishment of effective researches' networks. The title of the conference reflects well these intentions:

# Sh o CK! – Sharing of Computable Knowledge!

So the aim of the Conference was to knock our habitual design activities out, to compare the various methodological and technological trends and to disseminate the latest research advances in our community. Will our fine buildings and design traditions survive? Or, will they 'simply' be hybridized and enhanced by methods, techniques and CAAD tools? Obviously, computation is needed to match the ever-growing performance requirements, but this is not enough to answer all these questions we have to deal with the essence of problems: *improve design solutions for a better life*!

Obviously, *computation* is needed to match the ever-growing performance requirements, but this is not enough... As life is not a matter of single individuals, we need to increase collaboration and to improve *knowledge* and *sharing*. This means going back to focusing on human beings, and involves the humanistic approach, and the long history of architecture... from handicrafts to thinking to technology... to handicrafts again.

A large spiral of the *architectura* as *eternal* as our city.

# Α.

### Antonio Fioravanti eCAADe 2017 Conference Chair

\* This second volume of the conference proceedings of the 35<sup>th</sup> eCAADe conference contains 81 papers grouped under 14 sub-themes; both volumes contain altogether 155 accepted papers. The Conference was held at the Faculty of Civil and Industrial Engineering, *Sapienza* University of Rome, Rome, Italy, in via Eudossiana 18, Rome, on 20<sup>th</sup> – 22<sup>nd</sup> September 2017.

In addition to the accepted papers, the first volume contains *Keynote* speakers' contributions concerning the themes of their keynote lectures and the *Workshop Contributions* including the contents of workshops given; the second volume furthermore includes the *Poster Session* contents.

All the papers of these proceedings will be accessible via CuminCAD - Cumulative Index of Computer Aided Architectural Design, http://cumincad.scix.net

# Acknowledgements

Authorities, colleagues, researchers, professors, students, professionals all of you are welcomed to the 35th eCAADe conference, in Rome the *eternal city*.

It has been a long time ago – 31 years – since the previous eCAADe conference was held in this Faculty, hosted by our University - "La Sapienza".

That time, Gianfranco Carrara, one of the eCAADe founders, chaired the 4<sup>th</sup> eCAADe conference in 1986. That time on, there was only one eCAADe conference in Italy precisely in Palermo in 1995 chaired by Benedetto Colajanni and Giuseppe Pellitteri. This Faculty – now Faculty of Civil and Industrial Engineering – inspired by Parisian and Austrian models, is quite old as it was funded by Pope Pius VII in 1817, so now it celebrates its Bicentennial!

But it is quite young compared to our mother University "La Sapienza" that was established by the Pope Bonifacius VIII in 1303.

The original idea of bringing the eCAADe conference back to Rome goes rather back in times, I remember it was in 2009 at eCAADe conference in Istanbul. You know things take their time in Italy, so only in 2013 my Faculty approved and on 21<sup>st</sup> March 2015 eCAADe Council granted us the permission to organize the 35<sup>th</sup> conference. Over the last years several people have helped us to make this conference happen. We thank the former Dean of Civil and Industrial Engineering Faculty, Prof. Fabrizio Vestroni and especially the present Dean, Prof. Antonio D'Andrea for their supports.

During the process of organizing the eCAADe 2017 we have had the privilege to experience the supportive, collaborative and frank atmosphere of eCAADe Council, whose members, no one excluded, have helped us with all organizational aspects.

Let us be touched in remembering for his humanity the former eCAADe President, Johan Verbeke, who recently passed away. We all are sad in this moment thinking is no more physically with us now, but at the same time we are grateful to have met him and exchanged ideas on equal terms as his habit. In spirit, he is present so we can tell him: Johan, special thanks for your open-minded support, we warmly thank you! We miss you, and we do not forget you!

How cannot we mention Joachim Kieferle a friend, who is also the eCAADe President, for his encouragement and unswerving support during the last years and his ability to cut up dead-

locks into pieces. A special thanks to the great Bob Martens for his ability in organizing complex tasks and simplifying processes – Dutch origin helps – his daily support was precious and helped us relentlessly. And a "suuppper" thanks to a "super" friend as Gabriel Wurzer for his optimism and silent help in difficult issues.

Also, we wish to thank all the other previous conference organizers, Henri Achten, Rudi Stouffs and Emine Mine Thompson, for sharing their experience and knowledge. A special thanks to more recent conference organisers Bob Martens, Gabriel Wurzer, Thomas Grasl, Wolfgang E. Lorenz and Richard Schaffranek together with Aulikki Herneoja, Toni Österlund and Piia Markkanen!

Quality is the vital issue concerning conference proceedings.

To improve it we used different means: *OpenConf* conference management system that easily ensured that none of the reviewers came from the same institution as the authors; through special relationships between Liverpool University and eCAADe thank to Martin Winchester's support we were able to overcome program bugs; a second and handcraft check of interest conflicts among authors and reviewers was made during the reviewing phase; a double-blind peer review process; and an accurate reviewers' selection. The selection was fair, and only extended abstracts with high grades were admitted to full paper phase.

Quality means also typographic quality control in two ways: for printing results and for respecting author's layout; so, thanks to the well-known *ProceeDings* formatting management system eCAADe could fulfil these two needs.

Authors uploaded their extended abstracts (length of 1000 to 1500 words, two optional images, 5 to 10 references) by 1st of February 2017; each abstract was evaluated anonymously.

Altogether, we received 309 extended abstracts from 46 different authors' countries, shortly of r 5 were withdrawn. Each extended abstract had three blinded peer reviews so 912 reviews were accomplished in a short time and 165 papers were accepted for full paper submission, 21 of these were withdrawn and eventually 154 papers were published in eCAADe 2017 Proceedings.

Let us express our very grateful appreciations for all the 132 reviewers from all over the world for their constructive and thorough comments for each author. A special thanks to reviewers who spent their time to review more than 8 extended abstracts – Joachim Kieferle and Anand Bhatt - not to mention members of "Joker Reviewers' Team": Stefano Cursi, Salma Elahmar,

Paolo Fiamma, Silvia Gargaro, Gianluigi Loffreda, Wolfgang E. Lorenz, Davide Simeone, Gabriel Wurzer and me that were able to review abstracts during the last days to accomplish missing reviews on time.

We thank and congratulate all authors for their hard work and support on using the ProceeDings tool and finalizing their full papers carefully in time. In this last phase of editing full papers we want to thank for his "extra-ordinary" work Gabriel Wurzer, the Master of the ProceeDings and Wolfgang E. Lorenz and Ugo Maria Coraglia, who with high sense of responsibility worked with us and to successfully produce high quality proceedings.

We also continued the practice started in eCAADe 2015 conference in Vienna of having all the session chairs to give prospective comments of the papers and to evoke the discourse at early stage between the author and session chair for the 27 sessions of the conference. All the session chairs also participated the peer review process of the extended abstracts.

We owe great gratitude to the session chairs for their commitment and their long-term contribution to the process until the final paper presentations.

We thank the keynote speakers and their contribution of writing the keynote papers concerning their lecture themes: Gianluca Peluffo, Chair in *Exhibition Design* and *Art & Architecture*, IULM - International University of Language and Media; John Gero, Research Prof. in *Computer Science and Architecture*, University of North Carolina at Charlotte and Krasnow Institute for Advanced Study George Mason University; and Gernot Riether, Director of *School of Architecture*, NJIT – New Jersey Institute of Technology, Editor of *DCA Journal*.

Workshops are part of eCAADe conferences, so we thank all the organizers for their workshop and for their contribution of short papers (non-peer reviewed) about the contents of their own workshop.

We are also grateful to Wolfgang Dokonal and the eCAADe Council for organizing the traditional PhD workshop for young researchers and supporting the grant winners with a subsidy for traveling to Rome.

We recovered an old tradition of previous eCAADe Conferences bringing poster session to life again, so during the conference we had 4 free lectures on interesting themes.

This year for the first time we launch an international competition linked to the Conference, the "eCAADe2017 Logo Contest" that helped in disseminate the spirit and values of eCAADe in new areas. We thank the International Jury that was made up by Antonino Saggio (President, Chair in *Information Technology applied to Architecture and Urban and Architectural design*), Eleonora Fiorani (Vice president, Chair in *Cultural Anthropology and Sociology of Innovation*),

Henri Achten (former eCAADe President, Chair in *Computer Aided Architectural Design*), Maria Argenti (Chair in *Architectural Composition* and Editor in chief of *Rassegna di Architettura e Urbanistica*), and Antonio Fioravanti (Chair in *Architectural Engineering*). Two Winners and three Honourable mentions were awarded (see on website https://www.daadgroup.org/result/). We would like to express our gratitude for the administrative help in organizing this conference to eCAADe council and especially Nele De Meyere that has provided us valuable input and lessons learned from past conferences.

We have also had support from DaaD*group* for managing the conference services, ranging from the registration process to the actual on-site registration services. A big thank you goes to PhD students Ugo Maria Coraglia and Francesco Rossini for their extra-work in critical situations.

Thanks to the sponsors we were enabled to organize an international conference as eCAADe is. Financial supports, apart Sapienza University of Rome, was generously provided by A-Sapiens, AT Advanced Technologies, Autodesk; 3TI Progetti and Bentley Systems International Ltd. Technical support was provided by Epson Italia, Gangemi Editore, Geores, it solution, Noumena and ProceeDings.

We wish to also thank Gangemi Editore in person of Giuseppe and Fabio Gangemi for their very fast and accurate printing process and the high quality of both volumes.

As a special form of sponsorship, all members of the Organizing Team and students of Architecture-Building Engineering M. Course that donated their time to help prepare and organize this conference. Thank you all !!!

Rome, 1<sup>st</sup> September 2017

Antonio Fioravanti

#### **Conference Chair**

Angelo L.C. Ciribini, Gabriele Novembri and Armando Trento

**Conference Vice-chairs** 

# **Organizing Committee**

#### **Conference Chair**

Antonio Fioravanti

#### **Conference Vice Chairs** Angelo L.C. Ciribini, Gabriele Novembri, Armando Trento

**Web** Gianluigi Loffreda, Ugo Maria Coraglia, Antonio Alfieri (IT Solution)

**Media & Communications** Ugo Maria Coraglia, Ludovica Di Martino, Isabella Calderaro

**Technical Support** Claudio Nardi, Marco Di Bonifaco, Francesco Furia

**Publication and Proceedings Editing** Ugo Maria Coraglia, Wolfgang Lorenz, Gabriel Wurzer, Stefano Cursi, Kareem Elsayed, Francesco Livio Rossini

**Reviewing Process Management** Salma Elahmar, Ludovica Di Martino

Secretary and Stationery Roberta Cannata, Anastasia Fratangelo

#### Installations and Mounting

Alireza Jahanara Francesco Livio Rossini Kareem Elsayed

# Contents

- 5 Theme
- 7 Acknowledgements
- **19 POSTER SESSION**
- 21 Posters

# 23 DIGITAL HERITAGE

### 25 Causes and effects Mateusz Pankiewicz

- **31 Raising Awareness for Digital Heritage through Serious Game** Guzden Varinlioglu, Ali Aslankan, Gazihan Alankus, Gokhan Mura
- **39** From TSL survey to HBIM, issues on survey and information modeling implementation for the built heritage Alessandro D'Amico, Edoardo Currà
- 49 Post-Digital Design Khaldoun Zreik, Nasreddine Bouhai
- 55 Interiority & Perception in Cinema Adam Modesitt, Augustus Wendell

# 65 FABRICATION - MANUFACTURING

**67 An Italian BIM-based portal to support collaborative design and construction** Bruno Daniotti, Sonia Lupica Spagnolo, Claudio Mirarchi, Daniela Pasini, Alberto Pavan

### 77 From digital design to physical model Massimiliano Lo Turco, Ursula Zich, Arianna Astolfi, Louena Shtrepi, Matteo Botto Poaola

# 87 ROAMNITURE

Vasilija Abramovic, Ruairi Glynn, Henri Achten

- 97 Articulate Objects Clay Odom
- 107 Exhaustive Exploration of Modular Design Options to Inform Decision Making

Mohammed Mekawy, Frank Petzold

**115 Tangible Computing** Andrea Quartara, Angelo Figliola

# **123 FABRICATION - ROBOTICS**

- 125 Multi-objective design optimization and robotic fabrication towards sustainable construction Odysseas Kontovourkis
- **135 Case Specific Robotic Fabrication of Foam Shell Structures** Marko Jovanovic, Marko Vucic, Dejan Mitov, Bojan Tepavčević, Vesna Stojakovic, Ivana Bajsanski
- 143 Robotic Spatial Printing Manuel Jimenez Garcia, Vicente Soler, Gilles Retsin
- **151** Adaptive Industrial Robot Control for Designers Shani Sharif, Varun Agrawal, Larry Sweet
- **159 MoleMOD** Jan Petrš, Jan Havelka, Miloš Florián, Jan Novák
- **167** Low-Cost Housing Kareem Elsayed, Antonio Fioravanti, Francesco Squasi

## 175 FABRICATION - VIRTUAL AND PHYSICAL PROTOTYPING

- **177** Simulating Self Supporting Structures Shayani Fernando, Dagmar Reinhardt, Simon Weir
- **185** Integration of environmental criteria in early stages of digital fabrication Isolda Agustí-Juan, Alexander Hollberg, Guillaume Habert

#### **193 Fabricating Stereotomy** Pedro De Azambuja Varela, José Pedro Sousa

- 201 Geometry as Assembly Andrea Rossi, Oliver Tessmann
- **211 Digital fabrication with Virtual and Augmented Reality for Monolithic Shells** Stephanie Chaltiel, Maite Bravo, Angelos Chronis
- 219 Digitally Conscious Design Carlos L. Marcos, Mara Capone, Emanuela Lanzara

# 229 MATERIAL STUDIES - ENERGY

231 Kinetic Shading System as a means for Optimizing Energy Load Alireza Jahanara, Antonio Fioravanti

- 241 Implementing the General Theory for Finding the Lightest Manmade Structures Using Voronoi and Delaunay Mohammed Ezzat
- 251 Stereotomy, an Early Example of a Material System Irina Miodragovic Vella, Toni Kotnik
- 259 Form is Matter Michela Rossi, Giorgio Buratti
- **269 The Effect of Building Materials on LIDAR Measurements** Mathew Schwartz, Andrzej Zarzycki
- **277 Energy Model Machine (EMM)** Mohammad Rahmani Asl, Subhajit Das, Barry Tsai, Ian Molloy, Anthony Hauck

# 287 MATERIAL STUDIES - METHODOLOGIES

289 A framework to evaluate the architect-friendliness of environmental impact assessment tools for buildings

Elke Meex, Elke Knapen, Griet Verbeeck

- **299 3D Concrete Printing in Architecture** Marjolein P.A.M. Marijnissen, Aant van der Zee
- **309 Hygro\_Responsive Structure** Gülce Kırdar, Birgül Çolakoğlu
- **317** Photoreactive wearable: A computer generated garment with embedded material knowledge Efilena Baseta, Aldo Sollazzo, Laura Civetti, Dolores Velasco, Jaume Garcia-Amorós
- **327** Craft and Digital Consequences Thomas Lanham, Irvin Shaifa, Ebrahim Poustinchi, Gregory Luhan
- **337 Embedded Building Components** Andrzej Zarzycki

# 345 PARAMETRIC AND GENERATIVE DESIGN

- **347** Analogue Automation Katie Hitchings, Yusef Patel, Peter McPherson
- **355** Foldable Responsive Surfaces Filipa Osorio, Alexandra Paio, Sancho Oliveira, Andrea Casale, Graziano Valenti, Michele Calvano
- **363 Tangible Computing for Establishing Generative Algorithms** Emad Al-Qattan, Wei Yan, Philip Galanter

- **371** Square tessellation patterns on curved surfaces Katherine Liapi, Andreana Papantoniou, Chrysostomos Nousias
- **379 Parametric design** Aleksander Asanowicz

### 387 SHAPE AND FORM STUDIES

- 389 Parametric modeling applied to the virtual reconstruction of the damaged sculpture of St John Nepomuk in Petrovaradin Stojakovic Vesna, Igor Budak, Ratko Obradovic, Daniela Korolija-Crkvenjakov, Zeljko Santosi
- **399 The Interplay of Figures Using Superimposed Arrays** Kory Bieg
- A value-driven perspective to understand Data-driven futures in Architecture Mohammad Qabshoqa, Tuba Kocaturk, Arto Kiviniemi
- **417 Mapping Mass Customization** Filipe Brandão, Alexandra Paio, Christopher Whitelaw
- **425 Descriptive Geometry 2.0** Karolina Ostrowska-Wawryniuk, Jacek Markusiewicz, Jan Słyk
- **431** From Envelope to Layout Francesco De Luca

## 441 SHAPE GRAMMARS

- **443 The complexity of formulating design(ing) grammars** Rudi Stouffs, Dan Hou
- **453** Mapping the Architectural Genome Nicolai Steinø
- **463 "Houses for everybody" Brazilian competition** Elton C. Lima, Aline Vieira, Leticia T. Mendes, Cristiana Griz
- **471 A shape-grammar for double skin facades** Negar Ashrafi, José Pinto Duarte
- **477 Santa Marta Urban Grammar** Debora Verniz, José Pinto Duarte
- **485 A Shape Grammar of Emotional Postures** Nasim Motalebi, José Pinto Duarte

# 493 SIMULATION AND WEB-BASED DESIGN

#### 495 PhotoAR+DR2016

Tomohiro Fukuda, Kazuya Inoue, Nobuyoshi Yabuki

- **503 A Parametric Approach To Simulating Use-Patterns in Buildings** Kartikeya Date, Davide Schaumann, Yehuda E. Kalay
- 511 Luna Moth Pedro Alfaiate, António Leitão
- **519** A Simulation Model for Logical and Operative Clash Detection Ugo Maria Coraglia, Davide Simeone, Stefano Cursi, Antonio Fioravanti, Gabriel Wurzer, Daniela D'Alessandro
- 527 WP-BIM: Web-based Parametric BIM Towards Online Collaborative Design and Optimization Wei Yan

## 535 SMART CITIES

- 537 pneuSENSE Marcella Del Signore
- 545 Informed Design Platform Bige Tunçer, Linlin You
- **553 Participatory Evaluation of the Walkability of two Neighborhoods in Brussels** Burak Pak, Chotima Ag-ukrikul
- 561 A Multiscale Model of Morphological Complexity in Cities Mary Katherine Heinrich, Phil Ayres, Yaneer Bar-Yam
- 571 Plug-In Design Matteo Baldissara, Valerio Perna, Antonino Saggio, Gabriele Stancato
- 581 Stratification of Public Spaces based on Qualitative Attribute Measurement Anastasia Koltsova Jenne, Bige Tunçer, José Nuno Beirão, Gerhard Schmitt

## 591 SPACE PERFORMANCE

- 593 Modulated corrugations by differential growth Maria Giuditta Nerla, Alessio Erioli, Massimo Garai
- **603 Parametric Room Acoustic workflows** Dario Parigi, Kjeld Svidt, Erik Molin, Delphine Bard
- 611 Machinic Agency Aldo Sollazzo, Armando Trento, Efilena Baseta
- 619 CIM-St

José Nuno Beirão, Rui de Klerk

- 629 Exploring the Three Dimensional Spatiality of Polyrhythmic Drum Improvisation Jeremy Ham, Joachim B. Kieferle, Uwe Woessner
- 637 Towards defining perceived urban density Beatrix Emo, Lukas Treyer, Gerhard Schmitt, Christoph Hoelscher

## 647 SPACE SYNTAX AND ONTOLOGIES

- 649 An ontology-based platform for BIM semantic enrichment Stefano Cursi, Davide Simeone, Ugo Maria Coraglia
- 657 KBAD Jeffrey Collins, Russell Gentry
- 667 Ontological Instrumentation in Architecture Rachel Dickey
- 673 Sky View Factor Calculation Amer Al-Sudani, Hussein Hussein, Steve Sharples
- **683 Morphology & Development** Frans Magnusson, Jonas Runberger, Malgorzata A. Zboinska, Vladimir Ondejcik

# 691 VIRTUAL AND AUGMENTED REALITY

- 693 3D Spatial Analysis Method with First-Person Viewpoint by Deep Convolutional Neural Network with Omnidirectional RGB and Depth Images Atsushi Takizawa, Airi Furuta
- 703 Studying Architectural Massing Strategies in Co-design Leman Figen Gül
- **Lines from the Past** Jules Moloney, Simon Twose, Ross Jenner, Anastasia Globa, Rui Wang
- 721 Designing Colour in Virtual Reality Christian Tonn
- 729 Immersive retrospection by video-photogrammetry Emmanuel Beaudry Marchand, Xueying Han, Tomás Dorta
- **739 Soft Human Computer Interfaces** Martina Decker
- 745 Participatory Design Supported with Design System and Augmented Reality Krystian Kwieciński, Jacek Markusiewicz, Agata Pasternak