Interdisciplinary Design Approach through Maya

Claudia van Velthooven[1], Marc Aurel Schnabel[2]

[1] March(Prof) Student, Architecture, Victoria University, Wellington, New Zealand
[2]Professor, Institute of Architecture, Victoria University, Wellington, New Zealand

Abstract

This research uses Wellington's wind climate as the pivot of inquiry in all of its complexity, and explores design narratives that best respond to those circumstances in order to generate building forms with the capacity to emanate communicative energy of the city. The process of using an environmental conditions with the strongest effect (in this case, wind) as catalyst, takes the vagaries of concepts and plants them into responsive forms that excel in exploring the possibilities of a hyper-localized architecture based on its immediate environment. Autodesk Maya™ simulation and dynamic modeling capabilities allow for the exploration of a new typology that opens up discussion towards the acknowledgment of local climatic situations. The stimulation of this discussion generates awareness of environmental conditions and leads towards recognition for resilience, subject to specific locations. Our emergent system described in this paper, is established through generative computational methodologies. The geneses of complex geometries are subject to the rules that are defined by the wind dynamics apparent in Wellington.

Keywords: Interdisciplinary; simulation, climatology, Maya, Innovation

1. Introduction

This research aims to form a design methodology that recognizes the power and potential of Autodesk Maya™ in establishing an innovative design methodology that can provide for diverse and resilient architectures. This paper suggests that by embedding data into the design process, enabled through Maya's programming editor, a novel design language can be established that is rich with contextual intelligence and hence, unique to its environment. It looks at the role of computation in the design process and its ability to empower designers to breach into other fields, including various scientific domains i.e. climatology, infusing neoteric ideas into design. As a result, the algorithmic design process will develop towards an interdisciplinary domain that integrates different scientific algorithms into architectural cultures. Computational design has established itself as a fundamental aspect of critical design thinking and generation, including the simulation of scientific phenomena, and their evolution as a basis for information-based design approaches. To culminate, this paper will debate how these different domains are able to integrate with architectural design through the faculty of Maya by setting up innovative emergent methodologies that employ computationally mediated form generation.

Contact Author: Claudia van Velthooven, MArch(Prof)
Student, Victoria University of Wellington, New Zealand
Tel: +64 21 833182
e-mail: claudia.vanvelthooven@live.com

1.1. Maya

Maya is a powerful design tool for architects. Maya allows for embedded intelligence and performative criteria to define complex parametric relationships and behaviors (Tang, 2014). Its script editor supports *Python* programming language in tandem with the native Maya Embedded Language (MEL), both which are fully integrated within the interface. This allows the designer to take advantage of the software by programming repetitive, complicated, or highly specific commands that help save valuable time and also offer a method of sharing with others, allowing total control over any inputs. Fulvio Wirz, lead architect at Zaha Hadid Architects (ZHA), describes Maya as "a form synthesizer, a generator of ideas that goes beyond any classification if compared to other traditional 3D tools for architects" (Tang, 2014). Its simulation engines are capable of virtually reproducing physical behaviors existing in nature/ the environment which makes it a powerful tool for architectural form finding and analysis and fundamental for this research described in this paper.

1.2. Maya in today's Architectural Discourse

One of the architectural design strengths of Maya lies in its computational fluid dynamic (CFD) tools and *nDynamic* tools. CFD is typically used for scientific analysis and not for design generation which is where Maya intervenes. Maya facilitates research by design as it reacts to the design side of research rather than the evaluation of the endnote design. With alternative parametric tools such as *Grasshopper3D* and *Rhinoceros3D,* the designer must already have an outcome in mind whereas, Maya allows for more free-flow of design and simulation/animation. This results in more unexpected/emergent and exciting results.

There are an increasing number of large firms around the world who utilize autodesk Maya within their architectural practise. Patrik Schumacher, architect and partner at ZHA, advocates Maya in its parametric ability to enable relationships within the design to respond and interact with each other in the particular type of computational environment that was introduced to them through the animation platform of Maya. He describes how the scripting logic that can be embedded into Maya allows for forces to lawfully interact and goes on to state, in relation to Maya, one "cannot compete at the contemporary stage of architecture if you're not fully geared up with these tools" (Zaha Hadid Architects, 2016). Furthermore, Nils Fischer, associate at ZHA, describes Maya as follows;

"Maya allows [the designer] to create a layer of parametric knowledge allowing one to create complexity. It has a very wide range of options to simulate reality. We [ZHA] recognize the benefits of having a customizable tool with an open interface, so now we really want to explore these opportunities further. Looking at what we do, I think we need a tool like Maya to do it".(Zaha Hadid Architects, 2016)

Figure 1 depicts an example project from ZHA that was designed through innovative scripting within Maya. The project was a competition entry for a masterplan design in Apur, India.

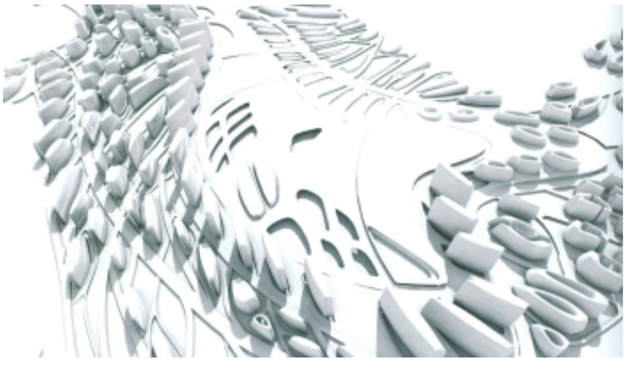

Fig.1. Apur, India Masterplan Competition, ZHA, 2008.

The project was derived through Maya simulations that involved a culmination of various ideas developed through smaller urban studies. Customized scripts in Maya were intrinsic for divisions of plots, location of open space, organising pedestrian networks, shortest city routes, and more. Shajay Bhoosan, a research architect at ZHA who worked on the project, explains how Maya was core to creating the design processes that involved a fluid algorithm used to drive parameters that generated the urban mass". (Zaha Hadid Architects, 2016)

2. Methods

2.1. Simulation

The research within this paper explores the simulation capabilities in Maya to extract local climatic data of Wellington City and embed it into the design process. This generates computational fluid dynamics (CDF) as a form generation tool, rather than an analysis tool, and manifests avant-garde architectural typologies as depicted in Figure 1. Within the software platform of Maya, there are many dynamic tools for simulating natural phenomena such as wind. A few of these methodologies are demonstrated in Figure 2.

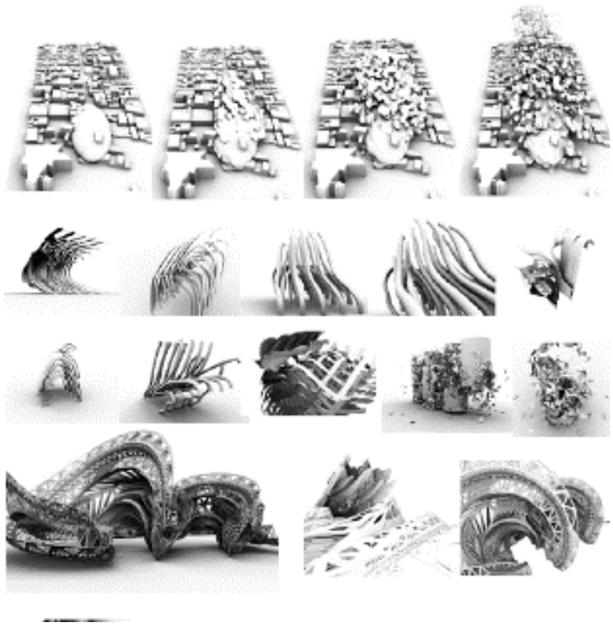

Fig 2. Outcomes of wind forming processes using a variety of scripts to generate hyperlocalized architectural forms.

The behavior and subsequently generated form of wind have an intricate relationship. The generated form affects the behavior of further wind dynamics in the environments. The behavior can be understood as non-linear and context specific. Of particular interest to this research's integration of climatic dynamics are the Maya nCloth and nParticle tools. nCloth uses rules of physics to simulate natural forces. Maya nCloth has been used to generate these forms that are driven by external forces (i.e. wind). The nCloth becomes a dynamic object and a formal expression of this natural phenomena through its ability to mimic real-life behaviors. nCloth simulations can be seen in figure 3.

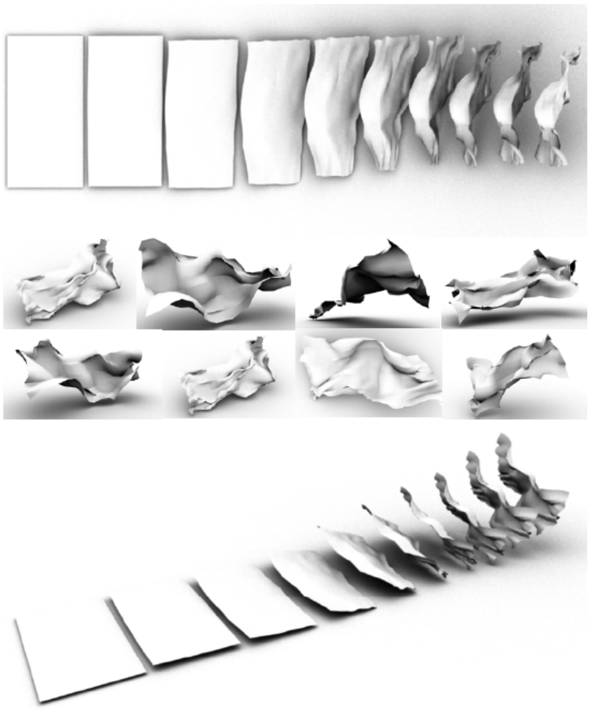

Fig 3. Outcomes of wind forming processes using nCloth simulations.

2.2. Data Embedment

To exercise further control over this interdisciplinary simulation (climatology and architecture) the nParticle function was investigated with unique scripts written in order to embed local climatic intelligence into the form generation process.

By utilizing the Maya script editor, a python script was written that extracts live weather data recordings of Wellington City and embeds the wind dynamics, including; wind speed, direction, air density and air pressure, as parameters into the particle attributes that are assigned from within the script. The particles respond accordingly, and from their generated animated motion path, a nurbs curve can be formulated and manipulated for the emergence of a unique, and highly specific synthesised expression, that is rich with local information.

Initially, this embedded data was visualized in 2D, as depicted in figure 4. The live data was extracted and applied to the nParticle system within Maya, for the same timeframe, as follows;

- air density effects the number of particles emitted
- wind direction dictates the x, y, z directions of these particles
- wind speed determines the particle speed.

This simulation was run across a few typical days to demonstrate the different effects of this applied process.

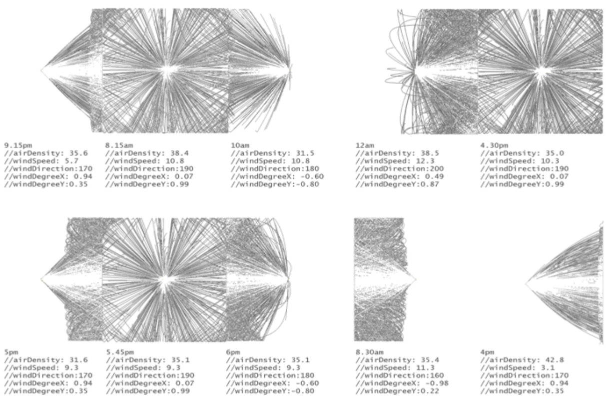

Fig 4. 2D visualization of wind data extraction and application as parameters to Maya nParticle system.

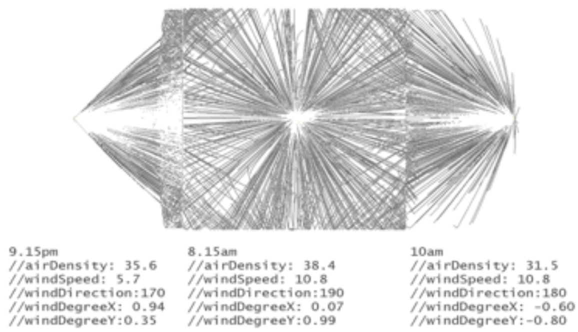

Fig 5. Closer look at 2D visualization of wind data extraction and application as parameters to Maya nParticle system from Figure 4.

Next, the data was animated within a 3D environment. Using MEL script, the particle motion path can be converted into a NURBS curve. Applications of the processes displayed in Figures 1 can be applied to the curves that emerge, and forms that are in response to this live weather data are originated. This involves techniques such meshing, lofting, animation snapshot. An example of this process is depicted in Figure 6. This process allows the data to behave as parameters that can be analysed within the script for more freedom and improvisation in the production of multiple localized design outcomes. This parametric methodology enables the designer to delve into other fields, such as climatology, allowing for a unique interpretation of localized data that generates hyperlocalized resulting forms.

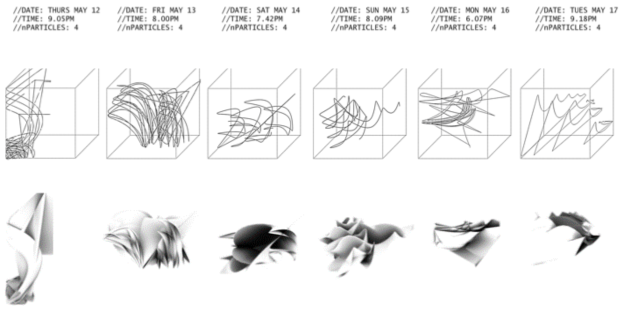

Fig 6. 3D wind data extraction and embedment as controlling parameters to generate responsive architectural reactions to site-specific conditions over one week (12-17 May 2016 at around 18:00 to 21:00).

3. Conclusions

This paper offers a point of departure for investigations of how local weather data extraction is integrated into a design process for the generation of an innovative typology for hyper-localized forms. The implicit contribution of this paper lies in its investigations of interdisciplinary practice between climatology and architectural discourse for responsive and innovative hyperlocalized architecture. The process demonstrates the ability to motivate discussion that acknowledges the importance of resilient architecture that specifically responds to its immediate environmental conditions, achieved through the novel typology that emerges from this process.

By extracting climatological data from a specific local environment and considering its effect on the social significance of the same environment, an architectural design manifests itself that can be validated as hyperlocal and offers a true representation of its genus locus, beyond what the human imagination could conceive alone.

This research continues into a resolved design that utilizes the interdisciplinary methodology offering a valuable approach for infusing innovative ideas into design. The computational process offers the ability to empower designers to delve into other scientific fields, i.e. climatology, and embed designs with local information. Through this methodology we begin to interpret, represent, and/or express our local surroundings taken as natural, through the design process that generates artifices (theory of emergence) for a hyperlocalized architecture.

The above described design process fuses the domains of climatology and architecture, not in a scientific manner, but in a creative and form-synthesizing process that is derived from data extracted locally. The resulting artifice is the product of its environment and explicitly unique to its context from the applied parameters, thus arguing as a hyperlocalized typology with the ability to generate discussion towards addressing the issue of diversity and resilience in architecture, specific to its context.

The research described in this paper is the starting point of design generation and design collaboration with the algorithm and script as well as the instrument, for an interdisciplinary approach to creative design, possible through Maya. The two are intrinsic partners within the design process which will facilitate the arrival at an architectural expression that are to some extent ambitious and conceptual, yet allow for the understanding and development of a novel architectural typology and expression, that is not possible otherwise.

4. References

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