

ARTURO TEDESCHI

AAD_

ALGORITHMS- AIDED DESIGN

PARAMETRIC STRATEGIES USING GRASSHOPPER®

Foreword by Fulvio Wirz

LE PENSEUR PUBLISHER

AAD_

ALGORITHMS- AIDED DESIGN

PARAMETRIC STRATEGIES USING GRASSHOPPER®

Main topics:

- Grasshopper environment and plug-in software
- Parametric modeling and advanced data management
- NURBS curves and surfaces
- Meshes and Subdivision Surfaces
- Digital fabrication techniques
- Recursions
- Form-finding strategies
- Particle-spring systems
- Topology Optimization
- Evolutionary solvers
- Environment-informed design

Algorithmic design is not simply the use of computer to design architecture and objects. Algorithms allow designers to overcome the limitations of traditional CAD software and 3D modelers, reaching a level of complexity and control which is beyond the human manual ability.

Algorithms-Aided Design presents design methods based on the use of Grasshopper®, a visual algorithm editor tightly integrated with Rhinoceros®, the 3D modeling software by McNeel & Associates allowing users to explore accurate freeform shapes. The book provides computational techniques to develop and control complex geometries, covering parametric modeling, digital fabrication techniques, form-finding strategies, environmental analysis and structural optimization. It also features case studies and contributions by researchers and designers from world's most influential universities and leading architecture firms.

Arturo Tedeschi is an architect and computational designer. Since 2004 he has complemented his professional career with an independent research on parametric design, focusing on relationships between architecture and digital design tools. He is the author of *Parametric Architecture with Grasshopper*, a best-selling book on parametric design, originally published in Italy and translated into English in 2012. He has taught at many universities, companies and institutions and from 2012 he is the co-director of the AA Rome Visiting School for the Architectural Association School (London). His work has been featured on a series of international magazines and exhibited in Rome, Milan, Venice, London and Paris. He has collaborated with leading architecture firms, including Zaha Hadid Architects, before setting up his consulting company A>T.

www.arturotedeschi.com

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Parametric Strategies using Grasshopper®

Arturo Tedeschi

with contributions by Stefano Andreani, Antonella Buono, Maurizio Degni, Lawrence Friesen, Andrea Galli, Francesco Lipari, Davide Lombardi, Ludovico Lombardi, Arthur Mamou-Mani, Alberto Pugnale, Antonio Turiello, Brian Vesely, Lorenzo Vianello, Fulvio Wirz.

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This book mentions several projects and buildings not necessarily designed using the algorithm editor Grasshopper®, but whose complexity was suitable for illustrating the potentials of the algorithmic modeling.

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Arturo Tedeschi

Foreword

In writing the foreword to Arturo Tedeschi's first book, "Parametric Architecture with Grasshopper," the scenario I portrayed on the use of digital tools and generative algorithms in architecture was rather different from today. It was just a few years ago, but the discipline had yet to complete the portrayed revolutionary cycle: both academic research and advanced architectural practices around the world were still in the process of discovering the newness of the digital era with little real focus on the building's industry. From the early nineties to the beginning of the new millennium, architecture went through an incredible period of creative acceleration which sometimes took the discipline progressively beyond product design, car design and art in general. In fact many spatial languages, processes and patterns developed in this period by students and digital pioneering architects with generative design tools, have been subsequently incorporated and produced in other fields with great success. It might then sound a little paradoxical that the discipline which did generate this revolutionary design shift is also the one which took longer to benefit from its implications in real world scenarios like manufacturing and construction. This delay was due to a number of issues intrinsic to architecture: the complexity of a built organism, its delicate bond with socio-economic and political context, and last but not least the timeframe and costs involved in constructing ambitious, unforeseen buildings.

Today the popularity of generative tools and the way students can now absorb information and train their skills has grown exponentially. At the beginning of the new millennium computational training were yet to be included within academic programmes and the average student could only passively watch the results of the new digital era on the internet, considering those visionary experiments as part of an elitarian education only accessible by attending expensive schools.

A changed paradigm can now be depicted. Not alternative or contrasting, just evolved. Looking back at the advances of digital tools in architecture in the last decade two aspects are clear. Firstly, computational research and knowledge have been widely spread thanks to those architects, researchers and universities who shared their experiences. The web has become an invaluable source for tutorials published in blogs or websites which are inspiring to young generations of digital designers. At the same time students have the opportunity to learn processes and theory through workshops arranged by experts and visiting schools showcasing didactic methods used by the most advanced universities all over the world. This gives students, coming from a more conservative background, the opportunity to practically understand this new approach to design. In parallel

the wider interest towards the topic has triggered the activation of many advanced architecture programs, computational departments and digital fabrication facilities from international universities which were previously known to foster a more conservative approach towards architectural research. Better awareness of the creative possibilities of digital tools has also strengthened the global sensibility of architects for the rising aesthetic of computational design which is increasingly becoming accepted as a global emerging style.

The affirmation of digital design culture de facto concludes the speculative era started in the nineties with pioneers using animation software to generate parametric forms and ending with agent-based designs programmed using Processing. Thirty years enriched by highly experimental architecture which have changed forever the way we perceive and design spaces.

Second aspect, which I believe could possibly trigger an evolution of the way architects make use of digital design, is the shift towards an integrated use of computational design which is already underway. Trying to contrast an unstable socio-economic scenario, the architects' main interest is moving from a mere pursuit for spatial complexity and newness to embrace collaborative workflows, sustainability and constructability.

The outcome of architectural research can no longer be a beautiful image printed in a magazine or a book, waiting to be eventually converted in reality after years of reverse engineering and money spent. Digital design can and must confront reality as early as in concept stages giving answers to both performance and functional criteria and achieving solutions tailored to overcome the constraints of contemporary building industry.

The rise of pre-assembled pipelines on construction sites, the necessity of reducing the number of special parts, the economical restrictions deriving from an era of constant recession and, more notably, the necessity of planning a sustainable lifecycle for the building are all part of the equation. These are concepts which can be seen as in opposition to the advancement of architectural research; however, digital architecture must be brought to this next level: form must reflect the integration between multiple disciplines. Ultimately, leading to a strong convergence between architectural languages, structural performance as well as building sub-systems. For the designer this means, to evaluate the output of their Grasshopper definition, Mel or Processing script for variables beyond personal spatial vision. In order to succeed in the current market it is crucial to go beyond. It is essential to dominate tools and processes in order to achieve a higher level of coordination within the design.

The need for digital designers and artists to redefine their agenda is quite well described in the article written by Michael Parsons for Design Review: "Tolerance and Customization: a Question of Value". Even if I cannot completely adhere to author's vision I think he is right when arguing that

as digital tools become more popular and ordinary the complex forms made possible by these tools will lose their status of cutting-edge research unless their aesthetic and spatial qualities are supported by meaningful constructive and functional strategies. Parsons sites as an emblematic case the Voronoi algorithm. Formerly a territory only explored by the most skilled computational designers, the Voronoi algorithm has now become an accessible tool. It is obvious that only a deep understanding of its geometrical properties and intelligent implementation of them can push forward and justify its use. Anything else is just a mere proof of knowing how to use a definition programmed by others, in which case, as Michael Parsons says, "there is no skill involved in it" and I would add there is no progress either. The goal, instead, must be to achieve a perfect equilibrium between complexity and coherency.

In this book Arturo Tedeschi delivers a text that is both a theoretical and practical reference for architectural professionals and students. The text demonstrates techniques of advanced digital form finding workflow, which enables readers to take a step forward, towards the mature implementation of digital tools in architecture. Computational design has refined the architectural language, and it is now time for designers to make dramatic yet meaningful poetry with it.

Fulvio Wirz

Fulvio Wirz, born in Naples in 1977, graduated in architecture from Federico II University in Naples. He earned a master in "Public Areas Design" in 2003 and in "Architectural Design for Photovoltaic Integration" in 2004. Since 2002 complemented the work experience in his father's studio with teaching at design courses with Lucio Morrica and starts a personal research focused on relations between architecture and new media, put into practice through several competitions and culminated with the achievement, in 2008, of the PhD in Architectural Design with the thesis "Digital representation and architectural composition". Since 2005 he cooperated at Zaha Hadid Architects office in London where he has progressed his career over the years earning the position of Associate in 2014. Within ZHA Fulvio has won prestigious international competitions as Seville's library, the Masterplan for "Kartal-Pendik" area in Istanbul, the "Lilium Tower" in Warsaw, the "Eli & Edythe" museum in Michigan, the KAPSARC (King Abdullah Petroleum Studies and Research Center) in Saudi Arabia. He has been project designer on "Aura", an installation exhibited at Biennale di Venezia in 2008, and on a number of cutting edge product designs including Zephyr Sofa, Z-Chair and Liquid Glacial Table. Currently he's working on several projects, such as the design of a mosque in Kuwait and the KAFD Metro Station in Riyadh. Fulvio has been co-leading Research Cluster 6 at the GAD (Graduate Architectural Design) at Bartlett School of Architecture and has been teaching at a number of universities in Italy and UK. Since 2013 he is lecturer at the London South Bank University and he has been guest lecturer at AA Rome Visiting School.