Inflexible Machines: Parametric Models and Early Stage Design Constraints

Matthew Fraser *matt.architecture@gmail.com*
Victoria University Wellington School of Architecture

Keywords: Prototyping, Generative Computation, Architectural Models, Early Stage Design.

Abstract

This research explores the topic of *generative Architectural computation* and how *parametric models* are currently limited in scope and inflexible in application within early stage architectural design. This research proposes to establish an understanding of new and experimental design processes which integrate virtual modelling with physical prototyping constraints for the specific Architectural applications.

The aim of this research is to elevate the profile of innovative *design computation* within the general Architectural curriculum and to raise pertinent questions about how the engagement of the *early stage parametric design model* is incorporated within existing Architectural processes. This topic is a response to the gap in knowledge at smaller institutions relating to architectural tectonics and recent advances in computational approaches.

This research frames the *parametric model* as an ideal process to mediate between virtual environments and physical form. New computational design systems manipulate geometry and associated logic in increasingly complex and innovative ways which allow for increased flexibility in early stage design. New media allow for dynamic associations to be defined in these virtual spaces 'free' from the constraints of formal architectural logic, yet it is only when the prospect of the creation of a 'final' or 'built' model that the *inflexibility* of these systems to account for Architectural situations is revealed. If these associations are limited from the outset to a few select criteria, including physical conditions and universal variables, the relevance to explorative architectural solutions is revealed.

The hypothesis investigated is that the inflexibility of computational methods for design exists as a product of both conceptual methods in architecture and interfaces in the design of software. In this context the relationship between design drivers and driven elements can be abstracted or reversed; this approach is currently under-utilised.

Research Question

How does an understanding of *the inflexibility of virtual generative* processes challenge the use of abstract logic within early stage design models?

Related questions

Which pattern constraints are of use for Architectural surface modelling?
What lessons can we learn from generative processes in digital architecture to be incorporated into the more traditional role of the Architect and the training of Architects?

The outcomes of this research:

1. Introduce digital processes and virtual parametric models in a perspective of 'incremental' experimentation. (Thesis)
2. Encourage further inquiry and useful experimentation of technical and conceptual approaches in digital design. (Papers)
3. Provide a unique example of new architectural outcomes and solutions which are clear and with reproducible results. (Ongoing instruction and development of digital architecture program for host institution)
4. Allow VUW School of Architecture to have a new platform for discussion with relevant regional and global approaches to computation. (compositions and exhibition material)

Relevance of the topic

This research is partly in response to a recently obtained sophisticated collection of computer aided manufacture facilities at the VUW Faculty of Architecture and Design; specifically 3D printing, 3D scanning and large scale CNC milling. These design facilities allow the investigation of modelling interfaces previously only accessible to global leaders of Architectural education such as MIT, SIAL, Cornell and the AA London.

At this institution (Victoria University Wellington), designing for and within digital manufacture environments is an under-developed field of study, and scale prototyping is rarely undertaken for Architecture. This topic is a relevant area of research because it seeks to integrate leading design computation techniques and fabrication technologies within specific Architectural outcomes.

Research design and methods:

Familiarity with field and precedent forms the basis for comparative analysis criteria. Ethnographic perspectives allow for a philosophical overview of generative processes and the issues surrounding contemporary digital architecture.

Develop a series of design systems (design tools) which allow for a contextualised investigation of the relationships of design and abstract logics with case studies from early development to fabrication. The modelling of architectural geometries as a series of surfaces allows for malleable relationships between parameters. The use of *Generative Components* (Bentley software) allows the new systems to take advantage of expressive associative geometry and is extensible to verification software; for example *Radiance* and *EnergyPlus* programs.

Observations and discussions on the conditions of flexibility within associative models of case studies will focus on the following themes: Structural efficiency, economic, day-lighting, complexity and variation.

Physical Models to be produced to highlight parameters of digital models and use CNC technologies to accentuate the link between virtual modelling and physical outcomes.

Conclusions to date:

Current status of research is one third complete. Completion date early Jan 2011.

Literature search and review ongoing. Manufacturing technologies (i.e. physical models) review underway and trial fabrications produced.
Trial examples of generative systems written in *Generative Components*. These are at an early stage. Additional perspectives required.

Selected Bibliography

Aranda, Benjamin., Lasch, Chris. (2006) *Pamphlet Architecture 27 – Tooling*
New York: Princeton Architectural Press [Link]

Frazer, John. (1995) *An Evolutionary Architecture*
London: Architectural Association [Link]

Kolarevic, Branko. (2003) *Architecture in the Digital Age : Design and Manufacturing*
United States: Spoon Press

Liu, Yu-Tung. (2007) *Distinguishing Digital Architecture*
Taiwan: Garden City Publishing

Loukissas, Yanni. (2006) *Design, Computation and the Boundaries of Practice*
PhD Dissertation proposal (unpublished), MIT Department of Architecture

Terzidis, Kostas. (2006) *Algorithmic Architecture*
Oxford: Architectural Press

Terzidis, Kostas. (2003) *Expressive form: a conceptual approach to computational design*
New York: Spoon Press [Link]

Selected Papers

Aish, Robert. (2000) *Custom Objects: a Model Oriented End-User Programming Environment*. Paper submitted to the Visual End User Workshop VL2000

Burry, Mark. (2005) *Digitally Sponsored Convergence of Design Education, Research and Practice* 11th International CAAD Futures Conference; Netherlands: Springer [Link]

Frazer, John. (1999) *Towards the Post Digital Era*
AVOCAAD Second International Conference, Brussels, Belgium.

Frazer, John., et al.,(2000) *The Use of Genetic Algorithms to ExploreAlternative Building Design Processes* International Conference on Construction Information Technology (INCITE), Hong Kong.

Frazer, John. (2002) *Creative Design and the Generative Evolutionary Paradigm*
Chapter in Creative Evolutionary Systems, (eds. P.J. Bentley, D.W Corne) Morgan Kaufmann Publishers, UK, pp 253-274.

Kilian, Axel. (2003) *Fabrication of partially double-curved surfaces out of flat sheet material through a 3d puzzle approach* Proceedings of the Annual Conference of the Association for Computer Aided Design In Architecture , Indianapolis pp. 75-83