



PARAMETRIC BUILDING DESIGN

USING AUTODESK MAYA



FOREWORD BY FULVIO WIRZ, (ZAHA HADID ARCHITECTS)

MINGTANG



Parametric Building Design Using Autodesk Maya

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Parametric Building Design Using Autodesk Maya

Due to its comprehensive tool-set and great potential for 3-D modeling, more and more architectural design and interior design firms are adapting Autodesk Maya and integrating it into their practice. There has been no book aimed at architects and designers who wish to harness the opportunities presented by this software, until now.....

The book promotes parametric design. It integrates the theoretical research of computational design and Maya nonlinear modeling techniques associated with simulation, animation, digital fabrication, and form-finding within 2-D & 3-D design. Readers will learn:

- How to use Maya polygon and NURBS modeling tools to create nonlinear procedural model.
- How to use Maya driver keys and relationship tools to generate parametrically negotiable solutions across various design professions.
- The design logic and generative processes, as well as the potential of parametric thinking as a resourceful tool for achieving diversity and complexity in form generation and fabrication.
- How to use Maya to prepare files for rapid prototyping and integrate Maya into various fabrication techniques such as laser cutting, CNC milling, and 3-D printing.
- How to simulate material properties and dynamic forces with Maya physics engine.

- How to use Maya skeleton system and animation tools to control complex architectural forms.
- How to create photo-realistic renderings with Maya lighting, material, and texture mapping. Using several real projects as examples, the book will go through the entire rendering process step by step.
- How to combine Maya with various CAD/BIM tools to create an efficient design pipeline.
- How to use Maya MEL script to create customized tools and interface.

The book includes case studies from Zaha Hadid Architects, Greg Lynn Form, Gage Clemenceau Architects, Tang & Yang Architects, as well as step by step exercises, demonstration projects, and crucially a fantastic online resource, which includes video tutorials, scripts, and Maya source files.

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FOREWORD

If software had a sex appeal and a gender, Maya would definitely be a beautiful woman, a diva. One of those characters loved by many but also criticized by those who question her talent, yet always capable of fascinating people despite their prejudices. Like all beautiful women Maya has its air of mystery that can scare someone from trying to approach her, almost giving the feeling of being “not for everybody”. This is particularly true when it comes to architecture since the use of Maya as a design research platform has been so far confined to few advanced university programmes around the world and even fewer international practices.

Although when we look back to the progresses made by our discipline in the last two decades in terms of spatial language and experimentation it is undeniable that this software, which was never created with architecture in mind, has been constantly among the platforms of choice

for the most innovative researches and projects along the entire “digital era”. As documented in Greg Lynn’s book *Animate Form*, back in the late nineties, the most tangible legacy of the newborn “digital revolution” in architecture was the early experimentation that used Maya animation tools to create forms in motion. Fifteen years later we are still learning and exploring new features and possibilities to implement this package to create breakthrough architectural concepts.

That is what makes Maya so unique: the sense of constant discovery a designer feels when navigating the software interface not only for the number of instruments available but also because using any tool in Maya to design architecture is a creative choice on its own. In fact the key to developing a successful concept with Maya relies on the capability of the designer to critically reinvent, readapt and customize the

extensive palette of possibilities offered by the software to fit their own design intent. Often the concept can fully coincide with this strategy in which case the final result can be really something unexpected and new, yet not random and uncontrolled as it comes from the logical coherence of the design process.

Maya is a form synthesizer, a generator of ideas that goes beyond any classification if compared to other traditional 3-D tools for architects. It is not a CAD but still it can produce fine NURBS surfaces with robust and highly interactive history-based tools, it is not a BIM but its node-based architecture allows one to define complex parametric relationships and behaviors, it is not just a 3-D sketch software but its implementation of Catmull-Clarke subdivision surfaces allows one to quickly design complex organic forms in no time. All you have to do is pressing the magic "3" button and a new world of possibilities will be disclosed to your eyes.

But the most interesting territory of exploration within Maya is definitely exploited by its simulation engines which are capable of virtually reproducing physical behaviors existing in nature. By feeding the design process with physically accurate tools not only can the designer achieve coherence and integration between the initial concept, its references, and the final design, but it is also possible to investigate form finding approaches, generative approaches, thus adding intelligence and performative criteria to the outcome.

Quite often though in order to get the most out of these tools it might be required to have a look under Maya's hood. In effect some attributes and node connections can only be performed via scripting using MEL (Maya Embedded Language). Luckily enough MEL is not very hard to learn and it is definitely worth it considering that it

is fully integrated within the interface to the point that Maya visualizes and keeps track of any command performed within the scene in MEL language. This way it is quite simple to get used to MEL syntax and writing scripts since there is no need to remember every single command.

All that said, I believe it is extremely difficult, if not impossible, to learn how to use Maya for architecture by reading any generic book written for character animators, special effects or CGI. That literature can only describe what the software was designed for and how artists can use it in cinema industry to produce those stunning special effects and 3-D movies we all know and enjoy watching.

As opposite learning Maya for architecture means going through the palimpsest of creative processes that students, researchers and avant-garde architects have built over the years, and once one has mastered the workflow and some tools it is also possible to variate or recombine them, or even invent brand new ones with their own logics. It is very much like learning jazz; you have got to play the best riff and solos if you want to be able to play your very own improvisation.

That is the reason why I welcome this book and I am really proud to be introducing it, because I strongly believe that the only way to effectively improve architectural research is by sharing knowledge and creativity.

Going back to the initial metaphor, I met this beautiful woman called Maya back in 2005 and since then I have never stopped being surprised and fascinated by what she is able to do when supported by a creative and critical mind. I have had the privilege of seeing some of the finest designers working with Maya and learned and experimented my personal workflows. After seven years her air of

mystery remains intact for me, there are still many unknowns. Everyday I meet her and it is always a brand new story for me, with its incipit and its ending, hopefully a good one. All I can advise those designers who get lured by her beauty is not to be shy and enter her world with passion and commitment, since she will change their way of thinking about design forever.

Fulvio Wirz

Lead Architect, Zaha Hadid Architects

PREFACE

The only limit you have is your imagination.

In 1998, I was deeply impressed by the amazing short animation film *Bingo*, made by Maya program. This award-winning film demonstrated the great power of digital technology in the motion picture industry. Ever since then, Maya has played an essential role in the world of CGI and pushed the limits of digital technology. Over the past fifteen years, I have paid close attention to the evolution of Maya and applied this program through a series of projects with MIND Lab in Michigan State University, ICT in the University of South California, and Savannah College of Art and Design. Maya inspired me and freed my imagination with its infinite power. I am enthusiastic to see the rapid development of the program in recent years, especially the latest nucleus engine and simulation field. It is evident that Maya has expanded beyond being a tool merely for the motion picture industry, but also for other fields including architectural and interior design.

The essential challenge for me, as a designer and educator in the field of architectural design, is how to embrace this non architectural program and integrate it with my design flow. In the early 1990s, only a few architects were using Maya program. Greg Lynn is one of the pioneers who introduced computational methods into architectural design. His research on advanced modeling and animation has changed my mind-set in this field.

Since 2003, I have embraced Maya in several digital design and computation-related courses in the architectural and interior design program at University of Cincinnati and Savannah College of Art and Design. The software became a vehicle to introduce parametric design, digital fabrication, simulation, scripting, performance driven design, and nonlinear thinking. Much of my academic research has been shared through various books, journals, exhibitions, and presentations at ACSA, ACADIA, SIGGRPH, SIMAUD, and CAADRIA. After years of accumulating my research and teaching materials, it is necessary to organize them into a book and share the knowledge with the larger design community.

It is not my intention to write this book as a comprehensive introduction to various Maya tools, but rather to write an exploration of specific design processes from the architectural and interior design aspect. The book intends to explore the potential of Maya in the building design process, rather than the modeling process, with the goal of extending the knowledge of parametric design and seeking novel design solutions. The book is not a collection of end results with eye-candy renderings; it is a breakdown of the design process as simple steps that the reader can follow and execute. It also highlights the advantages of using Maya in the conceptual design stages and how to integrate Maya with other CAD programs.

By using this parametric design program, architects and designers are integrating digital computation with analytical design processes. These processes are emerging as a new direction in computational design and provide unprecedented methods for the exploration of forms, simulation of physical properties, and evaluation of building performance.

Ming Tang

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