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02. PARAMETRIC MODELS OF COASTAL SETTLEMENTS' GROWTH

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ABSTRACT

Parametric design has been widely used by architects. However within landscape architecture and urban design its use has been very limited (Steino, 2012). This paper reports on initial findings of on-going research that aims at investigating the applicability of parametric design concepts when evaluating growth scenarios in small coastal settlements within New Zealand.

The objective of this research project is twofold. Firstly, it identifies issues associated with urban growth, alongside current urban design approaches. Secondly, the project aims to take the parametric design discourse out of its academic context and test its applicability on a real site that is under pressure from growth. This is explored by developing parametric urban design systems that operate at different scales. The case study site is Pataua North, Whangarei Heads. This site has an expected growth demand of 5000 people (Liang, A. 2010). The developed parametric urban design system models the inter-connections between greenspace, street layout and lot sizes.

The advantages and shortcomings of parametric models when compared with canonical top-down urban design approaches are explored through this research. Evaluation criteria for privileging models outputs are also reviewed. The research recommends a range of possible improvements to models and speculates on the future of parametric urban design.

INTRODUCTION

This research reports on the initial findings of the investigation into parametric design and its application into modelling settlement growth in coastal communities for Landscape Architects and Urban Designers. The research case study investigates a coastal settlement to the west of Whangarei, New Zealand - Pataua North. The site currently has approximately 100 houses and is slowly increasing over time. Whangarei District Council expects the growth over the next 50 years to be around 5000 people in the region, with some houses scattering inland into smaller communities (Liang, A. 2010).

The research outlines some of the major advantages of using parametric design throughout the various stages of design and experimentation and illustrates how this process can be useful for the profession. A background to parametric design and urban growth will be discussed in order to inform later discussions on techniques and knowledge gained through the research.

Figure 1: Pataua North

AIM

The overall aim is to explore possible applications of this design technique in the disciplines of landscape architecture and urban design and to identify any outcomes that may benefit, or enhance, the design process in regard to coastal growth modelling.

Parametric design is a concept, first discovered in 1963 by Ivan Sutherland in his PhD thesis on computer-aided design. This was one of the first and most influential ideas in computer-aided design. Putting changeable parameters into the Sketchpad system created an exploration of parametric capabilities, which helped shape what parametric design is today.

BACKGROUND

Parametric design is the process of designing in an environment where design variations are effortless, thus replacing singularity with multiplicity in the design process (Alrawi, O. 2007). Parametric design is carried out with the aid of Parametric Models. A parametric model is a computer representation of a design, constructed with geometrical entities that have attributes (properties), some of which are fixed and others that can vary. The variable attributes are also called parameters and the fixed attributes are said to be constrained. The designer changes the parameters in the parametric model to search for alternative solutions to a given problem. The parametric model responds to the changes by adapting, or re-configuring, to the new values of the parameters without erasing or redrawing (Slack-Smith, D. 2005).

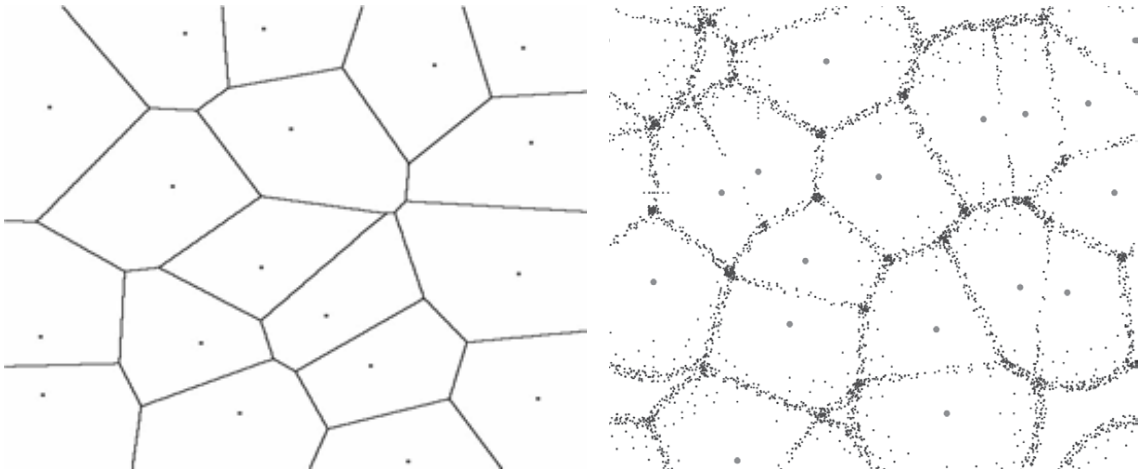
In parametric design designers' use declared parameters to define a form. This requires rigorous thinking in order to build a sophisticated geometrical structure embedded in a complex model that is flexible enough for doing variations. Therefore, the designer must anticipate which kinds of variations he wants to explore in order to determine the kinds of transformations the parametric model should do. This is a difficult task due of the unpredictable nature of the design process (Hernandez, C. 2006).

The parametric models discussed in this paper use (in several ways) the voronoi diagram as an organizational principle. The voronoi diagram is a pattern, which describes the minimal energy pathways between a set of points (Coates, P. 2010). Voronoi patterns occur spontaneously (bottom-up) in nature at a variety of scales. They resemble biological cells, forest canopies, territories of animals, fur and shell patterns, crystal growth and grain growth, cracks in dried mud, etc.

The traditional, top-down, analytical method to draw such tessellations looks rather clumsy and does not seem to capture the underlying dynamic of the phenomenon. It is explained by Aranda and Lasch (2006):

- Take a set of points.
- Construct a bisector between one point and all the others.
- The Voronoi cell is bounded by the intersection of these bisectors.
- Repeat for each point in the set.

The same pattern can be generated from the bottom-up just by using attraction and repulsion iteratively and in a parallel manner (Coates, 2010). The result is again a Voronoi tessellation that shimmers into being, rather than being constructed deliberately. This second method does not use any top-down geometry and seems to capture the underlying dynamic of the phenomenon in a more "natural" way. Regardless of the method used, the Voronoi diagram generates a space-filling topological structure and is one of the most fundamental and useful constructs, emphasizing its excellent applicability in modelling natural phenomena (Coates, et. al. 2005).



Figures 2 and 3: Voronoi Pattern using attraction and repulsion and a Voronoi pattern drawn top-down.

There have been many interpretations of the voronoi diagram across architecture, urban design and landscape architecture. One particular example is a waterfront development named the ***"Majok Project"***. This project used the principles of the voronoi diagram to pinpoint specific areas on the site and made them points of attraction and points of repulsion. The points identified were chosen for cultural reasons, hydrological, ecological, traffic, viewpoints, etc., and given a value of importance for the design process.

Urban design is the profession of shaping the physical setting for life in cities, towns and communities; a collaborative and multi-disciplinary process does this. Urban design has progressed over the past 50 years and has been gaining certain autonomy. With professions such as urban planning, architecture and, in recent years, landscape architecture becoming more involved, urban design has become a diverse and multi-disciplinary profession. The design process in general terms is seen by a lot of professions as – a brief, a need, a demand - a solution (Lawson, B. 2005).

Design solutions are generated and evaluated in a multi-objective parameter space, in which each planning aspect offers a different view on the problem. Typically, such a view is presented as a map, sketch, diagram or calculation, .e. in a static and deterministic manner. Parametric design is capable of changing a design and giving instant feedback, this is most effective in the early stages of conceptual design as investigations are made in a collaborative setting.

NZ coastal communities such as Omaha, Pauanui, Marsden Cove and Kaiteriteri (Peart, R. 2009) have seen significant growth in the past few decades. The expansion of coastal urban development places increasing pressure on the natural environment through the effects of land clearing, waste disposal and pollution. Structures built on the coastline can increase erosion, leading to the need for beach replenishment. Building along the foreshore and on sand dunes can affect the coastal landscape, coastal processes and the natural movement of sand. As well as increased erosion, coastal communities are also vulnerable to rising sea levels and a loss of identity. In addition, the discharge of sewage, stormwater, land run-off, river inputs of nutrients and sediments to estuaries and the coastal waters constitutes one of New Zealand's greatest coastal management challenges.

METHODOLOGY AND CASE STUDY MODEL

Pataua is a rural coastal community with a strong sense of local history. The area is valued in Northland for its recreational opportunities amidst a beautiful setting of safe beaches, native vegetation and farmland. The fact that generations of families have returned to the area to live and to holiday is testament to the natural beauty and community spirit of the area. In recent years Whangarei District Council have been expecting this area to grow by 5000 people within the next 50 years, an increase of over 800%, with a total of roughly 1700 houses. For the past 15 years the growth of the site has been witnessed first hand.

Pataua North is about a 31km drive from Whangarei, and there are just over 100 houses. These houses are made up of holiday baches and some that have permanent residents.

With the use of GIS data the site was mapped, including contours, hydrology, land-use, slope, aspect, viewpoints and built form. Mapping gave an insight into the spatial characteristic structure of Pataua, which helped determine site constraints and opportunities. The site's developable areas seemed to be along the coast, with the slopes to the west constraining the development from moving inland.

Currently the site has 1 boat ramp in the estuary, a community hall with a camping area, no shops and, as noted before, roughly 100 houses and large land parcels of farmland to the north.

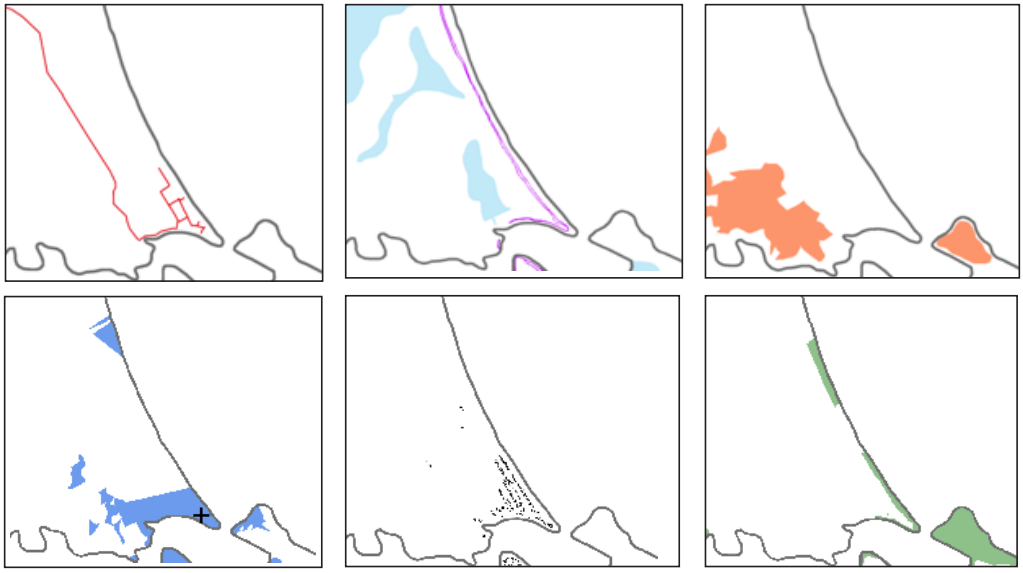


Figure 4: Left to Right: Roads, Flood/Erosion Zones, Slope, Viewpoint, Houses and Greenspace.

Earlier in the research studies were conducted into the spatial layout of several Auckland bays, including Castor Bay, Browns Bay and Orewa beach. This helped inform patterns that Auckland coastal communities had in regards to trends of house positioning, road layout and viewpoints.

The first parametric design experiment followed the mapping and analysis. The goal was to explore variations of road layouts, generated using Voronoi diagram around points of interest. The points included floodplains, road intersections, knolls, and landscape features. This relatively simple model helped with developing confidence in the concepts and gave insights into the workings of parametric design.

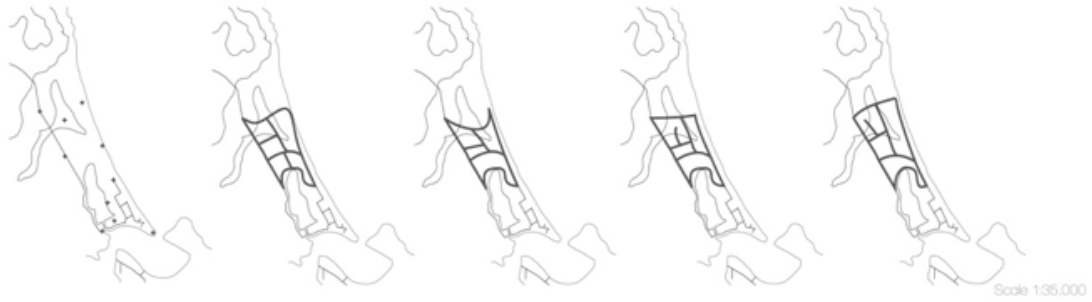


Figure 5: Pilot Parametric Model

The second parametric model used the processes of attraction and repulsion executed iteratively and in parallel. The aim was again to study variations of possible road layouts. The parametric road layout was attracted to certain areas and repulsed from others. These areas included important landscape features, such as floodplains, steep slopes, existing road networks and beaches to name a few.

Several parametric models were then created for various parts of the design using attract and repel notions as discussed above. All the models were incorporated together and a series of generations were created. Keeping record of the results enabled reflection and evaluation of the designs (see Figure 6).

New parameters and features were then added. These included open space proximity, housing density, and viewshafts.

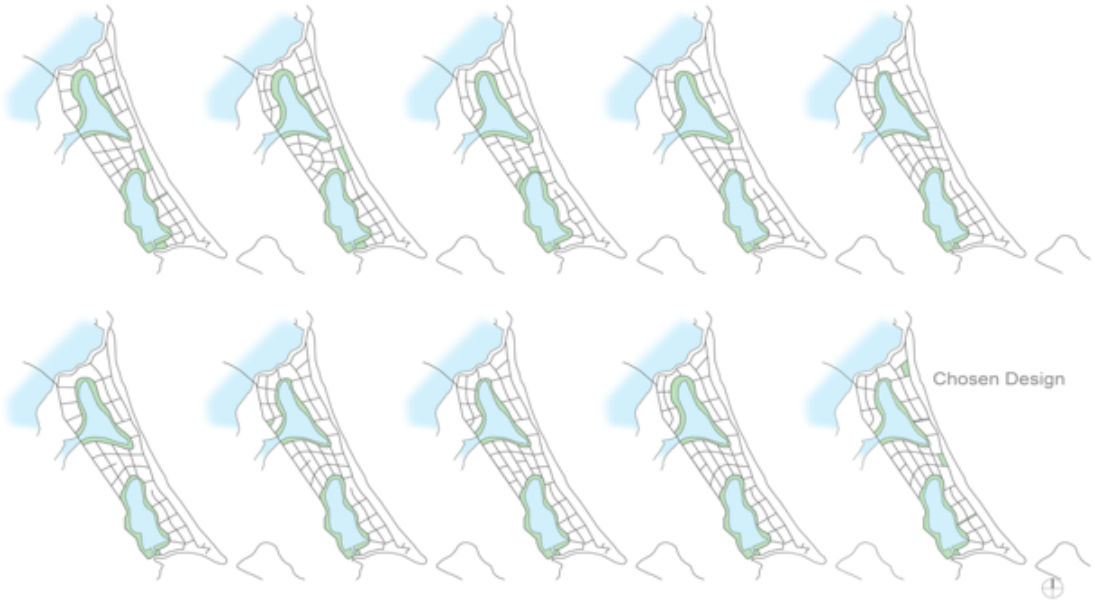


Figure 6: 10 Developed parametric variations

Some the components of the model will be explored in further detail in this paper.

The waterfront is a key component of Pataua, with one of the main attractions being the surf beach. Several points were located along the beach representing coastal features. One of the points was a knoll and another was a depression in the sand dunes, which opened up a view to the beach. This depression opened up the opportunity to locate a green corridor from the floodplain to the beach, creating a visual connection. These points were then used to influence the geometry of the road (shown in red in figure 7). The relationships that were established earlier meant that a slight change in the road could result in dramatic change in several areas of the design, including block sizes, road distances, greenspace sizes, viewshafts and housing densities.

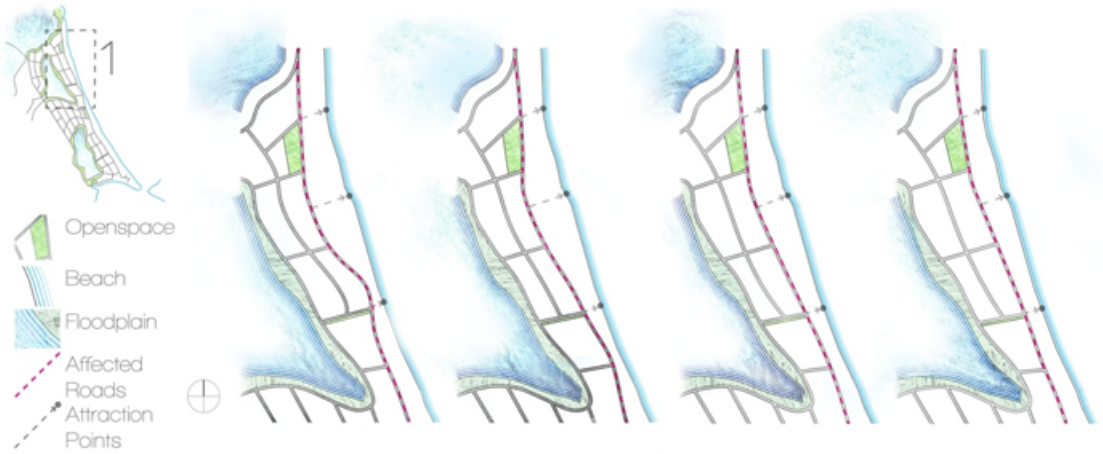


Figure 7: Waterfront iterations

In the greenspace design definition a visibility rule was added. This meant that the road (shown in red in figure 8) could deform only if the deformation increases the visibility of the green space (in green).

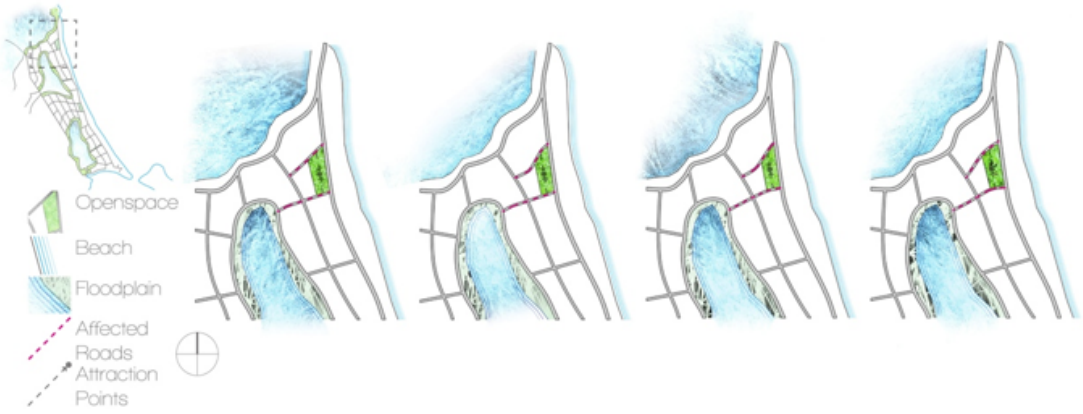


Figure 8: Greenspace iterations

DISCUSSION AND CONCLUSION

Parametric urban design focuses on the piecing together of subsystems to give rise to a larger system/program. This type of working is useful when multiple parties are involved in the design process because the parametric system allows instant feedback to alternative design scenarios.

One of the main challenges is the conceptualization and construction of the parametric system, i.e. what interrelations are depicted and explored, what is fixed and what can vary. Parametric techniques can leave little room for any kind of intuitive, emotional response to design and makes it easy to overlook or exclude vital characteristics that could make a design successful.

When it comes to design, the real value of parametric technology is not so much in generating geometry, but in offering instant feedback of design information and analysis during the design process. More options can be tested and their feasibility measured. The parametric systems are history explicit, i.e. the design process is entirely visible. Moreover, there is instantaneous and interactive feedback between design scenario generation and evaluation. These allow more constructive discussions, easy alterations and improvements of both the design process and the set of evaluation criteria. The challenges associated with coastal settlements growth were outlined in the section on Background. The parametric models developed collectively proved how the interdependencies between various elements of the settlements fabric (road network, open spaces, plot sizes, etc.) can be explored and evaluated in order to overcome the challenges in coastal settlements' growth.

Following the research discussed in this paper, there are several improvements that would be suitable to explore. The availability of data is key to accurate design decisions. This research had static non-changing information throughout, giving it a lack of variability.

The area of further exploration will be an attempt to build a parametric urban design system that operates at more than one level of detail.

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03. XSECTION: AUCKLAND'S CONTEMPORARY LANDSCAPE ARCHITECTURE JOURNAL

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Unitec

ABSTRACT

A new landscape journal has been developed called Xsection. This publication calls for articles from landscape practitioners, academics, and students. The journals intent is to promote rigorous discussion about landscape architectural issues from both an academic and professional viewpoint with a particular emphasis on the voice of young landscape architects. The theme evolves each year and is topical to Auckland. The journal has a refereed section. These articles are double blind peer reviewed by a panel comprising local academics, professionals and international academics. The journal is also a credit bearing negotiated study course for Bachelor of Landscape Architecture students.

A research question is developed and information is gathered on this topic in the form of articles. This information is then edited and sorted into sections that deal with particular aspects of the theme. Students then develop a response to the data collected and produce a conclusion to the journal that expresses some answers to the question posed. The journal is published and disseminated to 2500 members of the New Zealand Institute of Landscape Architects (NZILA) and is available as an e-journal.

The connection to industry is important as the relationships established through the production of the journal help to generate ongoing contacts that feed into teaching and research. The journal is a means whereby the Auckland approach to landscape architecture can be fore grounded and disseminated. The project contributes to the research environment by way of creating a vessel for double blind peer review articles and promotes ongoing contemporary discussion about landscape architecture in Auckland.