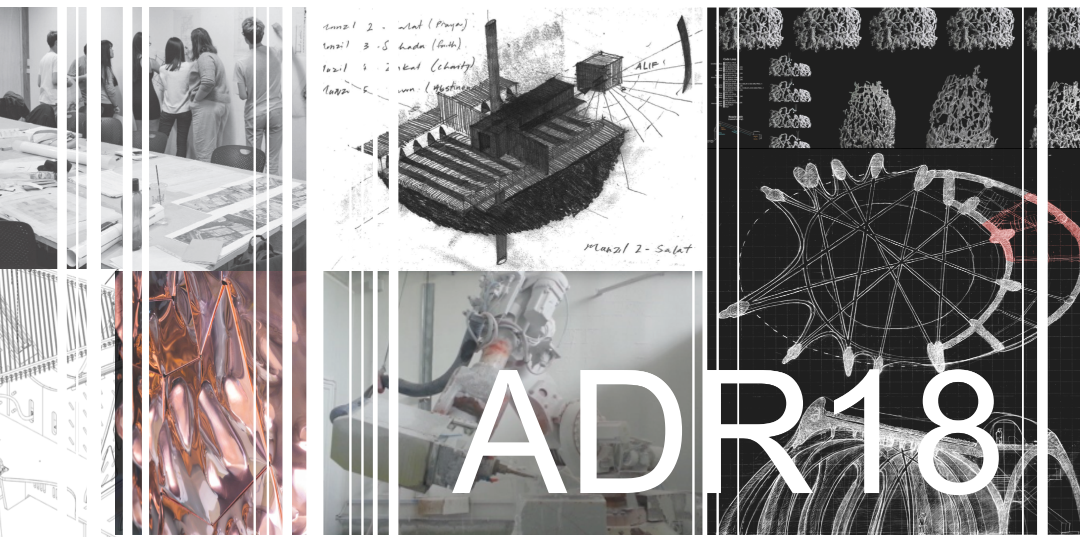

Proceedings of the 1st Annual Design Research Conference (ADR18)

The University of Sydney

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THE UNIVERSITY OF SYDNEY

Architecture, Design and Planning

Proceedings of the 1st Annual Design Research Conference (ADR18)

Held at the School of Architecture, Design and Planning

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Full details of the Scientific Committee of ADR18 can be found at the back of the proceedings.

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Foreword to the ADR18 Conference

Genesis

The idea for ADR18 was hatched in discussions that began in the Architectural Design Research Group at the University of Sydney's School of Architecture, Design and Planning. In our regular meetings, it emerged that it was difficult to find a suitable forum to discuss the work outside of the group. Similarly, the group was concerned with the problems associated with producing valid (and valuable) design research outputs, eager that they be comparable to those of more traditional research methods.

Unlike the other research groups in the School, it struck us as odd that there was no annual conference that could fully embrace our work. In Australia, we were aware that architectural history and theory has an annual conference (SAHANZ: Society of Architectural Historians, Australia and New Zealand), as does architectural science (ASA: Architectural Science Association) and heritage studies (ICOMOS: International Council on Monuments and Sites). Until recently, the Association of Architecture Schools of Australasia annual meeting often had a strong design research focus, but we understood that this was not so much a standing conference, but rather one organised at the discretion of the group on a case-by-case basis.[1] Similarly, we were also aware of the work going on in the multi-institutional Design Architecture Practice Research (DAP_r) group, led by RMIT, but to our knowledge it was not intended to be an ongoing forum.[2]

The absence of an annual forum devoted to design research in the built environment in the Australian context, was particularly odd given the leading role that Australian institutions, particularly RMIT, have played in developing and popularising this form of research. In the wake of RMIT's foundational role, and as a relative newcomer to the more established modes of researching the built environment, design research has enjoyed a wave of interest in recent decades. Currently in Australia, most Schools either have a cohort of PhD candidates working in the area, or at least have plans to launch a program. Yet, it seemed that beyond some notable exceptions — notably DAP_r and a handful of symposia and conferences — these discussions were usually strongly tied to their parent institutions and were mainly "in-house" events. With ADR18, it is our hope to take these discussions to a national and international setting.

Purpose

Beyond elevating this important discourse beyond the level of individual institutions, the ambition of the ADR18 conference was also borne of several more pragmatic problems:

> What role can Non-Traditional Research Outputs (NTROs) play within increasingly metric-driven research environments?
>
> How can research carried out within the design research field be better represented in research ranking exercises, such as Excellence in Research Australia (ERA) rankings?
>
> And further, how can projects and teams in this area get better access to research funding from groups, such as the Australian Research Council (ARC)?

In terms of the day-to-day problems that researchers face, the issues of support and networking are significant. As a researcher with early interests in history and theory, I was very lucky to enjoy the collegial support of SAHANZ as an early career researcher. Yet, to which forum can our current cohort of PhDs and Postdocs in design research turn? Similarly, as supervisors to PhD candidates, how can we access the shared knowledge of colleagues working this this area? And, importantly, where would we look to find a pool of peer reviewers and potential examiners?

We hope that the ADR18 conference will address many of these questions and establish a vibrant and collegial discourse in the area.

Ethos

In launching this conference, it was important to us that it not be seen as a University of Sydney venture, not a Sydney or Melbourne affair, and not as a narrowly Australian endeavour. Although the first conference will be held at the University of Sydney in September 2018, coinciding with the centenary of Australia's oldest School of architecture, we see this as a shared initiative. In 2019, the conference will be held at Monash University in Melbourne, and plans are afoot for it to be held at the University of Tasmania in Launceston in 2020. To make the intention for a broad and inclusive group clear, it was necessary to seek support from all universities across Australia. We were extremely buoyed by the level of positive feedback and support was generously and universally offered from across Australian and New Zealand.

Even though design research is relatively new, we are all aware that the field contains many hotly contested positions within it. Here, we think it appropriate to outline the spirit and ethos under which the conference was initially conceived. We hope that the ADR conference will be a broad-minded and pluralist network, one that can act in a self-assured manner precisely *because* we are aware that different schools of thought exist. We hope that this group will be inclusive of the inherent variety in the field and be open to programs that are either established or emerging, both from the region and internationally.

Format

Finally, as a relative newcomer to the suite of research methods in the built environment, we think the "rules" and expectations for design research are not yet fully set. The format of the conference was a topic of early and adventurous discussion that is not yet closed, and owing to the vicissitudes of design, is likely to remain an open subject of discussion for some time to come. We also imagined that a conference devoted to design research might tackle the issue of format in a novel and creative way.

We have suggested that there should be room for conventional papers and text-based research outputs, but there should also be room to show and talk about prototypes, models and designs, along with performances, screenings and installations. Such variety in the permitted "media" will also demand an expanded view on the traditional "Call for Papers", which we rebranded as "Call for Proposals". The conference, therefore, will be a mix of talking, presentation, exhibition, performance, and discussion.

Additionally, we were insistent on including research and input from outside the university. Researchers active in practice can get CPD points for participation, and we are happy to say that a few practitioners have made contributions to the conference. Clearly, one of the distinctive features of design research is that it can be carried out in industry as well as the academy, and this is a stream within the conference we hope will grow in years to come.

Finally, in thinking about the outputs, and bearing in mind the necessity for more exclusive peer-reviewed research outputs to access research funding, we pursued a two-track approach. Our brief was to accommodate novel and creative ways to capture and present design research that were, perhaps, more germane to its inherent variety in type and media. At the same time, we wanted to facilitate the sharing of knowledge and ensure that the conference can maintain a healthy participation into the future. In today's terms, this requires the generation of high-level peer-reviewed research outputs as publications and/or NTROs.

In addressing this brief, on the one hand we have developed a handsome conference proceedings that is a record of all peer-reviewed submissions. On the other hand, we secured commitment to publish selected outputs through *Drawing On*, an Edinburgh University-based peer-reviewed journal of Research by Design. Through this collaboration, selected ADR18 proposals will be considered for publication. As an online journal, one of the major advantages offered by the cooperation with *Drawing On* is that it allows for a wide range of formats and breadth of media.

Along with all the benefits that we hope the ADR conference will bring in years to come, we also hope that our colleagues will look forward to it — as a fixture in the annual research calendar that is known as an inclusive, rewarding, and very social conference.

September 2018

Professor Mathew Aitchison

Director, Innovation in Applied Design Lab

Chair, Architectural Design Research Group

School of Architecture, Design and Planning, The University of Sydney

[1] https://aasa.org.au/conferences/

[2] See: http://dap-r.info/about

ADR18

The Keynote Speakers

ADR18: Keynote Speaker

Professor Momoyo Kaijima

Atelier Bow-wow and ETH Zürich

Professor Momoyo Kaijima graduated from the Faculty of Domestic Science at Japan Women's University in 1991. She founded Atelier Bow-Wow with Yoshiharu Tsukamoto in 1992. From 2017 she has served as a Professor of Architectural Behaviorology at ETH Zürich. Momoyo has taught as a visiting professor at the Department of Architecture at Harvard GSD (2003, 2016), guest professor at ETH Zürich (2005 – 2007), the Royal Danish Academy of Fine Arts (2011 – 2012), Rice University (2014 – 2015), Delft University of Technology (2015 – 2016), and Columbia University (2017). While engaging in design projects for houses, public buildings, and station plazas, she has conducted numerous investigations of the city through architecture, such as *Made in Tokyo* (2001) and *Pet Architecture* (2002).

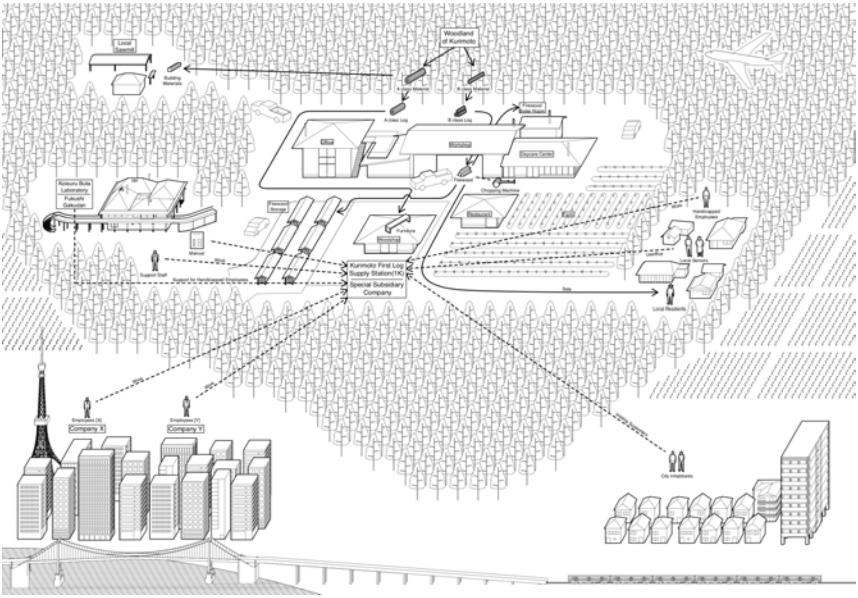

Figure 1: Koisuru-Buta Laboratory by Atelier Bow-Wow

ADR18: Keynote Speaker

Emeritus Professor Leon van Schaik AO

School of Architecture and Urban Design, RMIT

Paper: *In The Medium Itself – Three Decades of Design Practice Research at RMIT*

Emeritus Professor Leon van Schaik AO, B.Arch. Studies (Ncle), AADip (SADG), M.Arch (UCT), PhD (CNAA), RIBA, LFAIA, LFAA, School of Architecture and Urban Design, RMIT, has written books on spatial thinking, the poetics of architecture and the processes involved in procuring innovative architecture. The practice-based research program that he initiated in 1987 has become a template for institutions worldwide. His support of local architectural cultures and his leadership in the procurement of exemplary architecture has resulted in some of Melbourne's most distinguished contemporary buildings. He is a founding member of the Academic Court of the London School of Architecture.

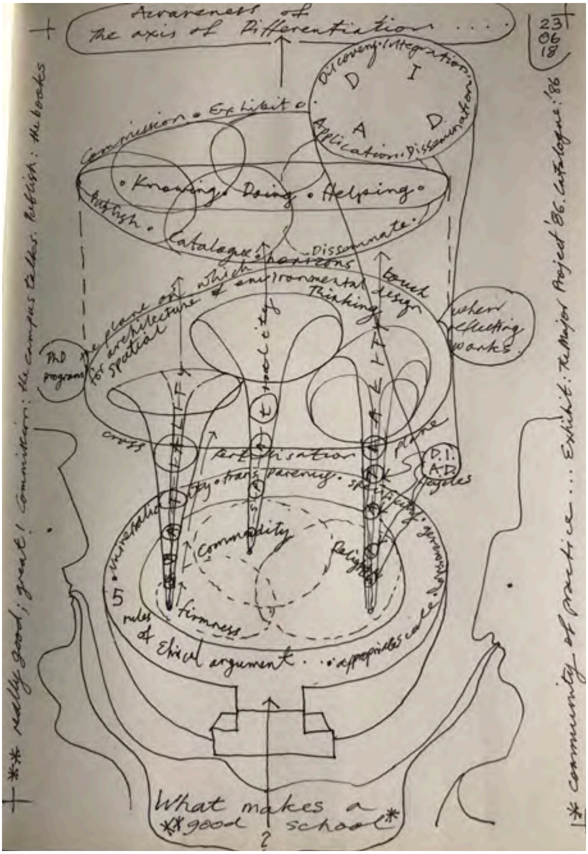

Figure 1: Ideogram_Building a Culture, by Emeritus Professor Leon van Schaik AO

ADR18

The Exhibition

ADR18: The Exhibition

Dr Sarah Breen Lovett

Post-Doctoral Research Fellow, Innovation in Applied Design Lab, University of Sydney

Dr Rachel Couper

Post-Doctora Research Fellow, Innovation in Applied Design Lab, University of Sydney

The exhibition of ADR18, held in association with Tin Sheds Gallery, features a total of 21 exhibitors from major institutions and practices of architecture and design from around the world. Curated through open call and double-blind review, the exhibition has the aim of presenting design research from a wide variety of built environment fields including: architecture, landscape, interior and urban environments; as well as illustrating a spectrum of mediums used and motivations for the research to be carried out. Despite this broad curatorial approach, a unifying theme of the exhibition can be seen though a consideration of the way processes of ‘making’ become tools through which design research can be conducted. This produces an array of physical manifestations in the form of objects, drawings, models, video, sound work, installation and performance. These artefacts in turn function as bearers of design research knowledge,[1] positioning research *through* design as an agent of critical inquiry into the built environment.

While many of the works have shared mediums and approaches to ‘making’, their motivations for carrying out the research are multivalent, and have been loosely categorised into three sections. The first are design research projects that critically evaluate the discipline of design: in relation to politics, by creating performative places or shifting engagement with modes of representation. The second are design research projects that focus on advancing digital fabrication and form-making. The third are the creation of design works that are concerned with environmental issues, urban densification and modes of living. Each will be discussed here to continue dialogues between different types of design research and to explore potential interconnections between prevalent practices today.

Critical Practice – Politics of Gender and Place

The first works to be discussed are those that aim to critique the discipline of design. Jane Rendell describes *critical spatial practice,* as work that has “spatial, temporal and social considerations,”[2] that sits “at the edge between and across different disciplines, [. . .] adopting methods that call into question disciplinary procedures.”[3] That is, the purpose of these works is to interrogate the parameters of one’s own discipline through other disciplines and the constructive discourses that arise through this inquiry. Perhaps the inter-disciplinary practices which most explicitly evaluate the broader implications of the design discipline are the ones that engage with politics.

Interrogating politics of gender, authorhood and social taboos of excrement are a series of work by Francois Roche. The first, *Coitus Interuptus* is a video work in which a naked man sits trapped inside a digitally created enclosure made from “petrified semen”.[4] The second work by Roche, *“The dance of the death’’ / digital morbidity / my anomaly _ BKK* is a text-based piece, printed onto take-home sheets for the audience. Together these works assert that society is lured in by the spectacle of digital, which is as a mask for politics of society that we choose to ignore. In an attempt to complexify, contextualise or counterpoint the first two works Roche offers a documentation type video that shows a sample of his vast body of installation and architecture work created digitally since 1997.

Looking specifically into the politics of gender and race in the urban realm is a site specific re-projection installation work called *Revel After The Curfew* by Bana Hankin, Jorge Valiente, Gonzalo Valiente, Amaia Sanchez-Velasco, Miguel Rodriguez Casellas, Leandro Cappetto, Miguel Valenzuela and Laura Touman. The purpose of this work is to act as a critique on "new geographies of violence in the neoliberal era"[5], specifically in relation to Sydney's nightclubs. Reading from NSW government Liquor Acts, our attention is drawn to the fact that there is an enforced assimilation, where we are expected to act and behave in specific ways in certain places. The work is particularly powerful in consideration of critique of power structures and how our experiences of place are defined by institutional frameworks.

Shifting to examine politics of rural places in contrast to the urban is a work called *Performance and Discipline in Architecture: The Accumulation of Cyclical Operations in Critical Spatial Practice* by Campbell Drake. This work engages with performance, installation, architectural processes resulting in four video works, where there is an unexpected engagement with and placement of a piano on four different sites. The sites include: D-Division HM Pentridge Prison, McRobbies Gully Waste Management Centre and Culpra on Barkanji country in association with the Culpra Milli Aboriginal Corporation. The contrast of the piano with these locations question issues around spatial politics and locational identity. Drake explains this as an examination of "how site-specific performance can activate engagement in the spatial politics of contested urban and rural landscapes in Australia."[6]

Critical Practice – Creating Performative Places

Rather than the main focus of a critical practice being social or political commentary on the impact of digital, urban or rural design, the following works engage with different mediums to create new ways of designing or experiencing place or space. These works take data and information from place, people and environment and translate these through a variety of mediums to create new 'performative places'. The first of these is the *Unreasonable Creatures* by Urs Bette. In this work, architectural design is re-defined by Bette. Rather than seeing the in-putting parameters to design as logical and justified by social or environmental context, this work proposes the consideration of the *unreasonable* – specifically arising from the "exchange between emotive cognition and analytic synthesis in the design act."[7] Bette says this is done in a specific attempt to "validate the role of the 'unreasonable' in the design process, unveiling the strategies I deploy in order to facilitate the poetic aspects of architecture within a discourse whose evaluation parameters predominantly involve reason."[8]

Further exploring the notion of unseen elements of site informing architectural design, is called *[FIHSIHKAHLVRRCHUWAHL<>] a conceptual film* by Robert Cameron and Andrei Smolik. This work considers various invisible influences on urban site as formative to its creation and reception. Created through a cumulation and analysis of data, the work proposes the "conventional use of surveillance technology as a means of controlling public behaviour" by exposing its presence through playful interaction, facilitating a dialogue between participants and the authors about the use of locative technology in the design of cities."[9] Thus using installation as a way to begin dialogues between virtual and physical mechanisms that affect the experience of the urban. Building upon engagement with digital data is the work *Finding Byaduk: thinking objects as prototypes of affective telepresence with digital data* by Chuan Khoo**.** This work captures environmental phenomena from a site called Byaduk, located in the Western District of Victoria, Australia and translates it into "interfaces and embodied expressions."[10] Rather than using this information to design place, as in the previous, and following work, this work sees the outcome as a "thinking object; that straddles art and design practice in order to encourage reflection on our relationship to digital data in the built environment."[11]

Focusing also on the creation of spatial experience through materialized environmental phenomena is *Everyday life* by Ainslie Murray. This author describes the work as a cross between architecture, performance and engineering, where a series of bodies are seen moving in a swirl of air and smoke. Murray says this creates a new space, a 'dematerialised' architecture, which she describes as a "space [that] forms and collapses with the passage of the body and exists in an enduring state of instability and unknowing."[12] The research element of this project is drawn forth from this state of unknowing, of that which could not be predicted before the creative work was made manifest. Further considering the idea of interior as a condition of 'flux' is *Two Way Hinged* by Roger Kemp, Anthony Fryatt and Katie Collins. This work is an interdisciplinary installation between interior and jewellery design, where a series of spatial interventions move with forces that affect it. This is made to reflect upon the normative perceived static nature of the interior and museological display, but also the often overlooked, interdependent relationship with the body. The authors see this as an examination of the "understanding of interior as a set of relations where object and subject are in constant negotiation."[13]

Critical Practices – Inhabiting Modes of Representation

Similarly, looking at alternative approaches to space-making the following works literally take typically two-dimensional modes of representation and communication and make them occupiable, if not inhabited by the body, then by the mind. The first of these is *Megalomaniacal plans: exploiting time and transparency* by Rachel Hurst, which looks at the singularity of orthodox plans and "questions what this cut of negligible thickness can tell of the three-dimensionality, if not hapticity, of architecture."[14] Hurst increased the scale of the drawing to be encountered as a hanging wall work by a body to create "an immersive tactile experience that both abstracts the original purpose of documentation and celebrates its embodied production."[15] In relation to design research Hurst states that "these works demonstrate how expanded drawing practices offer a new perspective on familiar knowledge […] Each exploration yielded fresh factual, historical information, [and] foreground the skills and communicative power of threatened representational modes."[16]

Moving into three dimensions, but on a small scale is *Diagonal Works* by Michael Jasper that *"*investigates the problem of the diagonal as a translation of painterly forms and ideas – those relayed through the diamond-shaped canvases of Piet Mondrian – into plastic devices and composition strategies."[17] Jasper states that this is to take up a proposition made by John Hejduk that Mondrian's diagonal compositions should be explored architecturally. In terms of design research, Jasper states that "The works on exhibition contribute to debates around the relationships of painting (two-dimensional space) and three-dimensional works (sculpture and architecture)."[18]

In larger scale three-dimensional form is *Exquisite Corpse Vault* by Simon Weir, Dylan Wozniak-O'Connor, Rodney Watt and Rin Masuda. This work takes the "surrealist parlour" game exquisite corpse and three dimensionless it into vaulted architecture. The process that this is done by is explained by the authors, "Imagine four artists decide to draw in pencil the image of a person. […] Adapting this process to vault design, the pencil of the traditional *Exquisite Corpse* is replaced with a heated wire, controlled robotically to cut billets of expanded polystyrene."[19] While digitally advanced, this work also explores the impact of chance and the unknown in design research and therefore also contributes to discussions around critical spatial practices.

Digital Fabrication and Form

The following works exemplify design research methodologies employed to explore the parameters of digital fabrication, innovations in technology, robotics and computational design. Many of these pieces embody the process of researching *through* design, resulting in a large range of prototypes, built outcomes and reimagined digital fabrication processes. Two of the works on exhibit, *Catenary Tales* and *Archi-Twist,* by Shayani Fernando consider the impact of innovations in machinery and technology by exploring a range of crafting methods in stonework. Fernando's work explores the relationship between the handmade and the machine-made through the creation of a series of sculptural prototypes. The research models investigate the potentiality of the relationship between robotic technology and artisanal traditions of hand-crafted stone. This research is further discussed in the paper Fernando presented at the ADR18 Conference entitled *The Culture of Crafting: Exploring the relationship between the Hand and the Machine in Digital Stone Sculpture.*

A Robotically Woven Ceiling Structure contemplates a unique approach to robotic collaboration in architecture. The work, produced by Dagmar Reinhardt, Ninotschka Titchkosky, Dylan Wozniak-O'Connor, Rodney Watt, Chris Bickerton, Densil Cabrera and Christhina Candido, employed collaborative design research methodologies to prototype a robotically woven ceiling system. Undertaken in partnership with industry, the research explores the implementation of automated, robotic processes in architecture and subsequently the potential this offers for new pathways in design, particularly for practical and large-scale applications. *A Robotically Woven Ceiling Structure* exemplifies the manner in which design research in robotics in architecture provides an opportunity to better harness aspects of automation, optimisation, precision, industrialised manufacturing and fabrication techniques.

The optimisation of fabrication techniques is a theme also explored by Paul Loh and David Leggett in their work, *Machining Aesthetics: Tool Making as Design Research*. In a detailed consideration of tool-making as a form of design research, Loh and Legget argue that designers now have the opportunity to be more engaged with the design and production of technology and thus have the capacity to develop novel machinery solutions for their craft. As a demonstration of this argument, their installations include an example of 'hacked' technology (via a 3D printer modified into a stitching machine) and hybridised technology in which three conventional building systems are amalgamated into a single fabrication technology.

Tim Schork, Paul Nicholas and Dane Voorderhake also address the importance of advanced fabrication techniques, particularly in relation to digital and robotic technology, in *Multi-Scalar Modelling And Robotic Fabrication Of Freeform Lightweight Copper Façades.* Their collaborative research aims to optimise the design of freeform lightweight copper façade systems by reducing the reliance on mould-systems for construction. The installation is an example of the mould-less system of Robotic Incremental Sheet Forming (RISF) developed by Schork, Nicholas and Voorderhake. The team argue that the development of the work demonstrates the way in which "digital fabrication has shrunk this gap between design and making by connecting design environments to the instructional data that control machining operations. With the increased precision and control it is possible to create customized design solutions and better performing structures."[20] The identification of digital fabrication as a means through which design and making are bridged positions this work as a clear example of the importance of design research practices within the built environment.

Working in the same vein, Schork was also involved in *Transient Geometries: Computational Design and Robotic 3D Printing of Functionally Graded Dynamic Meshes* alongside colleagues Daniel Tish and Tran Tuan Anh Dang. Exploring the impact of technological change on design practice, the work "explores the capabilities of large-scale robotic 3D printing to enable new hierarchies between form and material and calls into question material's subservience to form as well as the static and singular nature of architectural design."[21] The production of *Transient Geometries* offers a consideration of the way recent developments in computational design and robotic fabrication have moved beyond the simple mimicry of existing fabrication techniques and instead offer an array of previously unforeseen possibilities. In this way, the simplicity of the finished piece is deceptive. *Transient Geometries* exemplifies the possibilities offered by research *through* design as a means through which the parameters of traditional design can be expanded.

Design Works – Environmental Issues

Examining a similar subject matter, *Towards a Leaking Roof: An Experimental Water-Catching Building Design in Hokkaido, Japan* by Francois Blanciak reflects on issues of water sourcing through an analysis of the traditional pitched roof. The work was developed as a competition entry for the design of a spa in Hokkaido, Japan and the design attempts to maximise the penetration of water inside the building rather than resist it. Blanciak argues that the proposal contributes to design research in the field of sustainable design by "proposing a unique building typology, whose roof is constituted by a myriad of elongated, conical elements which capture, filter, and redirect rain-water (as well as melted snow) into the pool of the spa."[22]

Sam Kebbell, Cam Wilson, Riley Adams-Winch also used the development of their work, *All Along the Watchtower: Attitudes to Nature in a Coastal Visitor Centre,* to consider the relationship between strategies of design and environmental issues. The research team analysed a group of six design responses to the call for a new visitor centre and biosecurity checkpoint for Kapiti Island, New Zealand, and synthesised insights from several proposals into a single collaborative project. The proposal raises questions regarding the way architectural design and tourism might serve or facilitate the collection of environmental data through the integration and exhibition of 'selfies'.

Design Works – Urban Densification Issues and Rethinking Models of Living

Many of the works exhibited in ADR18 addressing the theme of robotic fabrication and technology resulted in the production of a range of prototypes and built artefacts. By contrast, *The Melbourne Section: A context specific design-research applied across a strategic metropolitan territory* by Markus Jung and Maud Cassaignau illustrates the way alternate design research approaches can produce different outcomes. Jung and Cassaignau's research considers the competing demands of the global economy with local employment, food production, water resourcing and management in urban design. Developed via a hybrid approach to urban design research, *The Melbourne Section* combines the narrative techniques of the metropolitan transect with fundamental aspects of the tomographic section. The content is then shaped through first-person interviews, historical studies and demographic analysis. Jung and Cassaignau argue that the employment of ideogrammatic mappings as a design research strategy "spatializes opportunities in unexpected adjacencies between knowledge, production and cultural-exchange centres, unearthed through non-quantitative sources of information."[23]

Another theme of the ADR18 Conference and Exhibition was new approaches to inhabitation and issues of urban densification. *Building the New Density: One Room Tower* developed by Phorm architecture + design with Silvia Micheli and Antony Moulis addresses the pressing need to establish new forms of housing typologies within the ever-densifying city. The intention of *One Room Tower* was to propose a redefinition of the inner-city site as a micro-context without defaulting to existing high-rise typologies. According to the authors, current approaches to density issues tend to "overlook the opportunity of considering single inner-city sites as micro-contexts for experimentation in urban densification."[24]

Addressing similar issues around density and city living David Tapias Monne's *Full-scale Minipod mock-up* forms part of a larger proposal for an alternate approach to living in multi-story housing. Developed in collaboration with industry, the *Full-scale Minipod mock-up* is a modular component of a larger 1:1 scale prototype of an 80 square metre apartment. Tapias Monne explains that the goals for the prototype are "bifold: to present innovative ideas and layout opportunities to both inhabitants and architects, based on customization, adaptation and flexibility; and to gather their feedback and reactions at the same time, in order to allow improvements the overall design."[25] The *Full-scale Minipod mock-up* therefore functions as a real-scale design research model, allowing both researchers and the general public to gain direct experience of the design.

The Future

This variety of contemporary design research has included practices that aim to: engage with politics, create new ways of designing space, encourage new ways of experiencing place, advance methods of digital fabrication and evaluate the capacity of design research to solve issues around environmental and urban living problems. This sample of works creates fertile ground to continue discussions around the different mediums and motivations for design research. This is not in order to argue that one is a more 'critical' approach, or others are a more 'pure' form of design research, but to highlight the spectrum of approaches and the generative nature of works which explore multi-media, hybridized practices. It is hoped that future iterations of ADR continue to define and re-define this dialogue, for the advancement of design research to the creation and understanding of the built environment.

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[7] Urs Bette, "Unreasonable Creatures," *ADR18 Proceedings*, (Sydney, University of Sydney, 2018).

[8] Bette, "Unreasonable Creatures".

[9] Robert Cameron and Andrei Smolik, "*[FIHSIHKAHLVRRCHUWAHL<>"] a conceptual film," ADR18 Proceedings*, (Sydney, University of Sydney, 2018).

[10] Chuan Khoo, "Finding Byaduk: thinking objects as prototypes of affective telepresence with digital data," *ADR18 Proceedings*, (Sydney, University of Sydney, 2018).

[11] Khoo, "Finding Byaduk".

[12] Ainslie Murray, *"Everyday life," ADR18 Proceedings*, (Sydney, University of Sydney, 2018)

[13] Roger Kemp, Anthony Fryatt and Katie Collins, "*Two Way Hinged," ADR18 Proceedings*, (Sydney, University of Sydney, 2018).

[14] Rachel Hurst, "*Megalomaniacal plans: exploiting time and transparency," ADR18 Proceedings*, (Sydney, University of Sydney, 2018).

[15] Hurst, "Mealomaniacal plans"

[16] Hurst, "Mealomaniacal plans"

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ADR18

The Exhibition:
Statements of Research Significance

''The dance of the death'' / digital morbidity / my anomaly _ BKK

Francois Roche on behalf of S/he

[Robotic-Fiction 5mn / https://vimeo.com/270862788*]*

Statement of Research Significance

First I have to apologize… mainly because I was invited to take the place of S/he, my trans post human CEO since 1993… and I'm talking today on behalf of them… and, secondly, because I will occasionally trespass the conventional order of discourse… in content, in grammar, in punctuation… in the pursuit of the notion of Parrhesia developed by Michel Foucault at the end of his life, mainly at Berkley and the College de France: " Is it possible to tell what is forbidden to tell you?"

I remind you of the estrangements of Ginsberg, the barking of Diogenes, the trespasses of Baudelaire, the repulsive soul of Celine, the gummy viscosity of Houellebeck, the catatonia of Artaud… etc., etc… so, on behalf of all of them and myself… first of all, I must apologize.

In fact, we are already beyond… beyond digital… beyond post-feminism, post-technology, post-human, and specifically in Bangkok where 17 genders are listed…and from where I'm writing and playing.

As an aside….if we fly over the planet of digitals … we face Mainly a disseminated de-territorialized zones, defining a fragmented country of nowhere, or everywhere ... a zone with loopholes work as the rules, able to overcome of any political situation or regime, able to ignore situation as illiberalism, liberalism, religious dogma, violations of human rights, women, LGBTqpia included, masking the sinking of the planet in the eschatological Anthropocene….in the fetishism of jiggling façade, twisted high rise building….in a morbid clownery of parametric libertarians, in the holistic medley of the dance of the death…

Merchandising mass media culture for massive elite has no frontiers…no limit, no states of mind….''in our society of spectacle'' to quote the situationist …Michel Debord …

Pierre Bourdieu described this mechanism of the social and cultural production of the taste, as a second exclusion, a second discrimination… the initial domination from the capital (the instrument of production and the social organization) overlapping the cultural capital (the instrument of narration, storytelling of subjective matter, that architects are developing)… We the instrument of the second…unrolling the red carpet for the first…

On our case… how to consider the temptation to scratch the pellicle of hypocrisies…as what we did for the Biennial in Istanbul…facing Erdogan…and his scary personal regime…two years ago…. by an installation "please let me go away"… engaging possible suicide, euthanasia as a political posture…facing the imposture…but international exhibition are like the digital niche, as restricted area…so contained and isolated that our claim of political, social and intellectual debate has been metabolized … addressed to the visitors of the event…mainly constituted by the people who are already in the show…like an airport corridor between two borders customs…

Human beings are no longer considered just bio-eco-consumers but are drifting into becoming psycho-computing-animals that define and defy their situation and condition of coexistence with the emergence of architecture as a co-dependency, a mutual relationship… a Siamese twin alienation. Parapsychoses, projections of the mind, delusions and singularities all seem more relevant: Lines of Subjectivities vs Functionalism, Substances vs Design, Scenario vs Concept… 'Pataphysics vs pseudo-scientific Positivism… environments and paranoia as symptoms of an inner condition, in a constant exchange between narrative and emergence, in a stuttering process: a storytelling manifested in the creation of a fiction that uses a fragment as a by-product and where a material structure, with its own physical characteristics, takes shape and instructs the story…

with... psychotic machines, psychotic apparatuses and fragments… bodies in verse, bodies-becoming… a plausible meeting in the stories of their symptoms. The "forbidden" is reintroduced as a possible, and, what was rejected or considered an improper ingredient is coming back like Georges Bataille's substances… in a repulsive "curiouser and curiouser" affinity, in the pursuit of Ulrich Beck's concept of risk society....

Each scenario is a condition of solitude in relation to a "symptomatic symptom" structure, where fragmentation is the very "raison d'être" of his/her emotions: the true story of an old Indian book collector ostracized from his community on the suspicion of atheism, who finds refuge in a tear-collecting shelter made of stones and lachrymatories ("**Would Have Been My Last Complaint**"); a scientist captured in the Anthropocene entropy, condemned to accept metempsychotic exchanges, according to the principle of the law of thermodynamics ("**Although (in) hapnea**"); a monster-boy endomorph constantly overfed, protected in a claustrophilic antidote-jacket from the love excess of his incestuous mother ("**(beau)strosity**"); the suspended time of Adrian floating between two periods, two macho spirals, testosteroned Theseus and the alcoholic Dionysus ("**Terra Insola**"); a feral child, innocent, naïve, and obscene, in the deep jungle, examined by scientism and voyeurism ("**The Offspring**"); the "difference and repetition" of an affective alienation that has become caged food in the pursuit of Gilles Deleuze (∑**days**); a post-culture spasm… in a mud-dirt turd where substances (human psyche and discharges) meet in their states of chemical transformation ("**concrete(l)land**"), an oracle trapped in carbon, similar to the Pythia, the oracle of Delphi, stoned on gas vapours, feeding and strangling herself and vomiting... to tell the truth ("**liminal**"), a real episode of a "Mister Thank You'' life, a man who died in the street two years ago. He was trapped in a stuttering Tourette Syndrome borborygmus, forced to face the cruelty of BKK kids ("**emet**"), a sardonic banished king's jester *arbitrista* dwarf living in the darkness of the Sathorn Unique tower, an abandoned skyscraper in BKK, growling within its Pandora's box, where hope is becoming a delusion of grandeur ("**whatEVS~4~EVS**")....

But also ("**It never happened**") as a prologue to a story about euthanasia in Switzerland where teenagers use winter to bring on hypothermia, but also the last seminal spurts of a Thai lady boy computed through a robot for a ''psycho-cartography'' choreography that dismisses the position of the artist with post-human substances and the delegation of authorship (the artist Mika Tamori)… until (''**eschatology**'') scientific research develops a perpetual loop between what we digest, shit, recycle, cook, swallow… assuming that some parts have a repulsiveness that must be negotiated individually. In our Anthropocene period…

here we can't fail to mention the (''**mind(e)scape**'') currently existing in Japan, where citizens can scream, insult, rumble, vomit out their frustration in the middle of a public space, exulting, exposing and exorcising their demons, protesting… but in a voice transfixed in real time to appear to be nothing but incomprehensible lamentation… a kind of Kafkaesque Bachelor Machine….

…including the one which is visible in these pages (''**Coitus interruptus**''), with a scenario of castration as an inverted mode of the Lacanian fragmentation mirror:

…a man and an object, a man-object, as knick-knack on the chimney…with all his parts around, dispersed: flesh, feet, penis, libido dismembered… as the inverse of stage of mirror, losing his unity, subversion of the masculine subject, voluntary trapped in the amnesia of desire…in a situation of re-arrangement, re-assembling…beyond frustration…an infinite possibilities of castration…caressing his eros-tanatos…condition. Educated as a predator, by western machismo routine… he is in the situation to surrender, abandoning his superb… shifting its representation…thanks to the transaction of the lady boy he abused, few years ago…to help him face his affective and sexual despair, as a casual pathology…He came initially in Bangkok to re-acquire the "legitimate" compensation of what he lost, or more precisely, what he never met, in his mishmash of pre-pubescent romanticism delusion…to…now …surrounded by his petrified semen…negotiate a subjective emasculation, escaping from previous vain agenda, from drive and suppression…to reach the un-raped grail…questioning as a white male the contours of his ID...

The architectural outcome emerged into being as a net-like 'glitched' structure. An artefact, or result of the slippage between three agents; human, robot and material. There is no linear top down relationship of human as designer - robot as servant - extruding inert material. The qualities of the glitch structure are folded into and from a narrative to become an actant, the shelter prop in the production of the associated film.

The inaccurate nature of the extrusion is further exaggerated as the structure continues to grows, resulting in an inconsistent cage 'wall' lattice like emergent effect. The catenary is also in effect at the larger scale of the overall structure formal language, making it inhabitable for the film's protagonist, shattering and dismembering his body as representative of his consciously partitioned psyche.

The next scenario 'mind(e)scape' learned from this preliminary research, by including the catatonia feedback of the human acoustic to corrupt the trajectory of the machine. As many scenario in Bangkok, the fabrication of the 'prop' is developed from unlinear robotic processes, with real sensor interface (RSI), using signals, inputs, analogue or digital. In this process, inputs are collected through UPD signal and the chain of Processing, Firefly, Grasshopper, Rhinoceros and re-injected (every 2m/s) in the 'parcours' of the machine, creating a permanent conditional position, between 'the point where the machine was' to 'the point where the machine should be', as a vector of translation in an iterative de-positioning.... It introduces local and stochastic perturbations, in real time, where the trajectory of the nozzle make visible the conflict of analogue-digital inputs (from robot's very noises , machine clicks, Inverse kinematics movement, pneumatic piston...to the scanning of the urban surface in Okayama city with ground penetrating radar to reveal the residue of the allies bombing in the second world war, and develop an architecture with underground data carrying the barbaria of the past….against amnesia, ….to other secrete agents as human pathologies and diseases as Tourette Syndrome, to shelter an homeless in Bangkok.

Those agents corrupt the programmed predictable work and modify in real-time the path of the fabrication, as a stuttering feedback coming from the intrinsic protocol of doing, increasing the intricate meanders of the tool in an ever permanent inaccuracy of positioning, introducing non-linear processes ... as a way of territorializing technologies, but at the condition to be defined through nondeterministic and loophole logic-illogic..., as 'de-expertise' on design process… with… at the opposite… the discovering of the potential of a masochism adaptation, in a strategy of contingencies and correlations…of co-dependencies...with the making as artefact….no design but process…no modelisation, no scripting if-then-while for bio-mimicry but uncertain input-output, artefacts,….failure, collateral effect, bugs, anomalies….are welcomed…to develop environmental-architectural psycho-scapes … psyche and environment, body and mind, and “Mania” (mythomaniaS) which refer, etymologically, to an insane drive of perception-projection.

We have been ourselves ‘’intoxicated’’ by the location from where we are emitting. In the concert of globalization, we choose to define an “interzone” and ‘’naked lunch’’ and plunge in the mud of the city, which scares and caresses us…

But what is the anomalies does bangkok bear the name ?

Principally: A degree of resilience? Resistance to any top-down institutions, considering them fictional representations of authority…. Waiting for the wheel to turn… (I’m not so naïve… fiction is not innocent or inoffensive)… but on this supposed resilience… I prefer to let Thais speak for themselves…explaining how this Siam Kingdom, surrounded by Indochina and British Empire was never colonized, never educated in the western way…

Secondly, as an architect who identifies the practice of urbanism as a coercive instrument of power… I admire a city where madness has not been massively interned within the walls of psychiatric hospitals, as Foucault described in his history of madness during the classical period in Europe… Modernist urban planning has essentially mirrored the panoptical psychiatric institutions of the eighteenth century, adopting the strategy of surveillance and punishment in term of flow, distribution, polarities, partitions, using an extreme antagonism between public and private… exhibitionism and intimacy… security and paranoia…. And using hygienist propaganda as a pretext to validate this fiction in the design process…. Outdoor cities in Europe have been configured as an extension of those indoor institutions… a topological inversion.

So… the city of Bangkok is a complex metastructure where madness is tolerated… meaning that the top-down structure of decision-making cannot regulate life on the street, the daily lives of ordinary people, the commoners… whether Thai or immigrants like me, even if that’s for wrong or bad reasons….

Finally, Bangkok as appeared as a stage on which heterosexual fictionalized storytelling as a unique mode of social, sexual, political and urban organization was abolished…

Let me do a flashback:

In fact, s/he, my androgynous business CEO character, developed a territory of fugitivity from a discriminatory world where sexuality has stamped its intrinsic logic on the walls of Westernized design. The “trans” condition and appearance of S/he, given birth by Photoshop 1.0 in the early nineties, was not a conceit of that period, but instead a strategy to historically question the system of masculine-feminine domination and its organization of power….

Architecture, by its nature, its genetic pathology, develops techniques and apparatuses of this violence, and this why, in the deregulated system of post-capitalism, architects dream of working under an illiberal political regime (many in Asia, in fact)… all to the advantage of the techno-structure, but with the performative cynical asymmetry of a top-down approach. This genetic pathology embedded in the master-slave discourse started with a patriarchal conception of the architect that corresponds to the normative political heterosexual system of the representation of domination/submission. Sex, space and power are consubstantial, as Paul Preciado described in *Pornotopia*. The hetero-violence in the sexual relation to such systems became naturally mapped in urban planning, in architecture, as a physical construction of the political- and gender-charged fictions of those relations… where tools and apparatus are directly used and abused as a strategy of design that assumes and reinforces this politic asymmetry. This masculine hetero-violence has been petrified in buildings and in cities themselves…

The anomaly of BKK is that it has performed, contradictorily, this predictable managerial iconic petrification… but exclusively in its skyline… while abandoning the urban sprawl, the unpredictable, polymorphic urban tissue, to the ground level… where it smells of commoners, genitalia, humanity, madness and hope… … and as we said… resilience….as the basic daily routine

These schizoid involuntary artefacts, with their top-down/bottom-up intricacy, including the infrastructure… is producing one of the leading complex cities of the twenty-first century, in term of the binaries of antagonism/control and resignation, networked and crafty, panoptical and heterotopic... including 17 genders… or is it 18… I’m perhaps late myself in counting up this post-human situation… which directly influences the normative ways to use the city… shifting the model of rigid representation into a zone of transgressive matter… with porosity… desirable mazes… obstacles and a fluidity…tension and line of escape…

All these overlapping ambivalences are directly and compulsively writing our agenda… our means and meaning…. Pushing and wiring our seven-axes robot in the BKK streets for small construction projects… without a permit, without any delegation of power… including the agreement of the neighbourhood, sometime just a temporary rental structure… as in the slum of Makasan, or in our lab on Chao Phraya, or in the Talad Noi Chinatown where we are based. We are able to touch the borderline… the forbidden… repulsive matter… and question… the concept of boundaries, the multiple frontiers between digital, robotic, biological and human substances, computation systemism, posing instead indeterminism, uncertainty, heuristic and haptic logical disruption… building amid the commoners, creating debate, controversy, arguments and agreement in situations utterly unlike the virginal symptom of bits and pixels….

The main interest of our BKK involvement….plunged in the middle of those antagonism forces…. is NOT to define a political position … but to assume politically a political position of creation… meaning to question the format, the condition of aesthetic, the synchronicity here and now in the today zeitgeist globalization, in the recognition that what we named “culture” became just another type a merchandize, privatized and vectorized in a fictional narration and dependences.

Could we, in the anomaly of Bangkok, reopen the transdoor of the vanguard where creation is experimental, radical , unorthodox, ………offering by nature a critique position of the relationship between producer and consumer (I prefer citizens in fact)…where art and architecture participate to change the rules…as the reason of their “historical de-functionalism”.

Pushing the boundaries of what is accepted as the norm of status quo…in the cultural branding…..to simultaneously and intrinsically promote radical, social and economic debate, through catharsis strategies…and reform…

Long time ago…in 1969… Arial Zeyman developed a curating on the famous and iconic “when the attitude become forms” exhibition /… as conclusion… we could admit that …in the deregulation, the loophole of BKK….. we are able to re-open the pandora box of attitudes…able to pervert – corrupt through technologies and fiction … form and shape… far away from the “déjà vu” symptoms.

“If you think this world bad… you should see some other”…. Seems a proto-Buddhism sentence by Philipp K Dick…already describing BKK.…

Welcome to #postDigital …..facing post-capitalism-age… as a strategy of resistance.[1]

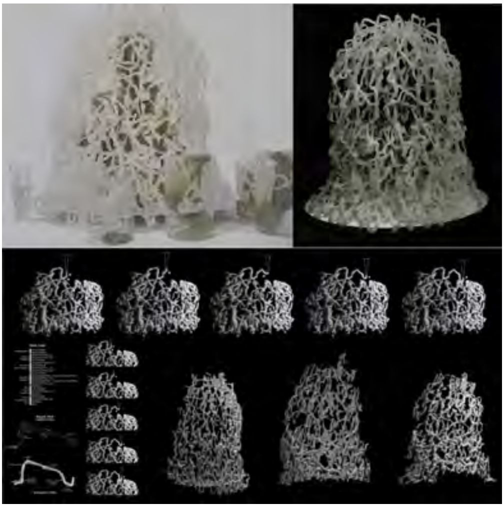

Figure 1: ‘Coitus Interruptus’ New-Territories / RMIT / 2018

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Last book (kindle or paper) / #digitaldisobediences https://goo.gl/Mz1SpK

Revel After the Curfew

Bana Hankin

Independent Artist

Jorge Valiente

Lecturer in Interior Architecture, University of Technology Sydney

Gonzalo Valiente

Lecturer in Interior Architecture, University of Technology Sydney

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Lecturer in Architecture, University of Technology Sydney

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Architect, TOMA

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Statement of Research Significance

Sydney urban space is a paradigmatic example of the effects of neoliberal politics on the city. The pressure of real estate markets, as well as the compulsive consumption of allegedly “new and exciting” experiences, have turned the city into a compulsory investment. Here, any unprofitable space or subject needs to be removed.

The Lockout laws have drastically shifted the way citizens can use public space at night. The criminalisation of Sydney’s cultural nightlife has displaced party venues further away from the city centre and forced young generations to revel clandestinely. Party venues do not constitute an architectural typology; rather, they form a series of relational spaces and atmospheric conditions that take over spaces and transform them into temporary heterotopias. They are spaces of illusion where the ‘homo faber’ becomes a temporary ‘homo ludens’ aided by the implementation of hedonistic experiences, purification rituals, uncontrolled interactions, and the loss of inhibition.

Revel after the Curfew is an architecture-object and an art-device; a dirty nightclub and a dark cenotaph; a synesthetic instrument and a synthetic atmosphere.

As a nightclub, it reproduces some of the atmospheres and rituals expelled from “what it used to be” Sydney’s nightlife. Thus, it will foster the adequate environment to draft alternative realities that stimulate the cultural diversity, hedonistic excess, unprofitable ugliness and unpredictable behaviours of unregulated nights. As a cenotaph, it becomes the definitive manifestation of the assassination of Sydney’s nightlife. Bringing some of the rites and absences of the night to the monumental manifestation of its death, it will generate the appropriate conditions for a collective confrontation with its regulated sacrifice in the name of public order and markets. The physical presence of the cenotaph will make possible a shared acceptance of this “necessary disappearance”.

The synthetic and synesthetic combination 'nightclub-cenotaph' makes a radical use of the material, ritualistic, aesthetic and representational capacities of architecture to articulate bodies, absences, discourses, traces and memories. It proposes an alternative scenario that allows us to escape from the estrangement of hyper-regulation.

This work is the continuation of a series of design research projects that stage, perform and debate new geographies of violence in the neoliberal era. Questioning the passivity of cultural consumerism and challenging the binary relationships between audience and artwork, this installation moves beyond traditional forms of architectural representation to become an entity. Its presence will invite the audience to become active participants in a celebratory, mysterious, physical and symbolic decease ritual.

Acknowledgement

Collaboration with Laura Touman

Figure 1: Revel After the Curfew, 2018

Performance and Discipline in Architecture: The Accumulation of Cyclical Operations in Critical Spatial Practice.

Dr Campbell Drake

Senior Lecturer, School of Design, University of Technology Sydney

Statement of Research Significance:

Situated within the field of critical spatial practice, this body of creative practice research examines how site-specific performance can activate engagement in the spatial politics of contested urban and rural landscapes in Australia. Intersecting performance and architectural processes, this project interrogates the disciplinary boundaries of architecture and performance through the performative re-appropriation of a series of landmark buildings and contested landscapes.

Consisting of four videos, this exhibition proposal is the outcome of a series of iterative performances that explore the interactions between spatial conditions, cultural practices, communities and their environments. Highlighting the cultural, ethical, and political resonances produced by staged performances within contested landscapes, the video works include *The Accumulation of Cyclical Operations* (2017) situated in D-Division of Melbourne's Pentridge Prison, *Spatial Tuning* (2015) at Hobart's municipal rubbish dump and *Instrumental* (2015) and *Cultural Burn (2016)* on a property acquired by the Indigenous Land Corporation as part of a land bank established for Aboriginal people.

In proposing to exhibit the performance documentation alongside a paper for plenary session, the research explores the motivations and critical operations behind mediatizing or documenting site-specific performance for the purposes of archiving, exhibition and dissemination. Drawing on the writings of Philip Auslander[1] and Peggy Phelan[1], I propose an expanded field of discursive potential in which the work can actively engage in spatial politics through multiple modes of dissemination and varied forms of audience engagement. Resonating with Miwon Kwon's writings about site specific practice and locational identity[1], I build upon the expansive notion of fragmented, multiple sites by repositioning it and adapting it to the field of site specific performance. Foregrounding the multiple platforms in which performance documentation can be broadcast, featured and published, I propose that site iteration and fragmentation is tied to efficacy and impact mobilized through the convergence of sites of research production and sites of research dissemination that together form a cumulative field of discursive potential.

Figure 1: *The Accumulation of Cyclical Operations*, Pentridge Prison, 2017.

Figure 2: *Cultural Burn*, Culpra Station, 2016.

Figure 3: *Spatial Tuning*, Hobart City Dump, 2016.

Figure 4: *Instrumental*, Culpra Station, 2015.

Unreasonable Creatures

Dr Urs Bette

Senior Lecturer, University of Adelaide / Director Urs Bette : Design

Statement of Research Significance

'Unreasonable Creatures' presents an investigation into the epistemological processes of my architectural practice that is rooted in the sculpturally driven community of Austrian architecture. Themes discussed include the emergence of space from a staged opposition between the architectural object and the ground, and the exchange between emotive cognition and analytic synthesis in the design act. In both there is a necessary engagement with forms of ‘unreasonable’ thought or behaviours. Through this research I seek to validate the role of the ‘unreasonable’ in the design process, unveiling the strategies I deploy in order to facilitate the poetic aspects of architecture within a discourse whose evaluation parameters predominantly involve reason.

The context is set by the relationships between existing fabrics and a secondary layer of architectural form. The presented projects illustrate an approach to architectural design, in which the confrontation between object and ground is understood as a constructive pathway towards developing a joint performative potential. The research contributes to the discourse of models of growth, by developing strategies for architectural design and urban densification that tap into local histories and voices, including those of the seemingly inanimate - the architecture itself and the ground it sits upon - to inform the site-related production of architectural character and space. In doing so, the work raises debates about the ways in which site-relatedness is both produced and judged.

The research offers encouragement to accept the usefulness and validity of the unreasonable in architecture, demonstrating how an artistic context of discovery - based on emotional intelligence - can effectively be linked with a consensus-based approach to decision-making. By establishing the design process as a synergetic loop between two different epistemologies - 'form as space' and 'form as meaning' - the resulting projects provide evidence for the productive use of post-rationalisation in creative processes.

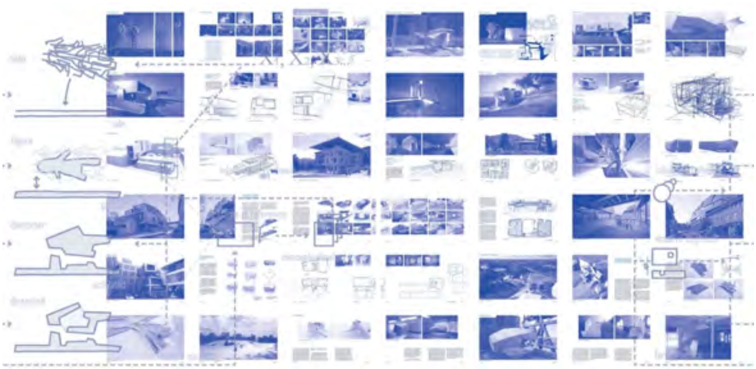

Figure 1: Unreasonable Creatures by Urs Bette

[FIHSIHKAHLVRRCHUWAHL<>] Conceptual Film

Robert Cameron

PhD Candidate, The University of Western Australia.

Andrei Smolik

Graduate Architect.

Statement of Research Significance

[FIHSIHKAHLVRRCHUWAHL<>] (pronounced “physical-virtual” and abbreviated to FV) was an interactive media art installation that experimented with the integration a gestural computer interface with an architectural surface through the use of computer vision. It was exhibited within the Claremont public promenade, Western Australia (WA), as a part of the Public Platform urban prototyping competition, 2016. The project challenged the conventional use of surveillance technology as a means of controlling public behaviour by exposing its presence through playful interaction, facilitating a dialogue between participants and the authors about the use of locative technology in the design of cities.

The following is a short film that was made as an entry into the urban prototyping competition. The film communicates our exploration of the site through the mapping of its online presence in relation to the physical space. The data derived from this analysis was used to generate an agent system to find locations in the site where there might be a confluence of flows of people both online and in space. The agent system was also used to simulate a catenary network from which the form of the installation was derived. The concept for the design of the interactive system stemmed from the idea of a constantly shifting ‘virtual topography’ layered over the public domain. Sound was chosen as the primary output and interactions with the artefact were framed as a game of “hot and cold”. The synthesizer layered a set of modulated frequencies randomly drawn from a list of standard musical notes, the result of which was an undulating waveform that’s tempo and pitch was controlled by the distance of the user to the invisible object. The field of sound created by the synthesizer provided real-time feedback to the user, so that they could navigate around the object to find an invisible marker. Upon finding a point, a second system would activate, reading out the latest tweet about the event through text-to-speech software.

By combining an open-ended making process with performative aspects, the FV project enabled users to experience relationships between locative technology and public space in a heuristic and embodied fashion. While conducting the project in the context of a placemaking festival presented issues in relation to the scope of the design and its ability to achieve some of its outcomes, it also revealed complexities that are introduced to practice-based design research when conducted within urban renewal projects. Reflection on this project has allowed us to critically examine the role of practice-based design research in the context of placemaking, to identify the problems that quantitative analysis brings to the understanding of urban problems, and to show how these methodologies are being applied to urban prototyping initiatives to direct cultural production.

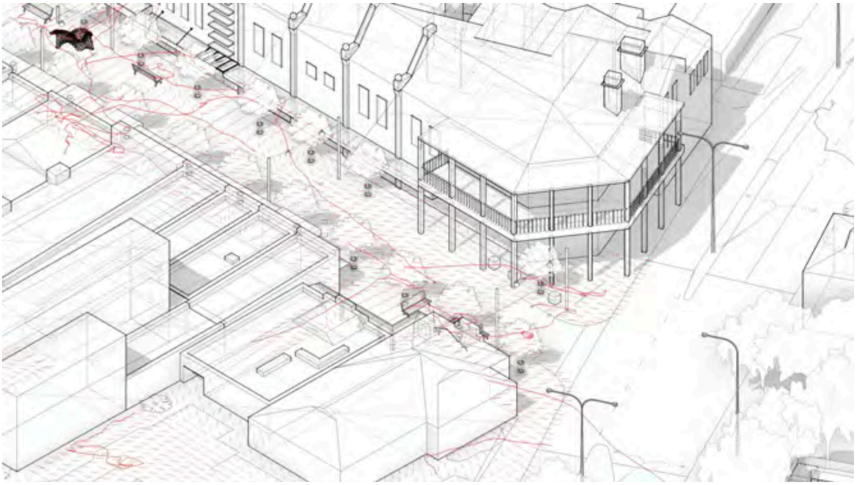

Figure 1: Fihsikalvirchual a conceptual film

Finding Byaduk: Thinking Objects as Prototypes of Affective Telepresence with Digital Data

Chuan Khoo

RMIT University

Statement of Research Significance

The Finding Byaduk creative residency is an experimental project, aimed at exploring speculations around the phenomenology of digital data representations of a landscape, and the design of interfaces and embodied expressions. Part of this process also adapts ethnographic methodologies in articulating and capturing visual descriptions of the site. The creative brief is developed as a thought experiment with 'affective telepresence' – finding means to remotely convey the qualities of a place using environmental sensors and exploring poetic roles that digital connected technologies might play through the design of embodied expressions and/or interactions.[1]

The work produced – *Finding Byaduk: Wind* (see Figure 1) – is an exemplar artefact of this creative research journey. It is an embodied representation of wind as sensed in the town of Byaduk, located in the Western District of Victoria, Australia. The work represents how speculative thinking can straddle both art and design practice to produce 'thinking objects'. These 'thinking objects' are realised thought experiments and ethnographic tools to engender further reflection, when they become embedded in and around the lives of the researcher(s), and the people and places where the project is situated.

Figure 1: The first designed object in the Finding Byaduk project. Chuan Khoo. Finding Byaduk: Wind, 2018. Plywood, brass tubing, 3D printed plastic, electronics, computer code, found glass bottle from Byaduk.

Figure 2: Two *Finding Byaduk: Wind* objects. Dimensions (excluding power cable) are approximately 11(w)x11(d)x20(h)cm and 11(w)x11(d)x30(h)cm.

Figure 3: Close-up of fan and reciprocating stem.

Figure 4: Close-up of base and location of power connection.

Figure 5: Location of sensing unit in the old Byaduk church, consisting of sound, light quality (lux, IR, UV levels) and wind sensor. Solar panel is located above on roof section (not pictured).

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Everyday Life

Dr Ainslie Murray

University of New South Wales

Statement of Research Significance

Everyday Life is a creative research project involving collaborative practice across the disciplines of architecture, performance and engineering. Airflows within and around a pair of performers are visualised as they enact a series of improvised 'everyday' movements. The movements and resulting interactions are developed from ordinary, routine, and habitual patterns of daily life, that through their regularity become 'invisible'. The visualisation of these patterns coupled with the visualisation of the contextual airflows form an architectural proposition in which space is agitated, stirred and concocted by the body and where inhabitants actively generate 'architecture' through their movement.

The work draws on theories of unstable spaces, and in particular on the 'utterance' described by Michel de Certeau in *The Practice of Everyday Life*. The conceptualisation of architectural space is likened to the word as it is spoken and caught in the surprising ambiguity of actualisation.[1] This de-materialised architectural space exists for and is created by the moving body as a product of the bodily vectors of direction and velocity – space forms and collapses with the passage of the body, and exists in an enduring state of instability and unknowing.

The works shown here are part of a series of working drawings, models, still photographs and videos associated with these experiments. The drawings are used generatively to describe set ups to collaborators, but also reflectively to document and analyse what actually took place but was not anticipated. In this way, the works operate dynamically within a research process as documents that provoke and converge exchanges between collaborators from diverse fields.

The method developed for handling the multiple invisibilities at play in the project involves producing drawings as 'negatives'. The traditional additive processes of drawing are reversed using drawing instruments that dissolve the drawing surface, and the resulting drawings are intricate networks of interrelated negative spaces. In this way, the drawings are presented as planes eroded through considered gestural action, where intensity is reflected through absence rather than matter. The more they are 'drawn', the more they threaten to disappear entirely. The drawings form the foundation of subsequent documentation and proposition in models, photograph and video.

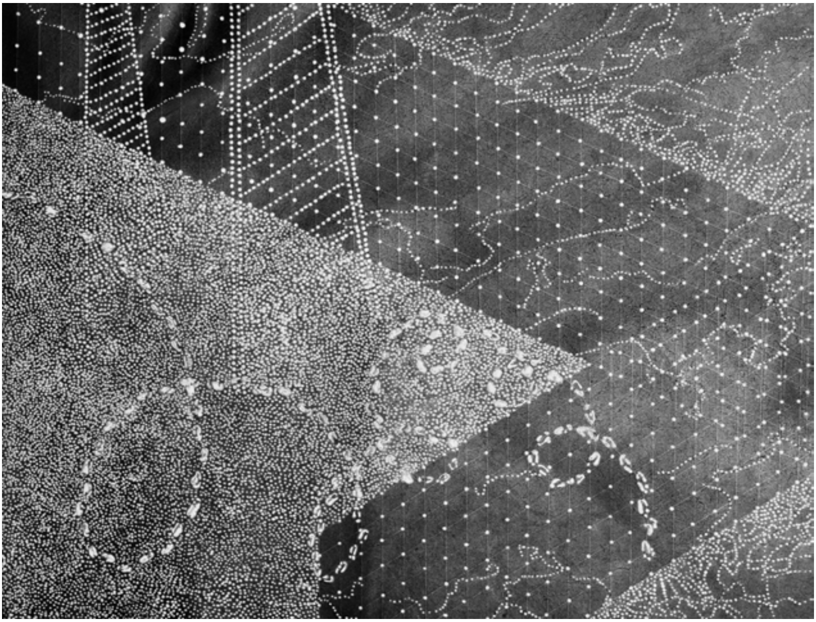

Figure 1: *Everyday Life Setup Drawing B*, 2016, approx. 210 x 290mm, perforated Tyvek.

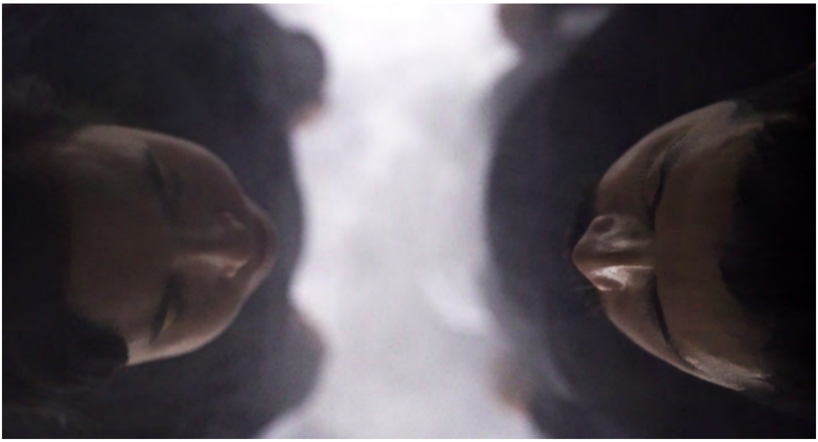

Figure 2: *Everyday Life*, 2018, HD Video still.

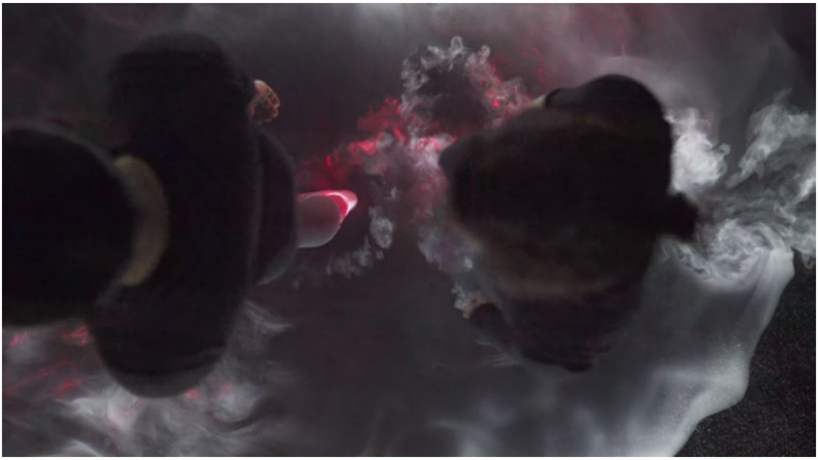

Figure 3: *Everyday Life*, 2018, HD Video still.

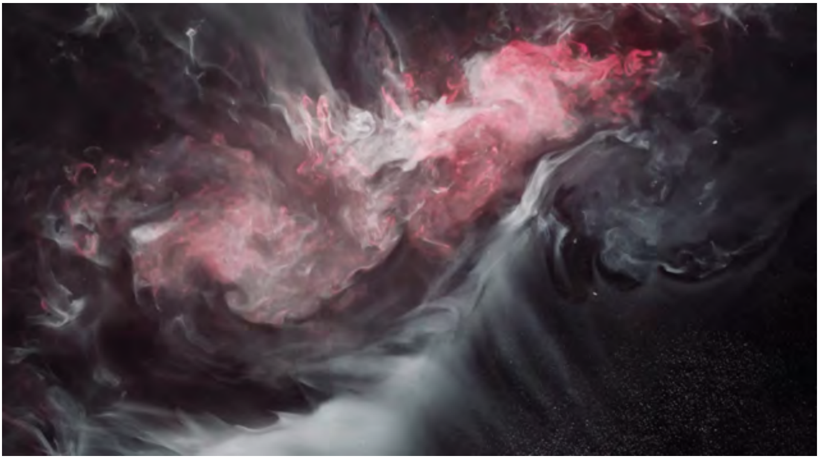

Figure 4: *Everyday Life*, 2018, HD Video still.

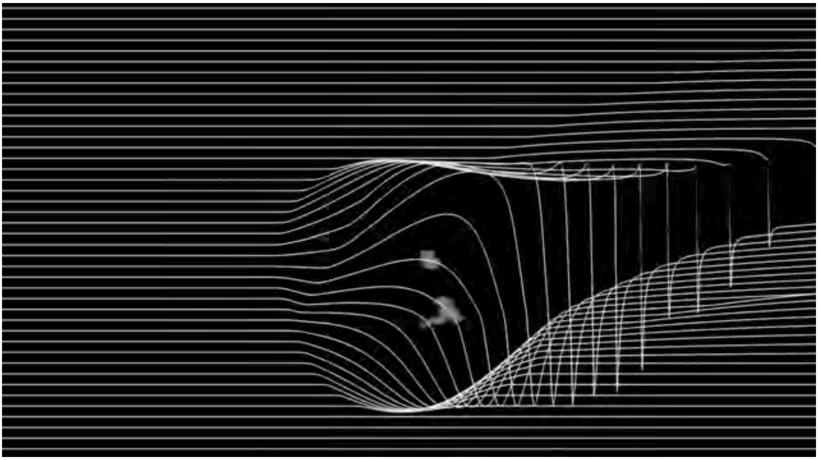

Figure 5: *Everyday Life*, 2018, HD Video still.

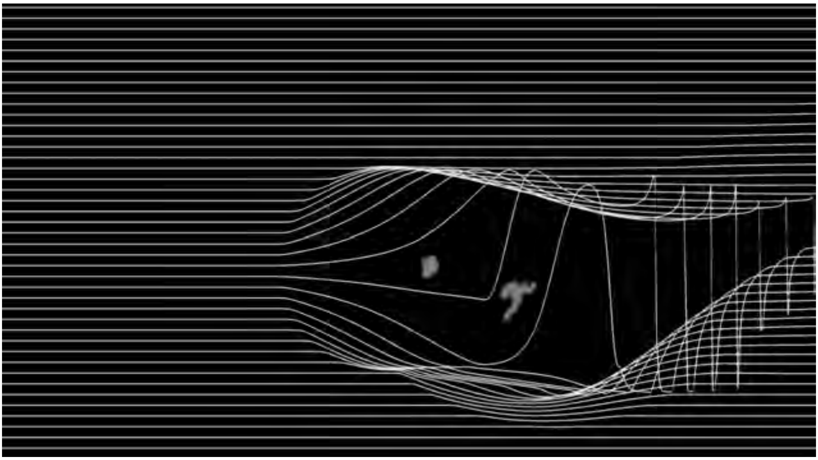

Figure 6: *Everyday Life*, 2018, HD Video still.

References

[1] Michel de Certeau, *The Practice of Everyday Life*, trans. Steven Randall (Berkeley: University of California Press, 1988), 117.

Two Way Hinged

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Statement of Research Significance

'Two Way Hinged' interrogates the idea of 'interior' as a condition of flux;[1] understood as contingent, dynamic and interdependent through relations to the participants and temporal forces that affect it.[1] The work is positioned within a field of research related to the examination of 'Interior' and the practice of designing interiors that is considered expansive and moves beyond the conventional understanding of interior as fixed and contained. 'Two Way Hinged' identifies the design of display environments, in this instance the display of jewellery, as an opportunity to more broadly examine this understanding of interior as a set of relations where object and subject are in constant negotiation.

Conventional methods of display of jewellery in galleries, museums or retail settings, often in the form of cabinet, plinth, mannequin, or wall leave little opportunity for interactivity or the multidimensional engagement that occurs through the wearing or holding of the object. These systems of display also set up a scale and orientation of spatial relations synonymous with museological conditions of repose that resist bodily activity of movement and touch. This approach to display is one that privileges materiality and form of the object over other spatial-temporal intentions considered important to the jewellery piece.

This project seeks to breakdown the rigidity of these conventional display systems to provide a more dynamic spatial and temporal environment in which object and display invite active and participatory engagement with its audience. For the jeweller, two situations are considered - as object (when encountered independent of a body) and as jewellery (when placed on the body). A third situation is evoked through this work in the transformation that activates the object in movement.

Measuring approximately 2.5 meters by 3 meters, the work takes the form of a spatially layered assembly of material components constructed from painted plywood, acrylic, steel, paper, digital image and jewellery object. The material selection is in part, a consequence of the revealed actions or movements within the components but also determined through performative moments of reflection, contrast and camouflage. The display environment hinges, moves, shifts and expands to display the jewellery object as both transformational and interdependent to the display and participating subject alike.

'Two Way Hinged' is a collaboration between two creative practices; a research focused spatial practice exploring ideas of 'interior', and a jeweller whose work explores the activation of objects and qualities of engagement through movement. The two practices have worked simultaneously to develop jewellery objects and the participatory display environment. The display is approached as an operative device; an active producer of encounters that challenges notions of stability in the relations between object, subject and the gallery site.[2]

The production of ‘interior’ occurs through the assembly of scenic fragments that draw people into the work, a mise-en-scène of objects and actions that intentionally seeks to activate the role of the participant in a scenographic negotiation of time and space.

Figure 1: Preliminary plan layout of display device.

Figure 2: View through display environment.

Figure 3: Scenic fragments produce display device.

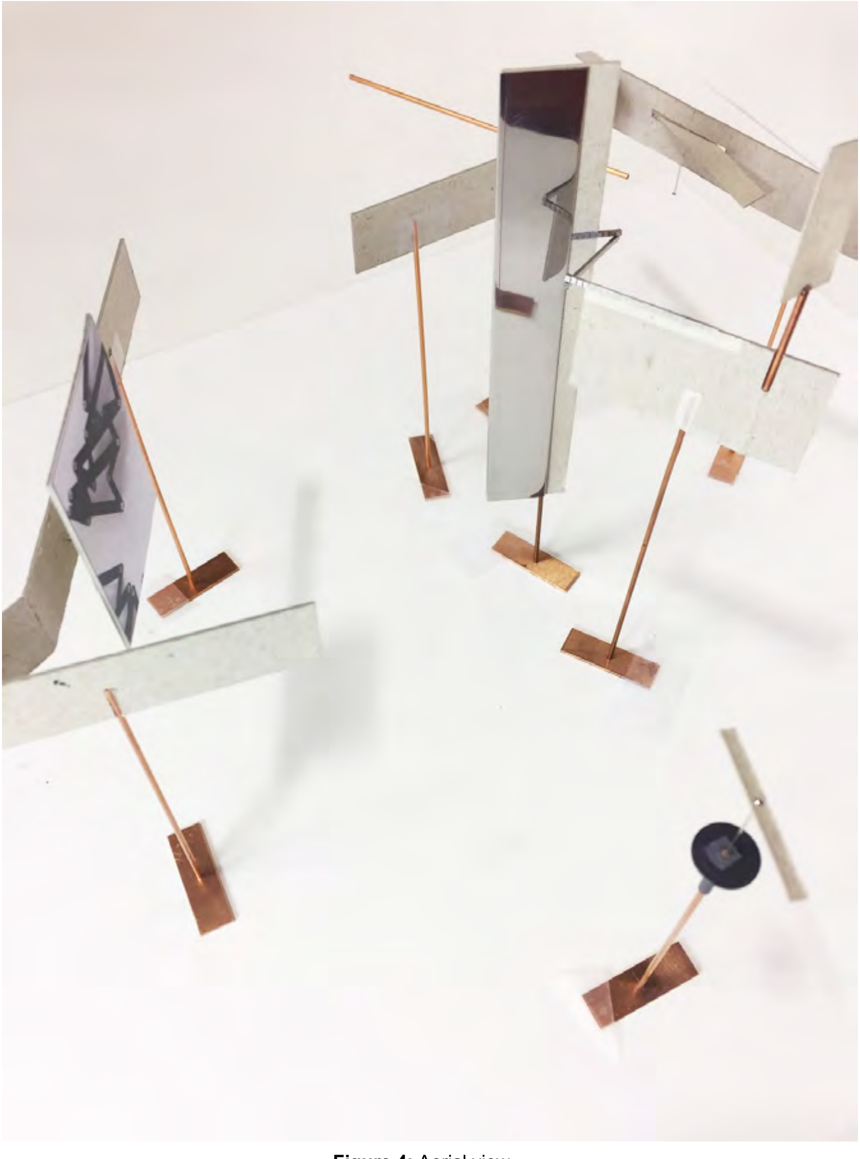

Figure 4: Aerial view.

Figure 5: Detail showing adjustable mirror and hinged surface.

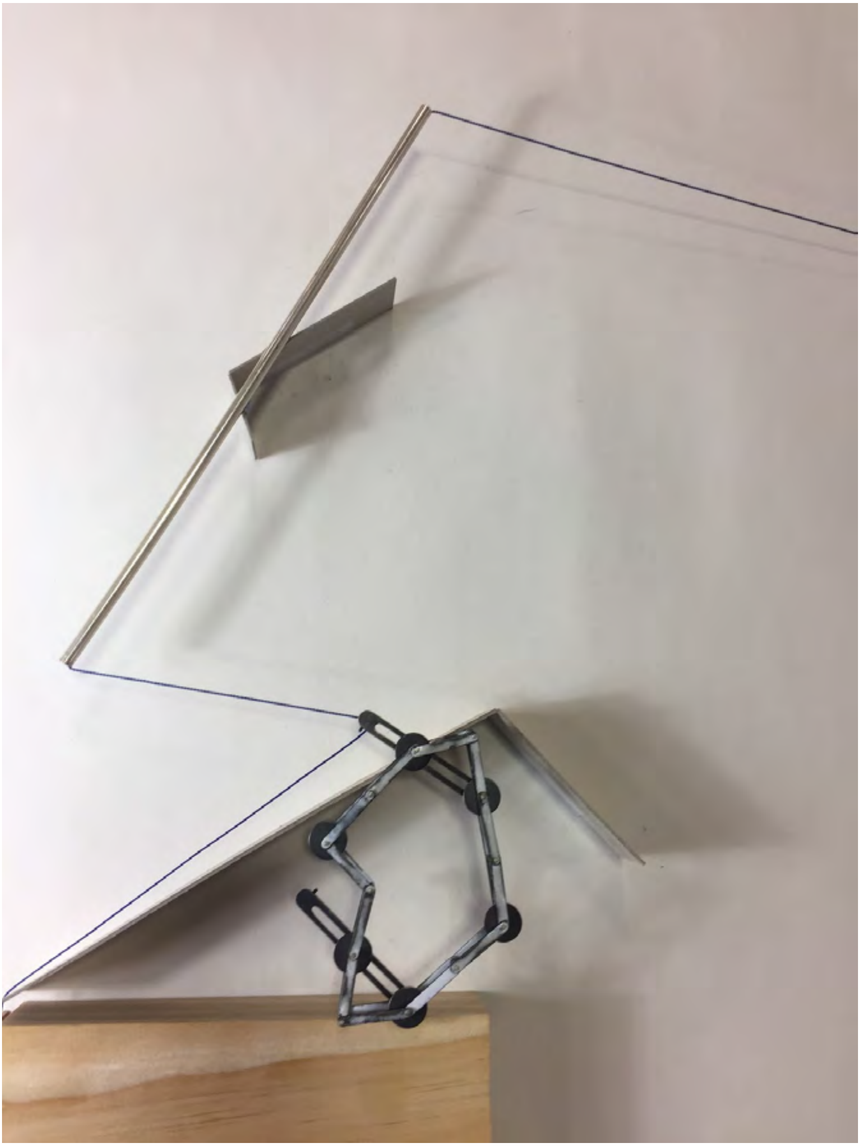

Figure 6: Detail showing cable system that allows simultaneous movement of both jewellery and display.

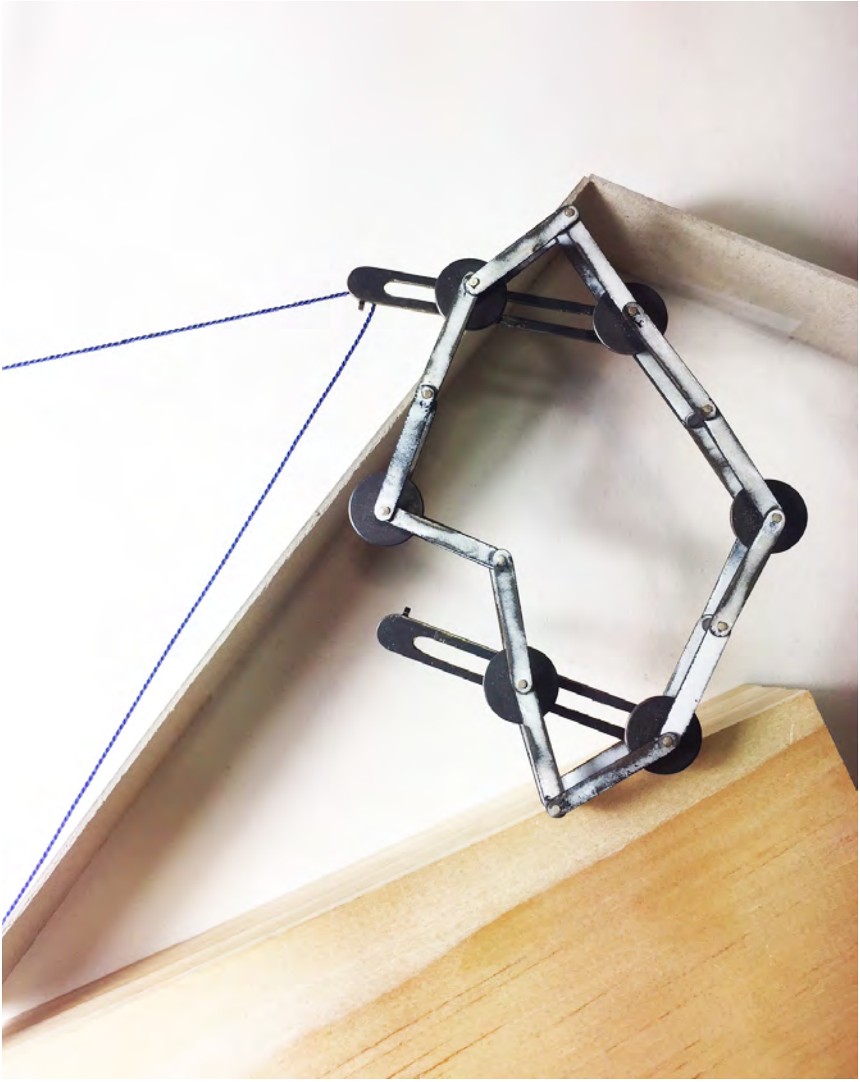

Figure 7: Detail of material relationships - timber, card, cord and jewellery.

Figure 8: Detail of activated junction between jewellery and display environment.

References

[1] Flux Doreen Massey, *For Space* (London: SAGE, 2005), 9; Lois Weinthal, *Toward a New Interior: An Anthology of Interior Design Theory* (1st ed. New York: Princeton Architectural Press, 2011), 19.

[2] Bernard Tschumi, "Operative Drawing" in *The Activist Drawing: Retracing Situationist Architectures from Constant's New Babylon to Beyond,* edited by Catherine De Zegher and Mark Wigley (Cambridge, MA: MIT Press, 2001), 135.

Megalomaniacal Plans: Exploiting Time and Transparency

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Statement of Research Significance

Despite the fact they carry the DNA of a building within them, architectural plans are often artefacts of flimsy substance on paper thin, transparent or virtual ground. Their material reality belies the weight of the knowledge they store. The works presented for *Megalomaniac plans* extend a research project into the plan as the ubiquitous depiction of architecture, and foreground the tactic of transparency as a long-understood way of simulating X-ray vision through a palimpsest of storeys, structure and time.

The components are derived from an entry for the Australian Tapestry Workshop Design Prize for Architects 2018, which focused on the influence of Beaux Arts architect Étienne-Louis Boullée. They deploy similar techniques of analogue superimposition and scalar fluidity developed by Libeskind, Lebbeus Woods and Perry Kulper, and explored in an earlier series of graphic works.[1]

This prior investigation used drawings from an Australian architectural museum as raw data to explore what superimposition can tell of recurrent tectonic languages and representational habits. A portfolio of thirty plans was selected across a nominal million hours of local architectural history, according to chronological, typological and drafting criteria. Traced by hand as compressions of type and time, these were compiled as six A2 drawings and paintings. The set revealed and emphasised specific insights into the facture of both drawings and buildings in particular eras.

Recognising that superimposition collapses information contained in single documents into an instantaneously comparative visual field, *Megalomaniac plans* is an interrogatory compilation of projects related by function, time and intent. In one drawing plane and at one scale, six of Boullée's seminal designs are layered against six comparable Australian projects, selected as closely typologically and chronologically as achievable. Each group is colour-coded and aligned with northern orientation and centre point. Furthermore the accumulation is united by a mutual ambition for architectural presence – or megalomania – whether in the first church or lighthouse of the colony, or in the expansive layout of David Walsh's MONA, as the intended site for the tapestry.

The resulting labyrinthine mandala of lines, enlarged and printed on linen to evoke its original 18th century medium, exposes not only contrasts of scale, but the relationship between idealised and realised neo-classical projects. It is a dramatic manifestation of the disjunction between the canon and its colonial lineage. In the process of tracing from Boullée's plans, a mistake is discovered and translated into a companion needlepoint, where the painstaking pixilation of the image references past and present techniques of depiction.

By altering the media, scale, and singularity of orthodox plans the project questions what this cut of negligible thickness can tell of the three-dimensionality, if not hapticity, of architecture. Re-materialising at the scale of the body creates an immersive tactile experience that both abstracts the original purpose of documentation and celebrates its embodied production.

These works demonstrate how expanded drawing practices offer a new perspective on familiar knowledge, and are propelled by different settings and tasks. Each exploration yielded fresh factual, historical information, in addition to parallel intent to produce creative artefacts that foreground the skills and communicative power of threatened representational modes.

Images

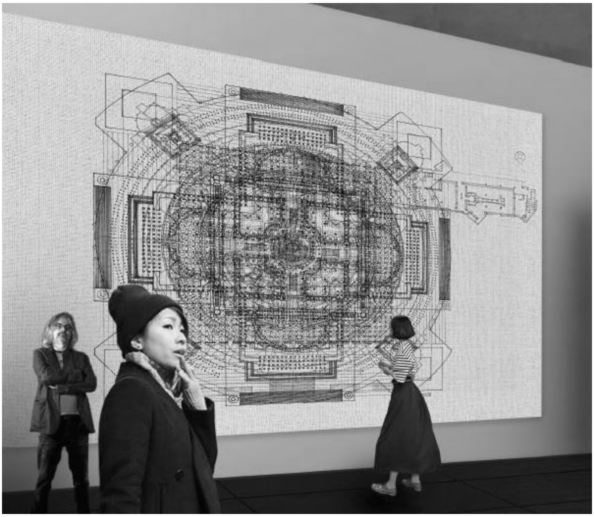

Figure 1: Rachel Hurst, Megalomaniacal Plans: installation render for Australian Tapestry Design Prize for Architects entry (2018). Installation for ADR_18: Ink on canvas, approx. dimensions 1370mm[w] x 2000mm[h]

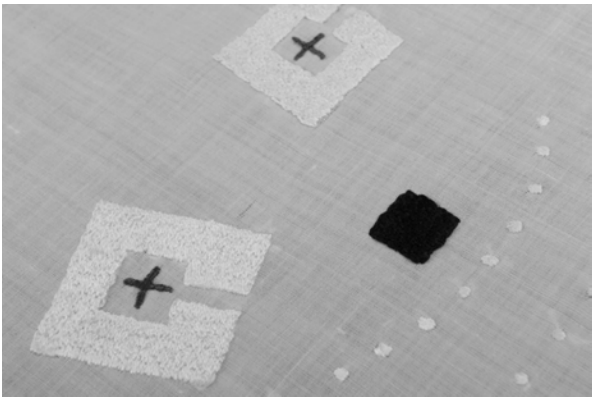

Figure 2: Rachel Hurst, Souvenir Cloths: Piazza di Porta Ravegnana Bologna_detail (2012).Silk on linen, 420mm h x 410 mm w. This prior work developed techniques for the translation of architectural

drawing to textile representation, and presages the scale and mode of the companion piece in the installation, *Megalomaniacal Plans: Boullée's Error*. (Wool silk + cotton needlepoint, on cotton fabric, double sided. Approximately 210mm[h] x 210mm[w])

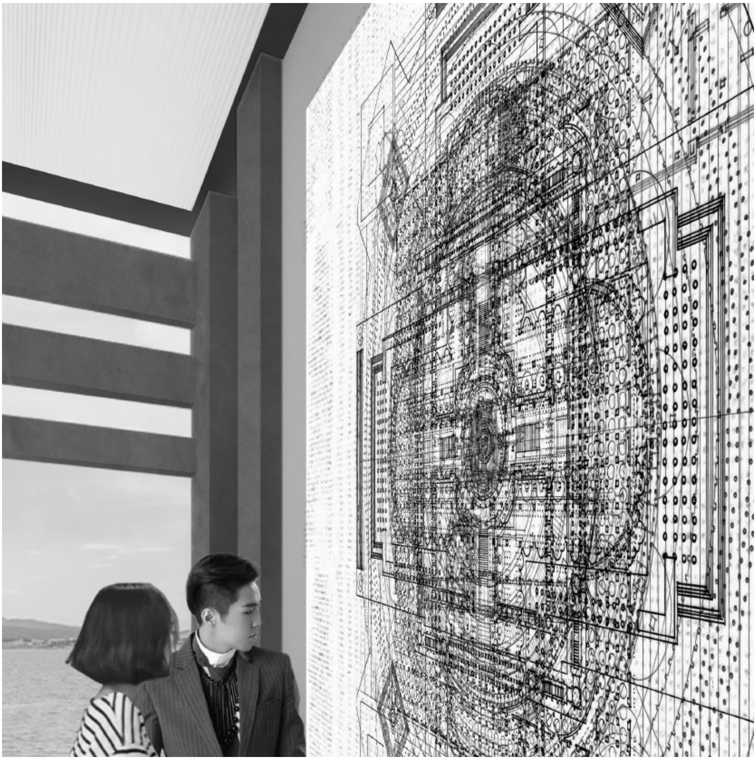

Figure 3: Rachel Hurst, Megalomaniacal Plans: detail installation render for Australian Tapestry Design Prize for Architects entry (2018). Superimposing hand-drawn plans of related typologies and chronologies at an immersive scale graphically reveals comparisons of scale, constructional contingencies and drafting precision.

References

[1] See for example the intense non-hierarchical drawings of Libeskind's *Micromegas* series and Kulper's exploration of speculative analogue representation in such projects as *David's Island* (1996-1997), *Contingent Practices 1* (2013) and *Archival Ghosts and Paradoxical Shadows* (2013). Nat Chard and Perry Kulper, *Pamphlet Architecture 34*, 'Fathoming the Unfathomable: Archival Ghosts and Paradoxical Shadows' (New York: Princeton Architectural Press, 2013): Daniel Libeskind and Juhani Pallasmaa, *Micromegas: Architectural Drawings: Catalogue* (Helsinki: Museum of Finnish architecture, 1980).

Diagonal Work

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Statement of Research Significance

The *Diagonal Work* series investigates the problem of the diagonal as a translation of painterly forms and ideas – those relayed through the diamond-shaped canvases of Piet Mondrian – into plastic devices and composition strategies. An underlying proposition is that a sustained exploration of the diagonal and conditions of diagonality will contribute to revealing formal and spatial capacities in architecture still to be fully exploited and theorised.

The project was launched in part to take up the challenge announced by John Hejduk to explore the 'significance in the diamond canvases of Mondrian for architects of today.'[1] At its most ambitious, Hejduk's challenge was intended to lead to the generation of what he characterised as a third idea of space alongside or perspectival space and cubist space.[2]

The works pick up two strands of twentieth century architectural investigations. One strand runs from El Lissitzky's spatial experiments to the radial, pinwheel approach of DeStijl that voids the centre. Theo van Doesburg and Cornelis van Eesteren's counter-constructions[3] and Gerrit Rietveld's Schröder House exemplify this approach which empties or alternately fully charges the centre. Another strand engages layered planar space, denying frontality through an intensification of edges and corners in order to charge the periphery with forces in a manner best illustrated in axonometric or oblique views. To take one example, and as Kenneth Frampton has suggested, Giuseppe Terragni's Giuliani-Frigerio apartment block realises this idea.[4]

Four interconnected themes demarcate the research: voided centres, peripheral tensions, boundless field extensions, and spatial warps realised from right angle relationships. *Diagonal Work 1* tests the idea of voided centres, the lozenge shaped field and projecting elements instigating centrifugal movements. *Diagonal Work 3* explores peripheral tension realised from planar layering that in turn charge edge conditions. It is ideally viewed on the oblique in a neutrally lit corner.

The works on exhibition contribute to debates around the relationships of painting (two-dimensional space) and three-dimensional works (sculpture and architecture), make a modest contribution to research into the potential of Mondrian for built environment practices generally and architecture specifically, and contribute to the conference theme scholarship and theory of design research.

Figure 1: *Diagonal Work* 1, early state, mounted on a wall (Medium: coloured plexiglass, dimensions: 45 x 45 x 22.5 cm).

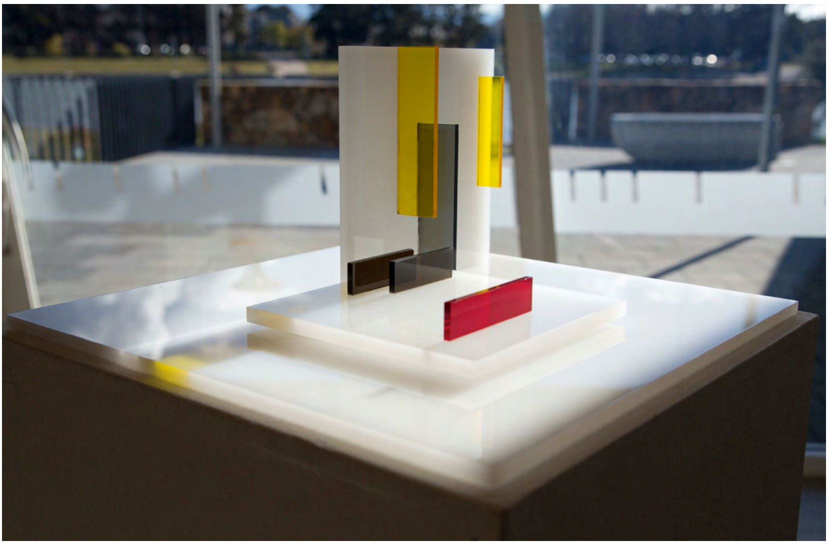

Figure 2: *Diagonal Work* 1, final state, sitting on a plinth (Medium: coloured plexiglass, dimensions: 45 x 45 x 22.5 cm).

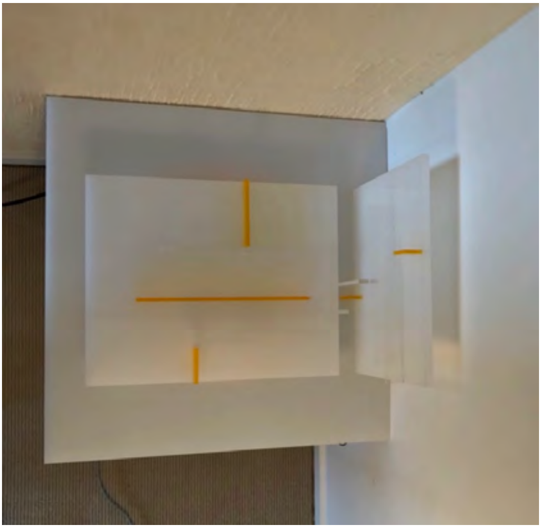

Figure 3: *Diagonal Work* 3, final state, mounted in the corner of a room (Medium: Coloured plexiglass, dimension: 53.5 x 53.5 x 29 cm).

References

[1] John Hejduk, *Three Projects* (New York: The Cooper Union School of Art and Architecture, 1969): s.p.; Useful documentation on Mondrian's diamond canvases can be found in E. A. Carmean Jr, *Mondrian: The Diamond Compositions* (Washington DC: National Gallery of Art, 1979).

[2] Hejduk suggests without substantial development this taxonomy of three space concepts in "Out of Time and Into Space," *A+U = Architecture and Urbanism* 53 (May 1975): 24.

[3] See van Doesburg and Eesteren's colour construction in the fourth dimension of space-time, axonometrics of the artist's house of 1923 reproduced in "Towards plastic architecture," in Joost Baljeu*, Theo van Doesburg*, (London: Studio Vista, 1974), 142-147

[4] Kenneth Frampton, "Introduction," in Suzanne Frank, *Peter Eisenman's House VI. The Client's Response,* 11-17 (New York: Whitney Library of Design, 1994).

Exquisite Corpse Vault

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Statement of Research Significance

Seeking a method for producing Surrealist Stereotomic architecture, this project presents a large scale prototype vault produced using a variation of the *Exquisite Corpse,* adapted to architectural design. Though the *Exquisite Corpse* has been adapted to many media, this project is the first known use for vaulted architecture.

Kochhar-Lindgren et al. in *Exquisite Corpse: Chance and Collaboration in Surrealism's Parlor Game* explain that the "rules of the *Exquisite Corpse"* are most easily conveyed through example. Imagine four artists decide to draw in pencil the image of a person.[1] A sheet of paper is folded horizontally into equal quarters. One person is given the top quarter to draw head and shoulders. They fold their quarter over, concealing all but the bottom edge. The second artist begins from the visible sliver of the previous artist when drawing the person's body. When the final quarter is completed in a similar manner, a drawn person is unfolded.

Adapting this process to vault design, the pencil of the traditional *Exquisite Corpse* is replaced with a heated wire, controlled robotically to cut billets of expanded polystyrene. The techniques of stereotomic processes for vault prototypes continues the work of Fallacara; and the problems of ruled surface stereotomy continues the work on robotic wire cutting by Rippman and Block, McGee et al, Feringa and Søndergaard, Weir et al, and Rippman.[2] The *Exquisite Corpse Vault* however aims to use these stereotomic tools, typically aimed at efficiency, and deploy them towards formal and visual excess, towards an oneiric architecture rather than a rational one. Additional consideration in the vault design process has been to the potential of materiality with the students engaging with industry partners Gosford Quarries to learn about designing for sandstone fabrication and use this as a guiding criterion of their stereotomic approach.

The sheet of paper of the traditional *Exquisite Corpse,* and the decision to draw a figure, were replaced with a basal catenary surface model (see Figure 1, 2). Two bays of a vault were divided into twelve sections. Each section was assigned to a student who sequentially developed their individual formal exploration and then blended with their neighbours. Each student designed their area so that it conformed to the limitations of ruled surface cutting, to the brittleness of sandstone, and so that their area was a stable compression-only structure. The aspect of the

Exquisite Corpse, where each artist is blind to others' work, Salvador Dalí called working in "semi-darkness".[3] In the case of vault design, where there is a significant and differing spreading load, this semi-darkness prevented students from accommodating the spreading load, generating large scale errors in the overall vault design relative to the purer aims of stereotomic architecture. The trade-off however is that the semi-darkness frequently succeeds in producing complex combinations of forms that rarely emerge from solo designers. This iteration of the *Exquisite Corpse* vault belongs to an evolving series of experiments with different amounts of systematic darkness, combining a pedagogical method in stereotomy and ruled surface geometry with practice-led research aimed at structurally-sound, stereotomic vaults with an emergent formal language.

Aside from the accidental inventiveness that arises from fortuitous adjacencies, the *Exquisite Corpse* throws into question the status of the object. Dalí described the figure produced by the *Exquisite Corpse* method as a "disturbing and arbitrary 'being' and [that] was credited with having an existence entirely dependent of the experimenter's activity."[4] The reconceptualisation of the object that the *Exquisite Corpse* induces connects this project with an emerging trend in architectural theory, Graham Harmon's Object Oriented Ontology and its initial architecturalisations by Mark Foster Gage.[5] The *Exquisite Corpse* vaults are not in a traditional sense a designed "objects", as no one designer overseeing, let alone editing, the outcomes of the processes, nonetheless the finished vaults seem to reliably produce a singular unity and animal-like appearance, though admittedly from some vantage points more than others. The longer ambition beyond these individual *Exquisite Corpse* experiments is not the vaults themselves, but to harvest fragments of the results of each experiment and use them judiciously as elements within a new vault design language. Some pairs or trios of students' works, adjacent to each other purely by chance, can suggest to a later designer an opportunity for translation, with or without refinement, into a final design, and be subject to the "fully lit" structural analysis and formal refinement.

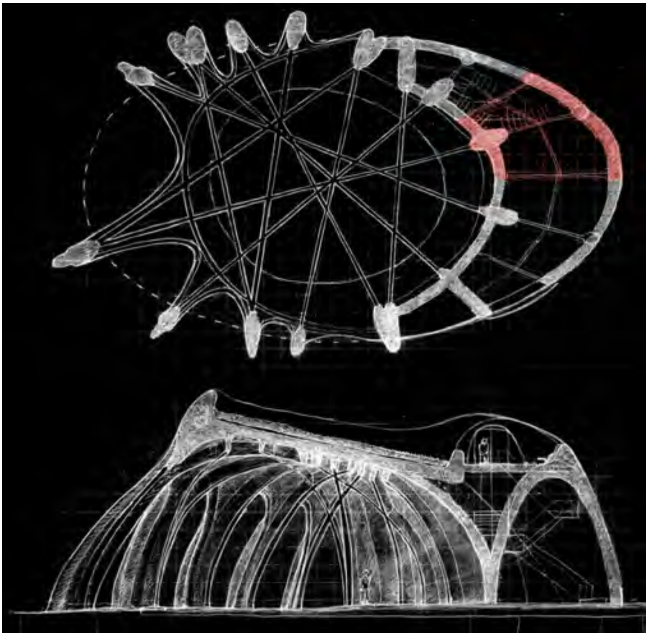

Figure 1: Plan of building design. The part of the building developed in this project's Exquisite Corpse in red.

Figure 2: Diagrammatic formal model of vault. The part of the building developed in this project's Exquisite Corpse in red.

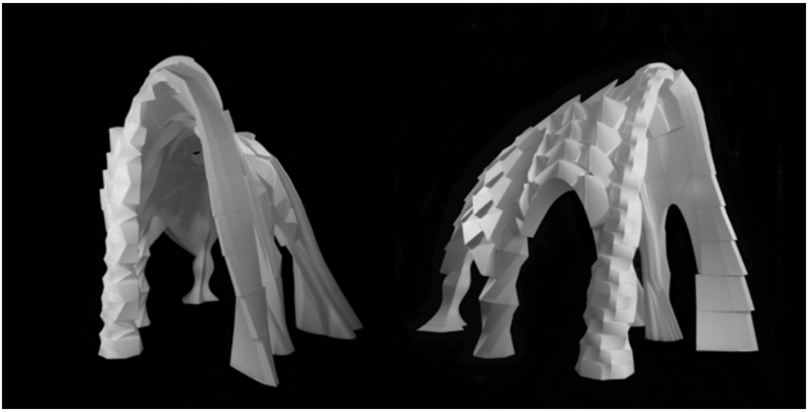

Figure 3: Two views of the vault, background removed, produced in Advanced Fabrication Research Studio 2018.

References

[1] Kanta Kochhar-Lindgren, Davis Schneiderman, and Tom Denlinger (eds). *The exquisite corpse: Chance and collaboration in surrealism's parlor game*. (Lincoln: University of Nebraska Press, 2009)

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[3] Salvador Dalí, “The Object as Revealed in Surrealist Experiment,” *This Quarter* (Paris) 5, 1 (1932): 197-207, p.201.

[4] Dalí, “The Object,” p.197.

[5] Graham Harman. *Immaterialism (*Malden, MA: Polity, 2016); Mark Foster Gage, “Killing Simplicity: Object-Oriented Philosophy In Architecture,” *Log* 33 (Winter 2015): 95–106.

“Catenary Tales” and “Archi-Twist”

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Statement of Research Significance

Work 1

‘Catenary Tales’ (2015) is an exploration of self-supporting structures in natural stone. The sculptural prototype is made from interlocking wave joinery in varying sizes of modules which engages with the tensile strength of stone.

Production Process:

‘Catenary Tales’ was designed in Sydney using 3D modelling software Rhinoceros and manufactured as part of the Digital Stone Project workshop and Garfagnana Innovazione in Italy utilizing 7-axis robotic carving machines. It aims to reform the value of ‘crafting’ through innovative manufacturing technologies and the use of sustainable natural stone. A combination of machined and hand finishes were applied to the sculptural prototype.

Dimensions:

38 x 36 x 80 cm, 60 Kg

Material:

Marmo/Marble: Bianco Acquamarina, Venato Orto di Donna, Bardiglio Imperiale

Work 2

‘Archi-Twist’ (2017) is an exploration of self-supporting structures in natural stone. The twisted catenary arch is comprised of innovative modular interlocking wave joinery based on catenary curvature.

Production Process:

‘Archi-Twist’ was designed in Sydney using 3D modelling software Rhinoceros with Grasshopper parametric design tools and manufactured as part of the Digital Stone Project workshop and Garfagnana Innovazione in Italy utilizing 7 axis robotic carving machines. It aims to reform the value of ‘crafting’ through innovative manufacturing technologies and the use of sustainable natural stone. A combination of machined and hand finishes were applied to the sculptural prototype.

Dimensions:

14 x 66 x 56 cm, 38kg

Material:

Marmo/Marble: Bianco Acquamarina, Venato Orto di Donna, Bardiglio Imperiale

Figure 1: Exhibited Sculpture “Catenary Tales’ in ‘Marble Codes’ at the Digital Stone Project exhibit 2015, Villa Strozzi, Florence Italy.

Figure 2: Exhibited Sculpture “Archi-Twist” in ‘Metamorphic Resonance’ at the Digital Stone Project exhibit 2017, Ex, Marmi Gallery, Pietrasanta, Italy. Also exhibited as part of the Salone Satellite 9th annual award at SaloneDelMobile2018, Milan Design week 2018 Italy.

A Robotically Woven Ceiling Structure: Systems Reef

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Statement of Research Significance

The proposal showcases design research into prototyping a robotically woven ceiling system that allows to flexibly iterate, novel physical solutions for data distribution as a driver for work scenarios. Main drivers for workplaces can be identified as organisational strategies, workforce attitudes and expectations, and technological advancements for workplaces.[1] To this extent, the research brings together different disciplinary domains; the development of workspace scenarios and conditions; ceiling services infrastructure and distribution; flexible team organisation; acoustic sound conditioning; and new robotic applications and material practices (more data can be displayed with accompanying materials/video).

As a collaboration between industry and practice, four of the prototypes have already been implemented in an onsite robotic fabrication while the architectural practice was ongoing. The proposed installation shows one, or a series of robotic prototypes that increase in complexity from a primary full figure weaving (a) to partial segments (b, c), and an expanded field (d), where shape and behaviour of fibres are a function of the interaction of weave system and density, material properties and overall geometry. These extend previous research through:

Development of robotic applications and reconfigurable material practices. Recent advancements in carbon-fibre technology and computer-controlled robotic manufacturing now enable the delivery of threading with consistent and reproducible qualities. Research has been undertaken in recent years for carbon-fibre polymer composites formed over moulds or core-less fibre winding, or with semi-autonomous mini robots.[2] The research expanded a robotic filament deposition of fibre composites towards a context of on-site, on-ceiling weaving for industry-scale application, as a material response to flexible spatial programming, and with varied structural performance implementing local constraints.

On-site and mobile robotic fabrication. Recent projects have expanded the fabrication space from closed settings towards scenarios of onsite and adaptive live robotic construction with mobile adaptive in-situ fabrication or aerial robots, including substantial research into onsite carbon-fibre threading as for example the V&A project.[3] Whereas these systems build on live-data feedback with sensing and feedback control as part of robotic programming and fabrication, in contrast, this research prioritises developing robust work protocols that are universally applicable to a variety of project constraints in the context of ceiling elements for workspaces, thus allowing robots to operate in inhabitable environments where obstacles or human flows are unpredictable.

Prototypes and other physical scaled weaving studies in builders rope and carbon fibre on customised looms can be displayed as a comprehensive description of morphogenetic weaving patterns, where the differentiated fibre layout weaving becomes a gradient variation of material properties and geometry. The prototypes show the directionality of anisotropic fibres, which express both tensile and compressive strength and so enables construction of complex, load-bearing surfaces.

For the exhibition, three different types of carbon-fibre woven structures on a circular frame/ frame segment are presented, with maximum dimensions approx. 2150mm diameter wide, ca 700cm high. Ceiling mounted, varying dimensions, patterns and densities possible (in setting up of approx. 3000x3000mm). The weaving structures are located at different heights, with potential real-time robotic weaving as demonstration. The installation is accompanied with video footage of the research process (design and manufacturing, June 2017-Feb 2018).

Figure 1: The robotically woven ceiling structure.

References

[1] Michael Brill, *Workplace Design* (Jasper, IN: Kimball International, 2001).

[2] Achim Menges, "Material Performance: Fibrous Tectonics & Architectural Morphology" (Studio Report, Harvard University Graduate School of Design, 2016); Marschall Prado, Moritz Dörstelmann, Tobias Schwinn, Achim Menges, and Jan Knippers, "Core-Less Filament Winding Robotically Fabricated Fiber Composite Building Components," in *Robotic Fabrication In Architecture, Art And Design 2014* edited by Wes Mcgee and Monica Ponce De Leon (Zurich, Basel: Springer International Publishing Switzerland, 2014); Maria Yablonina, Marshall Prado, Ehsan Baharlou, Tobias Schwinn, and Achim Menges, "Mobile Robotic Fabrication System For Filament Structures," in *Fabricate 2017,* edited by Achim Menges, Bob Sheil, Ruairi Glynn, and Marilena Skavara, 202-209 (London: UCL Press, 2017).

[3] Kathrin Doerfler, Thomas Sandy, Markus Giftthaler, Fabio Gramazio, Matthias Kohler, Jonas Buchli, "Mobile Robotic Brickwork—Automation Of A Discrete Robotic Fabrication Process Using An Autonomous Mobile Robot", in *Robotic Fabrication In Architecture, Art And Design 2016* edited by Dagmar Reinhardt, Jane Burry, Rob Saunders (Basel New York: Springer International Publishing, 2016): 205–217; Markus Giftthaler, Timothy Sandy, Kathrin Doerfler, Ian Brooks, Mark Buckingham, Gonzalo Rey, Matthias Kohler, Fabio Gramazio, and Jonas Buchli, "Mobile Robotic Fabrication at 1:1 Scale: The In Situ Fabricator System, Experiences And Current Developments," *Journal of Construction Robotics* 1, Issue 1–4, (December 2017): 3–14; Ammar Mirjan, Federico Augugliaro, Raffaello D'Andrea, Fabio Gramazio and Matthias Kohler, "Building a Bridge with Flying Robots," in *Robotic Fabrication in Architecture, Art and Design 2016*; Prado et al., "Core-Less Filament Winding".

Machining Aesthetics: Tool Making as Design Research

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David Leggett

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Statement of Research Significance

The prototype and model showcased in the exhibition examined tool making as a form of design research. With the widespread availability of open-source electronic prototyping platforms and its knowledge, designers are no longer the end user of emerging technology and digital toolsets. Instead, we see a surge of designers dappling in the discipline of software, material and mechatronic engineering, escaping the constrains of existing computer numeric controlled (CNC) tools through designing and fabricating novel machinery.

The artefacts are from a master-level design studio led by the authors. They act as evidence of the agentive capacity of the tool to deliver design outcome. Through testing and prototyping, the projects reveal their latent potential as future construction technology. At the same time, the projects explore emerging aesthetics of machining effects produced by the bespoke tools to create what Deamer refers to as the contemporary tectonic evolution of surface intricacy.[1] This unpredictable and unexpected material outcome holds the element of risk that Marble and Kolerevic have attributed to the workmanship of risk; a term borrowed from Pye's examination of craftmanship.[2] These material outcomes carry a sense of agency for design, evidence through the instrumentality of the material strategies within the design process and critical making as generative design drivers; delivering emerging tectonic and effects, we call Machining Aesthetics.

The artefacts demonstrate creative and novel tool-making procedure; technology that is either hacked, embedded or hybridized from a known system to create new material systems. They provide tangible evidence of how tool making through design and material experimentations could facilitate productive dialogue between form and content. Here, architectural form becomes an emerging factor dictated by the tectonic procedure of the technology.[3] When there is a need to search for new knowledge and a solution that goes beyond the standard toolsets offered to the designer, tool making can be a useful methodology for design research; utilising technology as material for constructing knowledge and a mean to search for design potential and solution. The process of making sense of the relationship between spatial requirement, effects, materiality and fabrication is the critical enquiry that is demonstrated in the projects. To make the research relevant to practice, it needs to extend into the social domain to engage technology with the built environment. This research contributes to our understanding of digital craft within the contemporary practice and examines making as a research methodology.

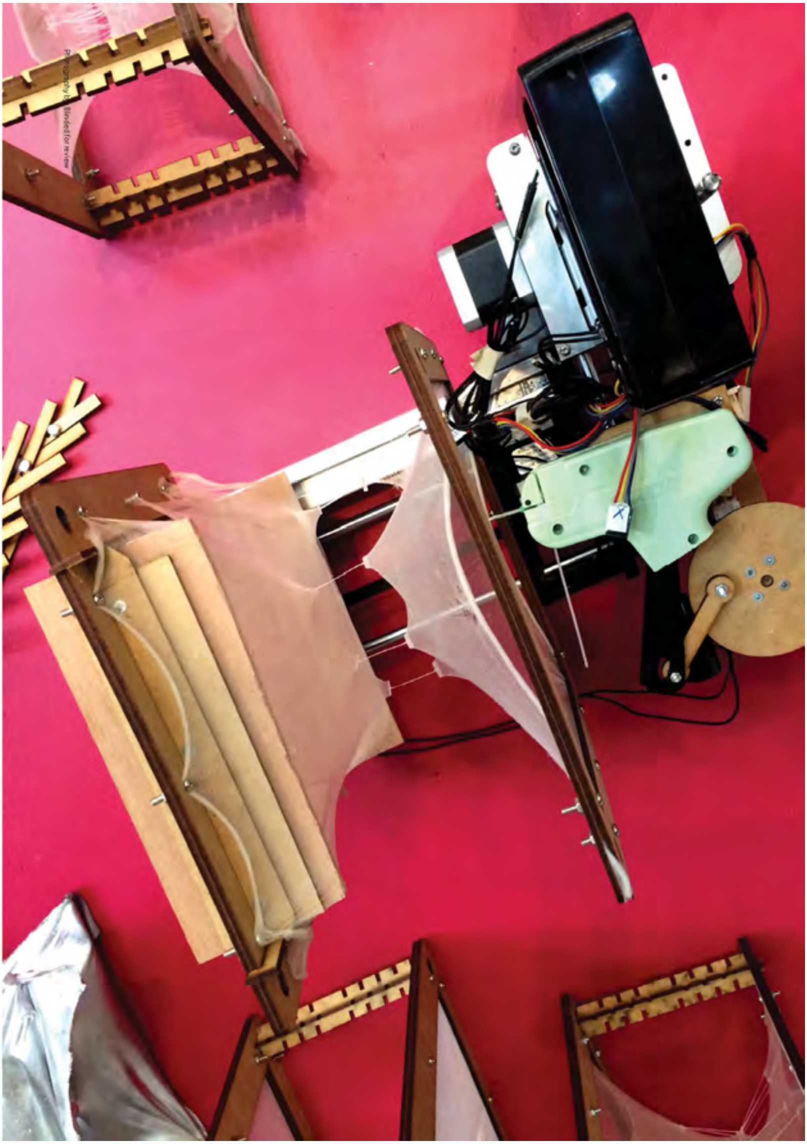

Figure 1: Artefact 1 — Morphic Intelligence, hacked 3d printer into stitching machining, Size: 250 tall x 400 wide x 400 deep

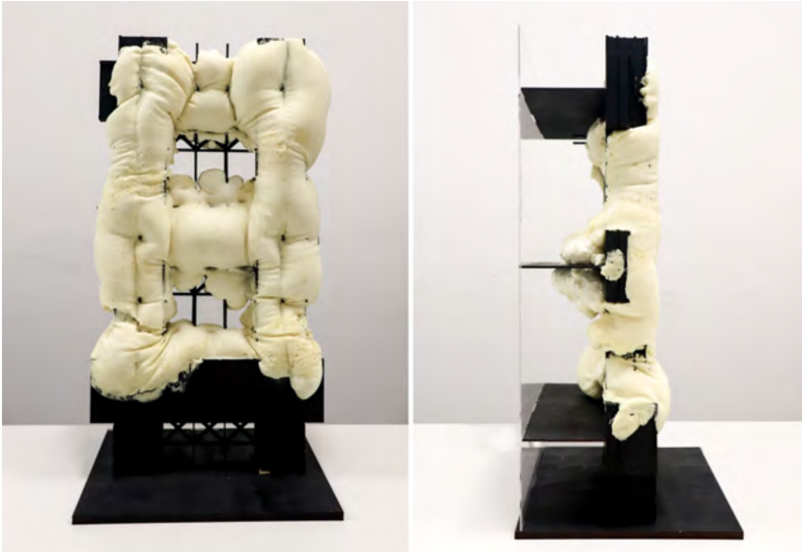

Figure 2: Artefact 2 — Hybrid fabrication: FOAM, Size: 400 tall x 250 wide x 150 deep

References

[1] Deamer, Peggy. "Detail Deliberations." In *Building (in) the Future: Recasting Labor in Architecture*, edited by Bernstein, Philip G. and Peggy Deamer, (New York: Princeton Architectural Press, 2010): 81-88

[2] Marble, Scott. "Imagining Risk." In *Building (in) the Future: Recasting Labor in Architecture*, edited by Bernstein, Philip G. and Peggy Deamer, (New York: Princeton Architectural Press, 2010): 38-43; Kolarevic, Branko and Kevin Klinger. *Manufacturing Material Effects*. (Abingdon: Taylor & Francis Ltd, 2008); Pye, David. *The Nature & Art of Workmanship*. (London: A & C Black, 2007).

[3] Frampton, K. *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*. (Cambridge, MA: The MIT Press, 1995). p.25-26.

Multi-Scalar Modelling and Robotic Fabrication of Freeform Lightweight Copper Facades

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Statement of Research Significance

Incrementally formed thin sheet metal enables lightweight structures that integrate ornament, structure and skin - a trajectory of architectural and structural opportunity initialized by Prouve, Junkers, and LeRicolais. However, where previously the need for a mould has limited rigidization to contexts of mass production, mould-less Robotic Incremental Sheet Forming (RISF) provides new opportunities for customized and bespoke panels. This project explores the possibilities of robotic sheet metal forming and computational design to support new material practices and new methods for designing across scales of resolution.

Metal facades are deployed within architecture to support the transmission of light and creation of shade, screen from wind and other climatic factors, resist weathering and can be highly expressive. Copper is an expensive however particularly sustainable choice of metal as it requires no further treatment once installed, is highly formable and expressive, and will last for hundreds of years. As increasing pressures of sustainability drive the need for increased material efficiency and lighter weight building practices, methods for increasing the structural performance of thin copper sheet can contribute towards stronger, thinner and lighter panels, decreasing the dead-loads carried by underlying structural systems.

Increasing the performance of thin metal sheet is possible through mechanical rigidization, which adds structural strength by increasing cross sectional depth. However, rolling, extrusion and pressing processes for rigidization do not easily support the local customization of geometry in response to structural requirements. Robotic Incremental sheet forming (RISF), a flexible and mould-less fabrication process, is a way to enable the cost-efficient fabrication of metal panels with customized rigidization.

Conventionally, design and representational approaches have privileged the geometric description of form over materiality, while industrialization has brought both real and assumed standardizations of material. Digital fabrication has shrunk this gap between design and making, by connecting design environments to the instructional data that control machining operations. With the increased precision and control it is possible to create customized design solutions and better performing structures.

Where architectural models of material typically assume stability of physical properties, geometric change implies property change in the RISF process. This research employs a multi-scale approach to predictive and generative modelling that incorporates these variables within the design process at material and structural scales, allowing for material and fabrication informed design.

The 1:1 prototype of a lightweight and highly differentiated copper façade system demonstrates the potential of integrating customized structurally responsive geometry with design constraints typical of a metal facade and managing the material property changes induced by RISF. The accompanying film provides insights into the shifting nature of design and manufacturing and reveal the digital design tools, material research and robotic manufacturing developed for this project and reimagine how physical objects will be designed and made in the future.

1:1 Prototype

Medium: Copper panels mounted on free-standing timber frame

Dimensions: Approximately 3 x 2m

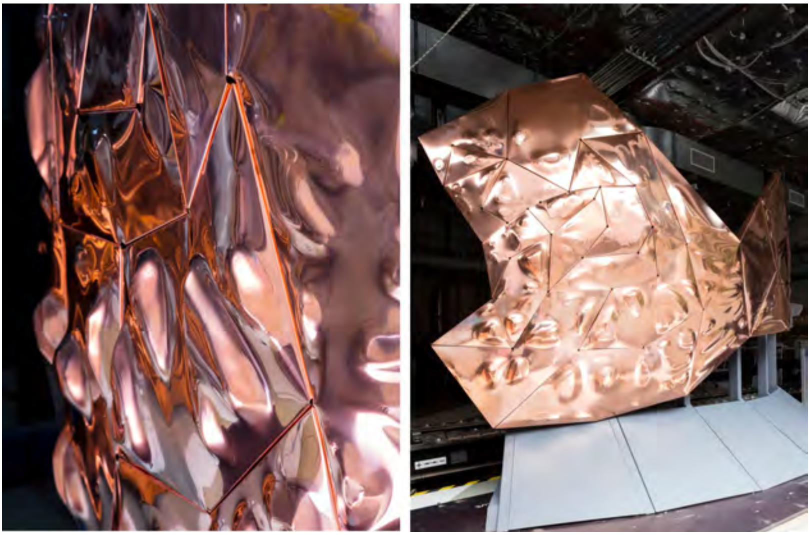

Figure 1: Pictures of the completed 1:1 copper façade prototype.

Film

Duration: 2min 45 seconds

Dimensions: 1920 × 1080 pixels

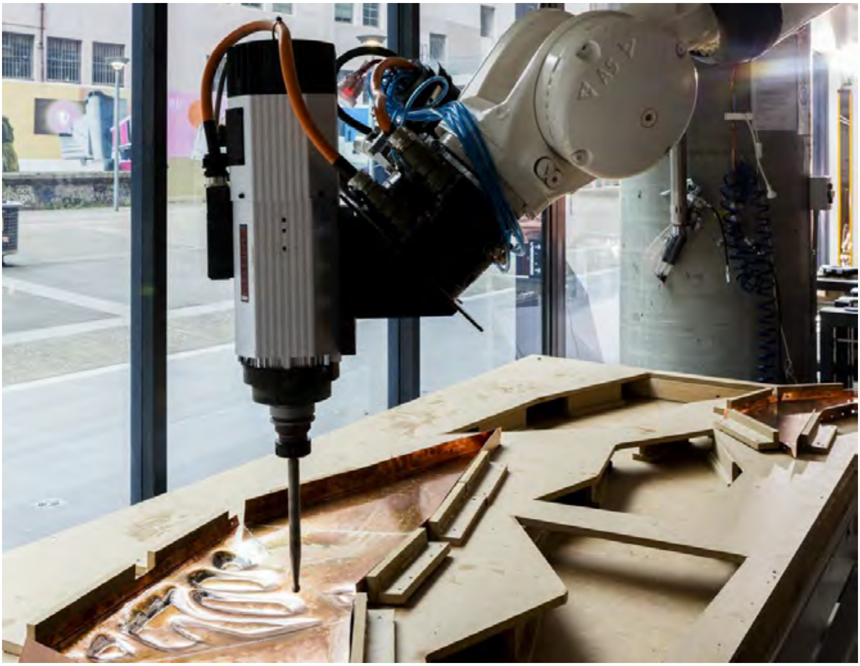

Figure 2: Setup of robotic single-point incremental forming process (RISF)

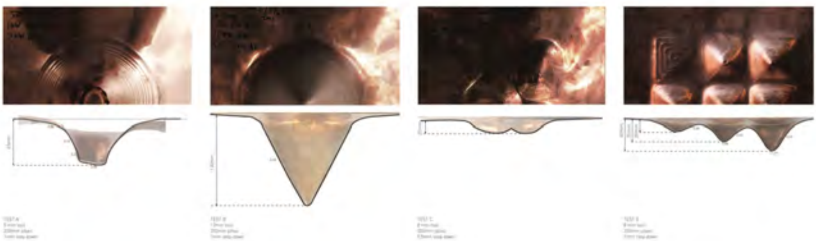

Figure 3: Prototypes were cut and carefully analysed to understand effects of cold working, wall angle and localised thinning on material properties.

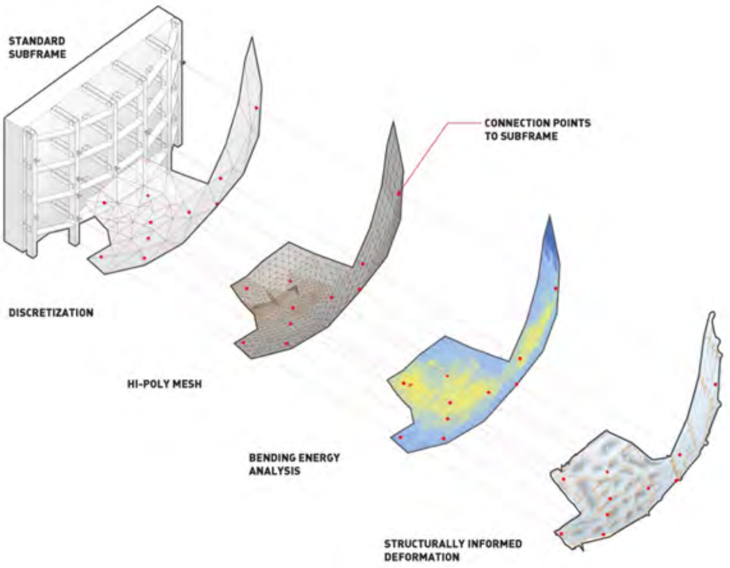

Figure 4: Structurally informed discretization and micro patterning.

Figure 5: Standing seam prototyping using industry standard tools.

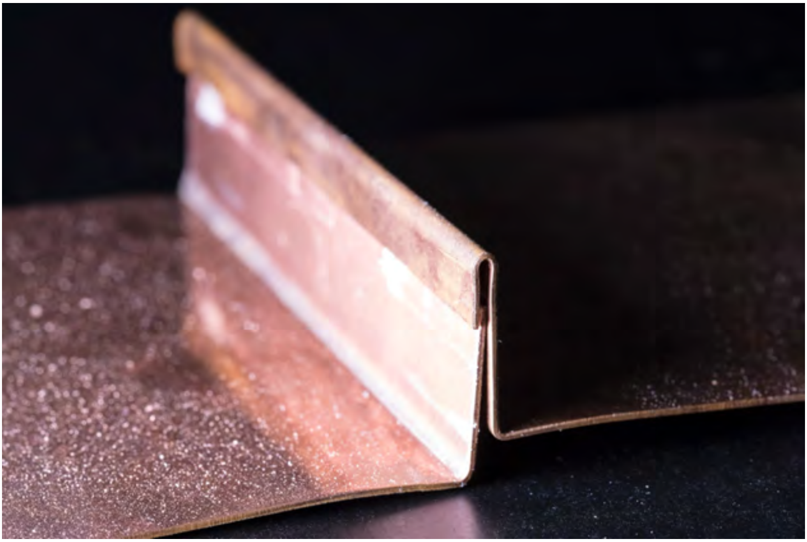

Figure 6: Standing seam connection.

Transient Geometries: Computational Design and Robotic 3D Printing of Functionally Graded Dynamic Meshes

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Statement of Research Significance

Innovation in architecture and transformations in their practices are closely linked to technological change, the practices of representation and tools of making. Recent developments in computational design methods and robotic fabrication have expanded the range of possibilities beyond the automation of traditional fabrication techniques in unforeseen directions. This body of work explores the capabilities of large-scale robotic 3D printing to enable new hierarchies between form and material and calls into question material's subservience to form as well as the static and singular nature of architectural design.

Using Marcel Breuer's iconic Cesca chair as a muse, the newly designed continuous seating surface takes advantage of robotic 3D printing processes of elastomeric materials to change the mechanical properties of the surface in response to anticipated load conditions. The result is a functionally graded material meso-structure, adapting the mesh topology to react to the unique loading conditions of every point along the surface, adjusting the overall density of the area to fit.

The large-scale 3D printing of elastomeric materials in particular also avails the opportunity to design and fabricate lightweight dynamic structures that are capable of responding not only to a given design condition but a multitude of situations that require uniquely tuned response from the entire architectural form. This mode of working addresses the reality that the world around architecture is constantly changing and represents a system that is far from equilibrium. Reconfiguration in this mode of design allows for an architecture that can be tuned to shifting performative, programmatic, or phenomenological demands, delivering new efficiencies, flexibility and spatial experiences.

Demonstrating this research *Transient Geometries* are 3D printed in thermoplastic polyurethane (TPU) using an industrial robot, with a bespoke 3D printing head and a customised computer algorithm that modifies the material's thickness, density and pattern according to the structural requirements of the chair. Similar to the structures that can be found in nature, in areas where strength is required the weaving pattern that makes up the chair tightens in order to become solid material and in other areas opens up in order to reduce the chair's weight.

Using geometry in this way allows designers to harness the technology of 3D printing to optimise the structures of objects according to their function.

Object

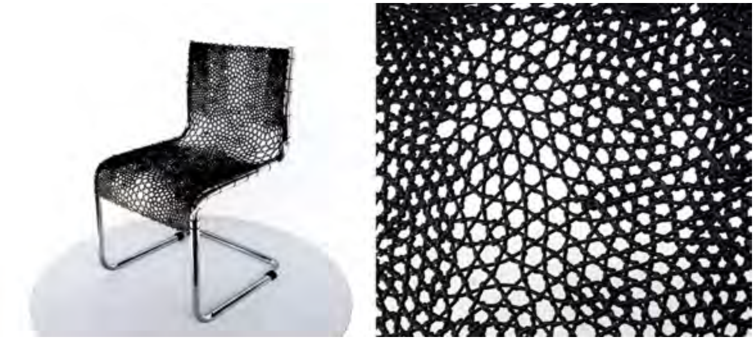

Figure 1: Chair. (Medium: 3D printed thermoplastic polyurethane (TPU); Dimensions: Approx. 47[w] x 60[d] x 80[h] cm)

Film

The accompanying film provides insights into the shifting nature of design and manufacturing and reveal the digital design tools, material research and robotic manufacturing developed for this project and reimagine how physical objects will be designed and made in the future.

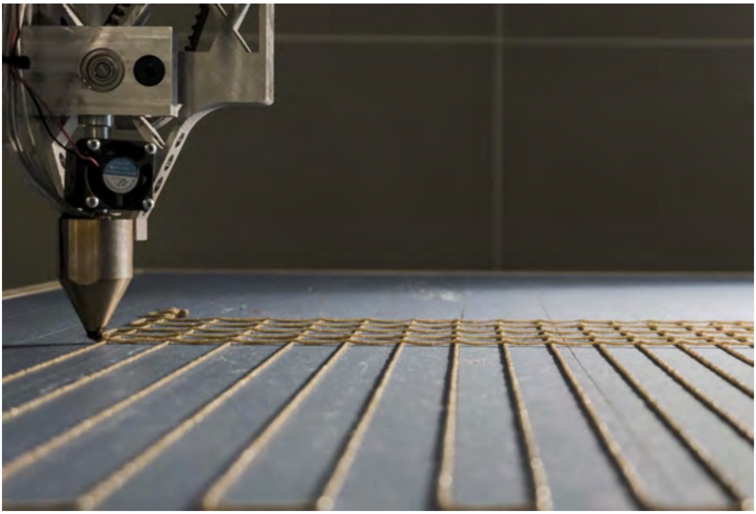

Figure 2: Film. (Duration: 2 minutes 45 seconds; Dimensions: 1920 x 1080 pixels)

Towards a Leaking Roof: An Experimental Water-Catching Building Design in Hokkaido, Japan

Dr Francois Blanciak

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Statement of Research Significance:

Epitomising the protective function of architecture, the traditional pitched roof is designed as a means to fight against water infiltration. Likewise, modern architecture is sometimes criticised for its incapacity to prevent accidental leaks while using the latest technologies. Yet, water is often referred to in sustainable design—and rightfully so—as a precious element to use and/or recycle. Taking this paradox into account, this architectural project—a competition entry for the design of a spa in Hokkaido, Japan—attempts to maximise the penetration of water inside the building, instead of preventing it from entering (see Figure 1). This proposal contributes to design research in the field of sustainable design by proposing a unique building typology, whose roof is constituted by a myriad of elongated, conical elements which capture, filter, and redirect rain-water (as well as melted snow) into the pool of the spa.

The local and indigenous ‘Ainu’ architecture of Hokkaido in Northern Japan is characterised by a systematic use of thatch, for both walls and roofs, which is made of long reeds collected from nearby riverbeds. The circular, hollow section of the reeds confers to them a natural waterproof quality (since they grow in the water), and resistance to wind (since they bend). The bundling of the reeds is what creates the thatch. This experimental project proposes to literally mimic the form, flexibility, and functionality of the reeds used in that ancient thatched construction technique. It does so by using long and partly conical hollow tubes of frosted polycarbonate as the main building material. The tubes are attached to each other around the inhabitable section of spa, and further extend to the sky beyond its structural ceiling to optimise the collection of water from both rain and snow, resulting in a symbolic and functional erasure of the roof. Two membranes contained in the ceiling make this possible: a structural, perforated one holding the tubes in place, and a slanted, waterproof one redirecting the collected water towards a tank.

The methodology used in testing the validity of this concept involved calculations, assuming that wind direction and speed allow rain and snow to be caught between at least one extra vertical surface in addition to the surface of the roof itself, which highlighted that this experimental design can increase the capture of water by over 50% in relation to yearly rain and snow falls (see Figure 2). Calculations were also used to figure out how the building can perform a recycling process that involves on-site natural resources, re-using the heat generated by compost made from neighbouring stables and surrounding meadows to warm up the collected water. This accumulated heat from the pool of the spa, as well as the heated gas coming from the composting process, are then re-used to warm up the structural grid onto which the roof cones are bundled, as a means to accelerate the melting of the snow that falls onto the building (see Figure 3).

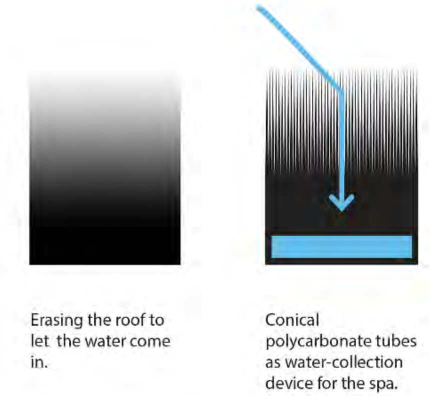
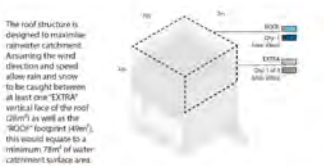


Figure 1: Concept.



		WINTER	SPRING	SUMMER	AUTUMN	TOTAL
SNOWFALL	ROOF (49m²)	8,918 L	5,292 L	0 L	0 L	14,210 L
	EXTRA (28m²)	5,096 L	3,024 L	0 L	0 L	8,120 L
RAINFALL	ROOF (49m²)	4,998 L	6,664 L	24,549 L	14,039 L	50,250 L
	EXTRA (28m²)	2,855 L	3,808 L	14,028 L	8,922 L	29,613 L

Figure 2: Water catchment calculations.

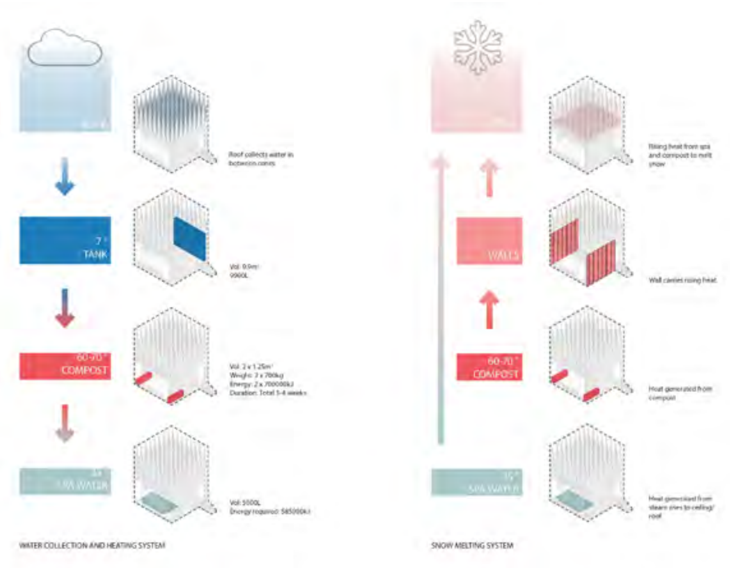


Figure 3: Functional diagrams.

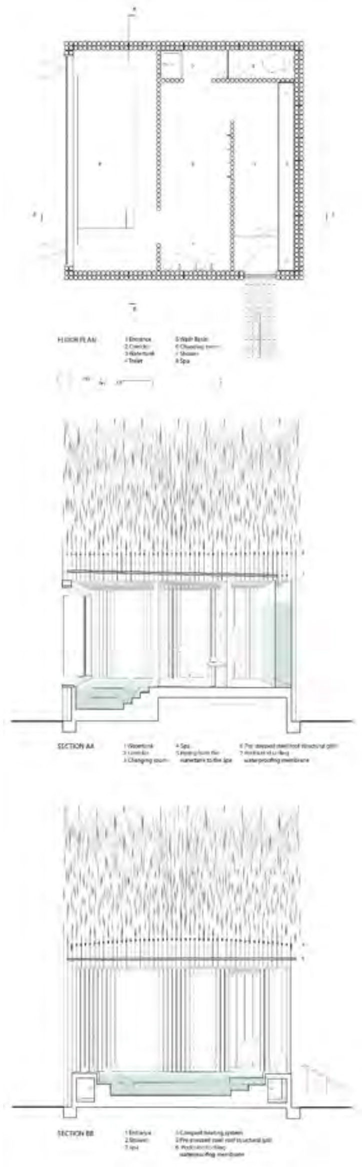


Figure 4: Plan and Sections.

Figure 5: Day time rendering.

Figure 6: Interior rendering.

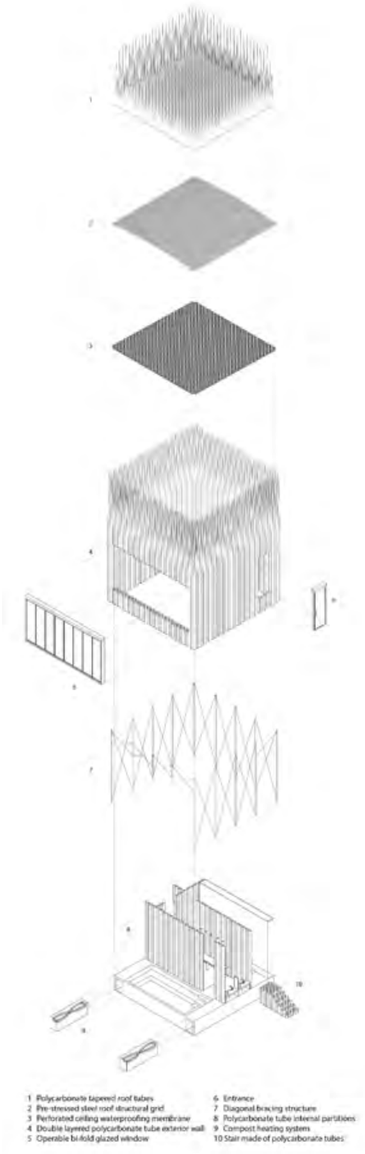


Figure 7: Structural diagram.

Figure 8: Night time rendering.

Acknowledgments

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Liying Tan

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Statement of Research Significance

Architecture has always looked towards nature, but architects continue to take a wide range of approaches to it. Nature was for a long time understood through God, and now many of us understand it through science and big data. The most celebrated relationships between architecture and nature still rely more on a poetic response to nature than a purely scientific one. Yet much of the global media around nature focusses on the numbers: tonnes of carbon, sea level changes, species populations, and so on. Aggregated data is a big part of how we understand nature now, but it is not normally a big part of how we experience it through architecture. Even nature tourism projects, which have a captive audience for both the scientific and the poetic, are typically less about swimming in big data than swimming with big fish.

The objective of this research was to find design tactics that bring the experience of a natural environment together with aggregated data about how that environment is changing. How might that architectural language serve the collection of data? How could the touristic experience facilitate data collection? The research team analysed a group of six design responses to the call for a new visitor centre and biosecurity checkpoint for Kapiti Island, New Zealand, and synthesised insights from several proposals into a single collaborative project.

The resulting proposal is organised around the axes of a three-dimensional grid system oriented to cardinal points of the compass (see Figure 1 & 2). Within each axis are a number of small kiosks (see Figure 3). These accommodate a café, store, bio-security checkpoint, information centre, and what we have called, a Museum of Itself (MOI). Selfie culture has put the tourist themselves into the foreground of their own gaze. Rather than resent this as a narcissistic turn, we propose to use it. The MOI is a space to exhibit selfies taken by visitors in front of the Kapiti Watchtower. The timber poles that repeat across the whole structure have stripes at 250mm intervals (see Figure 4 & 5), so the photos would reveal measurable changes to the sand dunes, tides, vegetation, stream, and the buildings in the village behind it. The proposal re-deploys the indulgent culture of selfies as a tool for environmental observation. Selfies would collect over the life span of the building into a visual database of environmental change displayed in the MOI. Our exhibit includes a model of the building and a hypothetical collection of selfies (see Figures 6 & 7).

The project reveals a combination of techniques that connect personal experiences to the wider environment. Firstly, visual calibrations on the building make local environmental changes measurable without complex equipment. Secondly, dedicating space to the MOI invites visitors to embrace the culture of touristic image making as a form of public memory and environmental data collection. Finally, the building's axes connect visitors to disparate areas of the urban environment, and by aligning with the Earth's own axis, to the wider environment too.

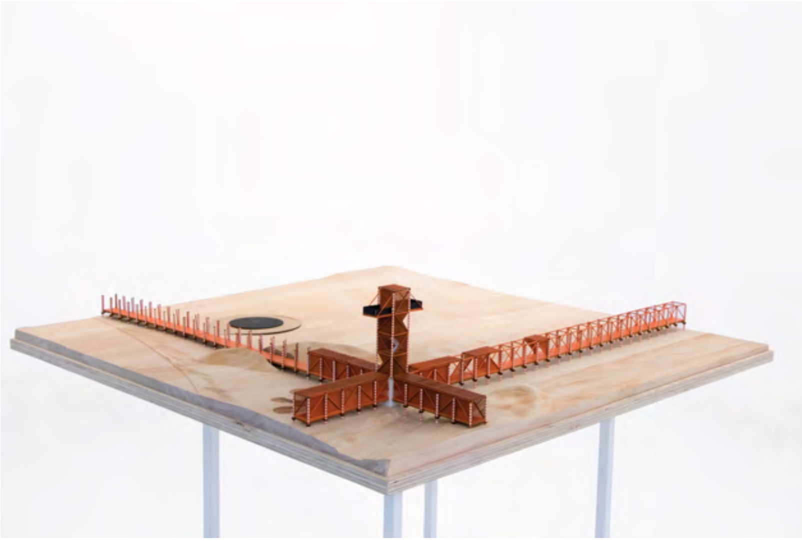

Figure 1: Overall view of the model from the north east, 1:100.

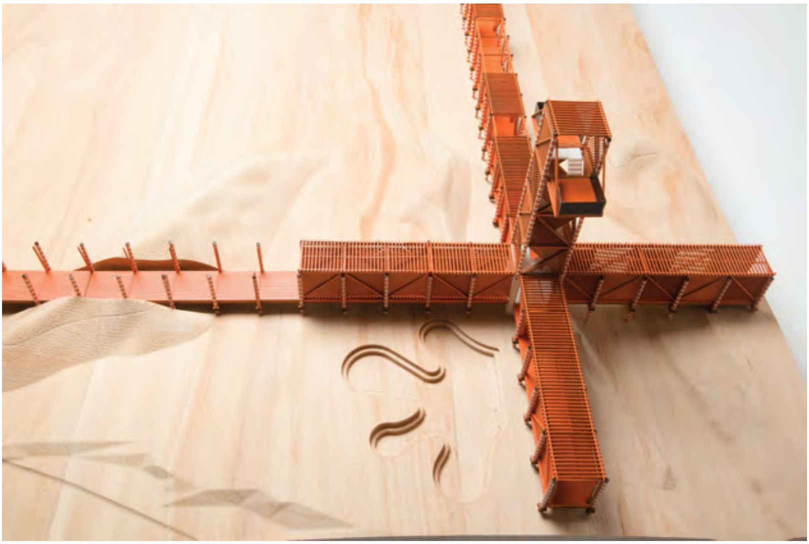

Figure 2: Overall view of model from the east showing hand-shaped congregation space.

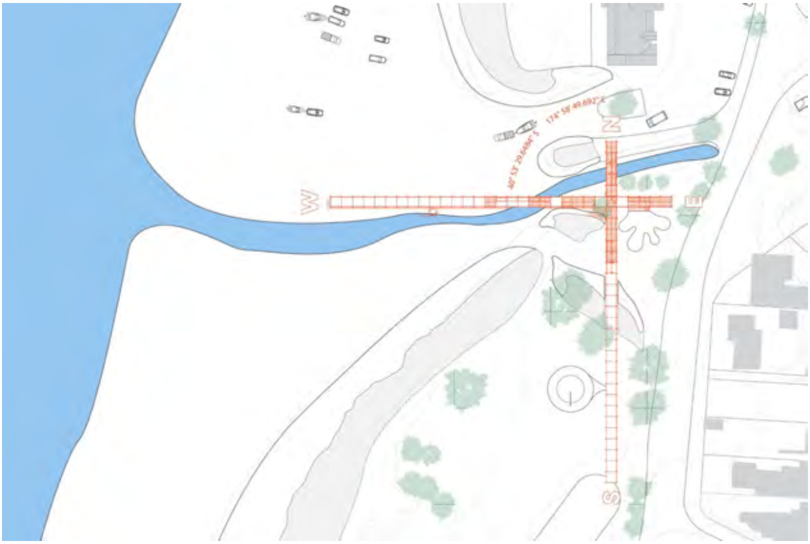

Figure 3: Site plan showing orientation to the compass and connections between car park (north), green park and shops (south), street (east), and beach (west). Not to scale.

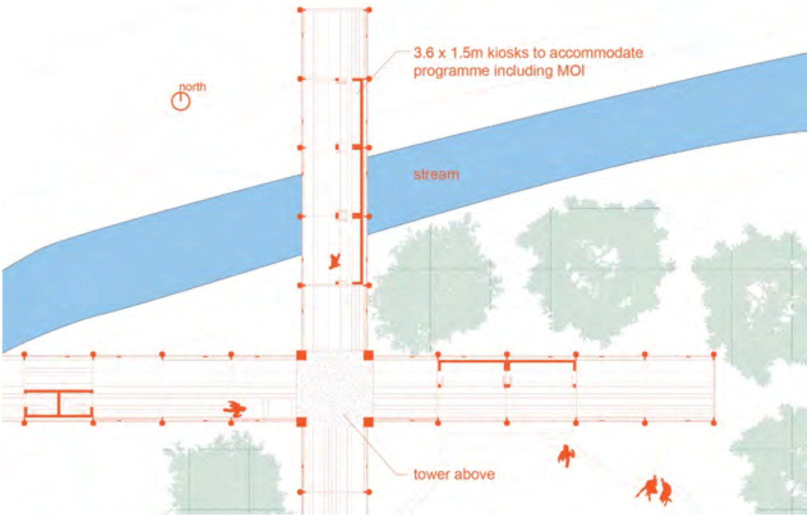

Figure 4: Partial plan showing modular kiosk components for MOI. Not to scale.

Figure 5: Perspective drawing from the east (street side) showing 250mm banding to measure changes in the environment captured in selfies and displayed in the Museum of Itself (MOI).

Figure 6: Perspective drawing from the west (beach side) showing 250mm banding on poles.

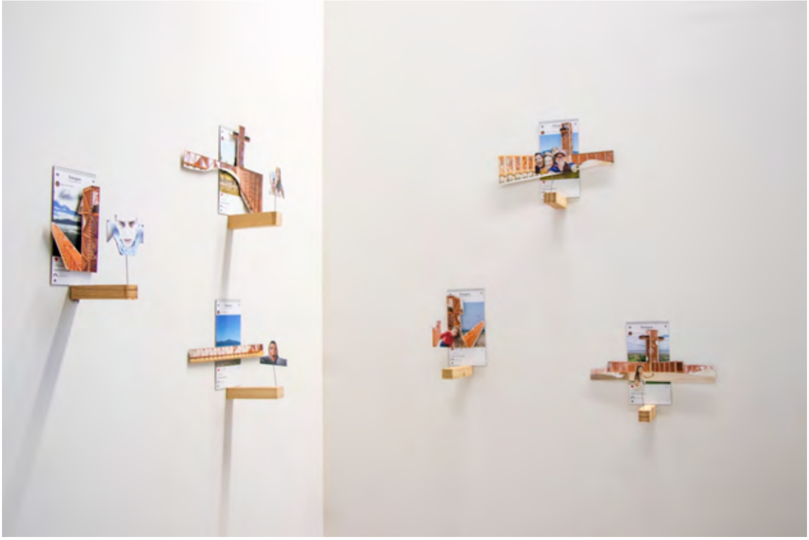

Figure 7: Preliminary mock-up of 2.5D 'selfies' to be exhibited in the MOI.

Figure 8: Detail of preliminary mock-up 'selfie' in the MOI.

References:

All images produced by the authors.

The Melbourne Section: A Context Specific Design-Research Applied Across A Strategic Metropolitan Territory

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Maud Cassaignau

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Statement of Research Significance

This entry discusses a unique multi-scalar narrative driven through urban design research. Employing the narrative technique of a metropolitan transect, the project investigates how established suburban areas will accommodate the city's projected population increase while enhancing resilience. The technique, analogous to a tomographic section, offers an insightful 'urban portrait', as well providing framing for a future metropolitan meta-narrative. At first it identifies a large band of territory containing smaller relatable components – a 60km transect running from Melbourne's compact downtown, across inner and post-war suburbs, and out to the rural periphery. This transect was positioned to include certain arteries of transport and resources – while also deriving from our experience and intuition for potential strengths and synergies.

Seven focal points were then analysed, exploring site-specific tangible and non-tangible characteristics such as housing stock, patterns of use, identity and experiential qualities. Combing mapping with personal observations of the striking, odd, and particular, the team formed intuitions about each locale's unique story and potential, which were tested through speculations amplifying these specialities. For example, in the suburb of Richmond a Vietnamese community operates a black-market street trade supplied through backyard farming – something that could scale-up due to the easy upgradability of the suburb's post-industrial building fabric.

These local findings were threaded back to re-inform the meta-narrative and vice versa in a dynamic way, positing the role precincts can play in addressing broad metropolitan challenges, and also potential reciprocities between precincts. From these emerged propositions for intensification through new typologies that hybridise denser housing with local specialisations. Each suburb along the transect is reimagined as a newly productive urban landscape with the following foci: communication and global branding, food production, education, immigration, manufacturing, water treatment, recreation and preservation.

In Richmond for example, the existing culture of food production is escalated into a larger scale urban farming and distribution network, using agricultural technology and resources from industrial and farming hubs further out. Likewise, adjustments are proposed to other infrastructures to better support the total network – e.g. a metropolitan water treatment strategy. Taking advantage of the visibility of nodes along a train line, the project seeks to make narratives around water, food, industry and human resources legible in the experience of the city.

Employing a local and regional scale 'flâneuring', the project threads together existing loose urban narratives within suburbs and across the metropolis to offer a provocative holistic vision. In contrast to the totalising approach of the modernist project, the method embraces incompleteness in favour of specificity and opportunistic synergy. The meta-narrative of the metropolitan transect enables our engagement with a complex territory that is difficult to comprehend as one system, linking place-specific qualities and interventions to major urban challenges. Thus, we argue it offers a powerful framework to explore the 'wicked problems' of resilient growth in post-industrial cities negotiating resource constraints as well as economic and climactic volatility.

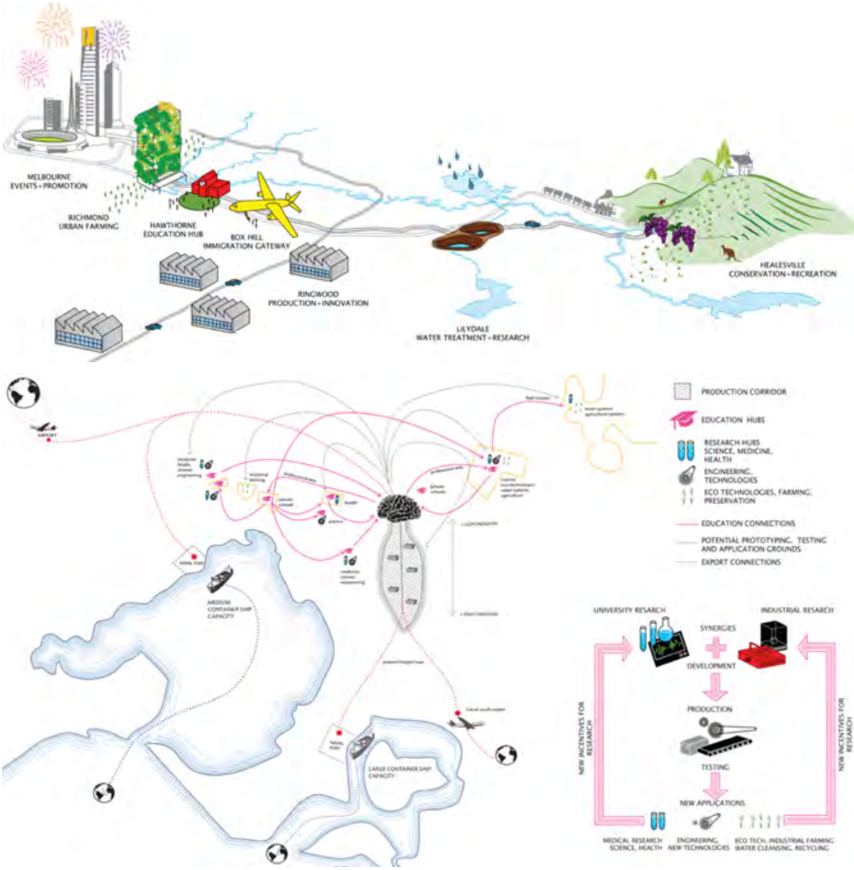

Figure 1: Images from The Melbourne Section.

Building the New Density: One Room Tower

Phorm architecture + design

Phorm is a Brisbane based Practice with 18 years specialising in residential projects located within the city's inner suburbs and in regional Queensland. The Practice's work has been exhibited nationally and internationally.

Dr Silvia Micheli

Lecturer, The University of Queensland

Dr Antony Moulis

Associate Professor, The University of Queensland

Statement of Research Significance

Current international developments in the practice of architectural design have identified the need to establish new forms for housing typologies in the making of the dense contemporary city. While the broader research focuses on high-rise typologies to respond to the increase in metropolitan populations, there is the tendency to overlook the opportunity of considering single inner-city sites as micro-contexts for experimentation in urban densification.

The project One Room Tower© by Phorm architecture + design with Silvia Micheli and Antony Moulis addresses the question of the inner-city site as a micro-context through the definition of new typological and technological strategies. Developed on the premise of "the site within the site", this urban device consists of a major volume developed vertically and is located adjacent to a pre-existing worker's cottage. One Room Tower© is a continuous space wrapped in a strict timber envelope, with openings at various scales. It is staged as a set of subspaces, platforms spiralling around a free-standing service core, with its light structure allowing for variation in height and internal arrangement. It provides innovation for the field of research in rethinking the practice of increasing residential density by questioning the conventional strategies of "addition" and "extension". One Room Tower© is also a response to multigenerational living and emerging social groups in demand of greater mobility and fluid aggregation models. It is also a strategy for preserving local character housing *in situ* based on the concept of creating a new accretionary layer of urban infill that complements the existing.

The significance of this research lies in the articulation of a new theoretical paradigm brought into practice through a built work, ready for consideration by the community, government and construction industry. In social terms, One Room Tower© is a living experiment and has the ambition to become a structure able to accommodate different scenarios. In technological terms, the use of readily available reconstituted timber materials, as structure and exposed finish, provides an economical and sustainable way to make the concept adjustable and transferrable to different contexts. One Room Tower© was awarded House of the Year, Brisbane Region, and received a State Award for Residential Architecture – Houses (Alterations and Additions), at the Australian Institute of Architects, Queensland Awards 2018.

Figure 1: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Corner Garden. © Silvia Micheli.

Full-Scale Minipod Mock-Up

Dr David Tapias Monne

Lecturer in Architecture and Industrialised Building. Innovation in Applied Design Lab; School of Architecture, Design and Planning at The University of Sydney.

Statement of Research Significance

This full-scale Minipod is part of a whole 80sqm apartment mock-up designed by The University of Sydney's Innovation in Applied Design Lab at the School of Architecture, Design and Planning in collaboration with Lendlease as part of the Innovation in Advanced Multi-storey Housing Manufacture project. The mock-up goals are bifold: to present innovative ideas and layout opportunities to both inhabitants and architects, based on customization, adaptation and flexibility; and to gather their feedback and reactions at the same time, in order to allow the IAD Lab and Lendlease team to improve the overall design.

It is therefore a 1:1 design research model and a bi-directional communication tool, that allows researchers and the general public a fuller, more direct haptic experience than other mediums like augmented or virtual. By displaying this mock-up in diverse locations, we gather data via a survey and informal conversations that are then analysed and applied in the following iteration of this modular system.

The Minipod contains the apartment's energy and fluids services, concentrated in a bathroom and an open kitchen. It explores people's comfort expectations and limits in terms of privacy and functionality, and introduces a mid-term horizon when our buildings will work with a higher average of locally sourced energy and will be able to produce no waste. It is part of a bigger component family that is being developed using advanced software and fabrication technologies, focusing on the bringing engineered timber structures to their full capacity in terms of design, manufacturing, assembly and performance as multi-storey habitats.

The Innovation in Advanced Multi-storey Housing project was made possible through funding from the Department of Industry, Innovation and Science's Cooperative Research Centre Projects (CRC-P). The project aims to develop and produce housing solutions using high-tech, renewable materials and advanced manufacturing. The full-scale mock-up is partially funded by the NSW Department of Industry's Research Attraction and Acceleration Program.

Figure 1: Minipod configuration proposal for the ADR conference.

ADR18: The Papers

ADR18

Patchwork

Chaired by Dr Francois Blanciak

Working Document, or, Final Product?: The Indo-Pacific Atlas in Seven Acts

Christina Deluchi

University of Technology Sydney

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Abstract

The Indo-Pacific Atlas is a 10-meter-long collage of 4000 images and a sound piece, a series-of-maps that explores the role of architecture in rapidly transforming urban environments. The Atlas is a compilation of four research projects that are linked by post-traumatic conditions, capital flows, gentrification and media. It was first exhibited at the inaugural Chicago Architecture Biennial, 2015.

Through a description of the methodology for its conception and production, this paper demonstrates the *Indo-Pacific Atlas's* ability to intensify the production of collective research. The *Atlas's* configuration as an 'atomised' cloud of detachable objects and images, encourages researchers to permanently re-negotiate its narrative structures. The simultaneous display of each element that constructs the *Atlas* allows researchers to visualise the adjacent, parallel, colliding, and intersecting connections between complex and multi-layered narrative sequences.

Calling on vast assortments of field and desktop research, this paper interrogates how the process of making, re-making, packing, installing, exhibiting and publishing have generated competing modes of enquiry. Finally, the paper provides a critical commentary on the role of the artefact as a perpetual working document, or, final product, and asks: what is the value in making public experimental and makeshift research?

Act 1: The Indo-Pacific Atlas

In February 2015, a team of researchers from the University of Technology Sydney (UTS) initiated a project called the *Indo-Pacific Atlas*. The project is a collection of architectural research-and-representation documents overseen by Urtzi Grau[1] in collaboration with the Masters by Research (Architecture)[2] and the Master of Architecture (coursework)[3] programs. Whilst still incomplete, the *Atlas* was presented at two public events. The first as part of the inaugural 2015 Chicago Architecture Biennial titled *The State of the Art of Architecture*, and the second as part of *Fieldwork*, an exhibition at the UTS Art Gallery in 2016.

The *Indo-Pacific Atlas* is a 10-meter-long panoramic collage constructed from over 4000 images, three-dimensional objects, and text based contextual data that connect urban nodes along the Indo-Pacific region. The Indo-Pacific region is the oceanic territory that spans from the east coast of Africa, through the Gulf and South-East Asia to South America's west coast. Its articulation in 2013, by the Australian Defence White Paper's "Indo-Pacific Strategic Arc", challenges the Atlantic-centric construction of geopolitical narratives through territorial definition, placing Australia at its core.[4] The territory is still an emerging, diverse, and broad-sweeping system configured by a series of sub-regions rather than a unitary whole.

In response, through the intersection of media, capital flow, gentrification and post-traumatic conditions, the *Indo-Pacific Atlas* explores, through four connected studies, the causal effects of urban growth, progressive development, rehabilitation, and spectacular transformations in the recent urban histories of the region.[5]

Act 2: Contradictions

The *Indo-Pacific Atlas* was initially produced as a student project in an institutional format. It was intended as a working document, a tool in research and for the visualisation of architectural data. The *Atlas*, during the events that it was displayed as an architectural document, caused debate not only amongst researchers but also academics involved in the discussions surrounding the project. The *Atlas* was displayed and presented at:

1. The Masters by Research and Master of Architecture studio review.[6]
2. The 2015 Chicago Architecture Biennial.[7]
3. The *Fieldwork* Exhibition, UTS DAB Gallery, 2016.[8]
4. The Masters by Research Stage One examinations.[9]

These events sparked internal debate between directors, researchers, and collaborators during production and display, and animated discussions between its external audience as the *Atlas's* communicative and disciplinary relevance was interrogated.[10] These debates occurred for the entirety of the *Atlas's* production phase, when it was read as a paper during symposia, and when presented as an object that explained academic research. The *Atlas's* display as a beautiful object also activated critique on its role as an architectural and design-led research document, or, as a spectacular and anecdotic object produced for commercial audiences.[11]

This paper addresses the *Indo-Pacific Atlas's* controversial reception as an architectural and a research document. On the one hand, through practice-based research methodologies, the *Atlas* as a tool in architectural or artistic production is contested. On the other, its ability to accurately communicate and represent research findings is challenged by its spectacular image. Both the internal and public debates surrounding the *Atlas* clarify that it is an object of visual power, an active working tool, and a document that stimulates academic discussion on the dissemination of knowledge all at the same time. This paper highlights the *Indo-Pacific Atlas's* methodology, its architectural processes and procedures, and its ability to identify, communicate, and discuss the urban transformations currently taking place in the Indo-Pacific region.

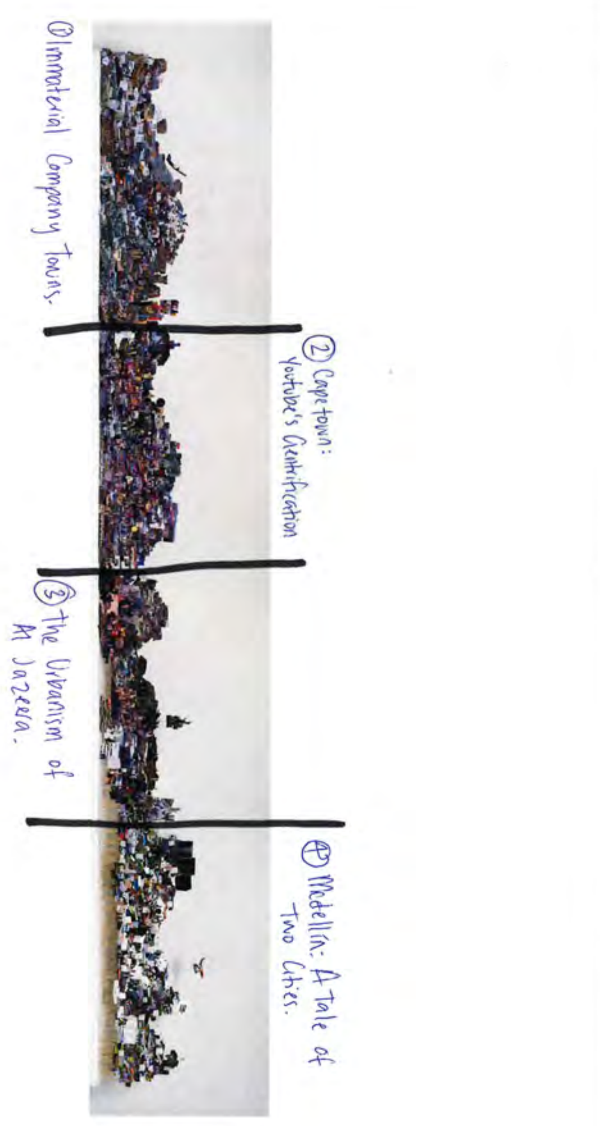

Figure 1: The *Indo-Pacific Atlas* composition.

Act 3: The Elephant in the Foyer

The *Indo-Pacific Atlas* is an architectural installation first exhibited in the upper-level foyer of the Chicago Cultural Centre during the inaugural 2015 Chicago Architecture Biennial[12]. From a distance, the installation appears as a topography made from thousands of printed (coloured and greyscale) graphic documents of different shapes and sizes. These documents are a collection of architectural images, facades, interiors, streetscapes, aerial maps, and orthographic documents. Interspersed between these are photographs of human actors, screenshots, media clippings, scans, textual descriptions, and a series of found objects and architectural models. All the two-dimensional documents are printed in colour on 80gsm white copy paper. Each document is cut-out and mounted, like a placard, on 25cm bamboo skewers with clear adhesive tape. Architectural models are constructed from both white and coloured card and mounted accordingly on skewers along with all additional found objects. Depending on its location, each placard, or object, was adjusted in height and fastened with masking tape to additional bamboo skewers. Combined, and arranged in sequence, all documents are punctured through and held in place by four 2500x250x450mm white polystyrene blocks, producing a forest of thousands of bamboo skewers. The four polystyrene blocks are horizontally aligned and placed a top of eight white IKEA end tables.

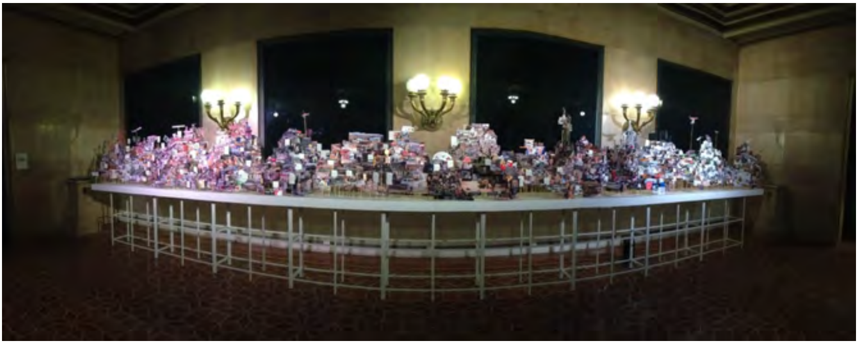

Figure 2: The *Indo-Pacific Atlas* as exhibited at the 2015 Chicago Architecture Biennial.

For display at the Chicago Biennial, the *Indo-Pacific Atlas* was accompanied by a four-channel sound piece that assisted visitors in navigating the installation. Speakers, and a sound system, were hidden in amongst the bamboo forest. Additionally, mounted on the wall centimetres away from the installation, a 300-word abstract summarised the *Indo-Pacific Atlas* as follows: 'The *Indo-Pacific Atlas* challenges current accounts of the Indo-Pacific region that focus on informal urbanism and tabula rasa developments. Rather, it claims the intersection of civil society, public institutions, and private capital as the space for architecture to operate.'[13] To further emphasise the *Indo-Pacific Atlas's* research claims, the installation was accompanied by an exhibition catalogue and website, physically and digitally archiving the object as a 'collection of maps of the Indo-Pacific region.'[14]

Act 4: Architecture? Research? Document? Tool?

The *Indo-Pacific Atlas's* classification as a 'collection of maps', positions it (as a unified document) within the well-understood modes of architectural representation. However, this also warrants an interrogation of the architectural formats with which it falls into. Is the *Indo-Pacific Atlas* an architectural document, or an artwork? What are the categorical architectural formats with which it sits? Does the *Indo-Pacific Atlas* adhere to these formats? And, if so, what are the consistencies, and contradictions, that position it within, or outside of these formats? Is the *Indo-Pacific Atlas* an architectural representation of a region, or is it architectural research? What are the representational techniques it employs? And, what exactly is it? A model, collage, diorama, installation, atlas, a research tool, or, all of them?

The *Indo-Pacific Atlas* is a diorama and a model, it is a dense assemblage of multiple juxtaposed documents that simulate an account of the Indo-Pacific region. It is non-linear in its format. It is a three-dimensional collage, and a model that contains multiple models. It is a panoramic collage built from 4000 printed images, archival documents, screenshots, drawings, data, text, models, and found objects. Therefore, as an architectural document, the *Atlas* is not one, but all the following: a diorama, a collage, a one-to-one model in totality, a collection of models, plans, sections, and photographs of buildings. The number of disciplinary documents that compose *The Indo-Pacific Atlas* seems to be enough evidence to consider it not only as a single architectural document, but also a vast, multi-channelled, and complex collection of architectural documents.

However, as previously mentioned, during the production process of the *Indo-Pacific Atlas* – as a project produced in an academic environment, and as a document produced for public events – it has been both accepted and rejected for its contribution to the architectural discipline. The *Atlas* has been publicly and privately defined as an artwork, as an artefact, and as a work of craftsmanship rather than an architectural object or document. It can be argued that the *Indo-Pacific Atlas* sits on the periphery of the discipline. Yet, there is a well-documented tradition of studio-led architectural production documented in alternative formats such as books, films, exhibitions, artistic installations, and performances. For instance, studies like *Learning from Las Vegas*[15], *Delirious New York*[16], or the cinematographic urban studies of Los Angeles developed by Robert Venturi and Denise Scott Brown together with their architecture students[17] are not considered to be unusual. Additionally, since the impact generated by the Global Financial Crisis, the development of the urban environment has, in some regions of the globe, shifted the disciplines attention to extend into research, the arts, and cultural production rather than traditional construction projects. For example, Andres Jaque's architectural installation (or artefact) *Ikea Disobedients* was purchased by the Metropolitan Museum of Modern Art in New York (MOMA)[18] and declared as part of its "architecture and design purchase fund" through its classification as an "architectural performance".

Interestingly, the *Indo-Pacific Atlas* was first presented in a biennial named 'The State in the Art of Architecture', a curatorial line that, even if ideologically misaligned, manifested its theme through a series of exhibition items, performances, and full-scale installations. The *Atlas's* appearance here positions it at the core of contemporary disciplinary debates, it also questions the numerous attempts at discrediting the *Atlas* as an architectural document by labelling it as merely an "artistic" object. Still, there are relevant questions concerning the *Atlas* that are yet to be clarified. Assuming its role as an architectural document, and its ability to communicate a regional scenario, how does the *Indo-Pacific Atlas* function in this format? True to its title, is the *Indo-Pacific Atlas* an atlas? If so, how does it sit within the typological understanding of atlases, or is it something else altogether? Furthermore, is it a complete and final product, or still a working document?

Act 5: Is it an Atlas?

Traditionally, the concept of an atlas involves the systematisation, or cataloguing, of a set of items. These items are primarily image based with textual support. Therefore, an atlas is a visual dictionary, or a repository of records that maps a specific subject. It is a communication tool, and a representation of observational sciences. Like the *Indo-Pacific Atlas*, an atlas acts as a collection of maps that depict either real or symbolic representations of a theme. Lorraine Daston and Peter Galison in *Objectivity* suggest that 'every new atlas must begin with an explanation of why the old ones are no longer adequate to their task, [and] why new images of record are necessary.'[19] In turn, this definition defines what is counted as an atlas and its value in re-mapping the sciences that it serves. Supported by this suggestion, the *Indo-Pacific Atlas* is named after, and claimed as an atlas. Like a traditional atlas, it is formed from images and supported by text. It is a record of a territory through a 'collection of maps', and resembling an atlas, orientates the viewer to observe its science in a systematised manner. As a book or volume, atlases are oversized and expensive collections of two-dimensional items. They are designed for longevity. The *Indo-Pacific Atlas* is not a book or volume. It is cheap in its manufacture, temporary in nature and constantly renegotiated as a collection of parts. In terms of its format, the *Indo-Pacific Atlas* is much more similarly aligned to Aby Warburg's *Mnemosyne Atlas*[20] rather than Abraham Ortelius's *Theatrum Orbis Terrarum (Theatre of the World)*.[21] Like the *Mnemosyne Atlas*, the *Indo-Pacific Atlas* was driven by intuitive logic, research, and scholarship.

Warburg, in the compilation of the *Mnemosyne Atlas*, trusted in the juxtaposition of symbolic images to advance an observer's insight into the afterlife through the pathos-charged images of Renaissance art and Greek cosmological symbolism. It is a cartography, exploring the movement between vast themes and genres, resetting the standards of how to describe, depict, and see its subject matter whilst transforming the long-established notion of what an "atlas" is supposed to be. Warburg created a "thought-space" of dynamic interchanges between once unrelated images to expose the underlying subjective and objective forces that have shaped Western culture.[22] Similar in approach, the *Indo-Pacific Atlas* compiles a range of two and three-dimensional items and rearranges them as a map, or "thought-space", of exchanges between various structures of power. Furthermore, expanding on Datson and Allison's definition of an atlas, the *Indo-Pacific Atlas* adds innovation in its field of enquiry and production due to its ability to chart the urban territory of a new geopolitical region, visualise its political and economic exchanges, and identify its social and cultural divisions.

Atlases are well known forms of documenting quantitative and qualitative forms of research broadly applied in the fields of cartography, biology, geology, geography, architecture, and urban studies amongst others. Sitting within the traditional and non-traditional definitions of an Atlas, the *Indo-Pacific Atlas* has provided the evidence that it is an architectural document. In its many editions, the

Atlas has been exhibited, photographed, published as an exhibition catalogue, and published as an academic paper.[23] It has also traced the steps of four Masters of Research (Architecture) students and their teams from the early research stages through to "completion". In its compiled form, the installation, the model of models, the collage of plans, sections and photographs, the catalogue, and the academic texts derived from it, the *Indo-Pacific Atlas* becomes an atlas not only of its theme, but also of architectural documents.

Act 6: Is it Research?

Korean philosopher Byung Chul Han[24] describes contemporary-time as an atomisation of historical-time narratives. He describes our time as the permanent juxtaposition of simultaneous atoms of the present as having no narrative connection, despite their permanent mutual aggressions; each atomic present competes against its contemporary other. However, in his critique, Han invites the audience to weave new narrative structures that challenge the former limitations of historical-time and current lack of narrative. We believe that the overwhelming and somehow spectacular impression that the *Indo-Pacific Atlas* causes for an uninformed observer opposes its powerful capacitation to weave unexpected connections through the atomised and simultaneous display of information that configures it. Moreover, we can claim that from our subjective experience, the *Indo-Pacific Atlas*, as a working document, operated as a booster for debate. It allowed researchers to refer, during their presentations and academic assessments, to non-linear data connections that evidenced their research hypotheses.

The *Indo-Pacific Atlas* was conceived as a tool to facilitate, and boost, the production of a research project that combined four independent projects into one overarching narrative. Its collage of thousands of juxtaposed images mounted on skewers punctured through white foam is not anecdotic. Rather, it is the result of a negotiation between the researchers and their teams in a combined effort to deal with multiple agendas like:

1. Finding the connections between seemingly unrelated topics and actors to map the urban image of a new geopolitical region.
2. Detecting the common circuits of urban transformation between the diverse and distant urban scenarios of each project.
3. Producing a seductive document to attract the attention of the public (and architectural) sphere highlighting the emergence of a new region and its specific urban constituencies.

The debated agency of the *Indo-Pacific Atlas* as an architectural object emerged from its early stages of production. The research had presented itself in a series of diverse iterations before it imitated the production logic of Geoffrey Farmer's Leaves of Grass.[25] Once the task of reformatting the *Atlas* in this way begun, superficial questions such as, "Does this look good here?" together with "Does this make sense?" enriched the *Atlas* with complexity, contradiction, and creative opportunity in the evolution of its construction process. The slow, crafty and non-linear process of negotiating compositional aspects and narrative relations between atomised fragments of information provided the opportunity to identify the hidden relations between information once unrelated. However, as a stand-alone object, the *Atlas's* capacity to transmit a clear message to a general audience is debatable. The sheer volume of information particles and narrative channels, without navigational guidance, might appear to be overwhelming.

Figure 3: Sketch on printed photo: “Detecting new connections, Chile and West Australia”

Figure 4: Indo-Pacific Atlas production phase.

Act 7: Is it complete?

Returning to Daston and Galison's definition that new atlases are to explain why their new records are necessary, we can discern how the *Indo-Pacific Atlas* received a mixed reaction from its audiences.[26] Firstly, as the *Atlas* developed, the relationship between researcher, student, supervisor, information, content, and production became ever more ambiguous with no clear leader, and at times, direction. Horizontality caused internal debates that already began questioning the role of the architectural document, its imitated production logic, and its crafty collage techniques; the *Atlas* was controversial before it was even made public. As project teams struggled to situate it as the result of a design-led research project, they were also critical of its aesthetic value. Consequently, each time the *Indo-Pacific Atlas* was displayed as a final product, all its former questions were continuously revived.

The *Indo-Pacific Atlas's* "instagrammic" fame will continue to challenge its capacity to optimise image-based architectural production; its inclusion in events like biennials and exhibitions will immortalise it as the spectacular image of a new region. Because of this, the *Indo-Pacific Atlas* does exactly as Daston and Galison suggested, it incessantly reiterates, explains, and argues its value in, and its capacity to, map the territory that it serves. Once the *Atlas's* controversies were embraced by the project teams, new narrative constructions highlighted the importance in its method and its incompleteness. Its haphazard and intuitive formation allowed for a fluidity in its investigation of the Indo-Pacific region and the geopolitical themes which it addresses. With new atlases come new uncharted territories, and with the changing conditions of transformative urban environments, the *Indo-Pacific Atlas* will remain, and must remain incomplete to serve its science.

References

[1] Urtzi Grau is a senior lecturer at UTS and co-founder of Fake Industries Architectural Agonism (FKAA).

[2] The four research projects that contribute to the Indo-Pacific Atlas are as follows:

a) *Medellin, A tale of Two Cities, Christina Deluchi:* Traces Medellin, Colombia, as a city that sets two parallel urban conditions against each other that have inherent proximity. Formerly known as the murder capital of the world and home to the Narco-bourgeoisie, Medellin was named the world's most innovative city in 2013 by the Wall Street Journal, Citi Group and the Urban Land Institute. Placing realisations of urban renewal adjacent to the recent trauma of the Narco-wars, the project reconfigures the urban strategies that have shaped the city since the 1970's.

b) *Immaterial Company Towns, Gonzalo Valiente*: Studies the historical linkages between extractive models of governance over Chile and Australia, and their mutation from colonial to late-capitalist regimes, as a non-interrupted project. It studies company-towns historically founded, managed, and many times abandoned by global corporations across both countries. The study identifies three late-capitalist mutations of traditional company towns: Valparaiso (Chile), El Salvador (Chile), and Perth (Australia).

c) *Cape Town Youtube's Gentrification, Kane Pham*: Ties the links between coexisting forms of gentrification in Cape Town, South Africa: the redevelopment of former industrial ports; the affluent youth culture taking over neighbourhoods historically associated with minorities or the working class; and the ZEF/Bogan/Darqueto culture portraits in the popular media that create value out of an unconditional rendition to the visual decadence of the ubiquitous enclaves of poverty.

d) *The Urbanism of Al Jazeera, Endriana Audisho:* Explores the effects of post-colonial media on the imaginary of cities. The rise of Al Jazeera during the Arab spring and its aftermaths destabilised consensual discourses on urban identity by appropriating western modes of representation outside their conventional symbolic orders.

[3] UTS Masters by coursework student researchers: Marston Bowen, Kim Angangan, Liam Corr, Eduardus Andrew Intan, Qian Zhang, Faraneh Jabalameli, Shokoufeh Rajaian, Melinda Barbagallo, Alice Zhaoying He, Natalie Xu, Hlaing Tun Oo, Abulizi Alimujiang, Zoe Phocas Deliat, Michelle Beck, Chrishani Thayaparan and Estelle Rahayem.

[4] Accessed July 30th, 2018. http://www.eastasiaforum.org/2013/05/21/australias-new-region-the-indo-pacific

[5] Joseph Grima, Sarah Herda, Andrea Bagnato, and Irene Sunwoo, The State of the Art in Architecture: Guide Book (Chicago, 2015) pg. 39

[6] In advance of the 2015 Chicago Architecture Biennial.

[7] The *Atlas* was exhibited as a solo object with limited discussion.

[8] The *Atlas* was discussed by collaborators at the event symposium without the inclusion of the research teams highlighting its ability to be interpreted objectively as a producer of knowledge.

[9] The *Altas* was presented as a product of the Masters by Research program at UTS whilst on display at the Fieldwork exhibition.

[10] Internal debates between directors, researchers and collaborators during production and external debates between researchers and invited jury members during public critiques.

[11] For example, the *Altas* existed for three months as an intriguing autonomous entity, an elephant in the room, in the upper-level foyer of the Chicago Cultural Centre.

[12] Accessed May 15th, 2018. http://2015.chicagoarchitecturebiennial.org/

[13] Joseph Grima, Sarah Herda, Andrea Bagnato,and Irene Sunwoo, The State of the Art in Architecture: Guide Book (Chicago, 2015) pg. 39

[14] Urtzi Grau, Indo-Pacific Atlas (Sydney: The University of Technology Sydney, 2015) pg. 3

[15]Robert Venturi, Learning From Las Vegas: The forgotten symbolism of architectural form (Chicago: MIT press, 1977)

[16] Rem Koolhaas, Delirious New York: A retroactive manifesto for Manhattan (New York: The Monacelli Press, 2014)

[17] Accessed June 22nd, 2018. http://radical-pedagogies.com/search-cases/a15-las-vegas-yale-school-architecture/

[18] Accessed June 20th, 2018. https://www.moma.org/collection/works/156886

[19] Lorraine Daston and Peter Galison, Objectivity (Chicago: MIT press, 2010) pg. 23

[20] Accessed July 29th, 2018. https://live-warburglibrarycornelledu.pantheonsite.io/

[21] Accessed July 29th, 2018. https://archive.org/details/theatrumorbister00orte

[22]Accessed July 29th, 2018. https://live-warburglibrarycornelledu.pantheonsite.io/about

[23] The Atlas is to be presented at the 2018 Annual Design Research Conference (ADR18) and published in the conference's proceedings.

[24] Byung-Chul Han, The Scent of Time (Cambridge: Polity Press, 2017)

[25] Geoffrey Farmer's *Leaves of Grass* exhibited at dOCUMENTA13, 2012. Imitating *Leaves of Grass* was a suggestion from the research supervisor Urtz Grau.

[26] Lorraine Daston and Peter Galison, Objectivity (Chicago: MIT press, 2010) pg. 23

The Melbourne Section: A Context Specific Design-Research Applied Across A Strategic Metropolitan Territory

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Abstract

How we balance the competing demands of the global economy with local employment, food production, water resourcing and management over the long term is a central question for urban designers. Building on Sassen's and Jacobs' theories of diverse urban environments as sites of creative opportunities, our research by design project set out to examine how we can utilise urban assets which model resilience, innovation and regeneration.

Our hybrid approach draws on a series case studies of Melbourne and a wide set of methods: first-person inquisition, historical investigation, demographic analysis and rigorous mapping to challenge planimetric thinking. Our hybrid urban project tests how found patterns of collaboration can be extracted and implemented in a densified form and how learning from each site's local synergies, interactions can inform wider thinking across territory. While our findings on latent substrata of urban innovation which are rooted in the history of place potentially hold a key to global resource shortages our design strategies show how connecting existing innovation seeds new productivity. Ideogrammatic mappings spatialize opportunities in unexpected adjacencies between knowledge, production and cultural-exchange centres, unearthed through non-quantitative sources of information.

Adaptive Economy of Diversity and Productive Cities

Our visionary proposal addressed questions of urban adaptation, asking how to balance economic, social and ecological priorities and renew our cities while building on existing assets. The project identified core themes around re-industrialisation and productive diversification; clean water, energy and urban food production; the linking of education, research and productivity; and thinking in wider production networks and cycles. Our understanding of innovation as a spatial driver for thriving cities was crucial towards the conception of the Melbourne Section.

Diversity and resilience are necessary for any self-sufficient, innovative economy, avoiding dependence on too few industrial sectors, importation and fluctuating global markets. The development of new sub-sectors, as discussed in the Melbourne Section project, contributes to adaptive innovation. Mitigating threats of pollution, climate change and resource exploitation, future-oriented industries targeting inevitable challenges also strengthen the export prospects of our own products.[1]

A vision of the city emerges, focussing on networked, diverse and sustainable economies, addressing water, food, energy resources needs. The city is rethought as a place of production rather than consumption. Through harvesting new synergies between existing structures, seeds for innovation are found in existing conditions. Because of its adaptive nature, research by design is best suited to investigate existing structures to be relinked and augmented, as conventional methods fail in gaining a complete and qualitative picture of complex spatial situations. Emerging questions are centred on where to implement connective ideas and new inserts in real contexts. Here designers can complement the work of economists, as spatial design methods are rooted in the investigation of existing urban conditions within our cities. Rather than introducing generic new concepts from the outside, as is commonly done by audit companies operating increasingly in the urban field, we believe in pinpointing and expanding these often-hidden urban potentials and translating them into visual design-research.

Urban potential is driven by the presence of a population with diverse knowledge and experience: a creative pool of professionals, density of education and research institutions, as well as traditions of entrepreneurship and diversity of small, medium and large companies, according to the Australian Government.[2] Cities reveal varying measures of innovation potential depending on the density of their pre-existing spatial and cultural connections. We imagine these substrata to operate like rhizomes. Growing under the visible surface of the city in a network-like manner they produce shoots when achieving a critical density of connections. This botanical metaphor is used by Deleuze and Guattari and describe their non-hierarchical and ever-changing nature of historical and cultural origin.[3] Seeds for future development can be found in such latent conditions, ready to sprout when a critical degree of interconnection is achieved. If these seeds can be identified, strategies of improving networks and connections can be developed.

Spaces of Encounter and Creativity, threatened by Corporatization

New spatial or experiential connections, promoting the encounter of people of different backgrounds, skills and experiences, trigger creativity, new ideas and innovation, when combined with spaces of opportunity, according to Sassen. Interwoven as personal networks and narratives they generate sub-economies, which form the strands of larger metropolitan ecosystems.[4] Massey describes, how each new connection or mixing creates new opportunities.[5]

But these opportunities found in existing diversity, are threatened by big corporations, globalisation, homogenisation and corporate. Sassen critiques how cities are increasingly expelling people and diversity, to replace them with an astoundingly homogenous ‘new global culture of the successful’ and ‘replacing the diversity of urban subjects produced by historical cities, by international “corporate subjects” with a similar cultural background.[6] This replacing of existing diversity by new corporate culture, which in actual fact is not producing any vital resources for the city but mostly managing things, can be found in Deloitte’s, “innovation heat maps” for Sydney.[7] Global corporate companies increasingly engage in the realm of city planning and design, replacing urban designers, and propose schemes to future proof urban areas through ‘innovation’ in their globalist approach.

Deloitte urban plan for Sydney surveys “hot pockets of innovation” which borrows and claims the artistic lexicon of ‘creativity’, ‘collaboration’ and ‘innovation’. This appropriation is in line with other global audit companies such as PWC or management educators such as Harvard Business School who have altered the meaning of creativity, collaboration and innovation.[8] They claim to grow these “in vitro” in the testing grounds of business schools, start-ups and businesses, before re-implanting them into cities, without link to existing local urban tissue. Existing urban economies, diversities, social networks and ecologies are at risk of displacement and disruption through these alien implants, consequentially threatening local place-specific potential for creativity and innovation.

Furthermore, these hot pockets of innovation are comprised of ‘business leaders with an innovative mind-set’ who work for ‘innovative corporations’ not of diverse urban actors from multiple backgrounds.[9] If we assume that innovation is sparked by collaborative relationships where creativity exists in multi-authorial platforms empathetic to different strata of society, then such documentation by audit companies is too reductive to produce real innovative and resilient economies. It covers global ‘business leaders’ who exist in carefully defined boundaries of capital and economy, dismissing more complex notions of who or what seeds opportunity, creativity and innovation.

Reclaiming the notions of creativity, and urban design

Under new business models, creativity and innovation become commodities, which are managed quantitatively rather than triggered by qualitative urban conditions. They negate the essence of Sassen and Jacobs’ conceptions in which creativity is linked to existing urban diversity, production and making. Corporate culture borrows an artistic language for a corporate culture and purpose and detaches the meaning from the production of objects or goods, moving fast and breaking things on the way.[10]

Creativity is also inherently contrary to the conception of managing and control. It is driven by opportunity, tacit acceptance, tolerance of niches, eccentricity and being outside of the norm. It is something that cannot be quantified or GIS-mapped, but can be identified, located and qualified in diagrammatic, synthetic and metaphorical mappings and documentation. The value in the mappings and documentation lies in its location and acknowledgement of its value, prefiguring its salvaging from displacement. By drawing new connections, new spaces of opportunity and tolerance can be created for innovation opportunity and cross fertilisation.

Design approaches established from creative potentials which are latently present in urban conditions offer an inclusivity and depth which is missing in large-scale corporate redevelopments. Urban creativity cannot be conceived as an isolated, transplantable organ or tissue grown in vitro, but rather as a network of ideas rooted in the city's socio-political and creative conditions and urban ecosystems. Urban design-research such as we propose can address more complex qualitative demands of different social strata, while building on existing relationships, experiences and activities at human scale, preserving the innovative nature of cities. Such soft and invisible factors and urban conditions are often revealed through non-traditional forms of qualitative investigation, going beyond GIS and data mapping of high yield companies and professionals.

Innovation is non-linear, open and often un-quantifiable, similar in nature to cities themselves, as described by Massey. They are essentially meeting places consisting of a geography of social relations, impossible to understand without the connections to elsewhere - a process rather than a thing.[11] The methods uncovering new innovation potentials therefore have to operate on a qualitative rather than purely quantitative level. They have to be empirical and based on strategic interrogation of individual milieu and existing conditions through multiple methods and lenses that reveals a complex picture of a multi-facetted reality. Intersections, junctions and inflections of existing interpersonal relationships inform future hybridisation more effectively than any top-down form of implantation. Mirroring the nature of conditions assessed, methods should ingeniously combine different sources of information and ideas, focussing on expanding readings of existing narratives and opportunities, rather than importing new ideas without connection to the place, while combining different modes of creative production.

Figure 1: Melbourne’s expansive urban region.[12]

The Melbourne Section Approach

As newcomers to Melbourne we were intrigued by our local colleagues’ narration of a fascinatingly diverse territory, which from the outside looked so homogenous. This contradiction led us to start a research project cutting through Melbourne’s enormous urban boundary. A particular band of territory- spanning Melbourne’s inner core to its urban hinterland was analysed and partitioned into a series of smaller components to understand differences between rings of urban development.

It followed a pars-pro-toto approach, with the possibility to expand the project at a later stage to other sections. The intention was to create a site-specific contemporary version of Geddes’ metropolitan ‘valley section’, explaining roles and relationships between different rings of suburbia within an ‘urban’ ecosystem formed by the urban region, while also drawing an ‘urban’ parallel to McHarg’s sections in Design with Nature.[13]

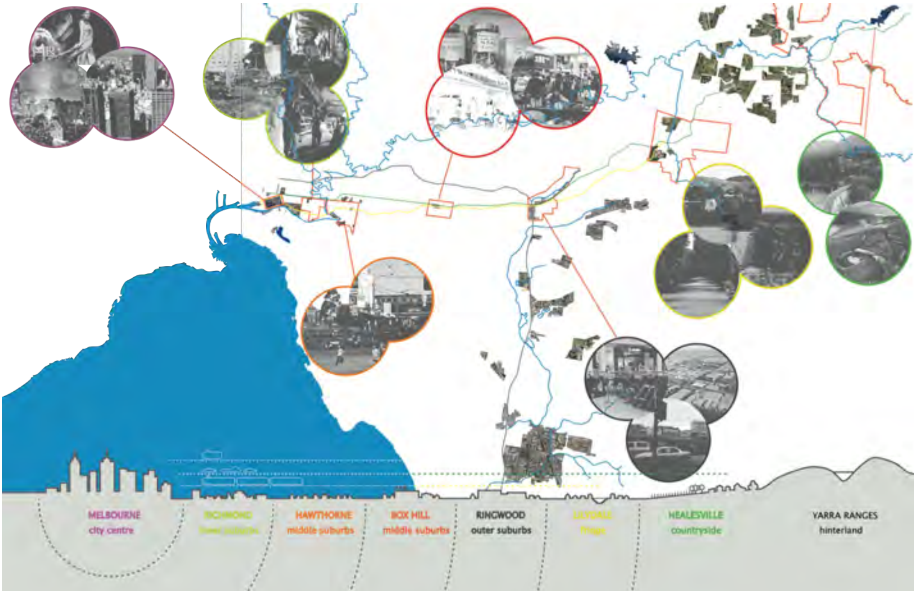

Figure 2: The Melbourne Section.[14]

Tomographic Section and Multi-Lens Observation

A slice of Melbourne's historical lineage was chosen for its inclusion of one of the first highways, train line and the Yarra River. Circulation routes and watershed formed common entry points and infrastructures to a series of sites which later allowed to pull the investigation together. An assumption on pre-existing potentials that allowed for the determination of a defined territory was informed by informal surveying of our peers and cross-checked by readings of aerials, maps and ‘biopsy-like’ site visits. The intention was to use a ‘tomographic’ observation method, derived from medical radiography, for the observation of a series of critical points along a linear trajectory. It allowed us to zoom in on particular points in space, gain a deeper understanding of overall spatial relationships, and see the interconnectedness of investigated locales and new synergies.

In deciding on the sites, we searched for local disruptions, extremes and oddities to confirm our hypothesis of hidden difference between the different components of the section: were there particular demographies to be found, missing, concentrating or revealing particular age groups, affluence, origin or mixity? Were there particular activities or signs of changing occupation (building sites, day-night activity, peak-hour, events)? Were there intriguing forms of urbanity (particular building forms, types, sizes, eras etc), disruptions or thresholds preventing urban development?

Seven sites were initially selected. Each location was subsequently investigated through a sequence of different observational lenses. Our method of looking at the same site from different disciplinary perspectives was drawn from medical anamnesis, where generalists call in specialists assessing a particular problem from different angles. It enabled us to subject each component to the same set of questions:

urbanistic lens/ urban maps

- how do things relate spatially?
- are there breaks in the urban grain?

historical lens/ timelines

- how have things changed over time?

sociological / interviews

- how do inhabitants think about their place
- what do they appreciate / miss, how do they live

geographical lens/ data maps

- how do things translate in official numbers

demographical lens/ statistics

- how do they affect who lives / works there

documentary lens/ photo surveys

- how do they affect the use of public spaces

Our findings revealed different realities within the same territory. At times they complemented or added detail, at other times they revealed contradictions or differing viewpoints. Interviews provided information of lived realities, which in some examples, brought statistic findings into question. Data mapping showed to miss some un-quantifiable information, while historical disclosure offered explanations to site developments.

Connecting and Expanding

These two methods of tomographic dissection and the multi-lens perspective allowed us to distinguish spatial and cultural components and re-join them later. Empirical findings and first-person impressions were compared to official surveys, maps and studies to create a multi-facetted snapshot of the site. Unexpected ideas for innovative designs emerged when joining up information in diagrammatic territorial maps of our analysis of cultural components. The findings were then strategized in a series of workshops, led by the authors, where large sketches or vision maps were utilised to visualise the findings and identity the connections, propositions and interventions which might seed new opportunities. The maps revealed formerly undetected potentialities and relationships, but as importantly the disconnections and missing links. The ideo-diagrammatic visual language of mapping clarified complex issues and were the turning point in in our decision to re-focus our designs on the generation of creative new synergies.

Melbourne Section Projects revealing Unusual Findings

The project's sectional investigations started from Melbourne's centre and moved progressively towards the peripheries through rings of urban development. Increasingly, each suburb revealed a particular role in our investigation.

These findings consolidated into an overarching framework, emerging from the investigation of Melbourne's future economy.

Richmond's Situation: Unearthing an unexpected economy of urban farming

Figure 3: Richmond's Informal Food Economy.[15]

The method of combining different observation lenses enabled us to uncover particular under-the-radar production networks in Richmond. Our investigation revealed a 'behind-the-scenes' style of living though photo-documentation, interviews on site, and historical mapping which contradicted the official data. A generational tradition of urban farming, fresh-food markets and street restaurants within the Vietnamese community represented a thriving, local economy of self-sufficiency which is notably hidden from conventional statistics and GIS maps.

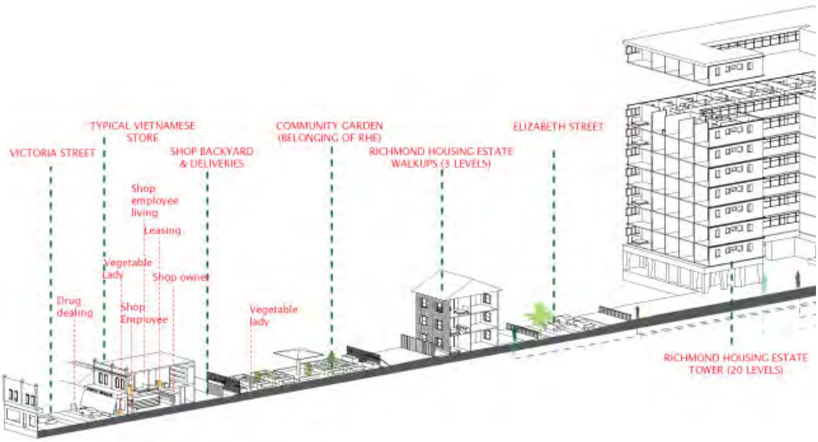

Figure 4: A cross section through Richmond.[16]

Our graphic documentation of shop frontages and temporary stalls, scattered with fresh fruit and vegetable show unseen commerce between shop owners, urban farmers, small restaurants and the wider public. It reveals the complexity of generational roles. The elderly, for example, teach and encourage the growing of traditional Asian vegetables, while rearing children, while the middle-aged generation run the shops and restaurants and are the landlords renting out the flats above the shops to younger employees.

Our research further found evidence of conscious intersections between the formal and informal economy. Improvised food stalls, for instance, are tolerated by shop owners in exchange for selling leftovers. Evidence of non-commercial food production as a discreet category is also visible around the commission housing flats where locals run large community gardens for their own consumption. Interviews led by native speakers, living within the community, further supported evidence of unexpected economic cycles and interconnected skills.

Richmond: Proposing Urban Food Hubs

Figure 5: Seed Project.[17]

The expansion of existing intergenerational networks was investigated on exemplary high-density projects. One example contains housing for families and elderly with balconies to grow their own gardens. A food research centre bridges to high yield production sites, offering employment and education, while building on intergenerational knowledge transfer. A market lined with food stalls and restaurants creates a social and commercial interface, overlooking the hustle-and bustle of people and goods at the station.

Our design tested synergies appearing in co-locating programs around urban food production. It spatialized a higher-density application of a successful but unnoticed form of production, while implementing community ideals of development, empowerment and increasing formal employment through farming. Through design speculations, reinforcing existing use-patterns, new urban typologies emerge, while leveraging existing infrastructures.

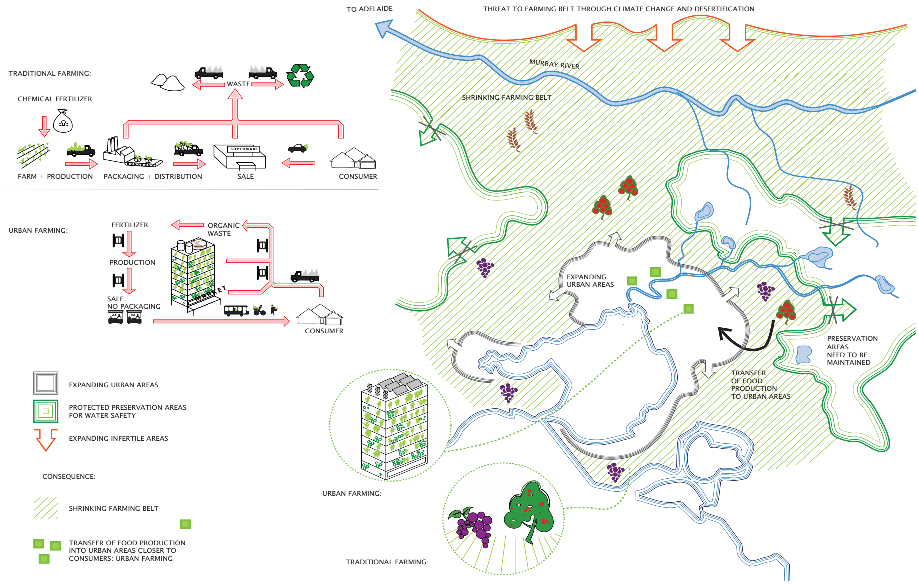

Figure 6: Urban Food Production.[18]

The proposed seed-projects address the increasing pressures on agricultural land surrounding Melbourne, threatened by desertification and urban sprawl. These were evidenced by mappings and surveys done in Healesville. This Industrialised central urban cultivation, possibly run as cooperatives, localises food production, while reducing manufacturing, packaging and transportation. New green employment opportunities and urban vegetation can be created here while expanding on an existing local savoir-faire.

Ringwood: Advantages for Production though Clustering

In turning to the middle ring suburb of Ringwood, we investigated its potential role in urban production, research and development. New urban food production could open up new demands for innovation and production, as requirements for research and development for industrialised farming equipment and water treatment becomes apparent. The location of Ringwood at the head of the Dandenong production corridor would economically and socially benefit its strategic position, at a time when car industry is visibly in decline. Notably, the area has a high rate of both young families and elderly but is not attractive to young professionals with cultural capital.

At the same time, we were intrigued by both the physical clustering of businesses and the evidence of an established economic chain reaching between small medium and large companies, leveraging off each other, and interconnecting with subsidiary businesses such as legal and accounting. While business and infrastructure proximity is an asset, we also noted some of these interconnected businesses were disadvantaged by a separation though bisecting transportation routes.

Figure 7: Ringwood's strategic position at the head of Dandenong Corridor.[19]

After identifying scale in aerial maps and confirming its underuse though economic studies and 'biopsy' site investigations we re-interpreted this precinct as a smaller-scale Silicon Valley for Eco-Tech. Our redevelopment proposed to re-use the area to house incubation spaces for maker start-ups, businesses, and production, integrating current research and manufacturing. This informed the mappings addressing synergies between production, research and education, determining strategic locations for new research and education centres. Urban food innovation could inform an industrial transition from automobile industries to agricultural and hydrological products in the currently struggling Ringwood-Dandenong employment corridor.

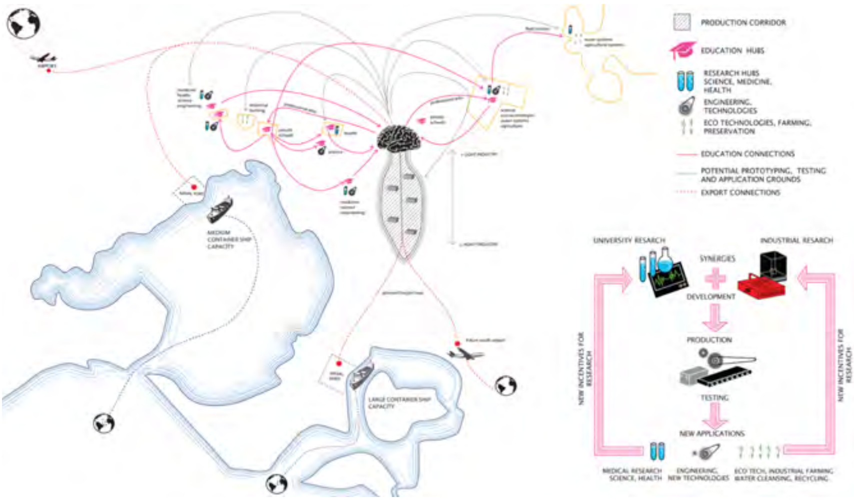

Figure 8: Production and Innovation Networks.[20]

Ringwood: Proposing an Incubation Hub for Eco-Tech

After identifying scale in aerial maps and confirming its underuse though economic studies and 'biopsy' site investigations, we re-interpreted this precinct as a smaller-scale Silicon Valley for Eco-Tech. Our redevelopment proposed to re-use the area to house incubation spaces for maker start-ups, businesses, and production, integrating current research and manufacturing.

Figure 9: Ringwood Commercial and Production Cluster.[21]

The speculative project establishes physical linkages between various scales of industrial and residential fabric on both sides of transport routes. Our designs further advantage existing infrastructure, proximity to research and services, and production clusters. The project houses business and production spaces of different scales, a plateau of flexible incubation space as well as dense living close to work and amenities for younger and older demographies. The idea is to facilitate exchange of ideas, knowledge, professional experience, supporting multiple needs for research and development in advanced manufacturing, agriculture systems, eco-tech, clean energy and water technologies. Building on pre-existing clustering of businesses, it extends these mechanisms of exchange in a hybrid and interconnected urban form, using design to reinforce exchange potentials.

Overall vision

Drawing the themes together an overall vision emerged: Melbourne's central business district forms a counterpoint to the picturesque Yarra Ranges recreation and preservation areas.

The two endpoints of the section bracket the production and innovation areas in the middle segments including Richmond's urban farming and Dandenong's industrial corridor. These localities are further complemented by diverse research and educational facilities in Hawthorn and Box Hill, nurturing skill and talent contributing to future research and innovative production. Informed by the particular urban conditions of each suburb, the synthetic mapping of heterogeneous findings across the three scales- city, suburb and precinct - allowed a holistic approach.

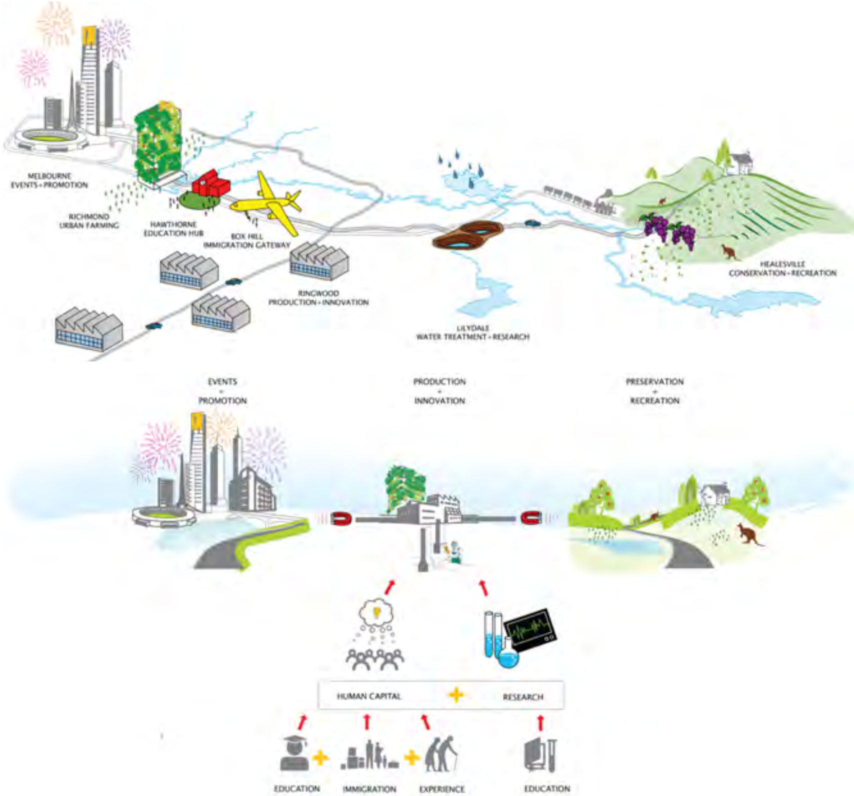

Figure 10: Production and Innovation Networks.[22]

Large synthetic mappings enabled us to connect unexpected findings from different sites along the section to find new synergies, while leaning on common infrastructures. They revealed potentials for innovation to address future urban food demands, loss of land though city expansion, and efficiency in food-waste networks.

It was the bridging, jumping and connecting between scales and observational lenses which enabled us to detect potentials hidden behind the urban surface, -such as Richmond's informal food industry, or Ringwood's clustering of businesses around accounting and legal services- unrecorded by data surveys of high-value-companies and GIS maps. The design-research and the mappings revealed a surprising diversity of site and potentials.

Particular Sites - Universal Themes

New opportunities emerge when unforeseen innovation potentials or seeds are planted and spurred into new catalytic relationships which make connections through ideas, space, infrastructure, and resource-sharing. Innovation can then generate new productivity which in turn can trigger new innovation. These connections build on the idea of exchange as an incubator for knowledge and ideas which can generate new research, applications, technologies and manufacturing. Understanding the particular and multiple histories of our sites, however, was crucial in establishing a sensitive and considered speculation on its short- and long-term future. The historical context informed our understanding of existing conditions and our decision-making process as it allowed for a more accurate enhancement of each locality’s existing qualities and informed our strategies for the sites. While each site's findings, conditions, and proposals are site-specific, they also reflect upon multiple challenges in metropolitan environments around the world.

Moreover, a holistic study of urban territory, experiencing existing urban activities and interactions between people, institutions, companies, urban fields and spaces offers the base for a spatial strategy through urban mapping. It reveals local specificities, creative activities and groups from within a large, seemingly homogenous territory, and positions them in the scope of metropolitan urban networks.

The Death of Modern Hospitals: Towards a Comprehensive Approach for Restorative Healthcare Environmental Design

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Abstract

This study criticises the design strategies of today's so-called sustainable hospitals which mainly focus on reducing the hospitals' adverse impact on the environment and energy consumption rates. Based on a review of the historical literature, the study offers an alternative approach to creating a true sustainable hospital, a restorative environment that connects human health with nature by combining *salutogenic* and *biophilic* design principles with restorative environmental design strategies. The positive impacts of biophilia, the inherent human affinity to affiliate with nature, on both humans and nature have been demonstrated through rigorous and empirical studies over the past 40 years. In 2008, Restorative Environmental Design (RED) was introduced by Stephen Kellert to integrate biophilia and environmental design principles to have a more beneficial impact on both building users and the surrounding environment. Still, implementing this approach in design practice is a challenging mission. Green building and evidence-based design principles are the main guidelines used by architects and planners to design hospitals, but little attention is given to improving the relationship between building users and nature. Further research is therefore required to facilitate implementing the RED approach in healthcare design. RED is based on Stephen Kellert's *biophilic* design attributes which need to be tailored to fit the complex needs of healthcare architecture and to consider restorative environment design principles. This study addresses common ground between *biophilic* design and *salutogenic* design by taking a comparative approach, exploring two case studies of recently constructed hospitals in Australia and Singapore to generate a comprehensive design framework. The targeted Restorative Healthcare Environmental Design (RHED) should be tested as a suggested model in introducing *biophilic* design to the healthcare design and planning community in a realistic and practical way. However, a more comprehensive assessment of the proposed framework is needed.

Introduction

Today, the global community shares a set of challenges and threats about health and well-being. Climate change, the noticeable spread of debilitating chronic diseases, waves of nature-driven or human-made epidemic threats, geriatric illness due to an ageing population, mental health concerns including anxiety, stress and depression lead to an endless list of irreversible social, cultural and economic issues. Meanwhile, over recent decades significant breakthroughs in medical treatment and diagnosing technologies, have been realised. However, chronic and lifestyle-related diseases are on the rise, and our hospitals are struggling to keep up with the consequent accelerating demand.[23]

The built environment of modern hospitals still plays a marginal role in the healing process, following design principles of the late modern era of the 1950s and 1960s. Such an architectural withdrawal has led to the predominance of medical and technological determinants over the design of hospitals; on the other hand, fulfilling emotional, psychological and social needs of patients, supporters and caregivers has either diminished or been neglected.[24] However, two promising design approaches are emerging in the healthcare design arena: *salutogenic* and *biophilic* design.

The theory of *salutogenesis* resulted from extensive research by Antonovsky during his long journey in *unravelling the mystery of health*. He assumed that good emotional, psychiatric and somatic health is maintained through the ability to cope with changing circumstances during a human's life.[25] While *Biophilic* design is stemmed from Ulrich suggestion in his psycho-evolutionary theory that exposure to safe, natural areas is inherently restorative because such settings were associated with survival during humanity's long evolutionary history.[26] Such an ancient bond between innate human affinity and natural systems and processes is defined as *biophilia* (love of nature).[27]

Salutogenic and *biophilic* design principles ideally serve the agenda of Restorative Environmental Design (RED) which highlights two overarching concepts: 1) nature can play a significant role in restoring the health and well-being of humanity, and 2) in response, human beings can change their lifestyle to show mutual respect and restoration to nature. This approach redresses an essential gap in the hypothesis of sustainable design, as "green" architecture will not suffice if its users do not enjoy it and find it worthy of maintaining in the long run.[28]

This study is driven by a key question: How does hospital architecture play a role in restoring the psychological, cognitive and social capacity of its users? The terms 'healing', 'therapeutic' and 'curing hospitals' have been widely used in the past decade. This study uses a mixed methods approach to the literature review of the recent body of empirical and clinical research that seeks to investigate the correlation between nature, and human health and well-being in multi-settings. It also takes a descriptive approach to exploring a set of contemporary, environmentally driven design trends in healthcare. The study pays attention to those trends which acknowledge integration between man and nature as a part of the healing process. Finally, a proposed framework is suggested for employing these approaches in designing the hospitals in the future.

Problem statement: The crisis of modern hospitals and the prospects of 'healing space'

The history of a healing environment and the crisis of modern hospitals

Until the 16th century, people depended on their contact with nature to experience a multi-sensory context dominated by environmental features such as light, sound, odour, wind, weather, water, vegetation, animals, and landscape.[29]

Traditional architecture provides a set of well-perceived examples of life-enhancing architecture which addresses all human senses simultaneously and fuses our image of self with the surrounding natural world.[30]

Historically, therapeutic nature was the embodiment of human pre-modern culture and still exists in some regions worldwide. Apart from western civilisation's degradation of nature, the far eastern principals of Feng Shui aim to create a balance between nature and the built environment.

Architectural phenomenologists claim that haptic architecture of the traditional and historic building has a much more substantial impact on cognitive, intellectual and social behaviour than the poor, materialistic and fragile architecture of the modern era.[31]

Psychological determinates of the crisis in modern hospitals

In contrast to the pre-modern healing environment, the architecture of today's hospitals undergoes two major determinates. Firstly, it is located within a high-density urban environment, which causes many people to become saturated with the sense of vision which surpasses all other human senses within a man-made context apart from connection to the natural environment.[32]

Pallasmaa, a Finnish architect and theoretician, further argued that western architecture across most healthcare buildings was manipulated to feed our desire for control and power through focused vision, while traditional, mostly eastern, architecture tends to lessen our focus and liberate the gaze from its patriarchal lens.[33]

Secondly, human segregation from the natural world has occurred in parallel with technological advances in the 19th and 20th centuries.[34]

Several studies addressed the offensive manner of handling psychological and spiritual aspects in modern architecture due to a fascination with technology.[35]

In the hospital environment, our separation away from nature, in its most literal sense, occurred during the mid-20th century, when hospital design was entirely dedicated to confined, industrial and sterile spaces.[36] Moreover, the seduction of modern architecture set buildings apart from users' needs. Pallasmaa stated:

> "The buildings of our own time may arouse our curiosity with their daring or inventiveness, but they hardly give us any sense of meaning of our world or our own existence."[37]

Theoretical framework: Healing environment and Restorative Environment Design (RED)

In response to the crisis of modernism, an incremental increase in the investigation of the impact of nature on human well-being has been witnessed in recent years. The term 'healing environment' was referred to by Stichler as "*a physical setting that supports patients and families through the stresses imposed by illness, hospitalization and medical visits*".[38]

Restorative Environmental Design (RED) was one of the earliest approaches to redefine the integration of natural elements within the built environment and used as a tool to promote psychological restoration. It also represents an emerging response to the continuous inadvertence of modern architecture to the needs of both its users and the natural environment.[39]

RED stemmed from two distinctive theoretical and empirical premises, which constitute a holistic perspective regarding a suitable environment for human adaptation, resilience and restoration: Attention Restoration Theory (ART) by Kaplan, and resilience domains theory (RDT) by Jonas et al.[40]

Attention Restoration Theory (ART)

This theory assumes that every human has depleted psychological, cognitive and social resources when responding to stressful daily activities. Kaplan claims that exposure to natural elements, especially water, vegetation and fresh air, can play a restorative role by providing interest-driven attention or fascination for humans in their encounter with the environment.

Resilience Domains Theory (RDT)

The healing capacity of humans is highly related to their resilience and restoration across four domains: physical, mental, emotional and spiritual (Figure 1).[41]

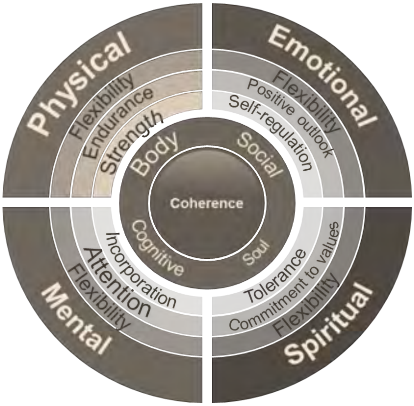


Figure 1: Four domains of human resilience and restoration.[42]

These domains can be reflected in the RED hypothesis. Thus, our study recommends using these dimensions to map the design framework of a nature-related healthcare environment that can evoke the genetic interaction between humans and nature, to provide a balanced and coherent healing environment for patients and staff within medical settings.[43]

***Biophilic* and *salutogenic* healthcare design: The missing framework**

The merits of a 'patient-centred' approach, prioritising patients over process, can be traced back to the courageous reform of hospitals by Florence Nightingale two centuries ago. Despite its humanistic origins, the concept of patient-centric care in modern hospitals diverged to support the work of physicians, with patients viewed as individuals who received care rather than being active participants in their journey of recovery and well-being.[44]

More recently, some emerging approaches to post-modern hospital design dedicated more attention to the features of 'patient-centred care', such as evidence-based design, the *salutogenic* design of the Plane tree, *biophilic* architecture and others. These features were developed to provide an adequate physical design for hospitals regarding usability, accessibility and controllability; access to external areas to promote a sense of normality; supportive environments for effective communication between patients, staff and relatives; and to facilitate more 'access' to the natural environment.[45]

Among emerging trends, *salutogenic and biophilic* hypotheses offer a comprehensive understanding of the relationship between humans, the built environment and nature.

Salutogenic design

According to *salutogenesis*, health-promoting resources have three related domains to enhance human life and provide a sense of coherence: (1) comprehensibility (to compromise and negotiate life challenges), (2) manageability (to manage daily physical realities in order to maintain homeostasis), and (3) meaningfulness (to desire living and to resist the entropy of sickness and extinction) (see Table 1). These domains can provide holistic theoretical guidelines for the objectives of health-promoting architecture beyond the specific findings of experiments and design interventions.[46]

In reflecting on hospital design, the extrapolation of *salutogenic* theory is an overarching criterion in decision-making design when dealing with stress-sensitive patients.[47]

***Salutogenic* domains**	**Architectural application**	**Impact on patient/staff**	**Key literature**
Comprehensibility	Common rooms	Control	Andrade et al., 2017 [48]
	Interactive healing gardens	Contribution	Jencks [49]
	Public activities (gardening, feeding pets, etc.)	Social enrichment	Garnham [50]
Manageability	Fewer nurse stations	Security	Andrade et al., 2016 [51]
	Private patient rooms	Independence	Chaudhury, Mahmood, and Valente [52]
Meaningfulness	Home-like settings	Sense of belonging	DuBose et al. [53]
	Meditation gardens	Meaning for life	Cleveland [54]
	Spiritual spaces	Hope	McCaffrey and Liehr [55]

Table 1: Domains of salutogenic healthcare design and its impact on patients and staff

Biophilic design

The *biophilic* relation with nature is a fundamental biological need that influences human health, productivity, well-being and even existence.[56] A *biophilic* design approach hopes to go beyond the standard goals of green architecture in merely lowering the environmental impact of buildings. This approach can reinforce the confident and secure connection between nature and humans to promote mutual restorative enrichment.[57] Hence, Kellert proposed 70 *biophilic* attributes that could potentially influence the design of the built environment.[58] (see Table 2).

Biophilic elements[59]	Possible attributes to use (samples)[60]	Benefits in key literature
Environmental features	Colour, water, air, fire, sunlight, plants, animals, natural materials	Stress reduction.[61] Relaxation and attention restoration.[62]
Natural shapes and forms	Arches, vaults, domes, tree and columnar support, shapes resist straight lines and right angles, natural shapes and forms Bio-geometry	Pleasure and satisfaction.[63] Attention and cognitive restoration.[64] Promoting health.[65]
Natural patterns and processes	Growth, central focal point, patterned wholes, transitional spaces, fractals, hierarchically organised scales	Mental restoration and inspiration.[66] Positive distraction.[67]
Light and space	Natural light, place connections, filtered and diffused light, spatial variability, inside-outside spaces	Less period of stay in hospital.[68] Pain relief, social restoration.[69]
Place connections	Avoiding placelessness, sense or spirit of the place, integrating culture and ecology, Indigenous materials Landscape orientation	Reduced mental fatigue.[70]
Evolved relations to nature	Prospect and refuge, order and complexity, enticement and curiosity Change and metamorphosis, affection and attachment, exploration and discovery	Improved concentration, attention and perception of safety.[71] Reduced boredom, irritation, fatigue.[72]

Table 2: Patterns and attributes of biophilic design

Thus, both *salutogenic* and *biophilic* design features can work in harmony to create a therapeutic healing environment within our hospitals. Thus, we suggest using *salutogenic* principles as an overarching guideline to inform the proper implementation of *biophilic* attributes and patterns. Based on the recommendations of empirical findings (Table 2), resultant settings will restore the depleted resources of patients and medical staff in different zones within the hospital (see Table 3).

Salutogenic domains	Targeted benefits[73]	Supporting biophilic element(s)	Possible zone(s)
Comprehensibility	Give a dynamic feeling of security, confidence and control over a predictable external and internal environment	Place connections Natural patterns and processes Environmental features Light and space	Clinics waiting for areas, emergency triage zone Daycare surgery Maternity and birthing units
Manageability	Enhance patient's resources for recovery, the sense of independence and the subsequent atrophy of essential life skills,	Natural patterns and processes Environmental features Light and space	Inpatient nursing units Long-stay nursing homes Recovery and intensive care units
Meaningfulness	To promote a sense of belonging and inspire the search for human's identity and respect for socio-cultural mores	Evolved relations to nature Natural shapes and forms	Patients/family common rooms Healing and meditation gardens Roof gardens

Table 3: Integration between salutogenic and biophilic design to create restorative settings within the different zones in healthcare facilities

Implementation in healthcare architecture

Equipped with understanding the patient, a nature-centred philosophy in *salutogenic* and *biophilic* design, the health architects paid more attention to the therapeutic impact of architecture to promote the recovery of patient resources.[74]

As a result, a new generation of healthcare facilities were based on recalling the human senses to be part of the game. The designers of hospitals tended to deify the incorporation of natural light and ventilation, views to the outside, connection to green spaces, and colour and spatial strategies to create healthcare environments that are both supportive and therapeutic.[75]

This study selected two pioneering case studies of salutogenic and biophilic hospitals to inform the outline of the design framework of healing hospital in the next section.

The Lady Cilento Children's Hospital in Brisbane, Australia was a leading *salutogenic* hospital in 2010. This project went further than merely applying good views and daylight into the building. It explored the concepts of story-making, psychology, neuroscience and endocrinology as health-promoting tools.[76] (Figure 2).

The hospital layout and spatial settings were inspired by a "living tree" model to generate a group of light-filled atriums and a network of double-height spaces branch out. The implementation of natural biomimicry was employed to satisfy the psychological and emotional restorative needs of the hospital users. Likewise, Khoo Teck Puat Hospital in Singapore was nominated as a role-model of *biophilic* hospital architecture with abundant planting, attracting native wildlife.[77] (Figure 3).

Figure 2: *Salutogenic* design of the Lady Cilento Children's Hospital in Brisbane, Australia.[78]

Figure 3: *Biophilic* design of Khoo Teck Puat Hospital, Singapore.[79]

The core aim of designing this hospital is to make it fully merged with nature and to act as a rainforest-like built environment. This nature-driven design responds to several senses, from sight of abundant greenery and water features to the smell of those plants and the sound of falling water.

Both case studies showed unintentional application and mixing the principles of both salutogenic and biophilic design. Both buildings are live examples of sustainable healthcare environments which use natural elements as restorative and healing agents for patients, family and staff, and the broader community. Nevertheless, the delay in widespread implementation of design approaches in healthcare settings is due to the lack of a comprehensive framework to achieve the sought after balance between users' needs and the requirements of nature for restoration and recovery. A primary reason for this delay in design approaches is the absence of association between design approaches, and the research agenda for medicine and environmental psychology.

Discussion: Mapping a comprehensive framework of Restorative Healthcare Environmental Design (RHED)

Human resources undergo an endless cycle of stress and restoration throughout the course of human life. Thus, the healthcare-built environment, according to RED theory, can play a significant role in the cycle of restoring the four domains of human resources, which become depleted during the process of resisting illness or suffering from injuries or pain. Furthermore, a need for more intense restoration increases during the phases of venerability in a healthcare environment. In this study, we have attempted to construct a comprehensive framework for designing a restorative and healing environment based on modifying the RED model for adoption in hospitals (Figure 4).

To construct such a framework, three questions need to be answered: (1) What are the components of this framework and how will they operate to work in harmony with evidence-based design and a patient-centred approach to healthcare? (2) Where precisely is this approach most likely to succeed within the hospital environment? And (3) For whom are they most likely to fit?

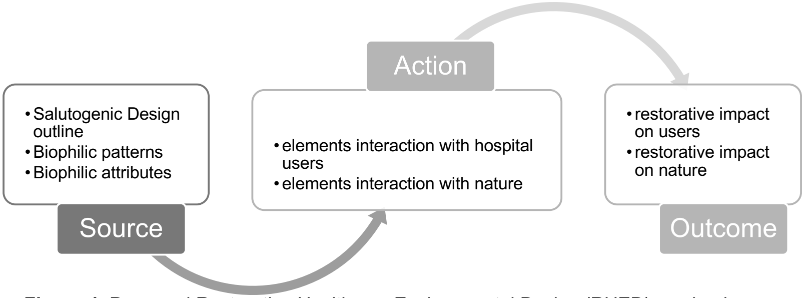


Figure 4: Proposed Restorative Healthcare Environmental Design (RHED) mechanism

RHED framework components and mechanism

The suggested framework can be generated by combining a group of theories and design approaches for environmental psychology, human behaviour and analysis of neural processes that occur in the brain.[80]

The three domains of restoration in *salutogenic* design formulate the overarching objectives of this framework (i.e. to achieve a comprehensive, manageable and meaningful healing environment). Design patterns, attributes and settings for *biophilic* design are tools which should be used to achieve the abovementioned objectives. The two theories of restorative mental well-being (ART and RDT) will act as the theoretical guidelines for future empirical and clinical studies to find the proper solutions for achieving a restorative healthcare environmental design (RHED) within different hospital settings.

Settings of RHED

The parameters of RHED can differ according to the intensity of stressors and the types of depleting factors regarding user's resources. Accordingly, it is recommended that RHED techniques take place in specific areas within hospitals, where stress, depression and anxiety symptoms are most likely to affect patients, families or caregivers. Meanwhile, hospital zones can generally be classified into five categories according to the intensity of stressors. They include: (1) high risk emergency departments, intensive care units and operation theatres, (2) day surgery and chronic treatment units (e.g. oncology), (3) diagnostic clinics, imaging departments create anxiety for patients due to the extended waiting period and anticipation of unfavourable outcomes, (4) common spaces including lounge areas and social spaces can play a crucial role in mitigating the level of stress within hospital zones, and (5) outdoor therapeutic gardens can be an indispensable source of restoration and recovery.[81]

Beneficiaries of RHED

Both *salutogenic* and *biophilic* approaches re-orient hospital design to seek a healthy and restorative environment for all users. Most crucially, RHED can support patient's health, well-being and restoration rather than focusing on the causes of disease and designing hospitals that only treat sickness.[82]

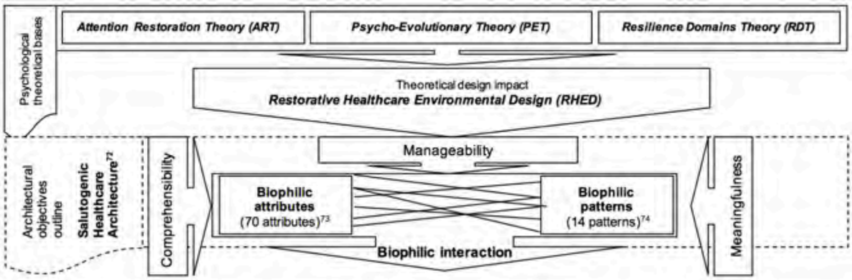
These approaches also enhance the physical, mental and emotional well-being of medical staff to avoid burnout, stress and lack of focus to avoid medical errors.

Figure 5 summarises the RHED framework that synthesises both *salutogenic* and *biophilic* design approaches in response to the needs and settings of both patients and medical staff within the five abovementioned categories of medical parameters, according to the level of tension and stress within each category. The diagram shows briefly the outcomes of earlier research literature that connects between the hospital's main users (patients and staff) and nature in five different categories of spaces within the hospital. Such a connection has various degrees of restorative impact on the physical, emotional, mental and spiritual needs of both patients and medical staff.

Conclusion and implications for practice

This paper has shown that traditional healthcare facilities until the pre-modern era inherently implemented some design techniques to create a built environment that both promoted health and was nature related. The reasons behind the current crisis in 'modern' hospitals in relation to the aggressive separation of users from the natural environment and presumable threats are highlighted. Thanks to the evolution of the green design movement in the 1990s, connections were established between improving environmental quality and human physical, psychological and social well-being in the built environment.[83] This research drew attention to the theory of Restorative Environmental Design (RED) which tends to restore the relationship between humans and nature within the built environment. Also, this study suggested that *salutogenic* and *biophilic* design principles, based on extant research from other disciplines as well as case study research, can ideally play a restorative role in mitigating symptoms of psychological and mental illness, for both patients and medical staff in different healthcare settings. However, the review of earlier studies showed there is no comprehensive setting to link these elements or patterns with much needed spaces within our hospitals.

This study has sketched a blueprint of a holistic framework of Restorative Healthcare Environmental Design (RHED) as a suggested approach of employing *salutogenic* and *biophilic* design elements to create an active healing environment within hospitals. It is recommended that RHED should be applied in certain areas within hospitals, where stress, depression and anxiety are most likely to affect patients, families or caregivers. A more comprehensive demonstration and assessment of the proposed framework is however needed. RHED requires empirical testing to prove what type of restorative environment is needed within each healthcare setting, and when and how much time should be provided for hospital users to experience such an environment.



		Zones of healthcare services (order according to the potential level of stress for patients and medical staff from 5 (highest) to 1 (lowest))				
		(5) Acute care settings (Emergency, ICU, Operation Theatre)	**(4) Treatment and recovery setting** (Day surgery, patient room)	**(3) Diagnostic settings** (Clinics, Imaging, labs,)	**(2) Common facilities settings** (Reception, cafeteria, waiting room)	**(1) Outdoor spaces**
Patient	*physical* *emotional* *mental* *spiritual*	**Low restorative impact.**[62]	**High restorative impact.**[63]	**Average restorative impact.**[64]	**Average restorative impact.**[65]	**High restorative impact.**[66]
Staff	*physical* *emotional* *mental* *spiritual*	**Average restorative impact.**[67]	**Above average impact.**[68]	**Low restorative impact.**[69]	**Low restorative impact.**[70]	**High restorative impact.**[71]

Figure 5: Proposed Restorative Healthcare Environmental Design (RHED) framework.

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ADR18

The Virtual Place in Architectural Design Research

Chaired by Dr Rachel Couper

Critiquing Hypermediated Public Space Through Exploratory Design

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Andrei Smolik

Architectural Graduate.

Abstract

[FIHSIHKAHLVRRCHUWAHL<>] (pronounced “physical-virtual” and abbreviated to FV) was an interactive media art installation that experimented with the integration a gestural computer interface with an architectural surface through the use of computer vision. It was exhibited within the Claremont public promenade, Western Australia (WA), as a part of the Public Platform urban prototyping competition, 2016. The project challenged the conventional use of surveillance technology as a means of controlling public behaviour by exposing its presence through playful interaction, facilitating a dialogue between participants and the authors about the use of locative technology in the design of cities.

In this paper we outline the design process and methodology in order to examine the relationship between conceptual experimentation, computer simulation, the design of the architectural form, and the design of the interactive programme. We then reflect on the outcomes of the installation, showing different ways the work generated opportunities for engaging the public in discussions about the impact of surveillance technologies in public space. We then discuss political and ethical tensions that placemaking introduces to design-research and identify how future urban prototyping projects might reveal and critique hypermediated space – public spaces in which cultural productions are tested for fitness based on their ability to attract and hold the attention of large flows of people.

Introduction

In the last decade there has been growing interest in the use of digital displays, electronic sensors, actuators, and surveillance cameras in the creation of interactive art in urban public spaces.[1] These urban interventions have emerged from a wide range of actors such as artists, architects, and designers, whose works produce novel aesthetics and critical speculations around the use of developing technologies. Concurrently, the same digital technologies are being deployed in “Smart Cities” research to develop new products and systems that increase the efficiency of urban processes such as traffic control and security.[2] Increasingly, these two practices have become blurred as interactive public art is utilised by institutional researchers as a means of understanding and experimenting with social behaviour. Design research conducted in the context of urban renewal and placemaking initiatives provides the benefit of a live context in which the effects of developing technologies can be tested and critiqued. However, the use of surveillance technology to shape perceptions of, and interactions with art and architecture in public space presents political issues around the agency of urban dwellers and ethical problems around the collection of user data, especially when this is obscured by the design of the object.

FV was an interactive media art installation exhibited within the Claremont public promenade, WA. The project consists of an architectural folly with integrated lights and speakers, and a gestural interface with wireless IP camera and a computer that processes live video data to track the position of people relative to the structure. FV combined two research interests of the authors; the design of systems of parametric aggregation and methods of digital fabrication related to their construction, and the design of an interactive system, integrated with the architecture of the proposed design. Both aspects of the project were examining how personal devices, location-based social networks, and pervasive computing mediate our understanding and experience of the built environment. Many dialogues around this topic identify a diminishing role for centralised public spaces as sites of public discourse as network culture has produced a distributed and dynamic social space which influences our understanding of local contexts.[3] These relationships are not evident in the embodied experience of public space and so we were interested in ways that relationships between digital information and physical space might be transformed into a spatial phenomenology.

In the following sections we discuss the context in which urban prototyping has emerged. We then outline the methodological approach to the design of the FV project to identify how it differs from related projects. Next, we examine the design process, breaking down the components of the prototype which were used to experiment with relationships between location-based data and public space. We then reflect on the outcomes of the installation itself, showing how the work generated opportunities for engaging the public in discussions about the impact of surveillance technologies in public space. Finally, we conclude by proposing exploratory design as a strategy through which future urban prototyping can be used to reveal and critique urban space that is being excessively or adversarially affected by digital media.

Digital Placemaking

Globally, cities are becoming increasingly surveilled to facilitate pervasive computing systems which automate and manage increasingly complex flows of things, data, and people. Simultaneously, networked culture has placed cities in competition with each other to access these resources.[4] Architecture and public art play an important role in emerging practices of placemaking which aim to “activate” city spaces to increase their economic and social benefits for their stakeholders.[5] Research plays an important role in placemaking practice as it reveals new markets and increases the efficiency of existing design approaches. Proponents of placemaking such as the thinktank Project for Public Spaces, claim that it provides further benefits for the community by “maximizing the shared value” of public spaces.[6] Increasingly, data derived from pervasive computing and location-based social networks is analysed to optimise placemaking practices.[7]

Methodology

There are several different research methodologies that have emerged around the integration of surveillance technologies in public spaces. Using the framework developed by Faste and Faste, these can be divided into two broad categories:[8]

1) **research on design** aims to understand the impact of design upon urban processes through analysis of quantitative and

qualitative data derived from urban sensors and location-based social media

2) **research through design** develops design approaches through the testing of experimental prototypes.

A combination of these approaches manifests in concepts of Urban Informatics and Urban Prototyping. Bilandzic and Venable define urban informatics as the "development of new technological means to resolve contemporary issues or support everyday life in urban environments".[9] Interventions created in urban informatics research are developed in response to clearly identified problems and are presented as research experiments. Urban prototyping, on the other hand, is a form of interdisciplinary research that combines urban sociology, human computer interface design, and architectural design in the production of interactive public artworks. The distinction between these two approaches is important as the framing of research around the design of interactive public art or architecture often obfuscates value-laden approaches to research with the intent to manipulate social activity. The project presented in this paper belongs to the urban prototyping category or research through design that can be further broken down into three methodological categories:

3) **Materialistic Approach** is focused on directly producing benefits for material contributors. Projects such as those of Behrens et al., Dalsgaard and Hansen, and Hespanhol and Tomitsch experiment with novel interfaces, spatial effects and their integration within existing urban contexts to produce new products and processes that can be integrated into the design of public art and architecture.[10] These projects are validated by their ability to transform social interactions and produce economic benefits for urban stakeholders.

4) **Critical-Speculative Approach** is primarily a speculative exercise designed to tease out potential solutions to urban public spaces or to point to unknown or unstated problem/s. Projects such as those described by Korsgaard and Brynskov, take an approach similar to the critical or speculative design of Dunne and Raby where interventions are used to provoke discussion and debate around ethical, cultural, social, and political issues that might emerge from the use of new technologies.[11]

5) **Participatory Making Approach** focuses on finding ways of involving various parties connected to the urban space in the design process. This third approach can be seen in the work of Caldwell and Foth whose DIY urbanism takes an approach similar to participatory action research where collaborative projects between researchers and laypeople are examined to find more effective ways of involving local communities in the design and production of public space.[12]

Exploratory Design is a combinatorial approach that analyses design through the lens of these methodological categories. The Materialistic approach is embedded in the context of the FV project competition which was validated by its ability to increase levels of social activity in public spaces and produce economic benefits for material contributors. This approach relates more to the placemaking brief of the FV project which came into conflict with less pragmatic aspects of our methodology. (which will be discussed in detail later in this paper). The Critical-Speculative approach is used in Exploratory Design to reveal ethical, cultural, social, and political issues that are presented by techno-social change, however it is less didactic in the way that it presents them. Also, in Exploratory Design the outcome is not a completed product but an open ended and imperfect prototype that is used to provoke critical discussion with a public audience. In this way it relates to Critical Making, in which these issues are communicated through heuristic engagement with the material both by the designers and participants with the work.[13] This leads to the use of the Participatory Making approach, which in the case of this research is not validated by its ability to generate “community engagement” but through its ability to reveal relationships between emerging technologies and the production of space and share the experience of these relationships with its audience. Additionally, Exploratory design draws from Donald Schön’s concept of “reflection-in-action,” whereby design decisions are directed through interactions between the maker and the material.[14] These insights emerge from an embodied interplay as the designer acts on the material, reflects on the response, and develops the design in response to unforeseen outcomes.

The Project

FV was submitted as an entry into the 2016 FORM Public Platform Urban Prototyping Competition.[15] The event was derived from the Market Street Festival, which funded speculative urban prototypes to find approaches that could be reused in other placemaking initiatives. The PPUP competition shortlisted 26 proposals and provided them with seed money to produce an urban prototype. These were then exhibited at a two-day event where a jury of three professionals (an architect, an urban planner, and a politician) selected a winner. The organisers provided a project brief from which we could develop a conceptual approach, access to a public space, assistance with equipment, facilities, and insurances, and limited funding for the construction of the installation. These benefits, however, were partially offset by the deadlines and requirements of the competition, and the need to produce a design that would also effectively attract and maintain the attention of festival goers. These constraints were not entirely anticipated at the beginning of the project but were revealed through involvement in the process.

Our approach to the issue of surveillance technology in the design of public space began by experimenting with rudimentary analysis of the online presence of different organisations and businesses through a custom data-scraping program developed in Processing. This data was integrated into a spatial model of the site that also created an agent system that speculated on the confluence of flows of people both online and in space (see Figure 1, 2). As part of the focus of the urban prototyping on the idea of objects in space, we conceived of a form that developed from the same set of integrated digital analysis and modelling tools as the interactive systems. Reflecting the idea of a constantly shifting ‘virtual topography’ layered over the public domain, the form was developed as a surface influenced by simulated agents to inflate and give rise to a catenary network mesh (see Figure 3). During the design process we integrated a carrier skeletal frame into what originally was a collection of interlocking components for structural reasons and the interactive part was reduced to a central cube element (derived from internal anchor points of the catenary network) which contained the light and sound producing hardware. The form of the components evolved from individual sensing/interaction parts to more general amplification cones for sound that were linked to the original triangular mesh subdivisions.

The idea of a ‘virtual topography’ layered over the public domain is carried over to the design of the digital interface. Previous installations by the authors had experimented with the use of screens to represent tracking data from surveillance cameras and the use of LED lights. In the case of this project, sound was used instead as primary output. Interactions with the artefact were framed as a game of “hot and cold”, this system was chosen as a starting point for our design because of its intuitive logic (the direct relationship between cause and effect), the fact that it is a culturally familiar form of play, and that this form of interaction is directly tied to subjects’ proprioceptive understanding of space (See Figure 4).

The field of interaction was conceived of as a zone around the object, defined by the limits of the field of view of the tracking camera and marked out on site as a bright dashed line to aid users in identifying where the limits of this space were (see Figure 5). Upon detection of a person entering the tracking zone, the program would place an invisible marker somewhere within. The user’s position would then be calculated relative to this point and the distance and position information would be used as inputs into a sound synthesis algorithm. The synthesizer was built on a process called additive synthesis which layered a set of modulated frequencies randomly drawn from a list of standard musical notes, the result of which was an undulating waveform that’s tempo and pitch was controlled by the distance of the user to the invisible object. The field of sound created by the synthesizer provided real-time feedback to the user, so that they could navigate around the object to find the invisible marker. Upon finding a point, a second system would activate, reading out the latest tweet about the event through text-to-speech software.

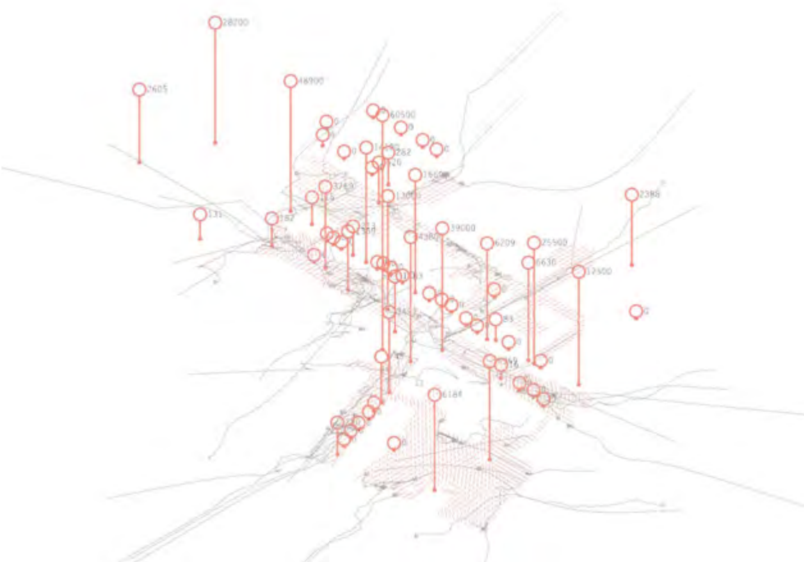

Figure 1: Agent swarm simulation visualisation based on 3D mapping of online presence of organisations and businesses forming a hypothetical field in space to which agents respond to.

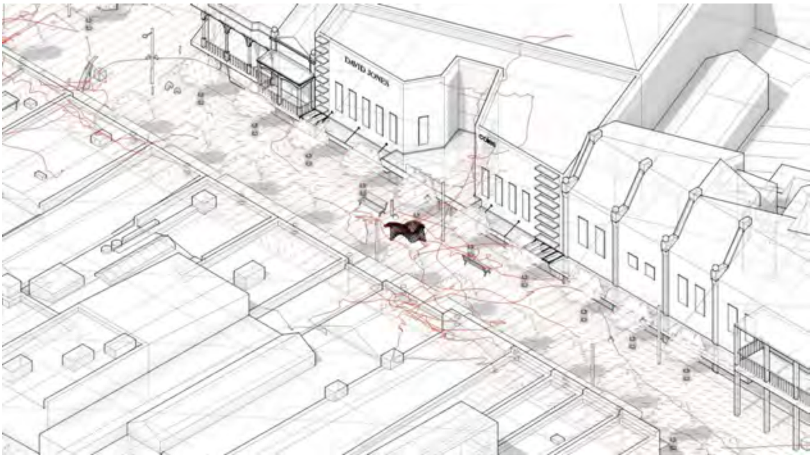

Figure 2: Diagram of agent system and its relation to the placement of the object on site.

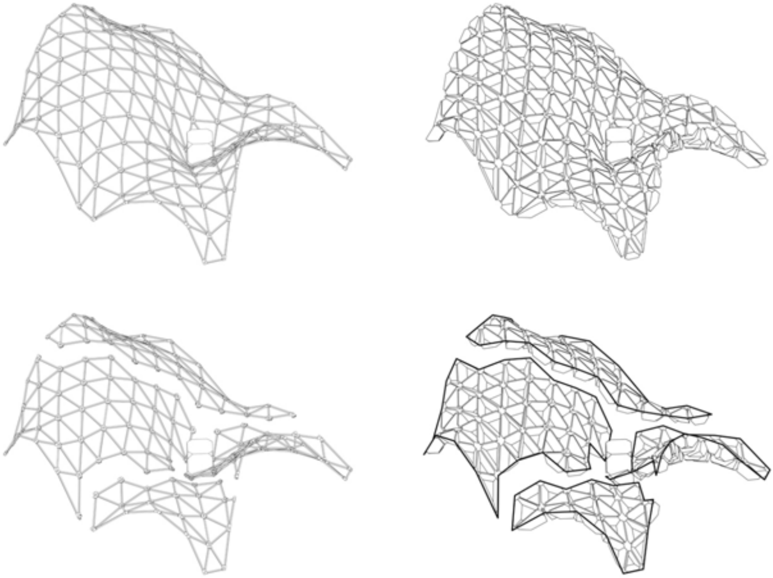

Figure 3: Isometric diagrams showing subdivision of structural system (left) and cladding system (right).

Figure 4: Diagram of interactive system.

Discussion

In the context of urban public spaces, assertions that specific approaches to cultural production are superior to others are problematic as they embody political and value-laden understandings of urban problems. These are "Wicked Problems" for which there is no singular stakeholder and no optimal solutions.[16] Despite this, claims of such optimisation from groups such as PPS or FORM are wide-spread and often give false or incomplete impression about the design process, its narrow set of parameters and desired outcomes: "Whenever a public space is judged to be successful because a community of users has been established, we should be suspicious. In whose interests is such cultural homogeneity or integration established, and in whose image?".[17]

The application of surveillance technologies to direct the curation and design of cultural production in public space leads to the production of *hypermediated space*. In hypermediated space public art and architecture are tested for fitness based on their ability to attract and hold the attention of large flows of people. This can be seen in the “Makers on the Market” research findings published by Gehl Studios as a part of the Market Street urban prototyping festival in San Francisco where quantitative analysis of activity in relation to urban interventions is used to justify their success.[18] The validation of creative production through statistical methods is problematic as it limits the scope of action available to the public to intervene within the city through their own agency. The possibility of such a situation necessitates critical reflection of design-research practice in urban public spaces to better understand the outcomes of these techno-social interventions.

Reeves et al. produce a framework for understanding the systematic relationships involved between parties that engage with digital interactive public artworks.[19] The parties they identify are performers, spectators, and orchestrators. Manipulations are the actions made by the performer/s that produce effects that are the physical or digital products of those manipulations. Orchestrators are people or software that operate in the background of the interface, hidden from public view but vital to the running of an installation. The degrees to which manipulations and effects from each of these parties are hidden or revealed sets the measure for this framework. Reeves et al. also argue that in the case of certain types of performance, the obfuscation of manipulation and orchestration is necessary to enable effective, legible interaction and more entertaining performance. The presence of orchestrators in interactive works is necessary for their functioning, however this is often concealed from the audience.

Herein lies a problem in the use of digital interactive art in public space. Any obfuscation of the relationship between the artist and the audience restricts the capacity of the audience to critically respond to the installation. In cases of non-digitally mediated public performances, this relationship between the authors and the spectators is clear. In the case of urban prototypes, participation in research is often unclear or taken without consent. Hiding the orchestration of interactive artworks may lead to more spectacular spaces and events but in the context of public space this threatens to produce hypermediated space. Urban interventions have a responsibility to engage in a more open dialogue with the public, allowing for interference rather than reducing its possibility by increasing degrees of orchestration.

In the FV project we did this by choosing to make explicit relationships between manipulations and effects so that users could respond to them. It did this by making visible the computing equipment and code it used, by making explicit the camera equipment which was collecting and manipulating data, and by making the interactive experience a process of revealing orchestrations through embodied manipulations. The authors, as orchestrators of the installation, were also present in the space – discussing the project with the public, showing how it worked (and didn't work), and allowing people to interact with the code itself.[20] This added a performative aspect to the work in which we were able to discuss issues relating to surveillance and public space with those who interacted with it (See Figure 6). The systems of surveillance and control are purposefully made accessible both from the design point of view (through interactions with camera inputs and manipulation of location-based social media information) and physical exposure of its functional components. This approach aims to discover ways of revealing systems of control and surveillance, find new ways of conceiving such works that through the use of a spectacle both interactive and formal, and use interactive protocols applicable to architectural design which engage digital and hyper-mediated contexts.

Figure 5: Exhibition - performer and spectator interaction, PUBLIC Platform 2016, FORM. Photograph by Bewley Shaylor, 2016.

Dalsgaard and Hansen, Hespanhol and Tomitsch, and Reeves et al. all claim that embodied interaction with media installations in public space should be considerate of the social and environmental context that they are placed, however, none of these authors define what they mean by public space or community. The authors suggest that the use of their frameworks will allow designers to produce more "appropriate" interactions with computers in public spaces. By curating specific types of interactive experiences based on their social context, and controlling the balance between manipulations, effects, and orchestration, these projects justify their value by finding more effective ways of attracting and capturing users. Hespanhol and Tomitsch suggest that there is a social value to this in the way that it provides the opportunity for physical interaction with people in cities which they claim has been lost due to our increasing reliance on personal devices. However, as urban theorists such as De Waal, Cuff, Massey, and Willis have identified, while digital technology detaches the public sphere from centralized public spaces, this does not reduce the capacity for embodied interaction between people in the city but expands and distributes it.[21]

If the collection and manipulation of data is obfuscated through the design of an interactive installation this reduces the ability of the user to understand how their actions are being monitored and for what purposes. While it could be argued that data related to activity in public space is a positional public good, access to that data is often determined by private and institutional interests.[22] So too is the software that controls these systems and the knowledge to be able to understand and work with it. The opacity of the urban spectacle of media architecture and interactive art conceals systems of control and surveillance which are often inaccessible to the public. In public space with large crowds of people interacting with the works it is difficult to establish consent. So far writing on this subject assumes that consent is given to record information about people because they are in public space. If people were aware that this data is being used to manipulate their behaviour this might provoke a different response.

How then might artists and designers intervene within public spaces without being subsumed into processes of placemaking? The answer may be found by reframing our understanding of what public space is and its relation to cultural production. As Crawford explains, the public sphere is not a property inherent to any place or space but is an event that emerges at sites of conflict.[23] Opportunities for transgression may emerge if cultural production is approached as something that can produce public space rather than something that is sited in it. This opportunity depends greatly on how urban prototyping is approached, whether it obfuscates hypermediated space through pure spectacle, or whether it reveals and critiques its emergence.

Conclusion

Exploratory design as a novel approach to urban prototyping presents a way in which hypermediated spaces can be revealed and critiqued. This design-based methodology approach interprets construction of digitally mediated public spaces by critiquing the reliance on quantifying interactions in a space and instead emphasises the content and transparency of design of these interactions. When urban prototypes conceal the methods of digital surveillance that enable the production of spectacle, issues emerge around the agency of participants. The use of covertly obtained data to optimise the design of urban interventions to attract attention for the sake of increasing the economic benefits of public spaces for urban stakeholders contradicts traditional conceptions of public space as a site of free and open public discourse. The FV project attempted to address this problem through a design intervention which enabled users to experience relationships between locative technology and urban space in a heuristic and embodied fashion. By making explicit the digital mediation that generated the interaction conceived as part of the spectacle of the work, more open-ended dialogues between participants, the interactive system, and the designers themselves could emerge around the idea of public space.

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Media Architecture and Spatial Systems: Mediated Realities in Architecture

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Abstract

In a multimodal era in which behavioural and cognitive factors are exploited within a range of digital conditions (computers, mobile devices virtual/augmented reality), media architecture and spatial systems (MASS) propels integrated strategies on digital prototyping and virtual/augmented reality (VR/AR). This study tackles the notion of multimodal design as different modes of experiencing space and design via a digital “Correalist” strategy between location, people, and behaviour. Built on a trifold relation between space, media, and technology, the research fosters the importance, creativity, and integration of immersive technologies and prototyping for future applications. Through a spatial relation between VR and architecture, the research addresses a system that correlates the use of virtual reality and robotic fabrication. The strategy was conducted in a design studio to test correlations between the physicality of design and its virtual stance. The use of virtual and interactive spaces offers a heterotopic form of experience whereby places and spaces function in non-hegemonic conditions through parallel tectonic and virtual conditions. The research exposes an overlooked relation between the virtual and the real, whereby space, media, and technology foster the importance and creativity of virtual design and its physical expression.

Introduction

With its origins in the aviation industry and later its adoption by architecture, computer-aided design (CAD) has changed the practice of architecture. From design representation to construction and intrinsic to the digital medium, CAD technologies have revolutionized architecture. Yet, these technologies are still in their infancy and have the potential to radically change the way we design in the coming years. Beyond CAD, VR will be thrusting new concepts in design, where their purpose will change from a focus from design and information to design and experience. The integration of these new media technologies with architectural design offers a comprehensive exposition of the principles, methods, and practices that will progressively underlie architectural design in the future. Media Architecture Spatial Systems (MASS) represent the aspects of information technology that are pertinent to architectural design, analyse the benefits and drawbacks of particular VR and AR methods, and examine the potential for emerging computational techniques to affect the future of architectural practice.[1]

A great deal of design articulation is related to CAD technology, which was introduced in the post-war era and has been adopted in everyday architectural practice since the beginning of the 1970s; today, CAD technology has become indispensable in architectural practice. Yet, it has had little qualitative effect. Computer-aided architectural design (CAAD) is capable of modelling and manipulating objects, not merely their graphical representations, and of predicting the performance of design solutions. As the latest CAAD techniques evolve toward generating new design solutions through algorithmic and computational design methods, which manage vast amounts of information. These strategies will take advantage in opportunities offered by new media for collaboration across time and space, as well as for the design of a virtual “space” itself.

Humans are very good at understanding, navigating, and solving problems in three-dimensional environments: a capacity intrinsic to architectural design. One does it effortlessly, from an early age, whereas any form of logical problem-solving techniques compose a much higher cognitive load and must be learned with great effort and frustration. One great promise of VR is that it will allow us to unlock our amazing spatiotemporal problem-solving capabilities—which occur within immersive environments that we create from the ground up—and therefore allow us to find solutions easily, even in domains like multimodal and behavioural design, both of which have presented great challenges in the past. However, at present, it is not obvious how to create these environments, and doing so will require the articulation and mastery of some “new” design tools that have been entrenched in design for nearly half a century.

The use of virtual and interactive spaces offers a heterotopic form of experience whereby spaces act in non-hegemonic conditions through parallel tectonic and virtual conditions.[2] Foucault defines heterotopic spaces according to five principles: (1) they are a constant to every culture; (2) an existing heterotopia they can function in a different ways; (3) they are capable of juxtaposing several other spaces in a single real place; (4) they are slices in time; and (5) a defined system that makes them penetrable. A design in VR is intrinsically spatial will be different from architectural design, which is always contextualized within space. The integration of these two spatial modes of design needs to incorporate a minimum set of cues that fully communicates key aspects of the environment and design simultaneously. Such an integration will be even deeper once the correlation is made between VR systems and their robotic fabrication counterpart, analogous to how CAD relates to computer-aided manufacturing (CAM). The relation between VR and robotic manufacturing is not an established area, and MASS addresses this gap between immersion and fabrication precisely. Deployed in an intense studio environment, MASS has developed a direct relation between interaction design and digital prototyping by harnessing the importance of creative correlations from algorithmic and computation design and their implementation experience and prototypes.

Through the use of computational design tools and strategies, the method allows the simultaneous integration of its information into the interactive use of VR and robotic prototyping parameters. With a boundless range of inputs, outputs, and add-ons within VR, the methodology correlates to digital prototyping and potentiates countless ways to generate spatial elements that transverse both real and virtual worlds. The research offers a systematic and rigorous application of VR as an additional design tool by exposing the reliance of digital design on old media conventions, such as drawings and physical models. The scheme also proposes how immersive and multimodal works potentiate reality, address the viewer, and represent spatial experience.

Correalist Strategy

Beyond providing significant information on novel methods and techniques in VR, the project will also provide detailed research documentation regarding the relationship between computational design, robotic fabrication, and VR by presenting aspects that go beyond the improvements in modelling, prototyping, and visualization for which these technologies are commonly used. The significance and innovation of the project is that it transposes the emerging fields of VR into spatial design, whereby information is a digital connection between locations, people, and activities. Immersive environments can graphically illustrate what is happening (where, how, and why) and provide insight into the impact of past, present, and (likely) future forms of experiencing architecture.

From the earliest times, humans have had tools like hammers that have extended our physical selves. Today's technology extends our mental selves, changing the way we experience the world, and it is therefore crucial to exploit its new capabilities. The project unfolds design development, addressing the integrated use of robotic prototyping and virtual reality. The outcomes will expose the correlation between a physical structure produced by a robot and an interactive virtual space that can be experienced through a virtual reality headset. The MASS aims to unfold an overlooked relation between the virtual and the real, whereby space, media, and technology will foster the importance and creativity of digital design and prototyping in the near future. This study departed from "Correalism" understanding of space where it dismisses "Functionalism," as Kiesler perceives forms "as points where apparent known forces met invisible, … and that reality was really the interaction of these forces", and aims at design proposals for a media surface that could operate in both the tectonic and virtual realms.[3]

The use of virtual and interactive spaces offers a heterotopic form of experience, where places and spaces function in non-hegemonic conditions through parallel tectonic and virtual conditions.[4] Operating within openFrameworks (OF) and Grasshopper (GH), the mediated realities methodology developed the integrated use of a robotic fabrication with an interactive virtual reality environment into a single spatial system. Beginning with an overview of robotic fabrication— namely, the GH's KukaPRC environment and OF's 3D graphics libraries—the strategy quickly moved on to the study of variables and concepts for simultaneously controlling both components. A team-based approach throughout the studio reinforced the requisite technical skills and established methods to apply to the integration of space in both systems. Through iterative procedures, the design of the surface evolved in tandem and was corroborated both in physical and virtual spaces. Once the capability and limitations of the tools were understood, the outcomes exposed the complexity and specialization of computational design through the additional value of interactive experience, which will subsequently resonate in the final fabrication phase.

Mediated Realities Methodology

The Mediated Realities in Architecture design strategy unfolds by addressing and developing the integrated use of robotic prototyping and virtual reality. The outcomes will expose a correlation between a physical structure produced by a robot and an interactive virtual space that can be experienced through VR and AR interaction.[5] The proposed methodology encompasses an overlooked relation between the virtual and the real, whereby space, media, and technology foster the importance and creativity of digital design and prototyping (Figure 1).

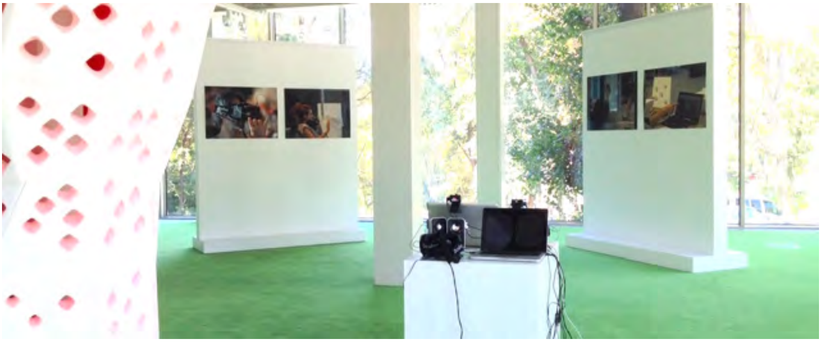

Figure 1: Exhibition of the parametric wall and its VR experience.

The methodology was developed through the analysis and development of a set of parallel studies on KukaPRC as well as the integration of digital fabrication with VR interactive systems in OF. Due to a higher degree of general knowledge in GH, the first phase prompted benchmarking and troubleshooting mainly on the VR systems tools. Through the combined use of Oculus DK2 and the LeapMotion tracking system, the main focus was on correcting standard points of spatial and tracking references, allowing for the correction of more recurrent faults of the VR system. Hence, there is a need for a thorough investigation of the headset, controllers, and importing of geometry.

The analysis of the robotic fabrication components was based on the integration of the KukaPRC and Kuka Agilus, equipped with a 0.33Kw spindle to be used on 84 Expanded Poly-Interaction System (XPS) blocks. The design phase subsequently introduced initial schematic models, which are characteristic of computational design approaches that constrain the final geometry through the use of flank milling. The use of this milling technique simultaneously provides geometric constraints and optimizes the production time since it only requires one peripheral pass over the material.

Subsequently, the integration phase of the project propelled the design from a formal phase to its integration in VR. Due to time and material constraints, the case studies were extracted from the most efficient fabrication and interaction techniques. Adjacent to the previously mentioned flanking technique, the case studies also relied on the integration of solid/void patterns that emerged from studies on spaces of heterotopic interaction. In addition, this part of the project prepared the system for the first tests on users. The prototypes varied in the form in which VR and physical models were laid out. Some concepts focused more on immersion and its variants of interaction and manipulation; or, inversely, where physicality prevails over virtual reality.[6]

Integration of Computational Design for VR

Being required to design a single surface out of modular XPS blocks propelled the decision on edge design, where the boundaries of each block were customized according to their own geometrical function. The use of the edge design technique and its counterpart in fabrication offers structural integrity. However, within VR, structural integrity is irrelevant; thus, the geometry needed another layer of functionality to follow a “correalistic” approach: an open systems strategy. As proposed by Kiesler, these forms of interaction with other spaces or heterotopias require another level of integration distinct from computational design. Due to the split of spatial mediums, this integration was overlaid with virtual information wherein solid/void patterns exerted a virtual stimulus and were subsequently appropriated in tectonic form. This means that the integration of computational design and VR became bidirectional, since structural integrity limits VR interaction, and the latter is inferred into physical design (Figure 2).

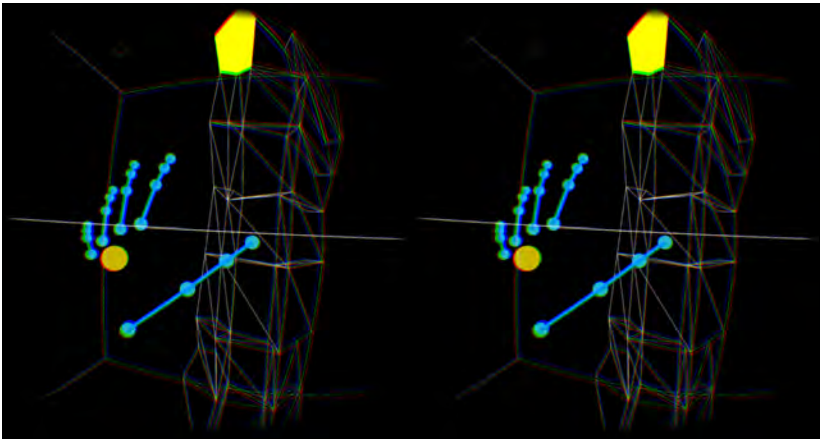

Figure 2: Geometric context and physical structure of the dFORM case study.

The integration of the design scheme resulting from GH precisely translated a balance between the interaction intent and a tectonic return. Through the geometrical output, the case studies unfolded their designs into a series of KukaPRC definitions as well as their translation into openGL mesh objects. Within OF and through the use of object-oriented programming, geometric integration in virtual space (Oculus), and interaction (LeapMotion), three main graphic classes were introduced in order to define the 3D virtual space, headset integration, and natural interaction. To define the immersive environment, a mesh class was used to represent and position geometry in an openGL space. Similar to the KukaPRC, this class uses sets of geometric vertices and faces, but with additional interactive traits that provide colours and texture coordinates at these points. Further geometrical and interaction refinement was added through the node function, which allows one to easily work with 3D transformations and which also includes the positioning of light and users in the virtual space. This function is the base of all design in a 3D virtual space, allowing for the representation of a location and orientation in 3D space and also for the addition of children or parents nodes so that sets of nodes can move together. This is useful for representing complex, interlinked 3D models, which is in turn useful to our modular base structure. Subsequently the OculusRift class allows the attachment of the Oculus Rift rendering and head-tracking pipeline to the existing camera. Lastly, with the aim of providing more natural gestural interaction within the immersive environment, a LeapTouch class, uses the LeapMotion touchless controller to setup mid-air “touch-sensitive” regions within the headset’s visual area. Due to the use of these core events (i.e., combining the headset with touch-reactive user interfaces), the interaction with the geometry became straightforward and intuitive in an array of four distinct projects.

Case Studies

The following case studies represent the proposed approach for traversing computational and virtual forms of interaction in the pursuit of systemic design applications that acquire another state of spatiotemporal being. The Unicode, dFORM, and Expanded Poly-Interaction System (XPS) represent on systems as open acts of interaction. Through distinct strategies, the studies examined the arrangement of relations between the parts or elements as active proxies in the development of architecture. All the developed approaches encompass generative strategies coupled with physical computing to create dynamic feedback processes. Potential forms of spatial organization were examined as virtual spatial ecologies that exploit physical proxies through bidirectional modes of design.

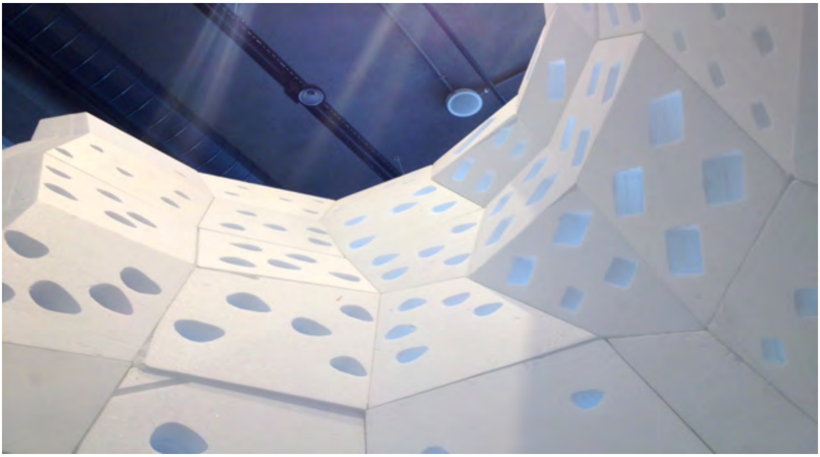

Figure 3: Flanked-milling construction composed of 84 tectonic and virtual panels.

The interactive-driven approach seeks to develop novel design proposals that are concerned with technological and computational vicissitudes of the present. The case studies' design procedures investigate the proposed trifold correlation between space, technology, and environment as a single spatial system. The outcomes engage and instigate contemporary design discourses that go across and beyond architecture all the way to media, computation, and materialization. Mediated Realities in Architecture explore how a bidirectional design mode may serve as a means of pursuing the aim to empower virtual design as a computational design proxy in architecture.[7] The Mediated Realities in Architecture case studies proposed the design of a wall surface based on the optimization of the flank-milling method and its potentials into VR. On an inverse path, a proposition was made for using the constraints of the LeapMotion controller and its effects on physical design. The overall surface design would need to come together and produce a macro wall composed of 84 panels in which each group presents its tectonic and virtual outcomes (Figure 3).

The initial XPS case study followed an architectural tendency whereby physicality prevails over VR. By focusing on the use of the 6-axis linear path key trait of flank-milling, the XPS project decided to subtract and optimize the integration of isosurfaces from their panels. As a design rule, the length between the isocurves decrease from bottom to top. This leads the patterns to increase their hole size at the top, which we used to extend our design into virtual reality. When visitors enter our virtual world, they are able to use their hands to touch a sphere, which, simultaneously, sonically and visually relates to the original block. When all spheres are placed in the right places, the visitor can see the overall physical design (Figure 4).

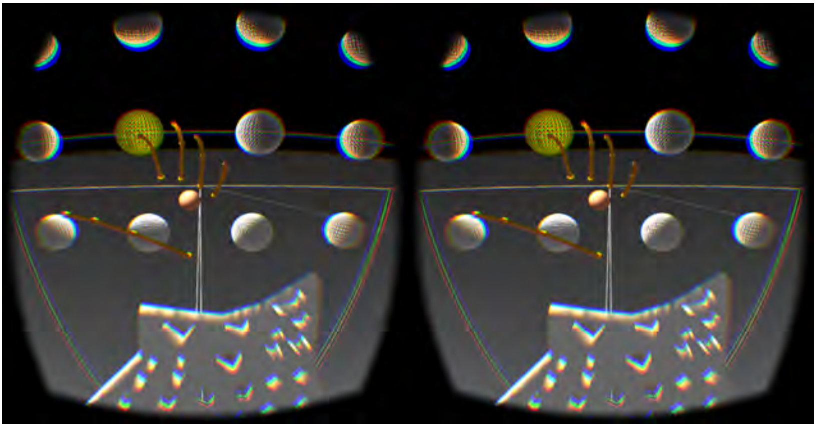

Figure 4: VR display of the Expanded Poly-Interaction System (XPS) case study.

Following the physical-to-virtual design strategy, the UNICone case study was initiated with the idea of subtracting solid shapes from the given prismatic panels. The conical shapes were due to the optimization of time and material of the flank-milling technique. Subsequently, in order to merge with the neighbouring panels, the cones hold variations as they progressively transform into squares with a depth limitation matching the neighbouring panel shapes. The principle was introduced into VR, wherein the inverted cones become attractive and progressively interact following the physical design proxy. The interactions are achieved through touch, which triggers sonic and colour outputs using a specific frequency and gradient related to the number of transformed interactions.

Following the bidirectional design strategy, the dFORM case study departs from the geometry of interaction in VR into a computational design output. Through a focus on the reach capabilities of the LeapMotion-enabled interface, the immersive environment establishes a deformed matrix resulting from the interaction limits. Inversely deployed to a common method of developing the physical content dFORM uses, vertices, edges, and voids are shaped as progressively deformed squares to instigate a user’s interaction. The use of the voids allows users to assemble the wall by dragging panels into the provided matrix within VR. The interaction with the custom and deformed panels is explored by making a clear correlation with the flank-milling technique used by the robotic arm (Figure 5).

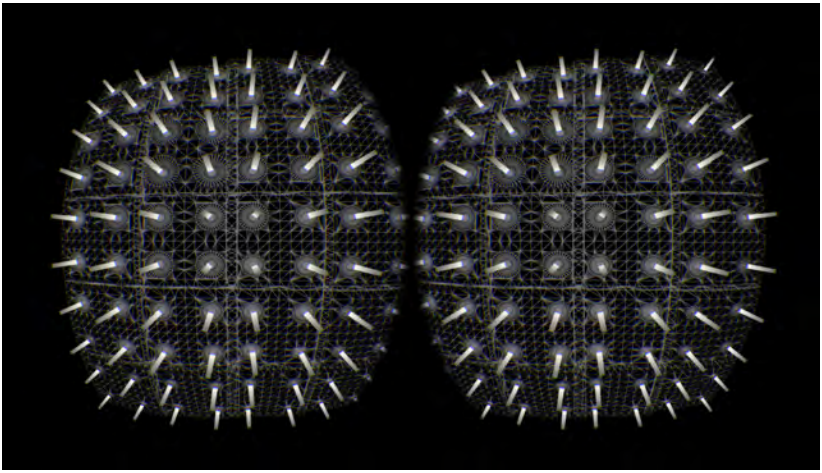

Figure 5: UNICone case study interactive geometry display in VR.

All designs unfolded through a series of tutorials and subsequent design and code development by addressing an integrated use of robotic fabrication, virtual reality, and human–computer interaction. The studies were finalized through their physical and VR assemblies displayed at an exhibition at the Turkmall Sanat gallery in Istanbul.

Conclusion

The Mediated Realities in Architecture design process unfolded design and code development by addressing the integrated use of robotic fabrication and virtual reality. The outcomes expose a correlation between a physical structure produced by a robot and an interactive virtual space that can be experienced through a virtual reality headset. The case studies aimed to unfold an overlooked relation between the virtual and the real, where space, media, and technology will foster the importance and creativity of digital design and fabrication in the near future. By operating from specified perspectives, one chooses a prominent understanding of the contextual environment and uses these data to extensively interact with a proposed space. The Media Architectural Realities methodology is about linear and nonlinear correlations between virtual and physical spaces. This was only possible through the combined exploration of spatiotemporal forms of communication that directly involve design prototypes at a computational and interactive levels. These mediated realities archetypes seek to develop novel design proposals that correlate spatial systems across VR and architecture. Overall, the research serves as the baseline model for the development of various works that are both abstract and specific enough to be scaled, augmented, and modified as needed. The bi-directionality of the definition facilitates experimentation with the form and structure of works developed using a computational and interaction design construct. In this manner, multimodal aspects can be readily exchanged with each other, leaving only the specifics of second-order cybernetics and other contextual considerations open for later definitions.

Acknowledgments

All projects were carried out within the MEF University Faculty of Art, Design, and Architecture in Istanbul. Participating tutors: Dr Alin Camci, Efe Gozden, Egemen Nardereli, and Dr Frederico Fialho. The Media Architecture and Spatial Systems (MASS) event focused on computational design strategies and the integration of New Media and Architecture. The exercise placed a particular emphasis on the interfaces between interaction design and the robotic fabrication phases. The strategy accompanies the increasing demand for graduates with digital proficiency alongside the increasing array of interdisciplinary design tools that can activate information technology for architectural design and its production process. The aim of the event was to enable students who already hold architectural knowledge to creatively add new media strands and approaches to the design of space.

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Canyon: Experiments in Drawing through Analogue Sketching, Sound and Virtual Reality

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Figure 1: *Canyon* Installation, 3D VR capture, video still.

Abstract

Canyon is a project in experimental design process that extends ideation through drawing, via a novel hybrid of hand sketches, soundscapes and virtual reality (VR). The inspiration for the project is the dynamic undersea landscape of Kaikōura Canyon, Aotearoa, New Zealand. The experiment draws atmospheric qualities from the unseen topography and vast body of water of the canyon, recently jolted by huge forces in the 2016 Kaikōura earthquake. The ominous scale and power of this submarine landscape is distilled through hybrid architectural drawing, merging presences within drawing with those in landscape.

The outcome of the first phase of the *Canyon* project is a mixed media installation exhibited at the Palazzo Bembo in the XVI Venice Biennale. This paper reflects on the Biennale installation, locating its contribution to architectural design research in terms of experimental process. Drawing's capacity to observe and distil intangible phenomena is augmented by the affordance of VR and spatial soundscapes. This triggers a discussion of drawing's active role in knowledge generation, intersecting with research into design as a non-linear and multi-factorial research methodology in architecture and art practice disciplines. *Canyon* also opens up critique of the traditional view of landscape and its relation to architecture. It alludes to less picturesque ways in which landscape and architecture might intersect, drawing instead from landscape's intangible, scalar and material presence. The unseen canyon landscape is used as a site to provoke and test these arguments and we highlight contingent connections to related areas of design research.

In the *Canyon* project, drawing is expanded as a hybrid medium, able to research architectural presences through multiple platforms, and the marine landscape, as a poetic drawn through this hybrid technique, is reoriented as a powerful influence in architecture.

Figure 2: Sea surface, video still.

Introduction

Architectural design research has many modes of operation, succinctly summarised by Peter Downton, in terms of research about (process), for (enabling knowledge) and through design (practice).[1] *Canyon* is the current iteration of a collaborative research project that has a focus on design process, where we are experimenting with a hybrid approach that builds from analogue drawing to explore the affordance of immersive virtual environments and spatialised sound. The theme is a mediation on imagined landscapes, inspired by the submarine canyon near Kaikōura, Aotearoa, New Zealand. The canyon landscape is not visible beneath the sea surface, yet its presence is palpable; it is a vast and dynamic material, with water kilometres deep, figured by seismic jolts, turbid flows, pressures and intensities. *Canyon* imaginatively projects into this unseen landscape, distilling its ominous scale and power through evocative graphite sketches, soundscapes and the inherent canyon-like boundlessness of virtual reality (VR).

This paper reports on design research arguments triggered by the broader *Canyon* research project, which is in its early stages, and which the installation in Venice is the first output. It addresses two main themes: hybrid drawing and landscape. The *Canyon* project contributes to design research on the role of hybrid drawing media in the design process, and the inter-connection of landscape to architecture, an omnipresent theme in the Australasian context.

In terms of the first research thread, drawing, *Canyon* raises questions about methodological complexities internal to both acts of designing and the materials and spatiality of representational media. The sketchy openness inherent in analogue drawing, which contributes to drawing being an aesthetic 'lens'[2] is brought into the world of VR and spatialised sound. This openness connects with research on intangible, tacit knowledge in designing by such people as Leon Van Schaik[3], Nat Chard and Perry Kulper[4]. This is paralleled by arguments about the power of indeterminacy in art practice, as commented on by Sarat Maharaj[5], James Elkins[6] and Jean Luc Nancy[7]. This paper acknowledges the theorisation of drawing in the late 20th century, including such figures as Robin Evans[8] and Marco Frascari[9], and, despite being in reference to this large body of scholarship, does not attempt to re-evaluate its arguments.

We propose the idea that VR and sound have the potential to be an open medium, having the same evocative power as a sketch, which is an original research direction. The field of VR is dominated by an assumed verisimilitude. *Canyon* shifts the VR medium into one that requires interpretation, despite being experiential. In *Canyon*, VR and sound begin to afford open possibilities through a presentation of a dynamic sketch-like spatiality. This links with research on both the affordance of digital media by Gibson[10], and arguments on material feedback; VR, as a digital material, has the potential to afford or resist an active drawer/ participant, similar to any design medium, and so influence understanding. In this sense, the VR/ sound environment extends the evocative power of a smudged, sketched mark, and with it, knowledge generation through drawing. This ties into research in practices and material feedback by such people as Sean Pickering[11], N Katherine Hayles[12] and Tim Ingold[13].

The second thread of research in *Canyon* relates to the subject matter of the drawing: the submarine landscape. In New Zealand, the scale and power of landscape is often romanticised, with landscape the natural, picturesque setting to an ideal, stand-alone architecture. The Kaikōura seismic event in November 2016 reoriented this notion. The sudden, dramatic movements of huge bodies of land and sea-bed, redrew not just the coastline but how we consider landscape in relation to architecture. *Canyon* looks at how a focus on abstract presences, highlighted by this event, might enable alternate correspondences between architecture and intangible presences in submarine landscapes.

The focus on drawing intangible characteristics, or presences, from landscape, aligns with a broad body of scholarship in art historical and cultural geography disciplines. The picturesque, the sublime, and affective landscapes are obvious areas of discourse. Our research into design process connects to these and to related work in design disciplines, looking at mapping tangible and intangible aspects of landscape, is also source material, such as that by James Corner[14] and Perry Kulper[15]. In art practice, Anselm Kiefer’s *Velimir Chlebnikov and the Sea* paintings, in which ominous presences are drawn from a marine landscape, also have resonance. These aligned precedents provide support for our thinking about presencing the marine landscape. We are interested in how an attention to abstract presences in the submarine landscape, observed through hybrid media, might shift architecture in the Australasian context, reorienting it from a focus on picturesque landform to atmospheres of sea. The *Canyon* project is an attempt to distil such presences and in the second phase of the research, we will work to generate new architectures and landscapes from the material.

Figure 3: VR screens in context, in Canyon installation.

Canyon installation

Canyon is exhibited at Palazzo Bembo, a 15th century building on the Grand Canal in Venice, in an invited group show entitled TIME SPACE EXISTENCE, part of the XVI Venice Biennale. The *Canyon* installation is shown in a small ‘room’ within the Palazzo. Once in the small space of *Canyon* a viewer is conceptually in an inhabitable drawing that projects to the abstract qualities of a vast, sketched undersea landscape.

Spectators to the installation are confronted by a 40 metre long drawing/ sculpture made from black tar-paper that wraps and crumples the spatiality of the room. A soundscape of shifting sound intensities accompanies the spectator's movements, evoking the scale and mass of the submarine canyon. On moving through the paper and sonic landscape, small screens allow glimpses into a virtual canyon, composed of abstracted sketches, flows and currents in the VR environment. The result is an installation where the visitor is physically present, in a tiny gallery room, and also projected into a space of vast scale and dynamic movement, drawn from presences in the Kaikōura canyon landscape.

Figure 4: *Canyon* Installation, bituminous paper, video, sound.

Drawing

In the *Canyon* research, of which the Venice installation is the first output, the inherent openness of analogue drawing is used to explore architectural possibilities in the undersea landscape. Sketches record observations of the unseen environment, distilling abstract presences through gestural marks of graphite on paper. In these crude and rapid drawings, there is a correspondence between the performance of drawing and the performance of the drawings' subject matter: drawing, as a gestural trace across rough paper, parallels the dynamics and materiality of the Kaikōura canyon.

The *Canyon* sketches were made by drawing sections, plans and three dimensional 'scenes' over a rock-like surface. The graphite was caused to skip over the paper by the jagged shape of the rock underneath. This skipping allowed unexpected elements to influence the drawing's marks. This was an exaggeration of the feedback normally found in analogue sketching and was used as an analogue of the material dynamics of the canyon; the rock beneath the paper caused the marks to smudge and change direction, so a sectional drawing of the sea floor became not a single line, but an indeterminate series of marks mapping the imagined presence of flows, pressures, mud and rock.

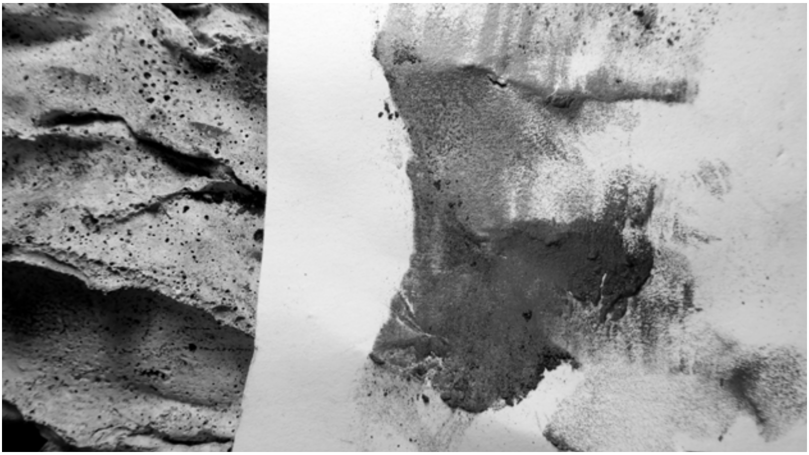

Figure 5: Rock forms impacting on drawings (detail).

Some of the lines are singular and fine, and describe pure boundaries between things, such as at the water's surface. Others describe transitions between materials that are less defined, such as where sea water blends into mud then to rock, or where sea cliffs drop vertiginously into an imagined darkness. There are lines that have no material analogue and are merely about directions of current or degrees of pressure or intensity. The drawings, as a set, are not arranged according to different scales but are deliberately mixed, in an attempt to allow ambiguities between scales. The jagged contours of a rock, at 1:1, correlate to landscape forms and flows at large scale and become indistinguishable. The over-arching intention is for the drawings to be a traverse of the imagined space of the canyon, allowing scale and material to be amorphous in order to distil something beyond instrumental description: the architectural presences of the canyon.

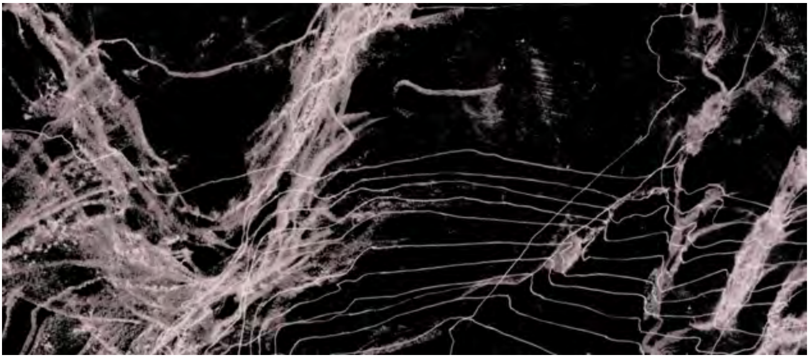

Figure 6: Presence-drawing study: pressures (detail).

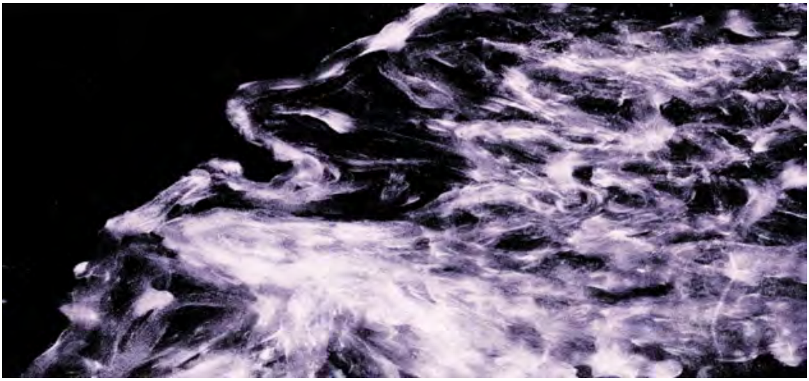

Figure 7: Presence-drawing study: sediment turbidity (detail).

Gestural analogue drawing has traditionally been associated with intangible, qualitative dimensions. Sketches are open: evocative, indeterminate, unfinished, and therefore, full of possibility. Drawing is, to quote Jean Luc Nancy, nascent, 'the opening of form'.[16] Architectural drawing involves understanding multiple presences. The rapidly drawn lines, smudges and other 'recalcitrant marks', as described by James Elkins[17], open architectural drawing to possibilities. These marks are where blurrings and unexpected shifts allude not just descriptions of contour, but intangible, imagined characteristics. They are marks whereby '… nuanced misalignments, approximate thoughts and imperfect moments … resist fixing normative figuration …' [18].

The gestural act of drawing crosses with performative dynamics in the subject matter, which in the case of Canyon, overlaps movements in an undersea landscape with arcs of the hand over paper, creating an exploration of the presences in the canyon at the same time as an exploration of how those presences are drawn.

This research connects with the emphasis in design research on non-linear, indeterminate and tacit modes of discovery. This gives agency to design, not simply as a tool for determining space but a way of researching contingencies inherent to acts of discovery. This ties in with current discussions on the value of design research. Terms such as 'spatial intelligence' place emphasis on the actions associated with a designerly understanding of space and with it, the potential to make rich non-linear connections. The *Canyon* drawings are in this mode, of knowledge emerging out of spatially aware action in concert with material, as happens in drawing. This capacity for openness is intensified through the spatial and sensorial modes of VR and sound, which is commented on in the next section.

Figure 8: VR navigation of presence-drawings, video still.

VR Drawing

Drawing in VR commonly involves realistic visualisations and as such is not geared to drawing's traditional openness. This project brings the open indeterminacy of drawing into VR technology, and questions how it might be generative in the same way as a sketch. VR hinges on verisimilitude, but is not often considered for its sketchy, generative possibility. The *Canyon* project argues that VR can afford a conceptual openness, through manipulating the visual acuity of VR space, prompting a viewer to imaginatively project into it, as in a sketch, rather than simply experience it passively. This is part of the hybrid approach of the *Canyon* project, which draws together human, digital and material conditions in a mode of open architectural drawing.

For architecture, virtual reality has typically been considered another form of visualisation, focusing on photorealism. In a similar vein to the transfer of drawing board practice to early CAD, the tendency is to repeat existing practice without fully exploiting the affordance of the medium. The reference point for architects using VR is the use of animation, which as documented by As and Schodek[19] has been developed primarily to communicate the kinematic experience of architecture. However, as they discuss, animation practice is conditioned by the traditions of projective geometry that underpin architectural content, and the technical apparatus of the animation camera, which utilises principles of perspective developed in the 16th century. While there are notable examples of architects exploring motion as a conceptual device, such as in the animation of geometric parameters by Greg Lynn or the opportunity for kinetic composition, VR as the ‘ultimate display’ has had minimal impact on the design process. Most applications have been in the field of virtual heritage with a trajectory towards photorealism, such as the use of high definition graphics and the use of 3D laser scanning.

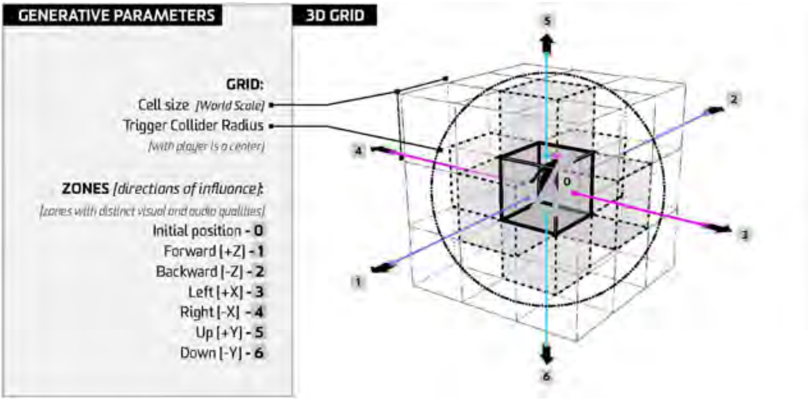

Figure 9: VR canyon parameters.

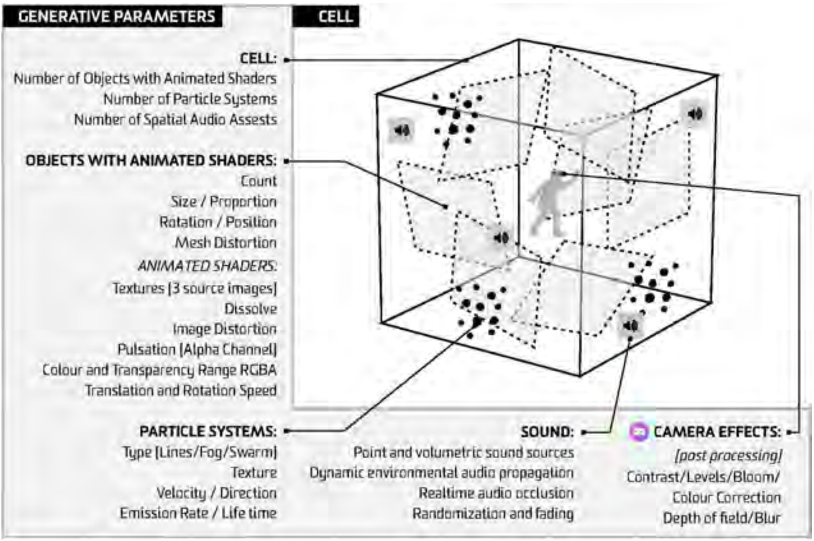

Figure 10: *Canyon* installation VR space design.

As outlined above, the trajectory of VR within architecture is towards verisimilitude. In contrast, the approach explored in Canyon is a doubling-down of the virtual, prompted by the legacy of openness in architectural drawings. The hand sketches are scanned and transformed in the VR version via procedural shaders, which drift in and out of focus within varying densities of particle systems, camera and lighting effects. The aim is to explore spatial qualities through VR technology, in order for them to be useful in creative ideation, similar to the traditional architectural sketch. For the Venice Biennale installation, the VR world is alluded to through glimpses of screen content, partially revealed through tears in the 40 M drawing wrap. The raw physicality of the over scaled tar-paper drawing providing a visceral spatial experience, at odds with the glimpse of lush digital graphics. The sense is of another boundless space obscured by the heavy tar-paper, a graphically seductive virtual canyon that is fleetingly present, requiring the surveyor to imagine its larger extents.

Figure 11: *Canyon* installation, navigations within VR presence drawings visible through paper surface, video still.

The VR aspects of the research agenda is informed by the theory of affordance. Initially developed in psychology by James J. Gibson the concept of affordance has been re-defined and used in a range of domains. This simple definition by Stuckey in relation to the design of virtual environments is the most appropriate for our research – '... we use the concept of affordance to refer to the latent possibilities for action presented by an artefact, tool or environment.' [20] From this definition and, given the current state of the technology, we propose that as well as immersive visualisation, VR affords an immersed sense of kinematics that is more visceral than watching animations on screen. In a similar vein, sound is spatialised and experienced, opening up the, comparatively, underexplored capacity to use aural senses to evoke spatial conditions and materiality. Complimenting immersive kinematics and sound are haptic interfaces that, while at an early stage of development, enable an enhanced bodily experience. Triggering the kinematic, aural and haptic senses - alongside the visual - provides one agenda for the virtual canyon. The second agenda is as important - the affordance of the computer to process information in real time. As has been explored through algorithmic and parametric design, this shifts attention away from the discrete architectural representation, and towards manipulating variables within which multiple representations can evolve. So rather than occupying a drawing, we conceive the virtual version of canyon as a procedural machine, that enables a journey through a landscape of possible spatial conditions.

Figure 12: *Canyon* installation, VR and sound drawings merge with paper landscape drawing (detail).

Sound Drawing

The experience of the Venice Biennale installation is as much aural as visual, with an eight channel spatial soundscape that evokes the vastness of an underwater terrain within the setting of a small exhibition space. The *Canyon* soundscapes are built from sounds that create an unsettling feeling of motion, in two layers. Six random cycling multichannel extended soundscapes are built from textures with fluctuating detail. Static, smooth sounds rarely appear. Where smooth sounds do occur, they are usually the result of computer processing to slow down spectral evolution drawing the listeners' attention to the internal motion of the sound. In other instances, spectral filtering and spatialisation splits off layers that orbit the space. Granular processing further breaks down sounds into smaller spatialised components. Overall there is a sense of being in motion subsumed by forces perpetually in flux.

The temporal organisation for the Canyon sound design can be likened to a mobile slowly turning in the room where the sonic layers are circling or revolving at different cycles. To ensure the order of the daily played soundscapes are constantly changing, there are six multichannel soundscapes with staggered durations from ten minutes, forty-four seconds to eighteen minutes, ten seconds. The six soundscapes and two silent sections of fifteen- and thirty-seconds duration are randomly selected and played. One possible reading of the sound design would be to experience this textural motion with the flows of the tar paper. Or to connect the tar paper folds, dents, cavities with an unsettled continuum of forces. From a strictly spatial listening perspective the sound design doesn't provide cues by which the listener can construct a stable reference point. There is no single place on which to stand and experience an acoustic vista, a privileged point where the electro-acoustic environment is 'correctly' delivered.

In the spirit of Umberto Eco's *The Open Work*[21]*,* or improvising musicians, synchronisation between the sound and digital media here is a feature not a technical problem. This also draws on our experience of gazing at a landscape and the likely occurrence of an event that might capture our awareness. Perhaps we happen to notice a feature, a detail, something connecting two elements. We create a structural connection - this becomes a memory of the place. We might just happen to be at the right position, at the right time when a small event, a movement, a change occurs and we imprint memory of that moment. The asynchronous revolving mobile structure might, or might not, deliver such a memory in *Canyon.*

We are not attempting to transport a listener to an actual location, but to create a setting where imaginative connections are made between notions of landscape and its influence in drawing, digital design, composition, and digital installation.

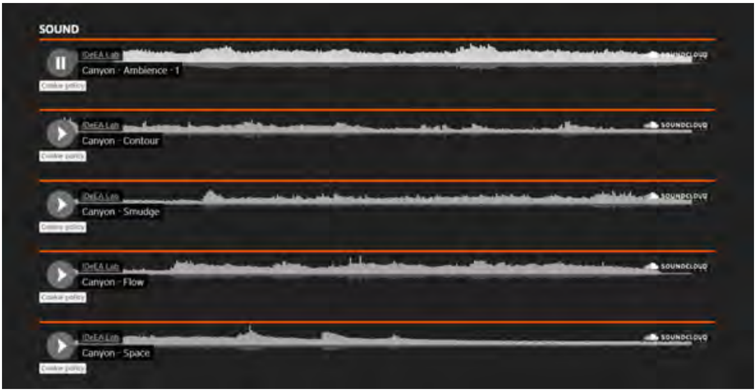

Figure 13: *Canyon* soundscapes, screenshot.

Figure 14: Raised seafloor, Kaikōura coast.

Landscape

The extension of the openness of drawing through the affordance of VR technology and the use of spatialized soundscapes provide on trajectory for our research. The second research thread deals with architecture's relation to landscape. *Canyon* attempts to draw presences from an unseen marine landscape and in doing so shift architecture's relation to landscape, reorienting it to the sea rather than solely land and air. Landscape and its capacity to trigger the architectural imagination is a significant international theme, particularly for new world architecture. In New Zealand, and Australia, the scale and power of landscape is usually romanticised, with landscape the natural, picturesque setting to an ideal, stand-alone architecture. The *Canyon* project departs from this picturesque tradition by focussing on a landscape that is not visible. It draws intangible, poetic presences from a submarine landscape in order that it might inform architecture through abstractions of scale, mass and ominous seismic potential.

On a small vessel, on a languid sea off the Kaikōura coast, the enormity of the sea is strangely present. At just 500 M from the shore the water is over a kilometre deep, and continues to deepen as it flows to the Hikurangi trough, which marks the junction of the Pacific and Australian tectonic plates. Huge forces in this undersea landscape were released in the recent 7.8 magnitude Kaikōura earthquake. The seabed lurched upwards, triggering undersea landslides and turbid flows of sediment; the marine landscape, previously unconsidered, suddenly became powerfully evident.

Figure 15: Kaikōura seafloor, abstracted.

This landscape is known through instrumental descriptions: multi-beam sonic scans, digital models and scientific data, yet less easy to record, is its powerful and ominous presence. The landscape, in this sense becomes a dynamic medium with vast mass and complex movements and pressures, latencies and threats. It is not appreciable through vision but through imaginative projection. This inflects the tradition of the picturesque landscape, which is dependent on views of landform. In *Canyon*, the immense body of water and ocean floor are captured through presences, imagined in concert with the open marks of hybrid drawing.

The continued inflection of scale has emerged as a theme throughout the Canyon project: initially conceived as drawn sketches of scale-less spatial qualities; installed as a 40 m tar-paper wrap that is simultaneously surface and over-scale mark; torn to reveal the boundless virtual canyon on miniature screens; compressed physical space extended through a soundscape that evokes an immense scale. This resonates with the legacy of the sublime omnipresent through discourse on landscape, in particular the mathematical sublime.

We get examples of the mathematical sublime of nature in mere intuition in all those instances where our imagination is afforded, not so much a greater numerical concept as a large unit as measure (for shortening the numerical series). A tree judged by the height of man gives, at all events, a standard for a mountain.

The Kaikōura submarine canyon defies such a scale measure, beyond the imaginative projection of the depths from its surface. This has, in retrospect, triggered our drawings of a spatial condition that is beyond architecture's typical tools of representation. In this short paper we can merely suggest avenues for future discussion, with the traditions of the picturesque and the sublime being fertile areas. The atmospheric power of the marine landscape, as something with vast mass and scale - and a latent possibility for movement - provides rich possibilities for architecture.

Figure 16: Presence-drawing study: gas eruptions (detail).

Further Work

In the *Canyon* project, drawing is expanded as a hybrid medium, able to research architectural presences through multiple platforms; and the marine landscape, as a poetic drawn through this hybrid technique, is reoriented as a powerful influence in architecture. The research provides a new trajectory for design process that exploits the affordance of VR technology and spatialized soundscapes for architectural design research. We are currently cataloguing the range of spatial conditions nascent within the Venice installation, the VR environment and the emergent soundscapes. The next stage of the research is to situate these experiments as a way to conceive built form that has a similar boundless, oscillating scalar resonance.

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ADR18

Explorations in Design Pedagogy

Chaired by Dr Simon Weir

Practice Research PhDs in Interior Design

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Abstract

This paper attends to the nature of PhDs in interior design and with a particular focus on practice research. While there is a growing number of practice PhDs in the discipline, the number is relatively small compared to those in architecture. Current design research happening within interior design is research *about* and *for* as distinct from research *in* practice and *through* practising.

Interior design as a practice is not adequately defined by the production of artefacts – such as products or buildings – so much as the design of relations between people and space in terms of physical, social and psychological parameters. Conditions of experience, subjectivity, atmosphere and affect are critical concerns that introduce questions of value and evidence and problematize notions of objectivity and subjectivity.

The impetus and argument underpinning this paper is one of advocacy for the practice research PhD in the discipline and the value of the contribution that practice research in the discipline can make more broadly.

Introduction

The term “design research” has a broad remit in addressing the conjunction of design and research including applied research, history and theory, research for and about design and research through design. This paper focuses on research through the medium of design – and specifically, that referred to as “practice research”. This term also has a range of different inflections and nuances expressed variously such as “practice-led research”, “practice-based research”, “practice as research” etc. and has been the focus of several conferences and publications for example: *Practice Based Design Research* and *Practice as Research in the Arts.*[1]

The focus of this paper is with the practise of practice research initiated and led by Professor Leon van Schaik at the RMIT School of Architecture and Urban Design who defines practice research as research through the medium of design “as distinct from research as something done in a medium different from your design practice and in a place other than where you practice”.[2] The critical distinction here is the word “in” – in the medium of design and in the place of practice. The other concern of this paper is specifically the discipline of interior design inclusive of the profession and the academy.[3] The title of the paper brings these two concerns together as “Practice Research PhDs *in* Interior Design”.

Nationally and internationally, there are few practising interior designers who have undertaken PhDs. There have been PhDs undertaken that engage in some way with the practice of interior design but identify more with creative practices such as spatial design, performance design and installation practice. While related, the research is not situated in interior design practice and does not seek to make a contribution to the discipline specifically. In this paper, the specificity of a situated-ness ‘in’ interior design is important as the basis for practice research – as the medium of design.

The criticality of this specificity is in part a response to an insightful comment raised in a symposium *What’s in a canon? The state of interior design at the beginning of the 21st century*.[4] Various people from interior designers to magazine editors, academics and students were invited to address the topic and present a series of case studies for inclusion in a canon of interior designs if they thought a canon useful. In the concluding remarks, van Schaik made the observation that most of the examples used were by architects, i.e. not by interior designers. "I don't see how you can claim for interior design, works which are clearly the product of architectural processes and architecture as a professional practice".[5]

The concern to address this question of practice in relation to a discipline is not a drive to identify and categorise but rather is motivated to articulate and give value to interior design practice. Through practice research PhDs, the value of practice becomes manifest not as a set of concepts based on principles of identity so much as a "how"; i.e. what and how a practice does rather than what is.

The position of paper is reflective and propositional. It draws on my role as a supervisor of PhDs in interior design where the majority of candidates I supervise are emerging practitioners who are generating a practice and a PhD enables them to create a space of experimentation that challenges their practice and the discipline. And the experience of embarking with a small group of senior interior designers who are in their first year of a reflective industry practice-based PhD. Therefore, this paper is not a presentation of design research conducted about or for design so much as a reflection on a current state in relation to practice research PhDs in interior design as part of a process of establishing and generating potential trajectories. It is also practice research – a reflection on practising practice research as a candidate and supervisor.

Practice Research

Practice research as a mode of design research was established at RMIT University over thirty years ago. Initiated by Professor Leon van Schaik, invited architects undertook a Masters where they reflected on their practice and a body of work. This mode now expands to various design disciplines across RMIT with a concentration on practice research PhDs and manifesting at biannual *Practice Research Symposium* in Melbourne, Saigon and Barcelona. The practice research PhD at RMIT is distinguished from PhDs that address research *about* design and *for* design. More recently, this mode has been supported by significant research funding and the development of a series of funded networks initiated by RMIT to engage a broader community and in its successful model of practice research PhDs – internationally through *ADAPT-r* (Architecture, Design and Art Practice Research) which was funded by a European Commission Marie Curie Initial Training Network 2013-16; and nationally by *DAP_r* (Design and Architecture Practice Research) – an Office of Learning and Teaching funded project 2016-17.

This model of PhD invites practising architects and designers to reflect on their practice, to research *in* the medium of design and to position their practice in a way that makes evident its critical contribution, its distinctiveness and community of practice. The outcomes of the PhD include a contribution to the discipline and through this the emergence of the profession as a critically engaged profession and culture.[6] I have experienced and participated in this mode as a PhD candidate and supervisor. I have also been involved in international networks regarding PhDs by practice and interior design including a conference organized by the European Council for Interior Architects in 2013 and more recently, a panel titled "Research + Practice" as part of the conference *Interior – inferior in theory?* in Berlin; and examined PhDs in interior design/interior architecture in other universities internationally.

While there appears to be increasing interest from within the interior design profession, it is only recent. Defined as an emerging discipline, the majority of research in the discipline has been undertaken by theorists and historians who position practice. Examples include publications such as *AfterTaste. Expanded practice in interior design*, *The Handbook of Interior Architecture and Design,* and *Interior Design and Architecture: critical and primary sources.*[7] Some of these include texts by designers and these are invariably descriptive accounts of their practice. Other publications such as *Intimus. Interior design theory reader* and *Towards a New Interior. An anthology of interior design theory* are anthologies which assemble and gather extracts from key theoretical texts that have informed and shaped the discipline – a little like a canon of influential texts (and open to the same criticism made by van Schaik in *What's in a canon?* symposium regarding the use of references outside the discipline).[8] There is also an increase in publications that address concepts and conditions of interior and interiority as these emerge as a focus of current concerns.[9]

Text continues to dominant as the medium of knowledge. The *IDEA Journal* – a journal published by the Interior Design/Interior Architecture Educators Association, an Australian/New Zealand association dedicated to the fostering and dissemination of research in the discipline of interior design – initiated the idea of the visual essay (under the editorship of Gini Lee, 2008 to 2011) as a way to publish practice research through the actual visual presentation of design research as distinct from text written about the design. In a recent issue of the *Journal of Interior Design*, Julieanna Preston as the editor of a special issue took up this challenge in the context of an international journal published by the American Interior Design Educators Council. Making a distinction from design research as research for and about interior design, Preston writes in the editorial about the challenge in introducing the visual essay format and how this "signifies JID's desire to augment and advance the presence, discourse, and impact of interior design creative scholarship to its readership … This was a research activity motivated in itself by a shared vision to see the design and development of interior works come to the fore and be recognized for the knowledge they generate in and of themselves."[10]

In relation to interior design practice, applied research i.e. research for design is increasing. In commercial practices, data is collated to enable 'evidence-based design' in response to demands and expectations of clients and other stakeholders. There persists a perception amongst interior designers themselves that their design practice is intuitive and subject and therefore requires external substantiation. Practice research offers a way of addressing these conditions through the valuing of the production of local solutions as distinct from universal concepts. In this context, practice research has the potential to offer an alternative understanding of research.

The concept of knowledge and what it is to know are challenged by contemporary conditions; and this where the PhD by practice becomes critical. Conditions of truth, value, evidence, subjectivity and objectivity are philosophical concepts which inhere in research and knowledge. This is not an argument against the value of applied research or theory, so much as the articulation of the need for others ways of thinking and producing knowledge to engage with living conditions which are temporal and ephemeral, where design is approached as an ecological situation of ongoing change and process.

Interior Design Practice

Interior design is often referred to as an emerging discipline – both in terms of the profession and academy – and a “slippery discipline”: “Interiors is an evolving and slippery discipline. Whilst the interior is everywhere, it is nevertheless ephemeral and difficult to define”.[11]

In 2011, the International Federation of Interior Architects/Designers organised and held a 2-day workshop in New York City with representatives of professional bodies, companies and institutions from around the world to address the role and value of the practice of interior design – its identity, relevance, contribution etc. The outcome was a single page document signed by all present and since then has been adopted by 126 cities around the world. Titled *IFI Interiors Declaration*, the document is organised around a set of principles: value, relevance, responsibility, culture, business, knowledge and identity. As part of this workshop, a definition of the practice was formulated: "Interior designers and interior architects determine the relationship of people to spaces based on psychological and physical parameters, to improve the quality of life."[12] This has proved to be a useful definition for the discipline in that it provides a focus and articulates a critical differentiation from other design disciplines. While other design practices may also attend to the relation between people and the environment, the difference with interior design is the focus on the design of these relations, as distinct from artefacts: “We shape the spaces that shape human experience”.[13]

The population of cities and of the world has reached levels that require a significant re-thinking of modes of inhabitation and relations between interior/exterior, people and space, people and time. Globalisation, mass migration, urban density and technology have transformed people’s sense of space, place and belonging. New ways of thinking about how we live in the world are needed. While this sense of an urgent recalibration is being addressed across practices, the interior designer’s concern with the experience of others, the affect and effect of relations both physically and psychological brings a particular set of techniques and orientations to these conditions.

Practice research offers a way of engaging with knowledge produced through an engagement in conditions situated in the everyday and the value of experimentation and experience. It also enables a way of thinking through the demand for evidence-based design and provability while engaging with actual encounters described as intuitive and subjective; while dealing with affect and atmosphere. This is the value and potential of practice research for the discipline and the profession. The situation specific nature of practice research reiterates the nature of interior design practice in the engagement with social, economic, cultural, historical and political forces in the making of relationship between people and environments, determining what is of value through processes of selection and arrangement, the provision of space-time-material arrangements for people to inhabit. Interior design practice attends to a problematic in search of a specific solution each time anew; and practice research enables a way to reflect on and articulate these situational conditions.

A Practical Philosophy

The conjunction of practice research and PhDs where research is through the medium of design and situated in the place of practice: "where the site of research is the site of practice, this is the location where the action takes place. These everyday sites of practice are integral to research enquiry; they provide the context, means and the parameters of the study".[14] Bringing practice research together with PhDs (a doctor of philosophy) invokes "a practical philosophy" – a focus on "how" and "actions" as distinct from a search for an answer to "what is".[15] This moves from a theory/practice divide and a positioning of praxis where practice is informed by theory to one which gives value to practice in the generation of knowledge as a material thinking; to think as doing.[16] In this sense, theory and history can also be framed as practice research if the emphasis is on the production of knowledge as distinct from understanding knowledge as something inherited; if the situatedness of this production is acknowledged and the value of what it does becomes critical, as distinct from processes of identification.

There is a criticality and vitality produced through practice as an experiment immersed in conditions that are dynamic and where questions of purpose and value foreground what practice does and what it produces, and how it is evaluated. The recent work of Irit Rogoff – an academic who established a PhD in critical curatorial knowledge production at Goldsmith University – in a recent presentation *Research becoming. The way we work* refers to the effect of practice research on knowledge and how this has produced a shift in understanding research from one which was based on "working from inherited knowledge to working from conditions": the conditions of our lives, drives and motivations.[17] She reiterates throughout her presentation that there is no objective distance, rather "we are in it".

There is something distinctly interior that resonates with this re-orientation of research and knowledge in the focus on living conditions as temporal and ephemeral, where design happens in and attends to an ecological situation of ongoing change and process; where atmosphere and subjective experiences are vital and challenge any idea of evidence or systematic repeatability. These are issues that challenge concepts of knowledge and what it is to understand. These challenges present an opportunity for interior design to address the production of subjectivity and subjects; and to engage this in the transformation of ideas of knowledge and knowing.

The PhD as a Doctor of Philosophy foregrounds philosophy rather than theory in relation to knowledge and ways of knowing. When this is coupled with practice, a thinking through practice is activated where ways of knowing and understanding the world come through doing. A practical philosophy – a philosophy of what we do as distinct from a philosophy of what is – articulates and manifests the significance and contribution of interior design practice as a thinking engaged with material, spatial, temporal productions; situated in the everyday and the actualization and production of interiors. Designing for life, practice research in interior design becomes not a search for one universal solution so much as an appreciation of life as process and hence change, chance, variation and difference. The discipline needs practitioners engaged in PhDs by practice that produce practical philosophies and articulate the value of interior design practice in the production of interior, interiority and interior designs.

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An Essential Tension: The Changing Space Between Practice and Academia in Teaching Design Research

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Abstract

This paper investigates the modelling of a collaboration between academia and architectural practice whereby students rehearse and re-examine processes of architectural change. It presents a case study of a studio-based design project aimed at transmitting the tacit design research employed in architectural practice into architectural education. The pedagogy advocates a critical tension between practitioner-researcher and academic to demonstrate an iterative process of making, critique, consensus and remaking.

The project – Ch-ch-ch-ch-Changes – invited students to adopt the design processes of an award--winning New Zealand practice, replicating the firm's office layout around a shared table on which card models are repeatedly assembled and critiqued. Crucial to developing the teaching programme was the practitioner's articulation of his vision of design – an iterative process in a dynamic, rather than fixed, context raising the question of when, if ever, can we really say architecture is finished.

The interpolation of this vision into a 12-week teaching framework provided students with separate areas of a connected site on which they responded to prompts for change by making and presenting six iterative designs. The process required students to record and analyse how their designs evolved - whether through altered context, planning, form, usage, external space or other means.

The co-teaching collaboration produced a programme of deliberate uncertainty. Students didn't know what change was coming next, not unlike what happens in practice. Analysis of the teaching process revealed how the model-making milestones were vital to students understanding how design is invigorated in the act of predicting, reacting, remaking and self-critique. The frequent critiques provided ongoing interrogation of the design process and demonstrated pivotal points of tension, difference and consensus between practitioner and academic. The process created a space for students to engage with unpredictability and, through the regular ongoing critiques, revealed and communicated aspects of tacit design knowledge.

Introduction

The proposition that change and uncertainty shape and animate not only the design process, but also the entire lifecycle of the built environment is at the heart of the Ch-ch-ch-ch-Changes studio design course first taught at the School of Architecture and Planning, University of Auckland, in 2017, then repeated in 2018. This involved two of this paper's co-authors, academic Chris Barton, and practitioner Jeremy Smith, co-teaching a studio. The idea to examine how change might affect design teaching is informed by Smith's current PhD by Practice. His research argues that while the architect's practice achieves a close relationship between building and landscape when the landscape is controlled and kept constant, when the landscape changes rapidly or catastrophically, such events highlight how existing practice fails to prepare for an outcome in relation to time. In short, it recognises that neither buildings nor landscapes ever stay the same. The research suggests architecture students in New Zealand are taught to finish buildings and architects are legislated to finish them, otherwise Councils won't issue Code Compliance Certification. The practitioner argues architects rely on repeatedly refinishing the landscape to negate the need to change buildings – a metaphorical, but also often actual, mowing-of-the-lawn around buildings.

Change and time are central to Smith's research. It shows, through case studies and precedents, that design outcomes generally fail to engage with shifting landscapes in rural settings due to a successional methodology that reifies the concept of finished landscape and buildings. He suggests that model of architectural practice is in itself exhausted, out-of-date, finished, and proposes a new approach where buildings are in an ongoing state of being finished and remain unfinished, like their landscape.

The proposed new approach is described as soft architecture – architecture that's malleable, not necessarily multipurpose, but with adaptation embedded into its DNA and able to participate in shifting landscapes. A building might be quick to change but to be soft it must participate in the landscape as might a river (with the ground influencing the way the river flows, and, in turn, the river affecting the ground). It's a two-way relationship, a dynamic ongoing exchange. The process, he contends, is no different in city landscapes, where the contexts buildings receive from their surrounds do not stay the same. Nothing is new for long and, as New Zealand's cities become more intensely developed, our buildings continue to be built as if they will remain finished. They are, in fact, continually responding, weathering, degrading, and practice relies on buildings being maintained and refinished.

Teaching Change

To bring the idea of change and uncertainty into an educational context required a radical shift as most studio teaching at the Auckland School of Architecture and Planning follows a successional teaching schedule leading to finished output at the end of 12-week course. This was disrupted by dividing the course into six outputs, one every two weeks, requiring students to present a design that iteratively changed at each of six hand-ins over the 12-week period – physical model, drawings and an evolving three-minute slide presentation visually documenting design changes of each iteration.

The idea draws from Juhani Pallasmaa's writing about relationships between change and time. Combining research and practice, suggests Pallasmaa, establishes "a dialectical tension between theory and design practice instead of a casual interdependence".[1] Research affects practice, and practice affects research, but the two are often divergent disciplines in New Zealand. Shifting architectural models to prepare and respond to change more readily requires testing ideas in a format where the timeframes to change can be readily explored and analysed.

The 12-week studio course provided a way to speed up time, with each week notionally representing a 10-year time-lapse in the life of the city. In doing so, the process replicated practice with designs and constructed buildings constantly undergoing change and facing new challenges.

Students were introduced to these ideas through an introductory presentation by Smith which traced the history of a holiday house designed to occupy a forest, but which found itself in a clearing following a cyclone. Bach with Two Roofs (see Figure 1) not only needed repairs but it needed refinishing for, as Smith showed, without the moderation of the forest the sun was hotter, the wind stronger and privacy had gone. The new work required a change in methodology to allow the buildings to be iteratively refinished as a new forest grows around them. Photos of the work graphically demonstrated the need for buildings to change.

This was an important start for the students and showed how the concept of designing for change worked in both practice and theory. Bach with Two Roofs won World Villa of the Year at the 2017 World Architecture Festival and forms a key part of the practitioner's doctoral research. Smith then introduced key texts, case study buildings and ways of considering change in architecture, including the work of Japanese Metabolists and Void Metabolists, landscape urbanists and further larger public projects from his practice.

Smith's methodology draws on creative practice research by Richard Blythe in J. Moloney et al's *Perspectives on Architectural Design Research*, and particularly Blythe and Leon van Schaik, amongst other examples, in Murray Fraser's *Design Research in Architecture: An Overview*, both of which marry various design research methods from the work of both researchers and practitioners.[2] Within this broad field, Peter Downton and Van Schaik drawing from Rockmore's epistemological viewpoint, where knowledge is created rather than discovered as an objective truth, are particularly influential in defining this design research methodology. It provides the basis of the alternative methodologies presented in the practitioner's research, where architecture results from shared understandings rather than social isolation, which has particular reference to New Zealand given its geographic and historical isolation and the "man alone" ethos that haunts the early and mid-twentieth century psyche of its literature and art.[3]

The challenge was to build a studio design course that would show buildings could be soft, malleable and prepare for change in city landscapes. It would require a context where students' designs couldn't rely on their neighbours remaining unchanged. What was needed was a state of flux, an ongoing building project where the urban fabric expanded and contracted all the time. Change would be the only constant. In such a context, buildings would have to change and their designers would need to establish strategies for doing so without knowing what was coming. Whether pre-emptively or reactively responding to shifting contextual relationships through function, program, size, or just time, the strategies for change would demonstrate an urban context that could be considered, and even designed, to be unfinished.

Figure 1: Bach with Two Roofs in forest (2007), after a cyclone (2014), in a clearing after the clean-up (2014), refinished to a clearing (2016) and projected into forest again (2116?). Images from top [l-r] to bottom.

The academic teaching with the practitioner selected an existing urban context with a series of adjoining sites notionally created (Figure 4). Here, amidst a strip of existing heritage buildings, students would be allocated a site by ballot and then design a building of their own choosing – the only requirement being that the design must incorporate a strategy for change and that they couldn't expect their design to stay the same.

Changes were then sprung on students every two weeks as roadblock challenges, with designs needing to change to participate in the shifting city landscape around them, be it changing context, change of use, an earthquake destroying the heritage buildings, or adding additional area or occupancy loads. Each change is seen as an opportunity for students to improve their designs and test their strategy for change in much the same ways as the practitioner does in his practice.

The process is iterative and sequential, with the project's key ideas being used to critique pressure points, and to look for opportunities at each roadblock regardless of whether the building is being designed, constructed or used. As Smith described to the students, learning how to look ahead in the design process turns change into opportunity. Figure 2 shows the itinerary for change with its weekly design milestones and roadblocks and Figure 3 compares the studio teaching process to Smith's practice.

Figure 2: Ch-ch-ch-ch-changes itinerary for change.

PRACTICE		CH-CH-CH-CH-CHANGES
Idea for change.	IDEA Establish what is important. Establish critique points.	Idea for Change
PHONE CALL	↓	***ROADBLOCK***
CHANGE NEEDED By client By cost By consent By context By time	CHANGE NEEDED Review to key idea for change? Where is there opportunity? What can be improved? What other changes might be needed?	CHANGE NEEDED By context : Week 2 By function : Week 4 By space : Week 6 By size : Week 8 By time : Week 10.
PHONE CALL	↓	***ROADBLOCK***
CHANGE NEEDED By client By cost By consent By context By time	CHANGE NEEDED Review to key idea for change? Where is there opportunity? What can be improved? What other changes might be needed?	CHANGE NEEDED By context : Week 3 By function : Week 4 By space : Week 6 By size : Week 8 By time : Week 10.
	↓	

Figure 3: Process chart comparing practice and Ch-ch-ch-ch-changes studio.

Figure 4: Seventeen notional sites placed around existing heritage buildings and modelled at 1:100 scale.

Pedagogy in Practice

From a pedagogical perspective, the idea of deliberately introducing uncertainty is not as radical as it might sound. As Kester Rattenbury, writer and Professor of Architecture at the University of Westminster, points out, schools of architecture often deliberately structure risk into their design projects.[4] Far from being as reckless as it seems, Rattenbury argues such risky strategies are essential for "teaching people to improvise, productively and well, and in detailed, complex, developed form, given unpredicted variables." In other words, "to work actively with situations which are inherently not predictable". But she recognises an inherent contradiction also acknowledged in the practitioner's research: "Professional legislation of all kinds increasingly tries to nail down every circumstance of building and teaching. But real architectural conditions are always non- standard. They always have vast numbers of variables — practical, aesthetic, human, chronological, economic, you name it — shifting in relation to each other all the time."[5]

Recognising this contradiction and deliberately embracing a teaching strategy for change littered with risk signalled the beginning of a collaborative process between academic and practitioner that became integral to the teaching process. It began as a dialogue, first to establish the architect's design process and then to translate that into a teaching programme incorporating the essential idea of change and uncertainty in design. The idea parallels Rattenbury, (referencing Neil Spiller and Nic Clear, Educating Architects: How Tomorrow's Practitioners Will Learn Today) – in particular her view of the opaque nature of both design and its teaching: "Design is a peculiar skill set: highly sophisticated, powerful, widely used, rarely explained or even understood. And design teaching is a really major part of this surprisingly uncharted territory. Indeed, it is a core aspect: where we start developing, and how we pass on, our powerful, rarely defined sense of what architecture is, how we produce it and appraise it."[6]

Later the dialogue became an open-ended conversation in front of the students at both the individual and group critiques of the students' designs – a back and forth banter between academic, practitioner and student to tease out the tacit aspects of the practitioner's practice and knowledge. The practitioner might say: "It is hard to know what to do here – you don't know what is coming. In practice you are always trying to look ahead. Can you see that by doing this you are setting off on this path? Is that where you want to go? Is that the best way to test your idea for change?" It was a process of showing, rather than telling students about design research. Rattenbury provides some context for how such a "teaching in pairs" model arose. Such studios, she says, are usually led by two tutors, (often a combination of practicing architects, other designers, or academics), which inevitably leads to debates and arguments between them. "This conforms with research where creative design is actively helped by the individual's ability to define their own position in relation to two other people's views. But so far as I know, teaching pairs is a formula which has evolved through trial and error."[7]

The initial dialogue established that the architect designs and responds to change by analysing from a founding question that sought a close, dynamic relationship between building and landscape as its answer. "We work most of our projects back to a question," says the architect "…critiquing what we are doing as a way of staying honest to the original intent."[8]

It is a position where epistemological discussions are as much process as outcome, with no single creative research path. As Downton puts it: “designing is a way of inquiring, a way of providing knowing and knowledge; this means it is a way of researching”.[9] The methodology is therefore a process of discovery, reflection, analysis and improvement, or in Atelier Bow-wow terminology, “transductive”.[10] The process also draws from James Corner’s placement of landscape urbanism into a reflexive methodology, with “field diagrams or maps describing the play of these forces… particularly useful instruments in furthering an understanding of… events and processes".[11] The practitioner might prompt, “What do you think is going to influence your building? What type of change are you preparing for?” In this way, as Downton asserts, making becomes a “way of knowing”.[12]

Translating such heady design research theory into teaching practice occurred in surprising ways, in moments of tension or slippage between theory and practice that revealed mechanisms of tacit knowledge. The first slippage revealed was in the iterative model making process at the heart of the architect’s design practice, involving a relentless critique and remaking of iterative card models. The teaching studio emulated this practice with a central table (Figure 5) where students’ models were displayed and critiqued each week.

The table provided a central means for observing student progress, but was also a place of interaction between the students as they watched new designs arrive and contemplated what affect it would have on their building. From the academic’s point of view the table brought together each student’s individual design into a shared context. This was notably different from other studio teaching Barton had engaged with where students generally worked from a common design brief, each evolving their own design solution separately. But here it was impossible for their design to exist in isolation.

The tacit use of iterative physical model making in the architect’s practice relates to ideas of authentic representation of the design. The process acknowledges drawings – plans, sections, elevations – as necessary to make the model, but sees them secondary to the physical model itself, as though it provides closer access to the yet-to-be building. Robin Evans argues that preliminary sketches and maquettes are much closer, more connected, to finished painting and sculpture than a drawing is to a building and that the drawing, rather than the building is the “real repository of architectural art”.[13]

The practitioner’s design practice places great weight on the model as the repository of the design. Models, he suggests, don’t lie and are easy to understand. A model doesn’t allow cropping of an image or changing the field of view.

Figure 5: Students piece the model together and then analyse and record the week's changes around their building. 2017 studio [Top]; 2018 studio [Bottom].

The shadow cast in a model is the shadow cast in the real building. This representational process was developed further in the teaching process with students encouraged to photograph their models and then, rather that create renders, use Photoshop to massage their photos to create perspective views, (Figure 6) of their designs as it changes each week.

It was essential that this photography included the surrounding context and the other student's designs to show the city landscape changing continuously – hence the need for the centralised table for the site model on which designs were placed in relationship to one another (Figure 7).

Figure 6: A 2017 student's perspective image developed from a photo showing other students' models as the cityscape and which was updated (left to right) along with the cityscape over six hand--ins.

Figure 7: Contexts and environments continually shift as students work develops each week and they face, and respond to, change. One week a view, the next week a neighbour changing the outlook. 2017 studio [Top]; 2018 studio [Bottom].

Essential tension

The most significant tension in the teaching process occurred during the weekly critiques of the students' works-in-progress when practitioner and academic were both present. Every second week this would occur as a group critique when each of the 16 students in the studio presented their latest design. The routine established a regular three-way conversation between student academic and practitioner – a show-rather-than-tell process where the student was encouraged to argue. "What do you think? Push back – disagree. Stand your ground," were frequent refrains. The underlying pedagogy here is that design is largely learned through a curated process of doing. That includes a group dynamic – students watching others design and seeing for themselves how to distinguish what works from what doesn't. Attending and participating in the feedback is how both students and tutors learn.

The milestones also provided a convenient assessment tool to provide feedback on student progress. At each design presentation both academic and practitioner would assess the work on a UDAM (Unacceptable, Deficient, Acceptable, Merit) scale and then compared assessments. These were then combined into a single assessment providing a useful means of recording student progress over the 12 weeks. At the halfway stage students were given written feedback which included their three assessments on the scale. The final grade was comprised from the six UDAM grades. For the academic, this was a significant departure from previous studio teaching where the student's final grade was mostly derived from their final presentation in Week 12.

A key to the process was ensuring each time a student's model was critiqued that it was done in relation to the student's description of their strategy for change. At each iteration students were encouraged to explain and improve their strategy for change in their presentation of their new design. Eg: "My idea for change is to establish a building which generates ways to change through its porosity in relation to how buildings grow around it. Because of my neighbour adding this additional area, my building has responded like this." While that included usual advice and suggestions of how to improve the design in relation to aspects such as circulation or space planning, it also involved comparison to what had gone before – i.e. the previous week's model.

The characterisation of a dynamic reflection model where the past is not fixed, but remains in flux and becomes altered by each new project, whether notional or real, parallels Fraser's "two-fold movement" creative components.[14] The process includes critical examination of theory and architectural works, and "both doing and reflexive" analysis of design work.[15] Pushing students to look back at their previous designs and self-critique whether they had improved in relation to their overall design concept, including their strategy for change, created a frequent stream of "what-if?" questions. Here the practising architect would often take parts of the model and move them or hold up pieces of card to demonstrate the effect. On other occasions the academic teacher would, when a particular unresolved design issue had been recognised, prompt the architect to describe what he would do in his practice to resolve the problem. In one instance, this involved suggesting a student remake parts of her model in different materials to show the effects of opaque, clear and translucent panels (Figure 8).

Figure 8: A 2018 student testing a model in clear, translucent and opaque panels before combining all three in relation to the developing cityscape.

The “try it and see” response became another regular refrain in the critiquing process. Inevitably, this led to tacit aesthetic judgements. Here, using their model, students could explore options. The architect would ask, for example: “What do you prefer – your design with the stair here (externally) or internally (removing the external stair)?” On such occasions, the student was asked to confront the consistency of the design concept. The architect would ask questions like: “Is that the same language (pointing to a design element on the model that might indicate a new direction)?” Or (looking closely at a floor plate of a model): “Use your design eye here – you have a way of managing gaps in the building. Do you want it to read as one, two or three buildings (Figure 9)?”

Figure 9: A 2018 student's model preparing strategies for what might be built around it.

The process fits with Blythe's field of "fascinations" – that is, the broader referential framework of the community of practice where the designer can be located and contextualised – and also key tropes that the practice returns to again and again. Blythe states: "What is the exedra to the specifics of individual projects that orients the designing and defines its intent, acknowledging that this intent may well remain tacit? The urge, then, is what drives the designer; and this urge defines, to some extent, the emerging line of inquiry that runs through the practice."[16]

Conclusion

This method of critique intensifies engagement and argument about design between student and teacher, pushing the academic to critically interact with both the practitioner's and students' strategies for change and adaptation. Each design presentation critique also involved evaluation, providing a successful feedback loop between teacher and student and proving a means to assess the ongoing process of design rather than the finish product.

For the practitioner the student work provided a way of testing various approaches to designing for change which is difficult to achieve in practice. This dovetails into the design research that has emerged in recent years from the RMIT model – loosely described by Rattenbury as a branch of research that sets out to research architecture's own native design processes on their own terms. "That means developing research terms and methods by building up knowledge of existing design processes that we are already using – rather than adding on some other discipline's framework."[17]

The Ch-ch-ch-ch-Changes studio provided a way for the practitioner to hone his own research, to extract and analyse his own tactics – the way he used models, presented to clients and other aspects of what happens in his practice to generate a design. It also provided a vehicle to articulate, communicate, describe, test and improve his thesis – in particular providing validation for his notion that city buildings need repeatedly to change.

In summary, this paper suggests four possible enhancements for design teaching that may help reveal tacit design knowledge. The first is the iterative making process formalised in six changing design outputs over the 12-week course and the second is the six iterative critiques of those outputs in a group context. The paper suggests a more regular interrogation of the iterative system of design is important because it's out of those tactics that architecture has itself evolved its own unspoken, tacit methodologies for design. More regular making and more regular critique of the making, as if to make it second nature. In other words for both architect, academic and students, practising, provides a strong vehicle to bring those latent design methodologies into the light.

While the critique or "crit" is a regular feature of studio teaching at the Auckland School of Architecture as a means of continuous improvement of student designs, it's also used as an assessment tool, particularly at the final crit where students may hear about the failings of their design but have no opportunity to address them. This studio argues for crit as a tool of continuous improvement and as an integral part of design practice. By modelling a regular three-way dialogue between academic, practitioner and student, (with its attendant agreements and disagreements) the teaching aims to engender a process of self-critique for students to harness in their own design methodology.

The combination of roadblocks and the relentless schedule meant students were regularly repeating and improving the presentation of their design arguments for the way they showed change and how they expressed their strategy for change. The repetitive nature of this inevitably lead to a honing of oral and visual communication skills and instilled confidence in students through visibly improving how they described their work. Practising makes perfect.

The fourth enhancement is setting up the studio around a large table on which the model is placed as a shared resource. This mirrors how Smith's practice is set up with work spaces circling a very large and long communal table where critique, discussions and modelling takes place and where everyone can be involved. In the studio this meant the students could watch and learn from each other's progress as their designs evolved. It also provided a highly accessible platform for critique, plus a means to watch a segment of the city grow, adapt and develop in unexpected and delightful ways.

The significant difference to note here is, compared to studio teaching where students may similarly make models to communicate their design intentions, that they are often doing so in response to a shared brief or design problem. Here the individual designs are all pursing their own brief but through the central table come together in a shared context affecting one another. With nowhere to hide, the designs are forced into conversation with one another.

The benefits of this type of studio was particularly evident when comparing the differences between the 2017 and 2018 students' designs. Both groups designed on the same site with the same brief, but produced vastly different cityscapes (Figure 10 and 11). It's clear that cities change as a collective, with one building change influencing its neighbours, and the process vividly demonstrates how buildings must be prepared for change. When shown the previous year's model at the end of the course, the 2018 students were interested in what had driven the 2017 studio to such a different result, but weren't surprised that the outputs were so different; cities develop iteratively from many different decisions, they suggested.

As the practitioner suggests of both practice and architecture, and the academic of teaching design: “Being finished is finished.”

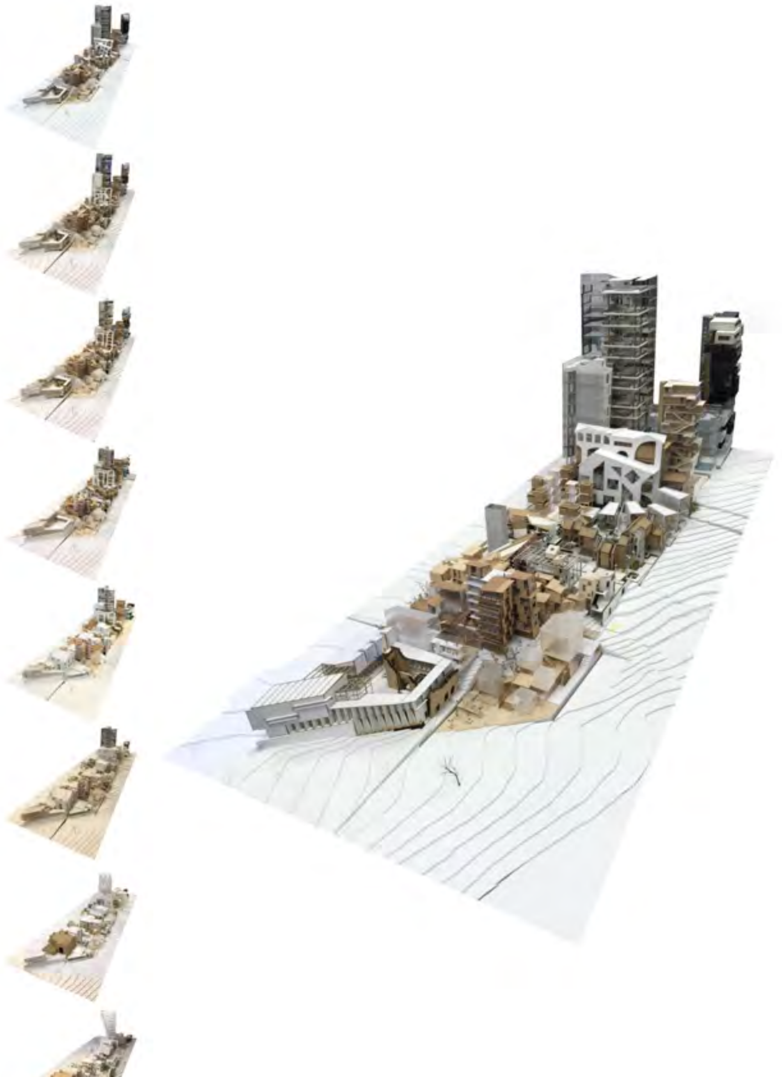

Figure 10: 2017 Ch-ch-ch-ch-changes Studio Week 12 model and weekly iterations.

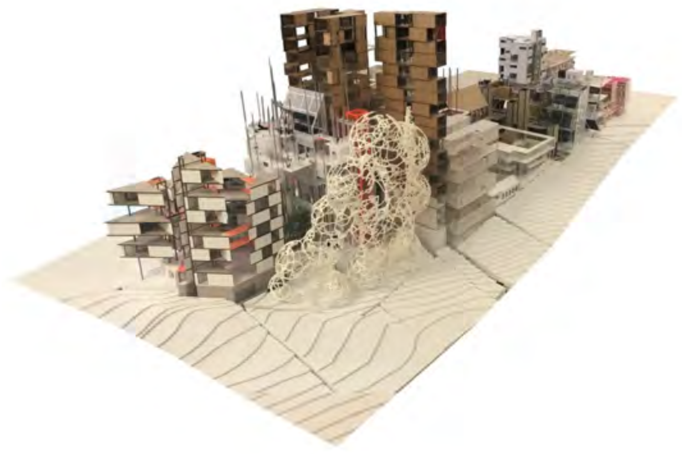

Figure 11: 2018 Ch-ch-ch-ch-changes Studio Week 12 model and weekly iterations. Vastly different cityscapes develop from the same brief and students responding to each other's designs showing that cities develop iteratively from many different decisions and changes.

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MAKE Studio: A Reflection on The Value of The Design Charrette in Architectural Education

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Abstract

This paper examines the 2017 MAKE DesignBUILD Raw Intensive Studio (or MAKE Studio) at the University of Sydney as a means through which undergraduate students were introduced to fundamental elements of design research in architecture through a material-based, fast-paced, iterative process of design development.

The MAKE Studio was conceived in the tradition of the architectural design charrette. It was structured in a competition-style format that ran over two weeks, incorporating real clients and a real build. The studio culminated in the construction of two student-designed structures for the 2017 DesignBUILD Expo. Enrolment for the studio was open to all architecture undergraduates, creating a student group with a broad mix of skill-sets. The success of the teaching method for the studio was evidenced by the fact that, contrary to expectation, the winning design was completed by a group of relatively inexperienced first years.

This paper examines findings from the MAKE Studio, which suggest that in order for the design charrette to be an effective introduction to research design methodologies, particularly research *through* design, it needs to incorporate key elements. These include a real build with a relatively simple project brief and limited scope; a competition-style, fast-paced, intensive format with a focus on speed of production; and iterative media rotation as modes of working. Regular presentations to clients or a jury are imperative to facilitate a feedback response loop that can be translated through iterative, non-linear design development. A mix of different year groups enhances the development of a cumulative, collective knowledge base via collaborative group work and discussion. In addition, a pass or fail assessment criteria and mandatory attendance mitigate the risk of limiting student engagement with explorative design.

Through a discussion of the MAKE Studio, this paper considers the value of the intensive design charrette as an invaluable experience through which students gain first-hand experience in architectural design research methodologies. This paper therefore advocates for the continued inclusion of the face-to-face intensive studio in architectural design education, particularly in an academic landscape that is progressively shifting towards online methods of course delivery.

Introduction

This paper considers the value of the intensive design charrette in architectural education as a means through which design research methodologies can be introduced to undergraduate students. The topic is explored through a reflection on the MAKE DesignBUILD Raw Intensive Studio (or MAKE Studio), coordinated by the authors in collaboration with Michael Muir in 2017.

The MAKE Studio was conceived in the tradition of the architectural design charrette. It was structured in a competition-style format that ran over two weeks, incorporating real clients and a real build. The studio culminated in the construction of two student-designed structures (a theatre and central hub area) for the 2017 DesignBUILD Expo (see Figure 1). Run over the summer as an intensive elective, enrolment was open to all architecture undergraduates. This created a student group with a broad mix of skill-sets, ranging from first years with little experience to high-achieving third years on the cusp of graduating.

Within the discipline of architecture, a design charrette is understood as the development of ‘a creative design solution, often in an intensive participatory or group format, within a shortened period ranging from one day to two weeks.’[1] It is derived from the traditions of the L’Ecole des Beaux Arts when architecture students completed a series of monthly competitions to reach the Grand Prix, the award for which was five years tuition to study in Rome.[2] The term charrette is in reference to the cart which would come around to collect the final assessment submissions and the legend of students jumping aboard along the way to finish last-minute details of their drawings.

Figure 1: The winning design for the theatre.

The designed outcomes of the MAKE Studio are not the focus of this paper. The focus is instead on the opportunities offered by the mode of delivery and structure of the design charrette as a material-based, fast-paced, iterative process of design development. While there has been a long tradition of intensive, high-impact design courses in architectural education, a reflection of the MAKE Studio serves as a reminder of the value of the design charrette in architectural undergraduate study, particularly in an academic environment where much of the face-to-face teaching is being replaced by online methods of course delivery.

Research through design

In recent times, scholars appear to have reached agreement that design research is a credible research methodology. The parameters of what exactly constitutes design research, however, have remained stubbornly ill-defined, so much so that Wolfgang Jonas titled his inquiry its logic as ‘Exploring the Swampy Ground.’[3] This evocative description makes reference to the earlier work of Donald A. Schön, who described the perceptions of research at the time as either belonging to the lowlands (design research) or more rigorous high ground (traditional forms of research). He states:

> In the varied topography of professional practice, there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and a swampy lowland where situations are confusing ‘messes’ incapable of technical solutions. […] There are those that choose the swampy lowlands. They deliberately involve themselves in

> messy but crucially important problems and, when asked to describe their methods of inquiry, they speak of experience, trial and error, intuition and muddling through.[4]

In 1993 Christopher Frayling offered some solid ground through his tripartite definition of design research based on research *through* design, research *for* design or research *about* design.[5] The processes involved in research '*for*' and '*about*' design are relatively unambiguous, but the parameters of 'research *through* design,' particularly in architecture, are not quite out of the swamp yet.

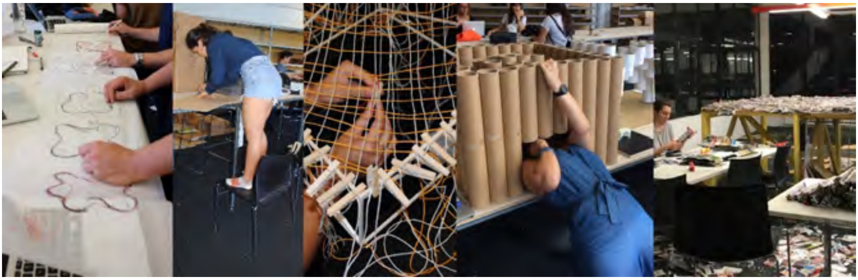

Figure 2: To an outsider, the design process can seem unsystematic and indulgent.

An influencing factor in this lack of clarity is the multifaceted nature of architectural design research and the tendency of architectural processes to align with wicked problems.[6] In a seminal publication exploring these complexities entitled *Design Research in Architecture: An Overview*, Shane Murray describes the architectural design process as seeming haphazard, indulgent and ineffective (see Figure 2), placing it in sharp contrast to more familiar methods of research which by comparison seem methodical, rational and objective.[7] Murray takes the position, however, that 'research through architectural design is not only possible but also fundamentally valuable for the discipline of architecture.'[8] This paper is in support of Murray's argument, advocating that the architectural processes of 'research through design' play a critical role in developing the tacit knowledge essential to good architectural practice. In the majority of cases, the development of tacit architectural knowledge begins in the studio environment of architecture schools. This paper argues that the inclusion of the intensive design charrette in undergraduate studies provides an excellent introduction to the myriad of opportunities offered by 'research through design' in architecture.

In a recent survey of the contemporary theory relating to design research in architecture, Yasser Megahed links architectural training with the production of tacit architectural knowledge.

> The knowledge revealed in design outcomes is often tacit and experiential. Tacit knowledge is a kind of knowing that is not separable from the perception, judgement or skill that the knowledge informs. While often straightforwardly 'read' by other designers, it usually remains unclear to those external to the discipline. Architectural projects – be they a building, artefact or speculative proposal – contain embodied knowledge that draws on prior experiences and the legacies of

> architectural training and are hence visible to those with the training.[9]

The key element here is Megahed's inclusion of 'the legacies of architectural training' as a vital component in the development of tacit knowledge in architecture. This statement contains within it the assumption that architectural training includes exposure to the messy lowlands of architectural design research methodologies. However, recent scholarly debate surrounding the changes occurring within the current paradigm of architectural education illustrate that this is not always the case.

The changing landscape of architectural design education

Like many tertiary endeavours, the nature of architectural education is changing. In a recent publication entitled "Studio Models in a Changing Higher Education Landscape" scholars Wallis, Williams and Ostwald argue that the design studio, once a central feature of design education, is increasingly at risk, particularly in a context that values 'efficiency dividends.'[10] Advances in technology have facilitated a shift to online content and as a result student expectations in relation to face-to-face tuition and course delivery have altered significantly in the last decade. Of particular relevance to this paper is Wallis, Williams and Ostwald's reference to current issues in poor student engagement and the difficulty this creates in implementing 'any type of studio-based teaching that relies on students learning from the peer group.'[11] Collective learning is a core feature of the design studio, functioning as a tool through which reflective practice is introduced, as is further explored later in this paper.

Changes to the nature of architectural education and the subsequent role of the design studio warrants discussion because, as Burnham and Wallis argue, 'Design is a troublesome concept to teach. It is varied, complex, difficult to capture in cognitive dimensions and is not really learnt through reading or instruction.'[12] Therefore, it is important to consider the way in which a shifting focus towards efficiency dividends in tertiary education has altered the academic landscape in architecture.

In a recent critique Sebastian Macmillan discusses the impact of competitive funding systems on academic teaching. He argues that 'lecturing staff are increasingly, and in some cases exclusively, lecturing and researching but not giving tuition in the studio.'[13] Increasingly, the face-to-face teaching of design studio tuition is being outsourced to less invested parties or delivered online. Macmillan argues that the distancing of academics from the face-to-face studio environment 'carries the associated risk that design teaching is perceived as the delivery of a craft skill, undermining its place in the academy.'[14] When this perception is compounded by the impression of architectural design research as an unsystematic, subjective muddle, it further undermines the perceived value of the design studio.

This is not to say there aren't a collection of architectural schools operating counter to the above description. There have also recently been an array of excellent publications championing the importance of studio-based design research, iterative model-making, non-linear experimentation and media rotation.[15] It cannot be denied however, that on the whole, the way in which these educational tools are being delivered is undergoing a radical transformation and, as a result, a new structure of architectural education will emerge. This paper is not arguing that these changes should be outright resisted or that the impact of these changes will all be negative; change is the reality of progress. This paper does, however, argue that within the reshaping of architectural education, there is place for the intensive design charrette, particularly if key features are included in the structure, as is discussed below.

The design charrette as an introduction to research through design

Megahed outlines that the key characteristics of design research in architecture include: 'saturation with tacit architectural knowledge; the iterative nature of its processes; and a commitment to reflexivity on behalf of the researcher.'[16] These strongly correlate with the fundamental elements of the design charrette, in which:

- students are asked to tackle an architectural problem within a short timeframe, often teamed with other students in small groups
- research is undertaken *through* design via in-studio exercises that involve experimentation, iterative model-making and fast-paced media rotation
- teachers (preferably alongside guest critics and clients) give regular feedback to the students in the presence of the whole group.

The MAKE Studio provides a lens through which the dialogue between the nature of research through design and the charrette studio model can be examined. The course revealed insights regarding the key elements required for a successful undergraduate charrette with a design research focus. These include:

- the intensive timeline of the design charrette;
- a speed of production;
- iterative media rotation as a mode of working;
- a competition style format with a real outcome/build;
- a limited scope through a defined project brief;
- regular presentations with feedback and reflection sessions;
- a diverse range of skill sets offered by a mix of different year groups;
- the collaborative nature of group work;
- pass or fail assessment;
- mandatory attendance.

The MAKE studio was structured around six contact days spread across two consecutive weeks. At the end of the second week, the students presented their final design proposals to the client. The contact days (Mondays, Wednesdays and Fridays) were focused on short and quick design exercises aimed at unpacking various aspects of the brief. The non-teaching days were reserved for design development, with key deliverables scheduled for presentation the following morning.

Speed of production and media rotation

The fast-paced nature of the MAKE Studio as a design charrette demanded an immediacy of rapid production which facilitated experimental ideation and design exploration (see Figure 3). Scholar Marc Angelil advocates this mode of working in *Inchoate: An Experiment in Architectural Education,* suggesting that the speed of activity enables valuable production precisely because ‘Action is prioritized. Through the requirement of an instantaneous response […] two mutually dependant mechanisms of production are brought to the forefront: interpretation and intuition.’[17] Instantaneous interpretation takes the form of Schön’s ‘reflecting-in’: immediate reflexivity on behalf of the designer as a response to the challenge or task at hand.[18] In the case of the MAKE Studio, the guided design processes which required instantaneous interpretation were also, in many ways, contributing to a foundation of cumulative knowledge from which the mechanism of intuition could act. This process fosters a kind of knowing that Megahed describes as being inseparable from architectural design.[19] Due to the speed of activity, the intensive nature of the MAKE Studio demanded instantaneous intuitive interpretation, resulting in a kind of production that is critical to the processes of research through design.

Figure 3: Ideation and conceptual experimentation through fast-paced design exercises.

In addition to speed, it was important for the students to develop an agility of thinking in order to translate their ideas across multiple materials and modes of representation (see Figure 4). The MAKE Studio was structured to encourage students to investigate concepts by moving back and forth between drawing and model-making, working in different scales and with different materials (including paper, cardboard, timber, fabric, thread, wire, and balloons etc). This kind of media rotation positions representation as an operative process rather than an illustrative one, fostering a consideration of the structural, formal, textural, material and organisational characteristics of each new medium.[20] Iterative media rotation demands an ongoing translation of concepts across different formats, and as a result, the evolving design model becomes a mechanism for the generation of new ideas. In the context of the Make Studio charrette, both concepts enabled the process of researching through design.

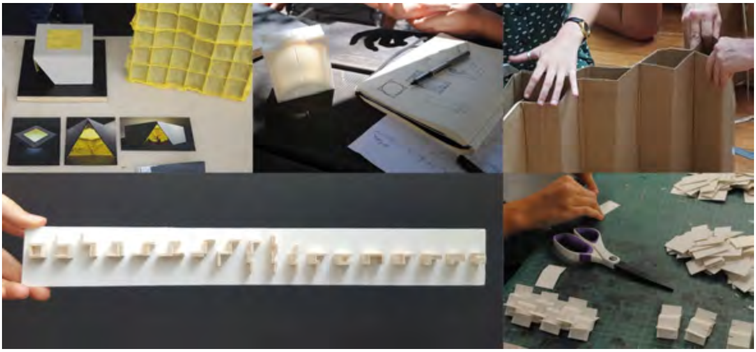

Figure 4: Media rotation as a means of research through design.

A simple project brief resulting in a built outcome

The brief for the MAKE Studio offered a particularly tight set of constraints. The primary objective was the construction of a temporary theatre to seat 75 to 100 people for a paid series of industry lectures and presentations. It was therefore important that the structure not only obstruct the view from the outside and buffer the noise generated by the expo, but that it was also structurally sound enough for a public event, meeting important safety and access requirements. Sustainability was a priority of the brief, dictating that the winning structure should be entirely recyclable. The intensive studio was held several months in advance of the event and the lack of storage options necessitated a structure which could be prefabricated just prior to the event, easily transported and assembled in under a day using unskilled labour (see Figure 5). The public nature of the event, a forum attended by large section of the design and construction industry, provided additional pressures. The structure would be exhibited alongside other local universities involved in the DesignBUILD Raw Programme of the Expo. It was therefore important that the winning structure reflect the capabilities of the University of Sydney and the Faculty of Architecture, Design and Planning in a favourable light. This was all to be achieved with very little budget (a constraint not uncommon for projects such as this one).

Figure 5: The brief required a solution which was recyclable, transportable, and quickly assembled with unskilled labour.

The need to respond to very real questions surrounding materiality, structure and buildability demanded deep consideration of these issues. The limitation of the scope to a temporary, indoor structure (thus avoiding complex issues of weatherproofing, servicing etc) provided a rare opportunity for undergraduate students to resolve architectural details in practice. Given the two week timeframe of the charrette, the limited scope of the brief was critical in facilitating the successful delivery of a design for a built outcome.

Iterative cycles of presentation, discussion and reflection

The competition-style format of the studio not only motivated production and increased the levels of student engagement, but also provided an opportunity to regularly interact with the client. Wallis suggests that one of the most important factors in this mode of teaching is the opportunity for hands-on learning in a real project, where the client's needs are of primary importance.[21] As central members of the jury for the MAKE Studio, the clients were invited to critique the work at key stages of development, specifically interim presentation and final presentation. This not only provided invaluable feedback during the design process, but also held the students accountable, thus increasing their desire to produce and showcase their best work.

The MAKE Studio was designed to encourage iterative development through a daily rhythm of presentations, design activity and discussion. During the morning presentations, students were given feedback in front of the whole group. This was followed by a period of design activity, after which the students presented their reconsidered design response for further discussion and review. The regular process of presentation, feedback and discussion was conducted collectively, allowing threads of discussion to be drawn across multiple projects. This group activity of reflecting-on the work facilitated a cumulative and collective development of knowing to occur, evidenced by the rapid improvement in the work of the less experienced students. As multiple emerging solutions were developed by the various groups, the regular collective reflection enabled the transfer of ideas and as a result, an accumulation of tacit architectural knowledge across the group.

Group work and a broad mix of skill sets

The regular reflective discussions throughout the MAKE Studio were enhanced by the diverse range of skill sets in the student group, a result of the enrolment being open to students in the Bachelor of Design in Architecture as well as those in the Bachelor of Architecture and Environments (the curriculum of which is a departure from a traditional architecture undergraduate degree.) While Australian undergraduate curriculums in architectural education are typically not structured around open studios (in which a range of year groups are collectively educated), some European institutions successfully operate in this way.

Figure 6: Competitive group exercises in the early stages facilitated team building and collaboration.

The diversity of experience was tackled through the use of group work and as a result the collaborative mode of the MAKE Studio contributed to rapid upskilling across the board. This was evidenced by the drastic improvement in the quality of first year drawings, models and visual communication skills, as well as the calibre and resolution of final proposals presented to the client. It is further supported by the fact that the first prize was awarded to a group of first years from the Bachelor of Architecture and Environments.

Undeniably, part of the effectiveness of the MAKE studio can be attributed to the collaborative nature of the course. The first contact day of the studio included two ice-breaking exercises focused on folding techniques, where the opportunities of paper as a structural material were introduced (see Figure 6). Both exercises were conducted in groups of four that had been specifically arranged to mix the year groups and experience levels. This enabled the cohort to familiarise themselves with team mates they didn't already know and become comfortable working with one another in a friendly environment. The ice-breaker activities also demonstrated to the students the value of the multiplied production capacity of group work and thus played a role in mitigating their resistance towards the collaborative aspect of the course (which can sometimes an obstacle in group work studios.)

Working in this way also had the effect of negotiating issues around the subjective nature of design research. Somol suggests that in group work scenarios 'subjectivity is not simply released, but negotiated and realigned.'[22] Design development in a collaborative group-work environment requires active discussion throughout the design process in order to achieve consensus across the group. The assumptions and intuitive decisions made in the process of design must be externalised and articulated within the group, and therefore made accessible and transferrable. This process aligns itself with elements of Schon's reflective practitioner and forms the basis of research through design.

Pass or fail grading and mandatory attendance

In order to encourage full commitment to the collaborative mode of working, it was imperative that the incentive of grades did not corrupt student motivations. Therefore, the MAKE Studio was run as a pass or fail elective and students did not receive number grades at the completion of the course. Research through design involves responding to shifting hypotheses as they emerge within the work, typically in a non-linear way.[23] At times, this mode of working involves varying degrees of uncertainty, and in the context of tertiary education, commitment to the process can be inhibited by the desire to perform according to a certain set of assessment criteria. Eliminating number grades had the effect of liberating design development and allowing fearless experimentation. Emphasis shifted from a grade-earning final product to the processes of design development and delivery. Students were able to fully invest in the fast-paced explorative nature of the charrette and immerse themselves in the mindset required for the non-linear processes of research through design, without the fear of being penalised.

A critical factor in the success of the course was the insistence on mandatory attendance *and* participation. To make this possible the MAKE Studio was offered as an elective course in the summer break so that the students would not have other study commitments competing for their attention, enabling them to fully immerse themselves in the project. Students had to be present and productive for the full six contact days in order to pass the course. This included all of the in-studio working time, presentations, feedback sessions and collective discussions, maximising the opportunity for students to learn from the peer group.

Conclusion

This paper charts the valuable contribution of the design charrette to undergraduate education, particularly as a means of introducing the practice of research through design. While this paper has focussed on architectural education, these arguments could be applicable across the teaching of many professions. In all cases, it is important to engage with discourse surrounding research and education because of the changing academic landscape of tertiary education. Scholar Inger Mewburn stresses the importance of engaging with these changes, arguing:

> Pedagogical techniques and practices once considered internal professional matters are now exposed to an institutional and managerial gaze, exercised through tools such as performance metrics and student satisfaction surveys. Therefore, there is an increasing need to provide adequate theories for contemporary pedagogical practice, to help design teachers to clearly articulate what they do and why.[24]

The undergraduate design charrette is one such pedagogical practice. It is important to articulate the somewhat intangible aspects of research through design in architecture because, as Megahed argues, ‘long-established academic disciplines habitually consider this kind of immediate experience as less objective when compared to factual and theoretical knowledge.’[25]

In summary, the findings from the MAKE Studio suggest that in order for the design charrette to be an effective introduction to research through design methodologies, it needs to include key elements: a real build with a relatively simple project brief and limited scope; a competition-style, fast-paced, intensive format with a focus on speed of production and iterative media rotation as modes of working; regular presentations to clients or a jury to facilitate a feedback response loop that could be translated through iterative, non-linear design development. A diverse range of skill sets and a mix of different year groups also enhanced the development of a cumulative, collective knowledge base via collaborative group work and discussion. As discussed throughout this paper, a particularly important aspect was the pass or fail assessment criteria because it avoided the risk of limiting the student's approach to explorative design and the mandatory attendance criteria avoided poor student engagement.

Emphasis on the way processes of iterative design and reflection inform each other was key to establishing a foundation of good practice for research through design. The fundamental structure of the MAKE Studio as a design charrette and a short, fast paced, face-to-face form of student interaction offered a valuable means through which design research methodologies were introduced to undergraduate students.

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ADR18

Digital Systems

Chaired by Dr Rizal Muslimin

Open Process Ecosystems: Beyond Product Platforms for Multi-Storey Habitats design and manufacturing.

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Abstract

There is a global interest in large-scale construction and development companies in the application of Product Platforms to achieve a repeatable industrialized house-building system. This paper analyses and evaluates several Product Platform aspects - modularity, commonality, scalability, resilience, adaptability, flexibility- in light of the particular challenges of multi-storey houses design and manufacturing. We identify and describe these challenges as: Inhabitable space and time. Site specific. Exposed to climate and weather. Lifespan and durability. Size and weight. The convergence of these variables is particular of architectural design discipline. The results show that the complex design needs and constraints of industrialized house-building are not fully covered by Product Platforms, and therefore a more suitable system architecture is needed.

Accordingly, in this paper we focus on the following questions: Which design and manufacturing processes can we develop in order to provide a better answer to the specific challenges of multi-storey housing production? How can a specific architectural design approach help to shape these processes?

After a comprehensive Product Platforms literature review, this paper introduces the original definition of Open Process Ecosystems as a suitable system architecture, which includes several Product Platforms qualities, but shifts from product to process, and from platform to ecosystem. Additionally, we inquire which parts of this Process Ecosystem work better by being open, welcoming as much heterogeneous and uncertain uses, components, agents and contexts as possible.

The paper concludes that Open Process Ecosystems could be a proper systematization framework for an efficient, ecological and successful multi-storey habitats design and manufacturing enterprise and indicates topics for future research.

Introduction

This paper speculates on a new systematized approach to the design and manufacture of multi-storey habitats, by applying architectural design knowledge to the field of Product Platforms. Instead of mimicking other industries, it is necessary to start with a critical revision of state-of-the-art manufacturing processes. At a time of increasing disruption, as the internet-age fundamentally changes how businesses operate, it becomes important to understand which technologies will thrive and which will become obsolete. Technological change is further compounded by today's global context of increasing resource scarcity, climate change, and demographic change. Currently, traditional industry looks to the digitization of 'Industry 4.0' as a means of responding to these issues.[1] Construction has a long history of looking to manufacturing, for improved work methods, yet there remain certain peculiarities about construction that industrial methods struggle to address.[2] Though construction also looks to the principles of Industry 4.0 for improvements, these are framed through the lens of traditional industry. Instead we consider that construction should look through the principles of Industry 4.0 (Figure: 1) and seek to adapt and transform them to respond to the peculiarities of construction, rather than further leveraging traditional industry's techniques.

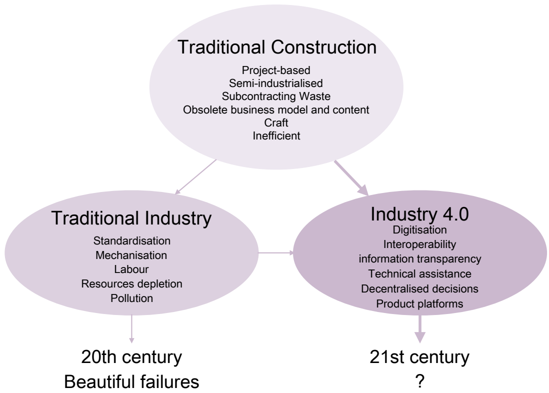

Figure 1: Construction Industry direction.

Alongside this push to digitize industry, the benefits of a platform-based approach to customization and families of products is acknowledged. Companies are being faced with the challenge of providing diverse product ranges to the market with highly standardized production methods to suit automation.[3] It is in this context that a detailed study of the potential applications of Product Platforms in the construction industry is of interest, especially to speculate on what the future of platform approaches will be.

Frame of reference and literature review

Product Platforms emerged in industry in the final quarter of the twentieth century as a means for companies to gain design and manufacturing efficiency through the sharing of parts between products. Famous case studies have emerged, such as that of Black and Decker redesigning their range of tools around a single motor. In the 1970s, or the use of product families by automotive manufacturers, such as General Motors during the 1960s, that lead to the creation of platforms that run across large automotive conglomerates such as Volkswagen today.[4]

By the 1990s, academics were studying the use of product platforms and their implications for increased manufacturing and design efficiency. Product platforms were first defined by David Robertson and Karl Ulrich, as a "collection of assets that are shared by a set of products".[5] These assets take the form of physical *components* and relationships between *people*, as well as the *processes* involved in design and manufacture, and the *knowledge* that the business uses to undertake these processes.[6] Using these assets, Alvin P. Lehnerd and Marc H. Meyer determined that a "stream of derivative products [could] be efficiently created and launched", by taking advantage of the platform's ability to generate "commonality, compatibility, standardization or modularization" between product lines.[7] The product platform approach brought efficiency, flexibility, and responsiveness to the product design and manufacture process.

By the 2000s, the lessons of product platforms were being proposed for industrialized house building by Swedish researcher, Jerker Lessing.[8] Furthering this proposition, Gustav Jansson proposed design support methods, that allowed planning, collaboration, optimization, and iteration to occur to address the unique requirements of construction as opposed to manufacturing.[9] Swedish companies have led the commercial implementation of product platforms for house building, forming close relationships with the academy.[10] However, these efforts still present strong limitations in terms of lack of contextualization, obsolete apartment configurations, and overall architectural design innovation possibilities. As well as Jansson's process-based adaptation, research has also looked at their application in terms of the built product. Patrik Jensen investigated the application of their principles to the design of the built product through the use of software configuration tools.[11] While some research has considered the application of product platform logic to single-dwelling design and construction, the majority has had its focus on the multi-residential domain, where efficiency is enhanced by scale.[12]

The diversity of usage of the term 'platform' in business has been noted.[13] While the use is profligate, when applied judiciously, the term refers to a specific logic of working method. This logic is defined by the above discussion of product platforms, which seek efficiency of process through the search for commonality in the pursuit of distinctiveness. This logic was furthered, by Annabelle Gawer, to extend beyond the 'internal' domain that creates physical entities from product platforms, to operate with a company's supply-chain, extending to create 'industry-wide' platforms that redefine a business' operations.[14]

In the mid-1980s, Michael E. Porter established that value in business is generated by a value-chain, a definition that saw value created by agents in a linear, sequential manner.[15] However, it was in 1993 that James Moore first articulated a vision of businesses operating as an ecosystem, fundamentally altering how relationships exist, generate value, and drive innovation.[16] The personal computing industry of the 1990s began to develop complex business ecosystems.[17] However, the widespread adaptation of the concept has only recently occurred with the development of the internet-age redefining how business transactions are able to occur. Recently, Choudary, Parker, and Van Alystne termed traditional businesses as 'pipeline' entities, noting that future competitive advantage would be established by companies that were able to create and own a platform ecosystem that would attract participants.[18] Ville Eloranta and Taija Turunen contend that platform ecosystems are founded on three principles: *connecting*, *sharing*, and *integrating*.[19] From an architectural design perspective, these principles it would appear are conducive to increased design-value generation for building occupants, and are a key asset in the intricate and often chaotic supply-chain and procurement management of traditional construction companies.

Researchers have begun to propose that these platform ecosystems may emerge to co-ordinate construction contracts, potentially removing the role of a central contractor, instead replacing it with an industry-wide platform to which sub-contractors would interact, delivering value for the building's end-user.[20] Rather than limit the scope of a construction ecosystem to a specific professional perspective, or partial product platform that different actors in the construction industry might develop in isolation from each other (fig. 2), this paper builds on previous research to develop a methodological framework at the other end of the building industry spectrum. This view is based on a case where a single entity takes care of the whole development, design, manufacturing and on-site assembly process, and builds on an emerging body of research where we contend that construction ecosystems of the future should have design at the heart of their organization, providing a central, coordinating role to oversee and enhance value generation in designed interactions.[21]

It is not clear whether emerging technologies will disrupt and replace construction companies. The particular characteristics of buildings, described in this paper, are a significant differential factor to other industry sectors. However, it is likely that construction companies that don't innovate their business model will be exposed to disruption. This vision for a shift from 20th century logics of prefabrication to a platform ecosystem, is especially relevant to the case of multi-residential projects due to their wide range of design and production inputs.

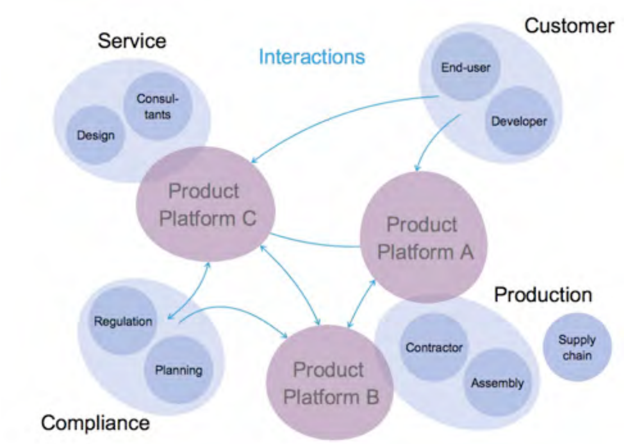

Figure 2: Diagram of current emerging isolated platforms in construction industry

Aims and Objectives

The aim of this paper is to shine a light on a near future design and manufacturing system that helps to improve the overall quality of a new generation of multi-storey housing. Therefore, the research object is a new generation of multi-storey habitat buildings that better responds to current and future human and ecological needs, and make the world more inhabitable.

Research questions.

Our hypothesis is that to do so, an innovative business model and manufacturing approach must be developed, where architectural design knowledge lies at the core of its success. This is addressed through two research questions:

1) Which design and manufacturing processes can we develop in order to provide a better answer to the specific challenges of multi-storey housing production?

2) How can architectural design help to inform the creation of an ecosystem for construction?

Methodology

A specific Architectural Design approach.

Architectural Design as a discipline is too broad and intricate to assert that there is a single, clear methodology attached to it.[22] We have used an exploratory method, which is useful for situations where there is little existing information.[23] Combined with this research method, is both of the researcher's backgrounds as professional architects, which has assisted the gathering of design related data as well as informing the hypothetical speculation required to envision an open process ecosystem. For this paper's aim, we have distilled the universal themes that are at the core of any multi-storey housing design and building process. When doing this, we are presented with further questions: Can architectural design disciplinary knowledge be applied when developing a full multi-storey habitats design and manufacturing systematization? If so, which specific strategies should be implemented? Is this process an opportunity for innovation in the architectural design disciplinary knowledge?

Findings and Discussion

Aspects of product platforms: *customization, modularity, commonality, scalability, adaptability, and flexibility*.

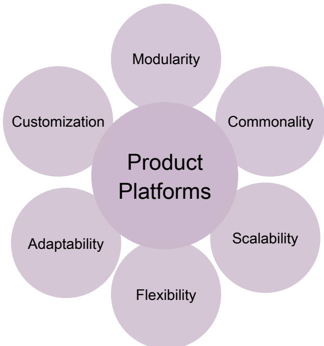

Figure 3: Product Platforms' six main characteristics.

a. Customization:
   - A customized product is designed to meet the specific needs of a particular customer; therefore, customers must be involved in the product realization process. Customized products can be either made to order, tailored to order, assembled to order, or made to stock, each of which has different implications for product platform development and the associated information technologies needed to deliver that product.[24] Until today, most multi-storey habitats are made to order, without the participation of any end-users, instead being commissioned by a real estate developer.
   - Mass-customization, according to Pine, is "a new way of viewing business competition, one that makes the identification and fulfilment

of the wants and needs of individual customers paramount without sacrificing efficiency, effectiveness, and low costs”.[25] Emerging modes of production present new opportunities for mass customization to be realized, presenting a fascinating opportunity in future for a new generation of multi-storey habitats to be realized that involve inhabitants in the design phase. Today, the different modes of occupancy and procurement separates end-users from this initial design phase. This is evident in rental apartments, where the possibility of post-occupancy reverse customization should be key. When a developer thinks about improving its business strategy, can an inhabitant be still addressed as just a consumer?

b. Modularity:
    - Modular products have a one to one or many to one mapping of functional elements to physical structures.[26] Interfaces between components have traditionally been a bottleneck for the proper development of prefabricated solutions, not only between companies, but between different projects within one company. The lack of size standards in the industry is a significant setback when designing for true modularity across construction, from structure and materials, down to furniture and appliances. Again, the diversity of situations might prevent from this from being possible, although it is important that the whole industry starts to move in this direction. Instead, a soft-modularity based on compatibility of interfaces should be pursued. How can we design modular solutions that adapt to each particular case?

c. Commonality:
    - Commonality can be defined as the reuse and sharing of components, manufacturing processes, architectures, interfaces and infrastructure across the members of a product family.[27] Product platform literature shows a positive bias towards commonality brought about by the manufacturing efficiency benefits of standardization.[28] However, the concepts of divergence and lifecycle offsets provide warnings with regards the challenges associated in realizing these expected benefits.[29] Lifecycle offsets are the temporal differences between the corresponding lifecycle phases of two or more products. Divergence is the idea that commonality declines throughout the product family lifecycle. Which kind of commonality would be more efficient in such long life-span structures as buildings?

d. Scalability:
    - According to Simpson et al, “Scalability refers to the capability of a product platform to be ‘scaled’ or ‘stretched’ by varying one or more of its design parameters to satisfy different customer or market requirements. Scalability can be exploited from both a functional and manufacturing standpoint to increase the potential benefits of having a common product platform.”[30] For example, Boeing designs many of his aircrafts by “stretching” them to accommodate more passengers, carry more cargo, or increase flight range.[31]

- Can a building be scalable? Or just its parts? In multi-storey habitats, scalability presents clear limitations when faced with site, local or national regulations, structural and services efficiency. Opportunities are present in optimizing the design process through component configuration such as walls or windows.

e. Flexibility:
   - Flexibility is “the property of a system that is capable of undergoing specified classes of changes with relative ease.”[32] Flexible elements are defined as “elements that can accommodate each product variant’s different requirements through modification at lower additional investment levels, relative to other unique elements that can achieve the same purpose”.[33]
   - These principles of flexibility apply not only to products, but designs themselves, the result is that changes are not necessarily based on project-to-project variations, but concurrent iterations.[34] Buildings are subject to change from the day they start being used, both by inhabitants and the organizations that take care of them. Habitats, therefore, need to allow change without having to be fundamentally altered. These alterations should be as easy, costless, and waste free, as possible. How can buildings be designed for change?

f. Adaptability:
   - Adaptable design aims to develop products that satisfy the various requirements of customers. More broadly it refers to the ability of a design or product to be adapted to new requirements and the reuse of a design or product when requirements change. Adaptable designs can be modified by a manufacturer to generate new designs that improve their products. The product with product adaptability can be changed by a user in a way that is usually reversible and simple, in order to achieve different functions or use. In a building, adaptability is multi-scalar and tackles diverse realms, which as we will see are the object of architectural design processes.

Architectural design challenges of multi-storey habitats.

The previous section highlights some of the benefits and challenges of a product platform approach for construction. Many challenges that are specific to a multi-storey house design and manufacture arise from an architectural design perspective. Current advances in digitization mean that it is possible to achieve a fully systematized and manufactured approach to human habitats production. However, these structures will fail to succeed, both in the market and in their environmental performance, if the following variables are not brought to the core of their design and manufacture:

Inhabitable space and time:

Complex multi-storey housing is a rather recent way of producing human habitats. However, the need or ability to inhabit the earth is arguably a constituent aspect of our species. Seeking shelter is as old as our species, homo sapiens. That poses some questions that need to be addressed when pursuing a systematized production of human habitats: Can a human habitat be a product? Can an inhabitant be understood as just a customer? Can a product be a home?

Site specific:

Each constructed habitat exists on a unique physical location. To render it efficient, not only in terms of performance and endurance, but also of production and transportation, the new system must be able to include all contextual idiosyncrasies, such as its geology, orography, services, local and national codes, neighbouring constructions, culture, memory of place, trades and unions, and transport infrastructures. This contextual response must occur in the initial stages of its design and continue through its lifecycle.

Exposure to climate and weather:

Each territory, city, and street, has its own macro and micro climatic condition. Hazardous climate change is already affecting our built environment and is a key design driver for the 21st century and beyond. Not only should new habitats adapt to increasingly uncertain and harsh conditions but they should cease being one of the main agents causing it. Resources are increasingly scarce, meaning that processes which make the most of material and energy availability will have the highest chance of success in the market.

Lifespan and durability:

Built habitats last for generations, surviving the organizations and technologies that built them. Most structures built today become obsolete upon occupation. It is crucial for design strategies to: facilitate low maintenance; provide longer material and functional durability; adapt to uncertainty; allow easy and waste-free repair; and partial or full, slow or fast, change of use.

Size and weight:

Most built habitats are bigger and heavier than ourselves. This means we need auxiliary means to make them. They are bigger and heavier than the means of transportations that humans have been able to develop, thus we must move them in smaller parts. They are also so heavy that they must be attached to the ground. Complex calculations make sure they can resist disasters. These factors together imply that a huge amount of matter and energy is needed not only in their process of materialization but also their operational life. A system that might work in location A might be totally useless in location B.

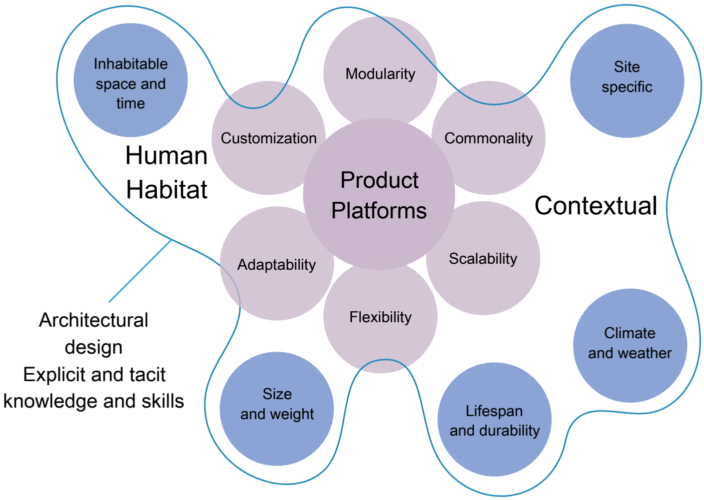

Figure 4: Limits of Product Platforms when applied to multi-storey habitats specificities.

From product platforms to process ecosystems.

Understanding product platforms alongside the architectural design challenges of multi-storey habitats makes clear that what needs to be systematized is not a product that can be repeated seamlessly and indifferently but rather a process-based approach that embraces difference and diversity. Similarly, the material, information and social heterogeneity that shapes these habitats is of such magnitude that a single platform approach is unable to run the process on its own. A process ecosystem has a far better chance of success. This process ecosystem could work with traditional construction's uncertainty and exposure to externalities, embracing and adapting to context and stakeholders. By deploying a product and process system where knowledge is self-organized or a designed multilayer social network that allows actors to participate in spite of their differing attributes, decision-making principles, and beliefs.

A process ecosystem would build on the principles of emerging platform ecosystems, already discussed, primarily seeking to *connect*, *integrate*, and *share* knowledge.[35] A process ecosystem would extend this concept for construction in order to merge the benefits of product platforms with the idiosyncrasies of multi-storey habitat architectural design.

Open systems

Seeking a merged process ecosystem, some researchers have compared and discussed the similarities and differences between biological ecosystems and societal ecosystems.[36] According to Tsujimoto et al., "This exercise sheds light on the management of innovation and technology from different angles. There are many stimulating concepts in biological ecosystem studies, for example, predation, parasitism, symbiosis, decomposition, circulation, trophic level, multiplier effect of chain reactions, and destruction of the whole system".[37]

Open systems in physics and biology informed the basis of General Systems Theory, as defined by Ludwig von Bertalanffy in the 1950s, and which contributed to a significant branch of theoretical knowledge that filtered through to architecture and engineering.[38] Built habitats are not an evolved, but rather a designed, system. However, some biological ecosystem qualities can help to shape process ecosystems. In this paper we address the idea of ecosystems specific to industrial ecosystems. It is important to be aware of the flaws of the industrial ecosystem concept, introduced by Frosch and Gallopoulos in 1989, which still remain unclear today, and therefore be careful with too literal analogies with natural ecosystems.

Figure 5: Main properties of biological ecosystems that can be applied to engineered systems.

Open Process Ecosystems.

An Open Process Ecosystem for construction must implement a design and manufacturing methodology that is based on customization, modularity, commonality, scalability, flexibility and adaptability, but that also includes the specific constraints of multi-storey habitats in its architecture. In terms of organization, a dynamic and self-adapting ecosystem based on collaboration, interoperability and context, which offers an environment for enterprises and partners to rapidly align their business and production needs. This is organized around:

a) A strong and diverse team of in-house architects.

b) Fostering innovation through collaboration with University research laboratories and other stakeholders.

c) Joint ventures to develop innovative products and solutions, with both external designers and manufacturers.

d) Greater involvement of community and inhabitants in all lifecycle stages of multi-storey habitats.

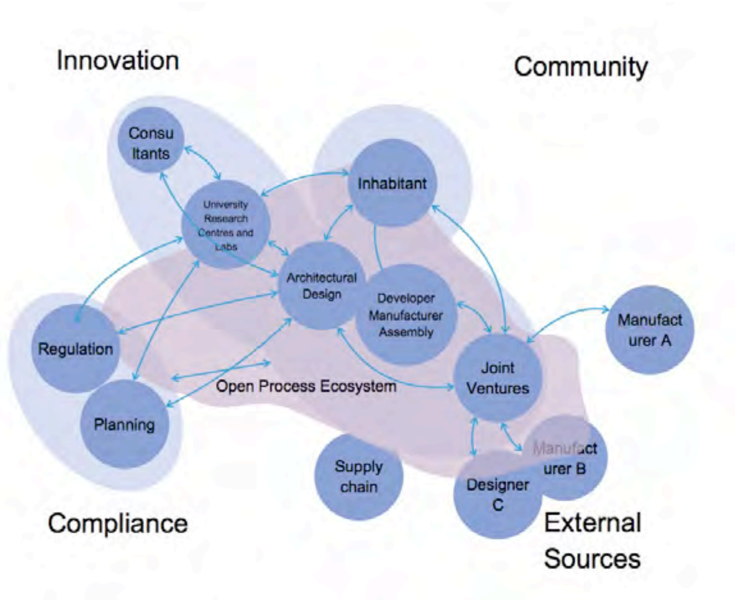

Figure 6: An Open Process Ecosystem for a multi-storey habitats design and manufacturing.

Conclusion

An Open Process Ecosystem is a methodological framework for a potentially efficient and ecologically-focused multi-storey habitats design and manufacturing industry. With our planet's current level of urbanization, even if construction could agree to standardize sizes and modules, future habitats will still need to adapt to each site of construction and user group, in order to be fully efficient, functional and inhabitable. Architectural design is the discipline that can develop the knowledge and tools to make this possible.

This systematization will also bring innovation to architectural design as a discipline. Further research is required to clarify these contributions to the field of architecture, while refining the Open Process Ecosystem concept for business, this will be achieved by applying these findings to a specific case study.

Acknowledgement

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The Ecosystem Revolution: Co-ordinating Construction by Design

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Abstract

Platform Ecosystems have emerged in the information technology sector to disrupt a range of business types, the most high-profile examples being: high street retail (Amazon); hotels (AirBnb); and taxis (Uber). These 'industry-wide' platform ecosystems hold network effects potential and are progressing beyond the tech-sector to disrupt more traditional business domains. Industry-wide platforms emphasize value creation from connectivity and collaboration, as well as the generation and use of data to inform and drive decision-making.

Construction industry business models rely on interaction to generate value. These interactions are commonly considered to occur along a linear, additive, 'pipeline' value chain. Professional expertise is typically contained within domains aligned to project phases. These domains form boundaries that inhibit and limit value creating interactions. Integration is sought as a means of providing a 'thread' through these project phases and between the professional domains. However, this thread creates further professional specialization requiring significant project management.

This paper proposes that the thread of integration can be a role that emphasises and uses the principles of design-thinking. This paper will articulate this potential and show that instead of managing project-value along a pipeline, design holds the ability to co-ordinate value interactions on an industry-wide platform.

Case studies look at emerging construction ecosystems, and this paper considers what a broader platform ecosystem for the whole construction industry may look like. The paper will focus on the questions: How are platform ecosystems emerging to redefine value generation in construction? How might a design-led industry platform ecosystem emerge in construction?

The principles of platform ecosystems stand to fundamentally alter integration removing layers of management and connecting actors more immediately. This paper reveals that an industry-wide construction industry platform ecosystem can benefit from utilising design as co-ordinator and integrator of actions in order to drive value generation.

Introduction

Platform ecosystems are emerging across a range of industries to fundamentally alter business models and redefine the nature of value generation, distinct from the linear value chain of traditional business, to derive value from interactions.[1] Well-known platform ecosystems, such as eBay, Uber, and AirBnb have disrupted traditional approaches to e-commerce, transport, and accommodation. The construction industry has yet to witness the emergence of these holistic, industry-wide platform ecosystems, yet through four industry case studies, this paper demonstrates how their principles are emerging as niche, focused concerns within specific sub-domains of construction. From these studies, this paper outlines the potential that design can play in co-ordinating a future industry-wide construction ecosystem at the strategic-level of business model design.

Scope and Methodology

Construction's traditional research focus has been described as supplier-led, that is, not focused on quality and function from the perspective of a broad grouping of stakeholders.[2] Research that is supplier-led typically contains clear, commercial demands with measurable outcomes based on financial or technical performance. On the other hand, research that is concerned with a customer-focus, commonly requires a qualitative approach, with outcomes that are harder to anticipate or to justify before research has been conducted. Design holds the potential to bridge these perspectives, to discover unknown factors, unlock true innovation, and subsequently offer this to the commercial marketplace for competitive advantage.[3] Yet design is commonly considered a qualitative pursuit when applied to topics such as business models. This contrast between the stable, knowable research terrain of technical performance, and the unknowable, speculative nature of qualitative market-demands, is especially true of strategic, business issues such as value creation and the structure of the construction industry. As platform ecosystems emerge in other business sectors, the onus is on the construction industry to embrace speculation in order to propose alternate modes of business for the future that deliver greater customer *and* business value. This paper thus utilises design as an *exploratory tool* to understand changes that are occurring in industry and to speculate on new pathways forward.[4]

This paper seeks to answer the research questions:

- How are platform ecosystems emerging to redefine value generation in construction?
- How might a design-led industry platform ecosystem emerge in construction?

To respond to these questions, the paper combines a literature review with short, descriptive company case studies. These studies, developed from marketing information, presentations, and whitepapers, show platform ecosystems to be emerging in support of the existing construction industry's structure without redefining the industry as a whole. Each responds to a sub-domain of the construction industry, that this paper identifies as: *service*, *production*, *compliance*, and the *customer*. They reveal new approaches to business are emerging and hint at the potential for a comprehensive industry-wide ecosystem to emerge, one that binds these disparate sub-domains together. At the core of this vision for a future construction industry is design. Design can generate radical innovation, while providing an holistic perspective that balances the context of people and place that is critical for successful construction,

Redefining the Business Model

Business models are essentially "stories that explain how enterprises work", as Joan Magretta noted in contrast to the connotation that the word *model* invokes — that there is some definitive and replicable formula at play.[5] The rise of the internet, saw business models studied more formally, defined by Amit and Zott as the "design of transaction content, structure, and governance" in order to generate value.[6] Importantly, here is the use of the word design, suggesting that business models are not scientifically formulaic, but instead reliant on the context of a commercial operation to inform a unique solution. Business model change is fundamentally problematic. Christensen et al. described how business models become more fixed over time and are designed not to change. Three stages of a business model were mapped out: market *creating* innovation, innovations that *sustain* progress, and finally a focus on innovation that promotes *efficiency*.[7] These three stages are important when re-considering construction's business model, as it has not ever experienced fundamental change and goes some way to explain why so much of construction's research and development has a strong emphasis on technical and production innovation corresponding to the final, efficiency phase of Christensen et al.'s business model stages.

Traditionally, construction's business model has relied on a *value chain* approach, as defined by Michael E. Porter.[8] This linear creation of value has suited construction' and is reinforced by project templates and plans, such as the RIBA's 'Plan of Work'.[9] This traditional perspective sees projects managed in a chronological manner, drawing expert inputs, client interaction, and involving contracting parties at specific points in the lifecycle of a project. This approach has suited the project-based thinking that has dominated construction, and allowed responsiveness to unique sites, yet it has not been conducive to a product-oriented vision of the industry, one that prioritises integration, early consultant involvement, and multiple lines of communication for clarity and responsiveness in order to meet stakeholder expectations. Stehn, Brege, and Nord presented the potential of an adapted business model for the construction industry, one specific to industrialised house building (IHB).[10] This adapted business model built on the traditional aspects of business models: the market position, offering, and operational platform, and ascribed elements specific to IHB for each of these.[11] Höök and Stehn also found benefits for construction participants in handling a portfolio of business models that could assist in handling standardisation and customisation, as well as managing strategic organisational change.[12]

Noted, has been the tendency for business models to suggest a replicable suite of processes, market choices, and offerings, around which the operations of a company can organise. There is debate as to business models' application in the creative industries.[13] Construction is fundamentally a creative industry with design, and subsequent making, at its core. Construction's existing business model is traditional, largely static, repetitive, and finds itself exposed to potential disruption. To fend off this disruption, organisations are turning to design-thinking for its ability to generate value through an empathetic engagement with human existence, and thus deliver greater value to a broader range of stakeholders.[14] Peter Rowe considered design to be reliant on gut instinct, rather than purely motivated by scientific fact.[15] From a business model perspective this means that design's impact on a future construction business model could result in greater flexibility and response to the context of engagements and changing stakeholders.

Business model innovation was proposed by Ibarra et al. to be conducted in four ways that either tend towards a traditional view of business and that seek *incremental* improvement, or that alternatively seek new business models through *radical* innovation.[16] In this latter category are platform ecosystems that leverage smart, connected, products and services. Design has been shown to be a critical factor in the generation of innovation, particularly when it comes to the unlocking of new markets and the creation of radical innovation. Roberto Verganti found that design can transcend both technological and market-driven forms of innovation through its ability to generate new ideas that could not have otherwise been predicted.[17]

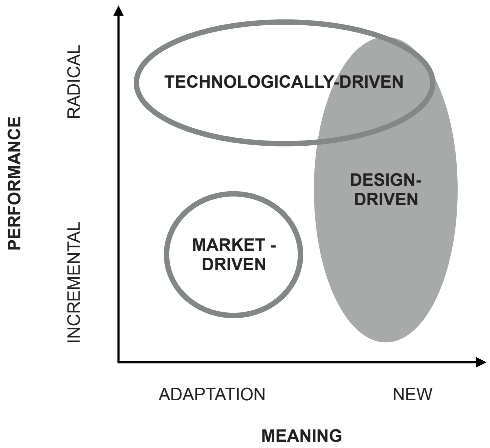

Figure 1: Roberto Verganti's identification of design as a tool to generate new and radical forms of innovation.[18]

Anticipating Revolution

Construction has traditionally looked to manufacturing for lessons of progress, the advances of the internet-driven information-age of the past decade have brought a suite of possibly avenues of change. Other sectors are undergoing fundamental and profound business model change brought about by the internet and together both construction and manufacturing are exposed to this potential for disruption.

A range of emerging concepts and disruption in other industries are sowing the seeds of a potential revolution in construction. These concepts, such as *Industry 4.0* herald a new era for manufacturing specifically, considering what role production in the future will play when connected to a network of intelligent systems. Industry 4.0 promises a more connected, accountable, and flexible modes of production.[19] Alongside the emergence of new modes of production have been concepts such as the *Internet of Things* (IoT) that not only underpins Industry 4.0, but also promises greater social, cultural, and design implications as cities become ‘smart’ with buildings that harvest and communicate data about users, occupancy, and modes of living, through connected urban and building services, appliances, and devices.[20] As a means of tracking these interactions and ensuring their credibility alongside these rapid technological developments, *Blockchain* has emerged. Blockchain creates a public ledger to track peer-to-peer value generation and seek opportunities for the elimination of non-value adding transactions.[21] This kind of tracking leads to calls for example, within construction projects, for the elimination of real estate agents as they do not add significant value but instead occupy the role of on-seller.[22] This example can be considered just the first of many changes brought about by the potential of disruptive platform ecosystem business models that are underpinned by greater accountability from blockchain and increased data generated by the internet of things. Added to these disruptive seeds are demographic and cultural shifts that are seen in the principles of the *sharing economy*.[23] The sharing economy, of which Uber and AirBnb are prime examples, utilise *platform ecosystems* to distribute resources more efficiently than legacy industries.

A Construction Ecosystem

Industries around the world are being subjected to fundamental and radical change brought about by the emergence of the information-age. Service industries in particular, are being transformed by internet-enabled technology. The past decade has seen the emergence of e-commerce platform ecosystems such as Amazon and eBay that connect retailers with customers with either a high degree of physical infrastructure as is the case of Amazon or as is the case with eBay a largely virtual infrastructure that is focused solely on connective seller and buyer. This concept, the efficiency connection of parties, lies at the heart of platform ecosystems. These connections lead to value generation from interactions which provide data to the platform owner, as well as immediacy, a sense of control, and new forms of knowledge to exist between the service provider and user. Further to ecommerce, the well-known platform ecosystems that deal in transportation, such as Uber, or accommodation, such as Airbnb have arrived. These platform ecosystems, however, are not just about software-based tech-sector 'apps', instead they represent a fundamentally different way of working and approaching value generation.[24]

The value of an ecosystem approach to business was first proposed by James F. Moore in 1993. Moore considered innovation to be the only sustainable competitive advantage, and that true innovation required inputs from outside of a business' internal structure, to create a "co-operative network".[25] Moore viewed the ecosystem as a collection of businesses working between sectors that progressed through phases of: "birth, expansion, leadership, and self-renewal" in so-called evolutionary phases.[26] Moore was writing at a time prior to the wide-spread penetration of the internet, and as such was simply predicting what could happen based on observation of companies during the preceding decades, noting that business ecosystems had always been in existence. Mohanbir Sawhney considers platform-thinking to be an extension of portfolio-thinking. Where portfolios express a company's activities and their offerings, to Sawhney platform-thinking broadened this perspective to include a more holistic picture of their brand, process, customers, and global network.[27]

Thomas and Autio found business ecosystems to be an extension of network theory. In their terms, ecosystems explicitly focus on value generation, allowing a collection of actors to create value that would not be possible if they were acting in isolation.[28] Thomas and Autio furthered that ecosystems consist of three characteristics: a network of participants; a structure of governance; and shared-logic. Similarly, Choudary et al. considered that platform ecosystems operate at three levels, that of the *networked community* that connects producers and consumers, with the support of *infrastructure* that supports these exchanges, that in turn creates *data* to support future interactions.[29] The author's PhD thesis mapped these levels of ecosystems against the assets of manufacturing product platforms as defined by Robertson and Ulrich, proposing a direct link between the physical domain that product platforms operate in, co-ordinating design and production, with the virtual domain of platform ecosystems that co-ordinate value creation.[30] This work built on the research of Gustav Jansson who had proposed product platforms' adaptation for industrialised house building, as well as Annabelle Gawer and

Michael Cusumano who proposed a spectrum of platforms from the internal platforms that businesses use to co-ordinate their operations, to supply-chain platforms that exist to work with other companies, through to industry-wide platforms that can be considered the platform ecosystem of a company's broad network of participants.[31] For this reason, this paper now proposes that an industry-wide platform ecosystem contains the potential to fundamentally transform the business model of construction, especially if design-led, in line with Ibarra et al. and Verganti's previously discussed findings.

Distilling Complexity

Construction's ecosystem is undoubtedly complex. Bröchner noted that the industry of construction is essentially service-based, though is not typically thought of as such due to its "heavy physical element".[32] Construction must not only deal with the constraints and inputs of traditional manufacturing, but also the aforementioned peculiarities of site-based assembly, temporary project-teams, and uniquely designed products. Yet this complexity creates significant opportunity to generate value from the multiple sources of interaction that occur between the range of stakeholders involved.

In order to distil this complexity, for clarity this paper considers four case studies within what are categorised as four sub-domains of construction (figure 2): *Service*, *Production*, *Regulation* and the *Customer*. These case studies reveal how platform ecosystems are emerging to shift thinking around business models in the construction industry. These sub-domains relate to the dominant stakeholder groupings that have impact on construction projects. Consultants that typically provide a *service*, *customer* user groups, stakeholders concerned with *production* of the built artefact, and stakeholders concerned with *compliance* whether at the technical or town-planning levels.

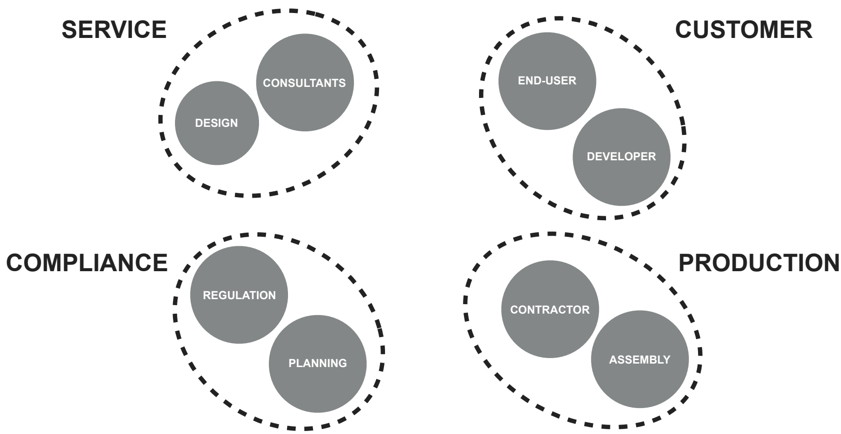

Figure 2: The four, distilled, sub-domains of construction to emerge from construction ecosystem case studies.

Researchers in Finland have sought to learn from ecosystems that have emerged across a range of sectors, to learn the lessons that exposed Nokia to disruption in the early 2000s by the platform ecosystems established by Apple's iPhone and Google's Android. This research has led to calls for an holistic construction platform ecosystem to emerge, and sought to outline how such an ecosystem might appear, though from the somewhat traditional perspective of the central construction contractor.[33] However, this papers' case studies show that platform ecosystems are emerging across the sub-domains of construction to solve specific problems and capture new forms of value from interactions internally. From their description and analysis is revealed a missing perspective, that of an holistic ecosystem that this paper positions, in contrast to the research from Finland, could be design-led rather than production-based, to derive and capture value from interactions between these sub-domains rather than within.

The Case Studies

Service: Productxchange

Productxchange is a cloud-based tool for designers and consultants to gather construction product data, ensure standards compliance, and deliver product models into a central BIM model.[34] A four-step process underpins the Productxchange platform. The client and contractor *set* product requirements, the platform allows participants to *collect* product data from manufacturers, this information is then *checked* on the platform to validate the product against the project deliverables established at the first stage. This information is the *delivered* into the BIM model from the Productxchange platform across a range of formats for example PDF export of safety data sheets at the project's end.

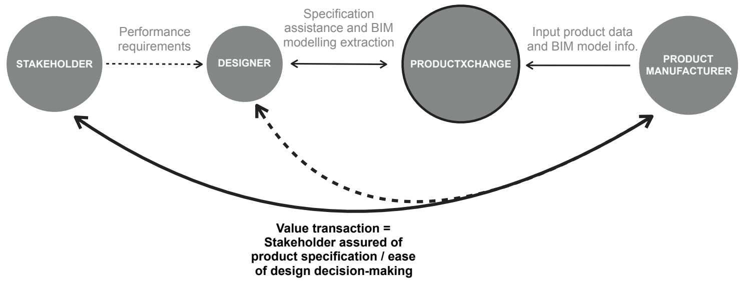

Figure 3: Productxchange's platform ecosystem, linking product manufacturers with project stakeholders

Customer: Ehab

Ehab is a finance-based approach to the creation of a construction ecosystem.[35] Promising to create new ways of tackling the growing problem of housing affordability, Ehab uses the principles of crowdfunding paired with blockchain technology to provide accountability, tracking, and assurance of investment. Ehab demonstrates the potential to remove non-value adding entities from construction's value chain, for example digitising and storing property deeds, digitised development payments, and the possibility of 'tokenising' property ownership in order to increase fluidity and open the potential for easy multiple ownership. Ehab shows the potential that digitisation to alter the conventional property financing narrative that is dominated by banks and real-estate agents.

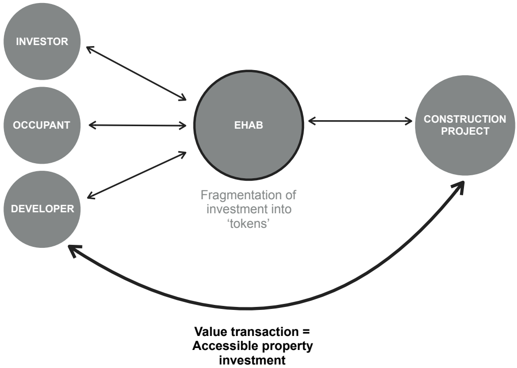

Figure 4: The Ehab platform ecosystem, connecting purchasers with construction projects

Compliance: CitySwipe

An online planning tool, City Swipe has been described as like Tinder, but for urban planning.[36] Developed by the local authority, residents to the Santa Monica area are shown images, and asked questions, to which they respond with a simple swipe right for yes, or swipe right for no.[37] Images range in content, from building appearance, questions about parking, forms of landscaping, and urban art. The tool, at this stage is very simple, yet it highlights that in this simplicity is an ease of use that avoids time consuming street-based questionnaires or complex online form filling that attracts motivated respondents. Instead there is the potential for City Swipe to evolve into an active tool of design participation that generates design feedback for local authorities to create more relevant and responsive city plans.

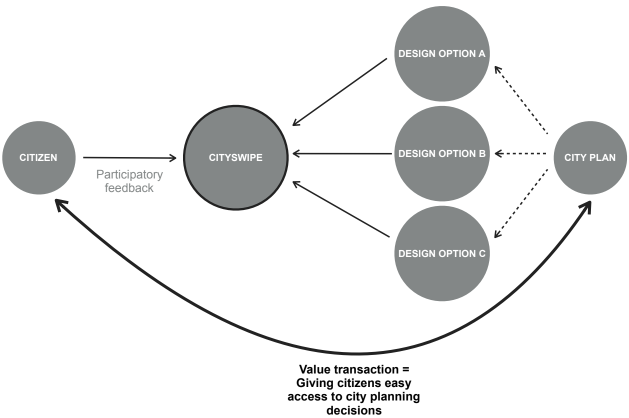

Figure 5: CitySwipe's ecosystem connects citizens with local authorities

Production: Keepsite

A construction management approach to envisioning a platform ecosystem for construction.[38] Keepsite delivers a 'software as a service' application (cloud-based software that is accessed through a subscription) focused on merging construction project management with a portfolio approach to business.[39] Keepsite provides the tools that traditional approaches to project management rely on (managing risk, documentation, responding to issues) creating a network of jobs that integrate to form a portfolio approach to business (one that harvests field data, and provides solutions for task and knowledge management) in turn this drives value between projects through the capture and use of data and knowledge between projects that exist on the platform.

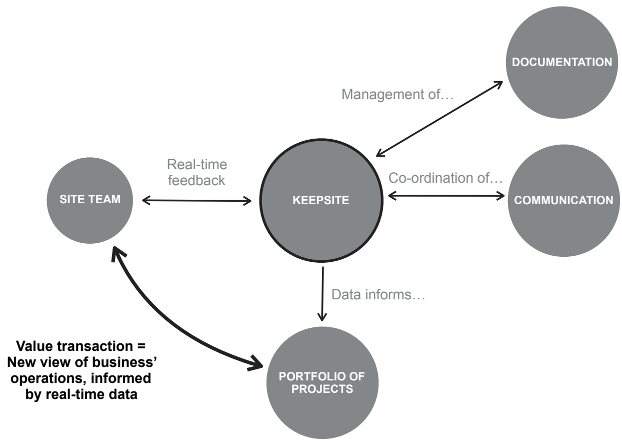

Figure 6: Keepsite allows construction business' a new view of their operations

Conclusion

These case studies reveal that while ecosystems are emerging to address specific issues within the sub-domains of construction, there are not coherent, 'industry-wide', ecosystems emerging yet.[40] An industry-wide ecosystem for construction would not only drive value from the interactions within the sub-domains as these case studies do but would also generate new forms of value from interactions between the sub-domains (figure 7). This value would be of use to the sub-domains to improve their internal processes, but also increase the value of the built product as well as the efficiency of processes that underpin its design and construction, thus increasing value for the end-user.

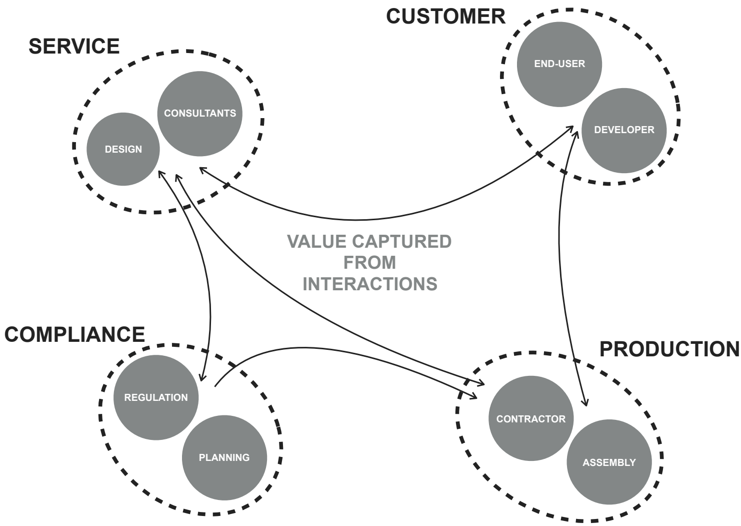

Figure 7: New forms of value could emerge from increased interactions between participants.

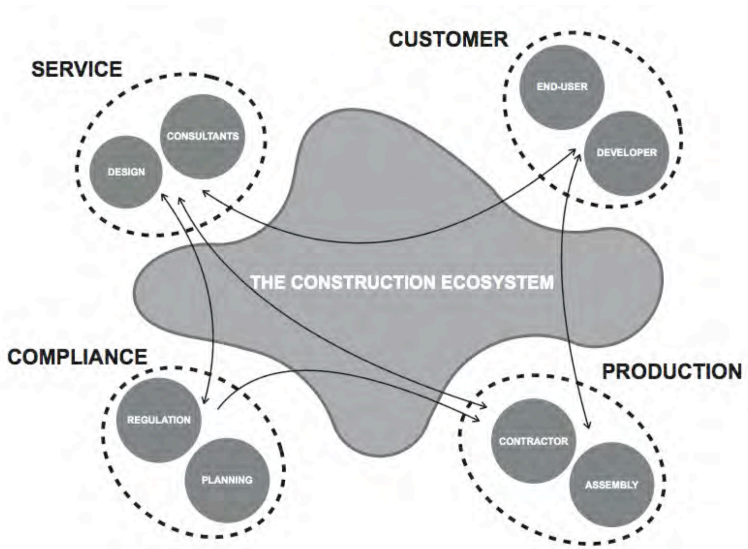

Figure 8: The potential domain of an industry-wide construction platform ecosystem.

Creating an ecosystem for construction that generates increased interactions between sub-domains and increases the value of interaction, would also improve the integration of construction's sub-domains, by linking previously disconnected parties through the ecosystem to create a more efficient and responsive design environment (figure 8). A construction ecosystem of the future would benefit from a design-perspective due to design's ability to operate holistically across issues. This design-led approach would seek to generate the new forms of business model required by construction to avoid future disruption from new entrants to the sector from other industries.

This paper, in conclusion, returns to its initial research questions in order to summarise the discussion. The principles of platform ecosystems have been discussed, while it has been shown that design, as an act of synthesis that is beneficial in seeking innovation, is well placed to enhance and extend these principles when applied to the unique and peculiar context of construction. A design-led platform ecosystem would mediate the territory of construction that exists between its stakeholder domains and the context of projects, ultimately helping achieve integration between parties by generating value from interactions between participants.

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Digital Dialogues: Computational Design from Promise to Retweet

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Abstract

This paper outlines a research project that adopts a sociotechnical lens and a mixed-methods approach to examine aspects of computational design culture in architecture. This argues that while numerous scholarly narratives advance the value of computational design in terms of realising more dynamic and responsive buildings, superior material knowledge, and (re)empowered designer/makers, everyday accounts of the ways computational design is *put-into-practice* in the profession of architecture remain limited. While quantitative research methods offer ways to measure technology-adoption in workplace settings, and qualitative ethnographic methods offer rich ways to examine the social and organisational contexts that shape—and are shaped by—technologies-in-use, this research frames the conversational representations of computational design in social media contexts as an open session and as an accessible form of 'naturally occurring data'.[1] Motivated by the initial findings of an empirical research survey distributed to employees in five large-scale architectural practices in Sydney, Australia, this paper describes the subsequent and novel research approach of collecting open social media data and applying social network analysis graph-theoretic concepts to analyse and visualise online users and communities who contribute to computational design 'conversations'. In framing open social media data as an unobtrusive way to access computational design practice, this paper further contributes to a critical reflection on its validity and usefulness as a research method.

Introduction

In the context of architecture, the term computational design encompasses an ecology of allied digital and computational technologies and practices. Computational design thinking and methods are now advanced by numerous scholars as those that can afford more dynamic and responsive buildings, enhanced material knowledge, and the (re)empowered designer/maker. A key position argues that computational design represents a significant shift in the processes, and thus conception of architecture from the production of a material artefact, to architecture conceived as a system of interrelated forces, pressures, and constraints.[2] Conceptually, a systems thinking approach to architecture is hardly new, however computational design practices are those that operationalize systems logic within a computer programming environment. These methods are valued for their ability to afford high degrees of mutability, the enhanced capacity to rapidly generate multiple design iterations, and equally, the capacity to more seamlessly communicate information to digital fabrication and advanced manufacture technologies.[3] In so doing, the 'design space' is reimagined as a dynamic and associative computing environment where 'design action' as well as actualization is mediated and operationalized through computation.

While a large body of computational design discourse powerfully communicates the value and viability of adopting its practices, insights into how computational design is being *put-into-practice* in the profession of architecture are limited. Put another way, the discourse on computational design in architecture can be seen to collectively constitute a technocreative imaginary[4] that, as Daniel

Cardoso Llach well argues, is characterized by a tendency to "…present desirable outcomes as factual accounts and possible futures as inevitable".[5] Consequently, as technocreative imaginaries are typically founded on ideals and exceptional examples they can overshadow the potentially messier, and more complex realities of everyday practice. Accordingly, the research study discussed here has adopted a sociotechnical lens and empirical research methods as a way towards problematizing the dominant narratives of computational design discourse in architecture. By looking inside the 'everyday' professional contexts of architecture, this research has directed questions towards the ways computational design thinking and methods are perceived, as well as the ways they are shaping—and are shaped by—individual action and professional organisational cultures.

Given the inherent methodological limitations of studying workplace, organisational culture, it is understandable that everyday accounts of computational design practice in the profession of architecture remain limited. On the one hand, while quantitative research methods such as surveys can measure technology-adoption or technology-use in workplace settings, they cannot offer deeper insights into the motivations for technology-use. On the other hand, qualitative approaches such as observation and interviews are limited by both the individual's recollected account and the researcher's lens of interpretation. Accordingly, a mixed-methods approach has been adopted in this research as a way towards uncovering a wider range of perspectives on the uptake of computational design thinking and methods in the contemporary profession of architecture.

Sociotechnical theoretical frame

This research seeks to understand the relationships *between* the social and the technical in professional architecture contexts and more specifically in relation to ways of working that can be interpreted to fall under the heading of computational design. From a sociotechnical systems perspective,[6] a sociotechnical lens gives focus to exploring "how human, social and organisational factors affect the ways that work is done and technical systems are used".[7] With a more detailed focus on sociomaterial assemblages, Lucy Suchman's concept of "intra-action" highlights the recursive production of human/nonhuman subjectivities through their encounters with each other and is thus concerned with the sites of technologies-in-use.[8] Given this, a sociotechnical lens allows us to see the architectural workplace as a site of locally configured interdependencies between technologies, technology-related practices, disciplinary, professional, and organisational structures, and cultural, social and individual frames and behaviours. This approach has directed the research inquiry and its initial approach to identifying what factors influence the access to, engagement with, and influence over advanced digital and computing technologies in the profession of architecture.

To better understand who is accessing, engaging with, and influencing digital and computational technologies this research adopted an online survey method. This survey attracted 102 respondents across five large-scale architectural practices (>100 architectural employees) in Sydney, Australia. Consequently, while situated within, and unified by, the macro-social systems and structures of the discipline and profession of architecture, the netted data spans across architectural practice contexts, and thus multiple work systems. The survey findings offer an alternate vantage point from which to challenge the technocreative imaginary of computational design as a radically transformative design practice of growing import to the negotiation of creative and organisational control in architecture.[9] This is evidenced in the ways the survey findings alternatively suggest a delimited engagement with 'advanced' technologies—and particularly those that necessitate a level of computer programming knowledge such as Grasshopper and Python software— negligible technology innovation leadership, and inequitable access to technology knowledge and technology-related skills.[10] Yet, the survey is limited by its respondent numbers, and it cannot be considered statistically significant, nor representative of the general architectural profession. Equally, the survey is further limited to the respondent's views and their individual practices, albeit largely situated within the organisational framework of their specific workplace contexts.

Adopting a social media network analysis research method goes some way towards capturing an organisation's point of view, or at least its public representation. This method also permits an expanded exploration of the questions around who is engaging, contributing, and influencing computational design in the profession of architecture. In so doing, social media network analysis confounds the traditional "metaphor of organisations as containers for work" and further problematizes "how and where the boundaries of socio-technical systems can and should be drawn".[11] The following sections of this paper further outline this method and its findings.

Research method: Social Media Data Analysis

Social Media Data: unobtrusive, open and accessible

Social media data is one major type of digital trace data defined "as records of activity (trace data) undertaken through an online information system (thus, digital)".[12] With the increasing use of digital tools and services and online interactions, user generated data in great quantity and variety has become a valuable source of data for social scientists.[13] Representing varying degrees of availability depending on the property rights of public or private actors[14], social media data offers opportunities to observe and measure collective human behaviour.[15] As compared with traditional methods such as survey and interviews, social media data collection is simpler, cheaper, and faster and allows us to dynamically map the continually shifting landscape of public conversations. Moreover, social media data analysis is an unobtrusive research method that allows the development of a more realistic understandings of the underlying social dynamics of conversations at a micro scale.

Twitter Data Collection

This paper explores computational design conversations on Twitter and discusses the findings of data collected between 20/11/17 and 28/2/18 using NodeXL[16] to collect tweets that match the search term: "Computational Design". The dataset also included the individuals who have posted or have been mentioned in those tweets, and the links between those individuals as Replies-to and Mentions relationships.[17] The collected data includes 2975 Twitter users, and 4211 Twitter links.

Attributes of Tweets and Participants in Computational Design Conversations

Extracting useful information from conversations in the noisy environment of social media requires data analytics and computational techniques. Social computing techniques enable us to identify influential individuals and emerging trends when exploring a large database of citizens' conversations collected from various social media platforms. One approach to analyse Twitter data is looking at the attributes of each participant and their tweets as primary units of analysis. For example, attributes of a tweet include tweet text, URLs and domains in the tweet, hashtags in the tweet, and tweet date. Attributes of a participant include following, followers, tweets, likes, a short bio (up to 160 characters), location, website, and joined Twitter date.

Figure 1 shows the most frequent hashtags including *design* (#114), *computational* (#81) and *architecture* (#57). This was followed by *architects* (#48) and *interiordesign* (#48). The other frequent hashtags included *designintech* (#46), *BIM* (#41), *synbio* that referred to Synthetic biology (#34), *clbfest2018*, Computational Law & Blockchain Festival, (#27), and *compchem*, Computational Chemistry, (#24). This indicates the higher frequency of architectural fields in computational design conversations as compared to biology, chemistry and law.

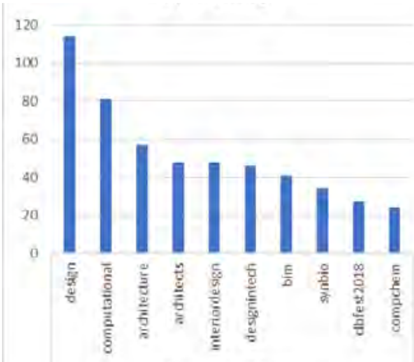

Figure 1: Top 10 hashtags in Twitter "computational design" conversations

Figure 2 shows top five words mentioned in tweets, including *design* (#3303), *computational* (#2641), *rt*, the abbreviation for Retweet, (#2096), *automation* (#779), and *research* (#706).

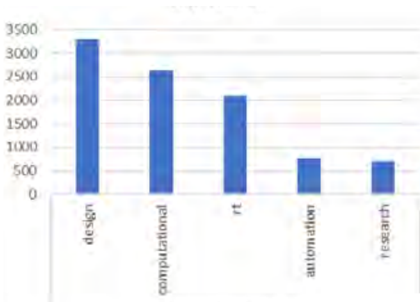

Figure 2: Top five words in Twitter "computational design" conversations

In this research, a key object of interest and investigation were the attributes of influential participants. To examine these attributes, graph metrics were first used to identify important individuals in the network. Wasserman and Faust[18] define prominent actors as "those that are extensively involved in relationships with other actors. This involvement makes them more visible to the others". In this paper, a single graph metric was used to identify important users: in-degree that refers to the number of connections that point inward at a node that refers to a user.[19] This is regarded as "the simplest actor-level measure of prestige".[20] In this network of Twitter conversation, nodes with high in-degree are users who have been highly mentioned by other users: a measure of the attention a user received and therefore they can be regarded as major source of information.[21]

This study identified 112 top in-degree users for further investigation and undertook a manual coding of their attributes. The highest indegree was 559 and the lowest in the selected group was 6. Each influential participant was then coded for the type – individual or organisation – and location as mentioned in their profiles. Figure 3 shows the distribution of users' locations including users from *USA* (#41), followed by *Europe* (#24), and *Britain* (#17).

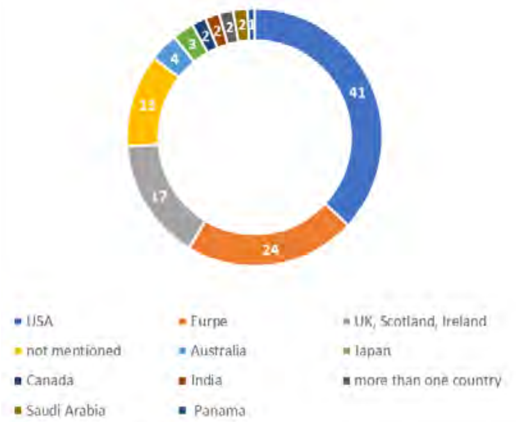

Figure 3: Location of top in-degree users

With respect to the type, influential participants included 62 organisations and 50 individuals. Among 50 individuals prominent in computational design conversations, 70% (#35) were identified as male, 18% (#9) female, and 12% (#9) were unable to determine. Moreover, 62 organisations identified and coded for their field and type as shown in Figure 4. From this it was shown that 29% (#18) of organisations were related to architecture, while 71% (#44) were related to other fields such as biology, chemistry, web, and engineering. All 62 organisations were also coded for their type including media (8%), research and education (47%), practice (37%), research and development/practice (4%) and other (3%). This suggests that computational design is a topic that is more research/education-oriented as opposed to practice-oriented, although the difference is not significant.

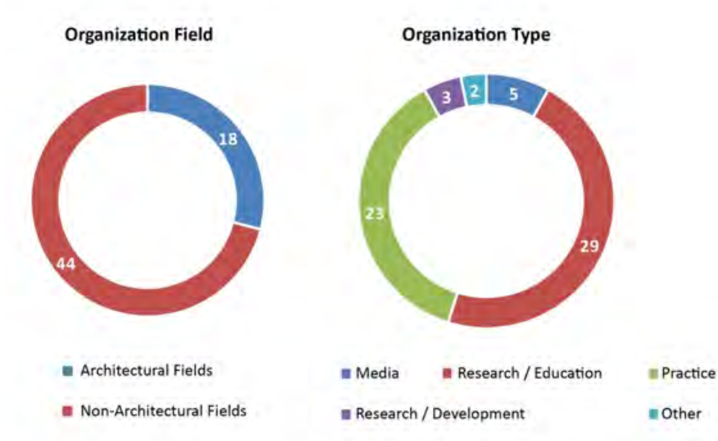

Figure 4: Type and field of top organisations in Twitter computational design conversations.

While architecture was one of the top hashtags used in Twitter computational design conversations, only 6% (4 out of 62) of influential participants were identified as architectural firms, none of which were well-known offices such as Hassell and BVN. Among tweets posted by these two accounts[22] at the time of data collection, there were no tweets mentioning the term computational design. The absence of these pioneers of architectural practice in the conversation, might indicate that computational design is not a prominent trend for tech-oriented architecture companies, or more simply that computational design is not part of the terminology they adopt to describe their technology-related architectural design practices. Moreover, as discussed by Rogers[23] in the theory of diffusion of innovations, there is a clear distinction between innovative members of a social system and influential members in spreading the word. While “innovators are able to cope with higher levels of uncertainty about an innovation”,[24] they play a limited role in diffusion. The influential members in the diffusion process are referred to as opinion leaders that “provide information and advice about innovations to many in the system”.[25.] As such, people who are innovative are not necessarily central in spreading the word. It should be noted that the analysis presented here provides only a snapshot of computational design discourse on Twitter. A larger dataset that goes back much earlier would help to identify innovators as well as early and late adopters of computational design as an innovation in architecture.

Communities in Computational Design Conversations

Another approach in social media analytics concerns the relationships between participants. “As people reply to and mention one another in their tweets”, Twitter conversations “create networks with identifiable contours”[26] that can be captured as relational data. This type of data enables us to study micro interactions on Twitter in which participants form social ties while they generate content by using the @ sign to mention other users in a tweet. Social network analysis has been applied in this paper to map and measure relationships.

Twitter data can be visualised as a network in which each node represents a Twitter user. A line between two nodes occurs if one user has mentioned or replied to another user in a tweet (see Figure 5 for an example). This paper identified communities of connected individuals, and to further explore the conversation, three largest connected components were filtered and visualised as a network. To place the node on the canvas, the force-directed layout algorithm in Gephi was used that identifies and visualises communities of dense relations and determines the shape of the network.

As shown in Figure 5, the largest community including 573 nodes represented a centralized network in which individuals were connected to a focal user and rarely interacted with each other. This single-agent structure emerged as the majority of users retweeted the following message including a GIF animation which was shared by a non-expert of computational design.

41 Strange @41Strange 23 Dec 2017:
Kinetic Lego sculpture of Sisyphus
(from Disney Research - Computational Design of Mechanical Characters)
Figure has been removed due to Copyright restrictions.

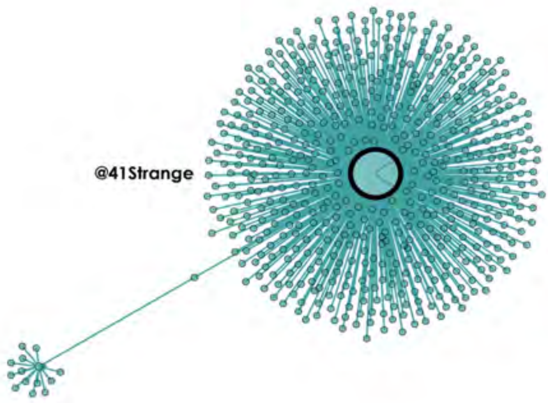

Figure 5: Community 1 structure and the central user, size of nodes reflects the in-degree of connectivity

The second largest community as shown in Figure 6 included 250 users. Rather than a central user, this formed around a number of individuals contributing to the diffusion of information on computational design. The most influential user was @thomson_lab, a lecturer in Chemical Biology whose work on computational design is related to protein biophysics, as mentioned in his profile. This user tweeted the following message that was 114 times retweeted (at the time of data analysis: 12-5-18).

Drew Thomson @Thomson_Lab 2 Jan 2018:
I will have a PhD studentship starting Oct 2018 for a talented chemist/biochemist etc to work on cyclic peptides. Will involve a mix of computational design (don't panic!), peptide synthesis and biophysical analysis. Contact me by email for more details!

The other influential user in this community was @johnmaeda (Head of Computational Design & Inclusion at Automattic) and his following tweets were among the most retweeted messages.

John Maeda @johnmaeda 24 Feb 2018:
2018 #DesignInTech Report using open-source remark.js will go deeper into computational design (plenty of machine intelligence stuff) and inclusion (suggesting a few concrete solutions).

John Maeda @johnmaeda 13 Jan 2018:
Quote2PDF using @drawbotapp saved me lots of click and dragging. Thanks @justvanrossum @letterror for such a useful computational design tool. https://maeda.pm/2018/01/13/quote-maker-1-0-using-drawbot/ …

A keyword search of the term architect (to include the family: architecture and architectural) in all tweets of this community returned no results.

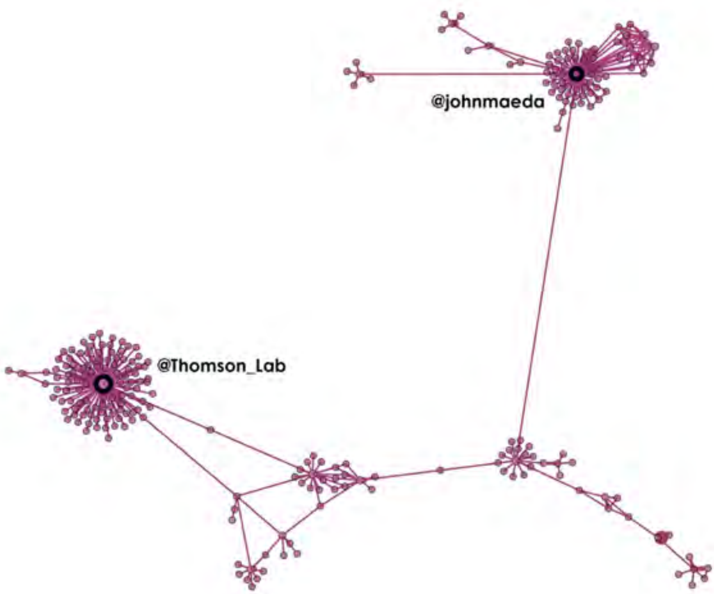

Figure 6: Community 2 structure and central users

The third community including 191 users is shown in Figure 7. This community represented a decentralized structure in which individuals interacted with more than one central node. One of the influential users was @DynamoBIM (an open source platform for visual scripting used in building information modelling). One of the tweets shared by this user was as below:

> **Dynamo** @DynamoBIM 20 Dec 2017:
> *Dynamo Workshops at Autodesk University 2017 included a closing session entitled "Computational Design in Practice". Video Available! dynamobim.org/au2017-computational-design-in-practice/ …*

The other influential user was @BIM_SFDUG (a group of visual programmers using Dynamo) who shared tweets (including hyperlinks to YouTube and blogs) about methods of computational intelligence in architecture. A keyword search of the term architect in all tweets of this community returned 8 unique tweets (excluding retweets) that indicates the strong architectural focus of computational design conversation in this community.

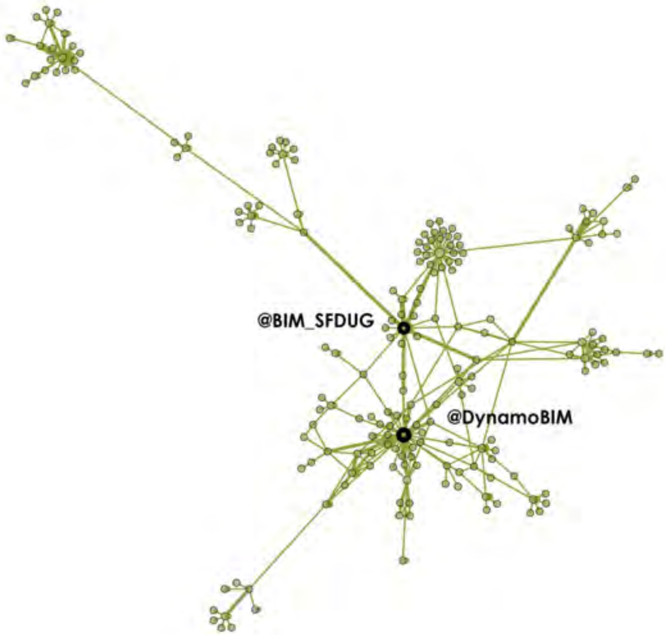

Figure 7: Community 3 structure and central users

Discussion

The findings of this social media analysis method show research and education organisations using Twitter as a platform to share new knowledge of techniques, software, workshops, and programs in relation to computational design. While computational design was found to relate to a wide range of fields such as biology, engineering, and chemistry, architecture is one of the most frequent topics of conversations. Unsurprisingly, the Twitter data collected for this study reiterated the gender bias identified in the earlier online survey,[27] in that among 50 individuals prominent in computational design conversations, 70% (#35) were identified as male. Future research using an expanded database could further verify, investigate, and visualise these observations, and the position of architecture-centric conversations, and identify the gaps as well as existing bridges to other disciplines involved in computational design.

Addressing an overarching objective of this research study to problematise dominant scholarly narratives, the social media analysis identifies a primary association of computational design with the topic of BIM technologies in a Twitter context. In dominant scholarly voices that have contributed to shaping the vision of computational design in architecture as the paradigmatic shift from sophisticated tools of representation (computerization), to designing in genuinely 'computational' ways, the topic of BIM is typically positioned as an adjunct discussion.[28] For example, in their most recent edited compilation on computational design, Neil Leach and Philip Yuan are at pains to point out that "…computation is the procedure of calculating, i.e. to determine something by mathematical or logical methods, [whereas] computerization is the act of storing information in the computer or a computer system. Computerization is about automation, mechanization, digitization and conversation".[29] Given BIM's valued capacity as an information management system it would appear, by this definition, to fall into the arguably less glamourous category of computerization, yet in the view of Twitter participants it finds greater centrality to computational design. This suggests that the computational design community perceive and use the term in a far broader sense that includes computerization as well.

In closing, social media network analysis is a useful tool for data collection, visualization and examination. The Twitter platform—that is popularly perceived as informationally-oriented—provides open access to data yet limits the duration of accessibility. The contested politics of data ownership notwithstanding, data generated through Twitter is presently deemed public from a legal standpoint, as well as by many universities from a research ethics perspective. Additionally, where permissions are given by Twitter users, accessed tweets may also include geo-locational data. For these reasons, Twitter is a particularly attractive platform from which to source large-scale socio-spatial datasets, and as it has a rich application programming interface (API), it offers multiple ways to access the data.

The Twitter data analysis conducted here is regarded as an unobtrusive method of 'observation' to render visible users and conversations connected to the topic of computational design that might be otherwise difficult or impossible to investigate. Unobtrusive research methods are often favoured over other methods as they can provide traces of people that "…speak more eloquently and truthfully about their lives than the account they themselves offer".[30] Qualitative research scholar Professor David Silverman strenuously argues that much contemporary qualitative research relies excessively on interview and focus group data as primary sources.[31] He refers to this data as "manufactured" or "provoked" data and advances the pursuit of "naturally-occurring data" such as conversations, advertisements, journals, blogs and websites.[32] Silverman reasons—as might be obvious to many researchers—that questions and prompting from surveys and interviews can distort the respondents intended meaning or obstruct the possibility for “naturally occurring data”. Silverman’s primary concern however seems to lie more with interviewers who lack the necessary introspection to acknowledge these inherent limitations.

While Twitter conversations can be regarded as an online ‘open session’ and as ‘naturally occurring’ data, it is necessary to note that it is a platform that captures a limited demographic. Broadly speaking Twitter users are more likely to be: aged between 20-30 years old, educated, well paid, white and identify as male.[33] Furthermore, for Twitter use in Australia, statistics indicate that approximately 11.5% of the total Australian population are active users, which is far less than Facebook’s 65.8%.[34] In short, Twitter data cannot purport to account for a heterogeneous range of perspectives. Yet, as Foth et al. well note, the structural dynamics of networked data are fundamentally different from other patterning mechanisms that researchers are traditionally familiar with, such as hierarchies and grids.[35] Social networks are composed of connected nodes that obey power curves operating through an internal logic that is self-organizing.[36] Consequently, the visualization of this logic offers potentially unique insights on issues of power and agency as it is mediated through social media discourse, and of the ways social media also unavoidably contributes to shaping technocreative narratives.

Conclusion

This paper has explored the novel method of collecting open social media data and applying social network analysis graph-theoretic concepts to visualise and analyse users and communities who contribute to computational design ‘conversations’ through Twitter. The findings are discussed here in the context of a larger research project that adopts a sociotechnical lens to explore the ways digital and computational technologies are accessed and influenced in everyday architectural professional practice contexts. The social media data analysis contributes to problematising dominant technocreative narratives connected to computational design that advance the radical transformation of architectural practice. The findings discussed in this paper show that online computational design community of Twitter predominantly consists of research and education organisations sharing new knowledge of techniques, software, workshops, and programs. Secondly, while computational design was found to relate to a wide range of fields such as biology, engineering, and chemistry, and architecture featured as a frequent topic of conversations, in the data collected architects and architectural practices were not identified as influential participants of the Twitter conversations analysed, and in other words, were not those ‘spreading the word’. Thirdly, the data collected for the study reiterates the gender bias identified in the initial online survey[37], as among 50 individuals prominent in computational design conversations, 70% (#35) were identified as male.

The corollary to these findings is a critical reflection of the methodological value of adopting social media network analysis methods. David Abernathy argues that the emergence of Twitter’s hashtag is what propelled its status from a social communication platform to that of a “cultural barometer”.[38] From a social science perspective, large-scale datasets accessed from social media platforms such as Instagram, Twitter, Foursquare, and Facebook are now considered as cultural artefacts that can be mined and filtered to reveal raw, and dynamic social insights. These approaches capitalize on access to data that is born-digital, user-generated, publicly accessible, and significantly, unsolicited. This has provided an alternate vantage point, from which to explore online representations of computational design and to further understand who influences conversations around digital and computational technologies in the context of architecture.

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ADR18

Art, Architecture, and Design Research

Chaired by Dr Sarah Breen Lovett

Curation as Creation of ‘Abstract Landscapes’ Comprised of Artworks: Creating Spatial and Temporal Links between Artworks in Multiple Gallery Spaces

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Abstract

The paper is about exhibition curation led by the skills of the architect and about the knowledge created through this practice. Architectural skills are defined by the capacity to assemble different shapes and objects that function as a whole spatial experience. In terms of curation, this means to construct links between distinct artworks in space. In the multiple exhibitions at different locations discussed in this paper, the links are amplified in time and space. The links are set at different scales, as an outcome to create one whole project. How does the concept of ‘architecture as landscape’, developed by the author in a 2010 book, apply to the practice of curation at the scale of one gallery space and at the scale of a series of exhibitions in multiple locations? A successful curation as creation of ‘abstract landscapes comprised of artworks’ creates, as defined by Foucault, a *dispositive* (display) that prompts thinking about the different artworks.

The curatorial practice that is discussed in this paper is a series of four exhibitions the author curated between 2015 and 2018 in three different countries. The exhibitions can be considered individually, however, the sense spatial connections within each exhibition is expanded when considering the extended context of the set of exhibitions across this longer-term project. The paper discusses the spatial and temporal characteristics of four artworks by Eric Stephany that have been ‘curated as abstract landscape’ for the fourth exhibition of the series in Sydney, and three artworks by Claire-Jeanne Jezequel that have been created by the artist for this series of exhibition.

As the artworks relate to aesthetics that have an architectural aspect, different singular aesthetics and viewpoints are combined to develop new aesthetics and, through this combination, prompt thought. The act of thinking via this prompt develops knowledge about the various architectural aspects and contexts of the artworks.

Introduction

The paper is about exhibition curation led with the skills of the architect and about the knowledge created through this practice. Architectural skills are defined by the capacity to combine different shapes and objects that function as a whole spatial experience. In terms of curation, this means to construct links between distinct artworks in space in the context of a gallery space. In this paper, the links between individual artworks in the context of the gallery space enable an aesthetic experience through an immersion of the viewer in the combined effects of the artworks.

The spatial and temporal scale is extended to multiple galleries in three different countries. The links are set at different scales, as an outcome to create one whole project. In the multiple exhibitions at different locations discussed in this paper, the links are amplified in time and space, and are more distant and abstract than in the architectural practice. How does the concept of ‘architecture as landscape’, developed by the author in a 2010 book[1], apply to the practice of curation, at the scale of one gallery space and at the scale of a series of exhibitions in multiple locations? Is there a type of curation that could be defined as ‘curation as abstract landscape’: when the work of the curator is about constructing spatial links between distinct artworks at large temporal and spatial scale?

In a curating process, a link can be set when one artwork is set in dialogue with another one by their aesthetic sense, involving shapes as expression of their concept. If we consider artworks that have a strong spatial sense, for example sculptural works, the link between individual artworks can become set in dialogue with the architecture of the gallery, creating the spatial character of the links between the individual artworks. That is, the curator creates new spatial links with the combination of gallery, artworks, and their position within the gallery space.

The spatial sense of an artwork is not limited to sculptural works. The sense also extends to representations of objects that bear three dimensional spatial characteristics, including architecture. That is, two-dimensional representations of three dimensional objects. Depending on the way the aesthetic sense is expressed in the artwork, the spatial and architectural aspects are diverse. This paper embraces this diversity in the artworks presented herein.

Spatial links that are created by the curator are mental links that are experienced by the viewer through virtual spatial links. According to Elizabeth Grosz[2], the virtual is a potential to expand and transform our real space, and in the case of architectural curation, the perceived shapes of the artworks. The shape of these mental links can be symbolized by connecting lines. The paper is about exhibition settings that can be qualified as ‘abstract landscapes of artworks’ because of mental links and thus connecting lines between artworks that structure the space of the gallery.

Through the layout at large scale ‘as abstract landscape’, the curator takes a position of creative actor in the exhibitions process. The curational practice is situated in the curating field of ‘curator as creator’, defined in 1994 by Bruce Altshuler[3]. Jonathan Watkins provocatively argued in 1987 that curating was a form of artistic practice and that curated exhibitions were likened to Marcel Duchamp’s installations, where the display or exhibition is aided by the curator’s “manipulation of the environment, the lighting, the labels, the placement of other works of art.”[4] Based on this definition of ‘curator as creator’, the paper discusses the position of the curator in the case of a series of exhibitions in different locations.

As an outcome of ‘curation as creation’, the exhibited artworks are viewed through the specific lens of the curator. The curator proposes proximities and spatial links between artworks that are discussed by the viewer. The artworks can be discussed in relation to one another, in time and in space. As such, the curation process creates knowledge about the artworks. According to Liz Wells[5], and also Terry Smith and Kate Fowle[6], the aim to produce knowledge about the artworks constitutes a field of ‘curation as research’. The paper discusses the type of knowledge developed by the curation as ‘abstract landscape’.

The Series of Exhibitions: Spatial and Temporal Links

The curatorial practice that is discussed in this paper is a series of four exhibitions the author curated between 2015 and 2018, that the author considers as one project in four exhibition stages. This project, which is termed the *Series* in this paper, occurred in three different cities: Berlin in Germany, Sydney in Australia and Lyon in France. Berlin, Sydney and Lyon are three points on a world map between which lines can be drawn. And, in a three-dimensional sense, virtual lines pass through the earth, and create a spatial play between horizontality and verticality at the scale of the world. There is an extension of the spatial network: the artists’ domiciles are

Paris, Lyon, Berlin and Sydney, and some of the representations are from further regions such as Jericho in Palestine (artist Eric Stephany). The table below offers a matrix of artists and exhibition location.

Exhibition	*Ungefähr Vier*, Berlin, Germany, 2015.	Shifting, drifting, dribbling, Sydney, Australia, 2016.	*Crossovers*, Lyon, France, 2017.[7]	*Cut Insight*, Sydney, Australia, 2018.
Claire-Jeanne	□	□		□
Geraldine Trubert	□	□		
Vesna Trobec		□	□	
Michael Tawa		□	□	
Lorraine Pellegrini	□			
Marie Reinert		□		
Samantha Donnelly		□		
Eric Stephany				□
Maxime Thieffine				□
Sarah Tritz				□
Katrina Simon			□	

Table 1: Exhibitions of the *Series*, 2015-2018:

The exhibitions can be considered individually, however, the spatial connections within each exhibition is expanded when considering the extended context of the set of exhibitions across this longer-term project from the author's perspective. The project is about displacement, as it has been experienced during a period of move and settling in Australia: the author moved in February 2015 from Paris to Sydney. It resonates with a move made by the author's family sixty years earlier from Germany to France. It is also about continuity: how can a long-lasting research on architecture and space, led through the practice of curating, be carried on and transposed into another context?

The displacement and a search for continuity led to the project and created an emphasis on linkages between exhibition spaces and artworks. What follows is a discussion of the links between artworks in time and space.

Claire-Jeanne Jezequel's artworks are a series set in three different exhibitions (one in Berlin, two in the same gallery in Sydney), and there are links between the exhibited artworks in that when the artist produced one artwork she created it with considerations of her previous work. The emphasis developed by Eric Stephany on the links between different geographical and cultural contexts (France, Berlin, Jericho and India in a different project) through subjects and means related to the architectural field, gave him naturally an important role in the last exhibition of the *Series* in Sydney. During this process, the author developed a new way of considering the layout of an exhibition in the gallery space, that sets emphasis on the spatial links between artworks, and on a meta-level leads to a practice of curation that was defined above as creation of 'abstract landscapes' comprised of artworks.

The artworks considered have spatial characteristics mentioned above creating links. A description of some artworks will enable to define these links more precisely.

Spatial Links Created in One Gallery Space: Eric Stephany

One important outcome of the curatorial process was the author's choice of works by French artist Eric Stephany, and their subsequent positioning in 2018 in the gallery space in Sydney[8].

First, some insight on Stephany's practice will give some background on this curatorial practice. He is an artist, architect, and former chief designer at Architecture Jean Nouvel. He is interested in the imagined projects of 18th century architect Jean-Jacques Lequeu. Lequeu's projects were imaginary utopian Enlightenment works, that mostly remained unrealized. Stephany is interested in Lequeu's representation of sections of buildings through pink watercolour, as in Europe in the 17th century, pink becomes the standard to represent cut masonry. According to Philippe Duboy[9], Marcel Duchamp was already interested in Lequeu's witty humour and play on gender and sexuality, and there is a link with the experimentation on sections, profiles and shadows in Duchamp's *Grand Verre* from 1915-1923. Stephany embraces the heritage of both Lequeu and Duchamp and develops experimentations of profiles, sections and shadows. He is exploring the sense of virtual by the means of tangible sculptures and installations. A section represents the inside of walls as we will never see them in real space. The same happens with elevations, but sections are especially challenging since we can never in real life see the section as it is represented. The collages of Stephany's major series '*L'index des ombres'* [Index of shadows] are directly related to Lequeu and display images of architecture, paper cuts, photographs, and cut Perspex. With beams of light passing through the Perspex, the shadow is at the same time a contour and a projection of all the shapes of the object. One exhibited artwork is part of '*L'index des ombres'* and is entitled *Archéologie*, 2014[10]. It features a picture of a building by Philip Johnson, and a picture of multiple frames that represent an endless space. The black surfaces emphasize the impression of carving through the page.

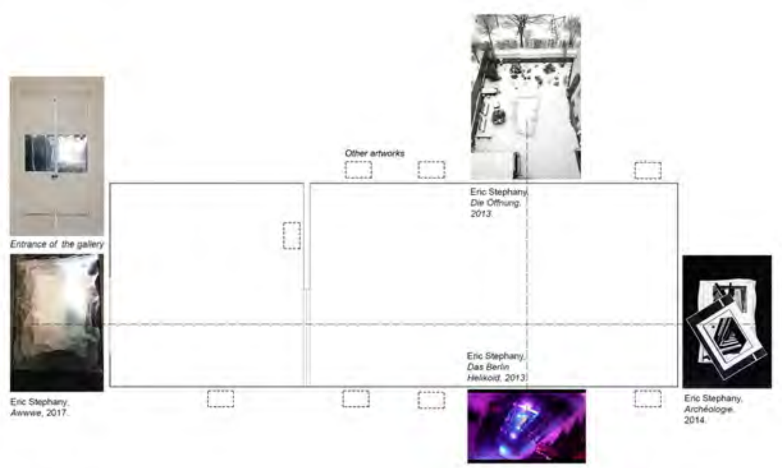

Figure 1: Plan of exhibition '*Cut Insight*', with emphasis on artworks by Eric Stephany, 2018. © Author

For this exhibition, Eric Stephany and the author created an installation that challenged the relation between interior and exterior of the gallery space.[11] The first virtual line to be recognised is between France and Sydney, through an axis passing through the earth. Stephany's works are positioned on the four walls of the gallery, to define links between the four exhibited artworks. *Archéologie* is situated on the rear wall of the gallery, opposite the door, akin to an image of the view plate of a camera with the door as the lens.

On the window door of the gallery, an adhesive transparent print of the artwork *Awwwe* from 2017[12] can be viewed from both inside and outside. Natural light enters the inside of the gallery through the photograph. *Awwwe* is a photograph of the negative image of the stairs of the Neolithic Tower of Jericho in Palestine from circa 8000 BCE. It is taken from above the stone staircase entrance of the tower. Stephany is interested in its openness towards the sky, and in the hollow staircase in the centre, directed towards the underground. Because of their thematic and their positioning, both artworks in the exhibition are connected through a horizontal axis in the gallery space. *Awwwe* presents an image of layers of stone in a way that they become concentric frames on the window. In negative, by reversing the black and whites in the photograph, the hole appears as transparent and creates the opening through the door, framed by the series of stones. In the gallery space, this horizontal link, prolongated towards the outside of the gallery, is working as an architectural feature. This architectural feature is defined by a structuring of space that creates a landmark in terms of relative orientation of the viewer and the artwork.

Two other artworks by Stephany are displayed on the adjacent two walls, creating a system of two horizontal intersecting virtual lines in the gallery space. These two artworks document performances in a disaffected staircase which was the former studio of the artist in Berlin, and the building courtyard. On one wall, an iPad displayed a video of the performance *Das Berlin Helikoid* [The Berlin helicoid] from 2013[13]. A performer is attached to a rope and is seen ascending the central void of the staircase; creating a vertical axis through the stairwell. Filmed from his position, the video shows the staircase and the spectators who witnessed the event. Visible on the steps of the staircase are a series of low, pink coloured furniture pieces that were made by the artist. The staircase, as studio, required furniture such as benches for sitting, book shelves and other storage elements. In tribute to Jean-Jacques Lequeu, the furniture was painted pink as was the artificial lighting of the stairs during the videoed performance.

On the opposite wall, the photograph *Die Öffnung* [The aperture] from 2013[14] shows the same pink furniture elements positioned in the building courtyard. Taken from above, the array of elements appears to be facing the viewer, creating a vertical axis between the subject and the photographer. The array of furniture also refers to the pink sections used by Lequeu. The Berlin context is recognizable through various details, and the elements appear like an architectural model of an urban block, in this case, possibly a Berlin block. Despite their different nature and size (video and photograph) the two artworks face one another and define a horizontal axis that is perpendicular to the axis from *Awwwe* to *Archéologie*.

The relations between the four different artworks define two horizontal perpendicular axes. The whole becomes a space-specific installation based on vertical and horizontal axes in the space, and the viewer moves in this virtually structured space. The verticality of both stairs is set in counterpoint with the horizontal links between photographs and video in the gallery. The spatial links inside the gallery space are set in resonance (or differences) with spatial relations in a broader geographic or cultural context of Berlin and Jericho. The network of spatial links inside the gallery appears subtly at first sight, but its perception increases progressively during the visit through the attention on the artworks and the knowledge that constitutes their background context. From four distinct artworks, their layout in the gallery creates a spatial installation at the scale of the gallery and beyond.

The curator uses architectural skills in the layout of the artworks in the space of the gallery. The curation process, i.e. the spatial layout and the links established, results in a new aesthetic proposal. The layout of artworks creates an effect on the viewer that was not expected in the initial artworks. The layout acts as a *dispositif* (French word that means ‘display’ or ‘device’ or ‘apparatus’. The word ‘display’ is adequate in the context of this paper) defined by Michel Foucault: “What I am trying to identify under the name of display is a resolutely heterogeneous set of ‘said’ and ‘unsaid’ as elements of the display. The display itself is the network that is established between these elements. The display is therefore always inscribed in a game of power, but always bound also to one or more landmarks of knowledge, which arise from it, but just as much condition it. This is the display: strategies of power relationships supporting types of knowledge and supported by them.”[15]

Through the viewer’s comparison between the spatial and architectural characteristics of the artworks (of the layout as display arranged by the curator), a knowledge is developed. Simultaneously, this knowledge strengthens the links between artworks of the spatial display. The ‘curation as research’, as defined in the introduction, produces knowledge about Stephany’s work, and the reflection on Stephany’s artworks strengthens the spatial virtual links between artworks.

Reference to Spatial Links Created by an Artist as Curator of his Own Work: Jean-Luc Moulène

The perceivable links in the author’s 2018 exhibition can be compared with other exhibitions that also have an architectural character.

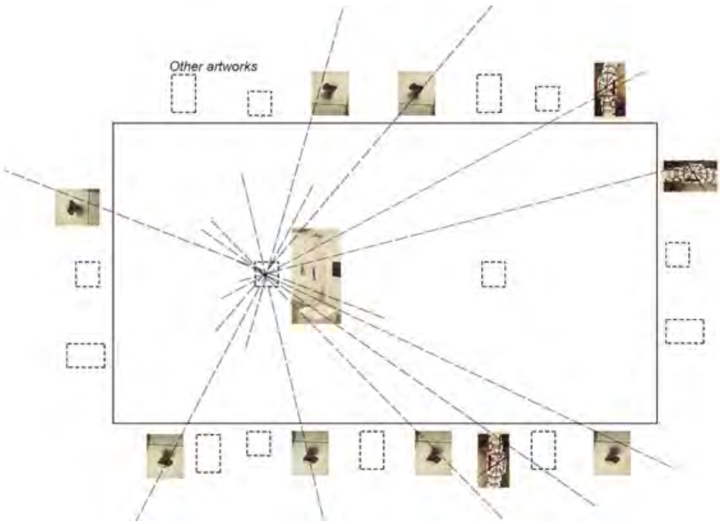

Figure 2: Plan of exhibition '*Mental archeology*' by Jean-Luc Moulène, 2010. © Author

One example is a 2010 exhibition by French artist Jean-Luc Moulène at the centre d'art contemporain d'Ivry. His exhibition *Mental Archaeology*[16] was primarily photographs and drawings on the four walls and two small sculptures on pedestals in the room. *Mental Archaeology* was organised in parallel with a separate exhibition at the Kunstverein Nürnberg, and Moulène chose to conceive these two exhibitions in parallel. An invisible link connected the two places in Ivry-sur-Seine and Nürnberg through this process. Moulène sets the photographs in space with the spatial skills of a sculptor who is a specialist of topological relations. These skills are very close to architectural and abstract landscape skills. Moulène presents photographs of a stone taken from seven different viewpoints which he made by keeping the camera still and rotating the subject. The viewer needs to walk through the gallery to create the mental image of the stone. The images are connected in space for the viewer.

The small sculptures in Moulène's exhibition space are off-centre, placed at two 'focal points'. One of them is a transparent plastic bottle, which serves as a support for a (fake) diamond. Through the images of the stone reflected in the multiple facets, the idea of perception from different viewpoints reappears: the photographs and the entire exhibition are reflected in the bottle and in the kaleidoscope-like diamond.

Moulène also presents images of watches in this exhibition overlaid with networks of converging lines. Other drawings are monochromes; the paper entirely covered with lines of a single colour. The viewer circulates in this network of virtual lines linking drawings and photos of the same series, radiating around the two focal points delineated by the sculptures. Moulène conceives a perceptive 'dispositive' based on multiple images more than a classic dialogue between artworks. The relations of sense or shape between photographs and sculptures are usual in Moulène's tentacle thinking process. In this case, the invisible links take us into a network of relationships that structure the gallery space (in relation with the

Nürnberg exhibition) and expand the temporal and spatial characteristics of the artworks space in direct continuity with the topological qualities of Moulène's artworks.

In the exhibitions of the *Series*, the virtual lines are constructed by the curator. As Moulène has a role of curator in *Mental archeology*, the curation of the *Series* is led as a creative process.

In contrast to *Mental Archaeology*, the exhibitions of the *Series* are group shows, with virtual links created through the curation in ways that were not originally intended by the artists in the original works. This leads to a different type of outcome as the combination leads to new aesthetics created by the coexistence of different artworks from different artists bound together by the curator's process.

Spatial and Temporal Links created by the Artist and the Curator: Claire-Jeanne Jezequel

Figure 3: Claire-Jeanne Jezequel, *Untitled*, 2017 (in the 2018 exhibition) and *Still Movie 2*, 2016. © Author

This paper has focused thus far on spatial links. Links can also exist through a succession of exhibitions in time. Artist Claire-Jeanne Jezequel created two major sculptures for the *Series*; one for the Berlin exhibition in 2015 and one for Sydney in 2016. For the 2018 Sydney exhibition, the author procured another Jezequel work: An *Untitled* black varnish painting on lead-light in front of a black aquarelle drawing.[17] In this work, the lines of lead and of the boundaries of the geometric shapes create a virtual space. The artwork, although two-dimensional, has sculptural characteristics. In the 2018 exhibition, it was set in dialogue with Stephany's work on the entrance door, and the horizontal lines of two photographs by artist Maxime Thieffine. Referring to Figure 3 above, Jezequel's *Untitled* linked through time to her previous works in the *Series* reminding the viewer of the large scale and structure of the sculptural works that appeared in the 2015 and 2016 exhibitions.

Figure 4: Claire-Jeanne Jezequel, *Still Movie 2*, 2016. © Author

Jezequel's artwork in the 2016 Sydney exhibition[18] was, in itself, an architectural intervention: the metal structure and black painted tracing paper rolls of a 13 meters long sculpture entitled *Still Movie 2*[19], transformed the wall into a partition of movement for the body of the viewer in space. She created a new horizon which, according to her, united and divided the space at the same time, as we see in Figure 4 above. Jezequel set one primary virtual horizontal plan, which connects the different parts of the sculpture, and connects the sculpture with other artworks in the gallery space. Vertical elements are secondary in comparison with this primary horizontal levelling. The roll of tracing paper could unfold in front of the window of the entrance door. A link is made between this 2016 sculpture and Stephany's transparent photograph on the window of the entrance door in 2018.

Figure 5: Claire-Jeanne Jezequel, *Still Movie 1*, 2015 and *Still Movie 2*, 2016. © Author

Still Movie 2 was created one year after *Still movie 1*[20] for the exhibition *Ungefähr Vier* in Berlin.[21] In this sculpture and its installation, vertical elements predominated. Subsequently, there was a shift from the dominant verticality in the more enclosed gallery space in Berlin, to a predominant horizontality in Jezequel's work in the Sydney gallery. The curatorial process created links between the different artworks in time (2015, 2016 and 2018) via the virtual structuring of the space in two different architectural settings (the Berlin and Sydney galleries).

The role of images, i.e. two-dimensional representations or framed areas of colour and matter, predominate in the virtual links discussed so far in the work of Moulène and Stephany. For Moulène, both sculptures and photographs are images: a sculpture is the outcome of the images that one discovers by turning around and a photograph is the image one discovers in a single glance. In a similar way, Stephany's preferred mode of expression is images of three-dimensional architecture. In the two artworks *Still Movie 1* and *2* by Jezequel, the framed parts of the black sprayed tracing paper, although abstract, appear like images from a film. Their succession creates sequences and gives a sense of movement. According to Jezequel, "the black sprayed tracing paper opens another space, and strangely a space of photographic images"[22], and of film images through the unrolling of tracing paper. They seem to unroll vertically in *Still Movie 1* and horizontally in *Still Movie 2.*

In addition to the connections set by the horizontal plan in *Still Movie 2*, the images create a network of connecting lines in the gallery space.

In Jezequel's work for the *Series*, there is an addition of temporal sense (between the three exhibitions where she had work exhibited), the strong spatial structuring inside the gallery space for *Still Movie 1* and *2*, and in these two latest sculptures, the timely sense of movement of images. The viewer experiences this network of connecting lines involving space and time in the architecture of the gallery space. The viewer gradually builds up the experience of the connecting links. And if we consider the moment when all the network of connecting links is set in the mind of the viewer, a certain climax is obtained. According to Jezequel, her sculptures *Still Movie 1* and *2* "are like still moments of suspended time, which explains the titles. The black spray on tracing paper fixes this immobility, this fusion of images. It shifts towards the timeless fuzziness of images. A note is held, like in music"[23].

By creating large scale installations in the gallery space, Jezequel takes part of the role of curator for multiple elements and images combined in the gallery space. Through the invitation by the author to create two successive installations in two different countries and gallery spaces, Jezequel created two different iterations of the installation that she adapted to the two different gallery spaces. In the 2018 exhibition of the Series, the author chose an artwork of Jezequel that concludes the curatorial process 'as abstract landscape'.

Conclusion

The curation as creation of 'abstract landscapes' of four exhibitions of the Series has been developed by creating linkages between artworks in the space of the galleries, and between places on the world map. A further aspect of the architectural curation was the creation of linkages between artworks in time, through the succession of exhibitions across a number of years. These linkages have been set in relation to the architectural space of the galleries where the exhibitions took place. The curation has been developed through architectural skills. These have been defined as the capacity to combine different shapes and objects that function as a whole spatial experience. That is, via curation, to construct links between distinct artworks in space in the context of the gallery space.

In comparison with the exhibition *Mental Archaeology* by Jean-Luc Moulène from 2010, in which one artist combines the artworks in space and time and in relation to the architecture of the galleries, in the process exemplified by the *Series*, space and time and architectural contexts are combined by the curator, creating new linkages between artworks, and thus new aesthetics. As Moulène has a role of curator in *Mental archeology*, the curation of the *Series* is led as a creative process. In contrast to *Mental Archaeology*, the exhibitions of the *Series* are group shows, with virtual links created through the curation in ways that were not originally intended by the artists in the original works. This leads to a different type of outcome as the combination leads to new aesthetics created by the coexistence of different artworks from different artists bound together by the curator's process.

The curatorial process has been shared in the collaboration with artist Claire-Jeanne Jezequel, as she creates large-scale installation in the context of the gallery space, and as she chose to create two iterations of a similar installation.

The effect of these links is to capture the viewer in spatial orientations that enable a singular aesthetic experience through an immersion in the combined effects. The virtual lines are set at different scales, as an outcome to create one unified project. A successful curation as creation of 'abstract landscapes of artworks', using architectural skills, creates a *dispositif* (display) defined by Foucault that initiates a thinking process about the different artworks in time and space. As the artworks relate to aesthetics that have an architectural aspect, different singular aesthetics and viewpoints are combined to develop new aesthetics and prompts thinking about artworks and architectures. The act of thinking via this prompt develops knowledge about the architectural aspects and the 'abstract landscapes' aspects of the artworks. The curatorial practice has a research outcome about the artworks of Stephany and Jezequel as abstract cultural landscapes.

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Performance and Discipline in Architecture: Investigating the Spatial Politics of Contested Australian Landscapes

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Abstract

This design research examines how site-specific performance can activate engagement with the spatial politics of contested Australian landscapes. The research has been carried out through a series of iterative performances situated within a variety of contested spatial contexts, each centred on the semiotic potential of pianos as cultural artefacts of European origins. Emerging from the iterative project work are a series of four operations that include *Spatial Inversions*, *Instrumentalising*, *Spatial Tuning* and *Cultural Burning*. Synthesized as a concluding performance within the decommissioned Pentridge Prison, the research offers this combined set of operations as a methodological contribution to the field of *critical spatial practice*[1], with capacity to activate new spatio-political formations and critical engagement in the spatial politics of contested landscapes. Consistent across the body of iterative project work is an exploration of the performative relations between spectatorship, action, and spatial contexts. In investigating these performative relations, research data collected includes video, audio and photographic performance documentation, diagramming, surveys, interviews, journaling, and structured reflective writing. The data collected has been interpreted using multiple modes of analysis, including reflective analysis, semiotic analysis, critical discourse analysis, and phenomenological analysis. The project work is framed within an existing field of practice in which a variety of creative practitioners engage pianos as performative devices to renegotiate situations, subjects and environments. Providing an overview of research undertaken over a period of five years between 2012-17, this paper contributes to design research by providing new creative practice knowledge to how site-specific performance can activate engagement in the spatial politics of contested urban and rural landscapes of Australia.

Introduction

Situated within the field of critical spatial practice, the following paper provides an overview of four spatial operations generated from research exploring of the cultural, ethical, and political resonances of juxtaposing pianos within a variety of sites in Australia.

Commencing with *Spatial Inversions* that emerged from preliminary performances situated in nineteenth century landmark buildings of Melbourne's Flinders Street Station and the Princess Street Theatre, followed by the operations of *Instrumentalising*, *Spatial Tuning* and *Cultural Burning* that emerged from a phase of investigative engagement with the spatial politics of contested Australian landscapes at Hobart's municipal rubbish dump and on a property acquired by the Indigenous Land Corporation as part of a land bank established for Aboriginal people.

While the four operations are addressed separately and chronologically in the order in which they emerged (see table 1 & 2), their formation, actualisation and value are by no means linear or autonomous. Rather, the operations run through the projects to resurface and recombine in both cumulative and cyclical ways. Foregrounded with a final summative performance situated with D-Division of Melbourne’s decommissioned Pentridge Prison titled *The Accumulation of Cyclical Operations*, the research offers the emergent potential of cumulative cyclical operations as a method for activating new spatio-political formations and critical engagement in the spatial politics of contested landscapes. Emerging through the performative re-contextualisation of contested landscapes, this process of practice-based enquiry provides insights into the conflicting claims, territorialisations, values, and temporal attributes that constitute spaces of conflict.

No.	Title	Date	Site	Instrument(s)	Action	Spatial Context	Political Concern
RESEARCH PHASE 1 _ URBAN LANDMARKS							
1.	Duration	October 2012	Flinders Street Station ballroom, Melbourne	2 Grand Pianos	Piano Recital	Dilapidated historical ballroom within privatised public building	The impact of privatising public infrastructure
2.	The Princess Theatre Inversion	April 2014	The Princess Theatre, Melbourne	2 Grand Pianos	Piano Recital	19th century proscenium theatre	Hierarchies of dominant forms of cultural production
RESEARCH PHASE 2 _ CONTESTED AUSTRALIAN LANDSCAPES							
3.	Instrumental	September 2015	Culpra Station, Rural New South Wales	1 Upright Piano	Piano Tuning	Property acquired by the Indigenous Land Corporation as part of a land bank established for Aboriginal people	Ongoing impact of colonialism in Australia
4.	Tuning Space	June 2016	McRobies Rubbish Dump, Hobart, Tasmania	1 Upright Piano	Piano Tuning	Municipal rubbish dump / landfill site wedged in Mt Wellington national park	The environmental impact of consumer cultures
5.	Cultural Burn	October 2016	Culpra Station, Rural New South Wales	1 Upright Piano	Piano Burning	Property acquired by the Indigenous Land Corporation as part of a land bank established for Aboriginal people	Ongoing impact of colonialism in Australia

Table 1: Projects

Operation	**Operative Effect**	**Activating engagement in**	**Value to Critical Spatial Practice**
1. Spatial Inversion	*Inverting* conventional relationships between performers, audiences, the piano and environments	Questioning the normative spatial conditions of western theatre and dominant modes of cultural production	Method for destabilising hegemonic structures through embodied encounter and activation of critical insights into dominant forms of cultural production
2. Instrumentalising	*Instrumentalising*: reframes and assigns non-human agents an active role in the production of performative spatial condition	Questioning the instrumental logic and legacy of colonisation	Method for reframing and assigning non-human agents an active role in the renegotiation and activation of new spatio-political formations.
3. Spatial Tuning	*Spatial Tuning*: producing immersive sensory engagement with the spatio temporalities of contested environments	Questioning the environmental impact of consumer culture.	Method for producing immersive sensory engagement with the spatio-temporalities of contested environments
4. Cultural Burning	*Cultural Burning:* Provokes recalibration between cross cultural binaries stuck in particular forms of categorization	Questioning the ongoing impact of colonialism in Australia and the duplicitous spatial politics of intercultural land ownership.	Method for recalibrating cross-cultural binaries stuck in particular forms of categorization
Cyclical suite of operations: *Spatial Inversion* *Instrumentalising* *Spatial Tuning* *Cultural Burning*	Activates critical engagement with spatial politics	Spatial politics within a variety of contested environments in urban and rural contexts.	Combined set of cyclical operations as a methodological contribution to the field of critical spatial practice, with capacity to activate new spatio-political formations and critical engagement in the spatial politics of contested landscapes.

Table 2: Summary of Operations

Operation #01: Spatial Inversions

The research commenced with two preliminary performance works that took place within the nineteenth century landmark buildings of Melbourne's Flinders Street Station and the Princess Street Theatre. Providing an overview of the origins of the research trajectory, these early studies revealed how the cultural authority of the piano could enable researchers to enter landmark buildings usually considered off limits to the public.

Questioning relationships of power within the spatial arrangements of dominant modes of cultural production, *Spatial Inversions* incites an active political engagement in the spatial relations between performers, audiences and environments. This operation emerged from the *Duration* project through the restrictions imposed on having a live audience attend a 90-minute performance of *Canto Ostinato* within the Flinders Street Station ballroom. In response, a film crew was used to broadcast the performance from the ballroom to the Federation Square screen, to the internet, and via the public announcement system to the stations' thirteen platforms and public concourse. Through the inversion of conventional spatial arrangements between the performers and audiences, *Duration* temporarily enabled the reactivation of privatized public infrastructure, returning the ballroom to the public realm.

Figure 1: *Duration*, Flinders Street Station Ballroom, 2012, Image by Greta Costello.

This operation of introducing a spatial inversion was further developed and enacted within a second project titled *The Princess Theatre Inversion*. Re-appropriating The Princess Theatre, this project questions conventional socio-architectural spatial relations by inverting the relationships between performers, the audience and the theatre. With an audience of one hundred people on the stage, facing two grand pianos and an empty auditorium, the performance was activated through a twenty-minute performance of Steve Reich's *Piano Phase*. Exploring the spatial politics of the proscenium theatre as a dominant hierarchical form of cultural production, the inversion that took place within The Princess Theatre temporarily destabilises socio-architectural hierarchies through an embodied encounter with the spatio-temporalities of the built environment.

Figure 2: *The Princess Theatre Inversion*, Princess Theatre, 2014, Image by Campbell Drake.

In the early project works of *Duration* and *The Princess Theatre Inversion*, the spatial inversions re-cast conventional relationships between performers, audiences and environments. Questioning the impact of privatising public assets (in *Duration)* and normative spatial conditions of the western theatre *(*in *The Princess Theatre Inversion*), this inversion of spatial relations is a method of destabilising hegemonic structures and activating audience engagement with, and potential reflection upon, dominant forms of cultural production.

Operation #02: Instrumentalising

The operation of *Instrumentalising*[2] emerged from the 2015 performance that took place as part of *Interpretive Wonderings*;[3] a critical cartographies workshop on a property known as Culpra Station that was acquired as part of a land bank established for Aboriginal people. The project is titled *Instrumental* and is the first of three spatial investigations that provide a considered engagement with the semiotic resonance of the piano as a critical instrument to activate engagement in spatial politics. This project took place on land intended to be a compensatory land bank for Aboriginal people, and brought about an opportunity to explore the semiotic potential of the piano as a cultural artifice to engage in the spatial politics of land, Indigenous Country and the ongoing impact of colonialism in Australia. The project *Instrumental* features a local tuner attempting to tune a broken upright piano outdoors on Culpra Station.

Figure 3: *Instrumental*, Culpra Station, 2015, Image by Greta Costello.

The title of the work is both a framing device and an operation. The operation of *Instrumentalising* actively engages with the spatial politics of Culpra Station through a sustained encounter with the spatio-temporalities of the duplicitous locational identity of a contested Australian landscape. *Instrumentalsing* seeks to poetically problematize the instrumental logic of colonialism in Australia by reframing and assigning non-human agents an active role in the renegotiation and activation of new socio-political formations.

Adapting Murray Schafer's theory of *acoustic ecologies* as a form of critical discourse analysis of sound*, Instrumental* bought about the use of this concept as a theoretical framework to analyse the performative relations between the piano, a piano tuner and the spatial politics of contested Australian landscapes. The term acoustic ecologies was coined by Schafer and is defined as a discipline studying the relationship mediated through sound between human beings and their environments.[4] In developing the term, Schafer devised a new terminology for soundscape studies. He defines background sounds as 'keynotes,' foreground sounds as 'signal sounds,' and sounds that are particularly regarded by a community are 'soundmarks.' Schafer's terminology helps to express the idea that the sound of a particular locality (its keynotes, sound signals and soundmarks) can express a community's identity, to the extent that a site can be read and characterised by sounds.[5] Beyond the audible spectrum, Schafer also developed the concept of 'acoustic coloration.' This term describes how the 'echoes and reverberations that occur as sounds are absorbed and reflected from surfaces within an environment, and the effects of weather related factors such as temperature, wind and humidity.[6] Exploring complex networks, multiple logics and rich contradictions, the project work is interpreted through an analysis of the *keynotes, sound signals, soundmarks* and *acoustic colorations* produced within each of the performance works. Seeking 'to bridge the gap between the textual and contextual analysis of site specific performance,[7] Schafer's terminology is adapted as an interpretive framework to analyse performance as a critical practice that is capable of constructing, reproducing and contesting the cultural identity of contested landscapes. [8]

Operation #03: *Spatial Tuning*

From the initial questioning of the ongoing impact of colonialism, the research expanded to question the environmental impact of consumer culture. A fourth performance project titled *Spatial Tuning* that took place at a municipal landfill site in Hobart, Tasmania, involved the staged tuning of a piano situated outdoors, within the contested boundary between the Mount Wellington National Park and the McRobies Gully Waste Recycling Centre.[9] In shifting the emphasis from Indigenous to environmental politics, this project revealed that the symbolic connotations of the piano are contingent on the situation in which the spatial tuning takes place.

Figure 4: *Spatial Tuning*, McRobies Gully Waste Recycling Centre, Hobart, 2016. Image by Campbell Drake.

The operation of *Spatial Tuning* activates engagement with environmental spatial politics by provoking an immersive sensory engagement with the impact of urban waste on the Tasmanian landscape. By actively engaging in the relations between aesthetic practices, human and non-human interaction, and spatial politics, *Spatial Tuning* questions how artistic experimentations can be used to understand the issues around the acts of crossing borders and shifting boundaries. Exemplary projects that undertake a form of *Spatial Tuning* in which pianos are used as performative, spatial and semiotic devices to intervene within dominated spaces of conflict include Markiyan Matsekh's *Piano for Berkut* (2012) and Ludovico Einaudi's *Elegy for the Arctic* (2014).

Figure 5: Markiyan Matsekh, *Piano for Berkut*, 2013. Photograph: Andrew Meakovsky, Oleg Matsekh and Marikiyan Matsekh

Also used as a title, a framing device and a process, the operation of *Spatial Tuning* is informed by Felix Guattari's concept of 'ethico-aesthetics'[10] as a framework to explore how aesthetic practices can destabilise dominant power structures to produce new political subjectivities through the crossing of experiential boundaries.

Figure 6: Ludovico Einaudi, *Elegy for the Arctic*, 2016. Photography: Pedro Armestre / Greenpeace

Supported by audience feedback on the live performance event in Hobart, the act of *Spatial Tuning* brings about new forms of negotiating and constructing relationships between landscape, bodily absence, and perception, through an immersive sensory engagement with the spatio-temporalities of an anthropocentric landscape. In doing so, this operation of *Spatial Tuning* fosters new perceptive sensibilities for close encounters with previously distanced landscapes, suggesting how the convergence of aesthetic and political practices can collapse the distance between passive spectators and contested landscapes.

Operation #04: *Cultural Burning*

Cultural Burn is the fifth performance work in this series and is centred on a return to Culpra Station to burn the piano that was used earlier as the tool of negotiation in the project *Instrumental*. The motivation to burn the piano emerged from an acknowledgement of my propensity to preserve the harmony of the piano, which resulted in an eagerness to explore alternative experimental modes of piano interaction. *Cultural Burn* is informed by a community of practitioners who have burnt pianos as part of their performance practice, including Annea Lockwood (*Burning Piano*,1968); Yoshita Yamashita (*Burning Piano*, 2008); Chiharu Shiota (*In Silence*, 2011); and Douglas Gordan (*The End of Civilisation*, 2012).

Figure 7: Annea Lockwood, *Burning Piano*,1968.

Figure 8: Yoshita Yamashita, *Burning Piano*, 2008.

Figure 9: Douglas Gordon, *The End of Civilization*, 2012.

Figure 10: Chiharu Shiota, *In Silence*, 2011

Through the juxtaposition of the Aboriginal land management practice of cultural burning, and the burning of pianos within contemporary arts practice, the operation of *Cultural Burning* activates engagement in Indigenous and non-Indigenous political sensibilities towards land and Country. Drawing on Jaques Rancière's concept of the 'distribution of the sensible,'[11] *Cultural Burning* intersects aesthetic and political practices to provoke a transversal condition through the juxtaposition of Indigenous and non-Indigenous cultural practices, artefacts and environment.

Figure 11: *Cultural Burn*, Culpra Station 2016, Photography: Campbell Drake.

Supported by a detailed account of burning the piano on Country, the value of *Cultural Burning* as an operation is in its capacity to reposition environmental contexts as active participants. Proposing the landscape as a choreographer and a performer, *Cultural Burning* activates environmental contexts to both determine and effect the making of form and meaning. Reformulating the relations between human and non-human interaction, *Cultural Burning* can enable environments to speak through artefacts, thus reframing the environment as active in the formulation of spatial politics.

The Accumulation of Cyclical Operations

Summarised in this paper are four critical operations that emerged from the development of an iterative series of five site specific performances. Enacted within and through the practice research, each of these operations revealed a particular potential to activate engagement in the spatial politics of contested Australian landscapes.

Consistent with the practice-led mode of research enquiry, a sixth and final investigative spatial performance was undertaken to explicate the potential of accumulating cyclical operations in critical spatial practice. Titled *The Accumulation of Cyclical Operations*, this performance was staged as a concluding gesture on the morning of Wednesday 18 October 2017, in D Division of the former HM Pentridge Prison complex in Coburg.

Figure 12: H.M Prison Pentridge, Image courtesy of Forbidden Places.

Structured in two acts, *The Accumulation of Cyclical Operations* was produced in the medium in which the research was generated and offers an intensification of the research value through an embodied encounter with the critical spatial operations of *Inverting Space, Intrumentalising* and *Spatial Tuning.*

Figure 13: D-Divison, Pentridge Prison, 1997, Image courtesy of Coburg Historical Society.

Figure 14: D-Division Prison Yard , Image courtesy of Fairfax Media.

Act 1: Tuning

The performance commenced at 5:45am with an invited audience of fifty people asked to assemble in the darkness at the front gates of HM Pentridge Prison. The audience was led to a prison yard where an upright piano had been positioned in front of a block of fifty deck chairs, all facing the prison wall. Crowned in coils of razor wire, the wall was around five metres high, with the first four meters built of solid bluestone capped with a later addition of red brick.

Figure 15: *The Accumulation of Cyclical Operations*, Act 1, D-Division Prison Yard. Image courtesy of Greta Costello.

Drawing on the method of tuning the piano that had been developed in the *Instrumental* and *Spatial Tuning* performances, the audience were presented with a man facing away from them, tuning the piano. Taking their seats, the audience sat in silence, listening and watching the tuner go about his task. In a symbolic, material and sonic dialogue, the tuner faced away from the audience in close proximity to the wall, which seemed to beckon over, through and beyond the impenetrable mass of the concrete and bluestone.

Figure 16: *The Accumulation of Cyclical Operations*, Act 1, D-Division Prison Yard. Image courtesy of Greta Costello.

In the early dawn, the sunrise gave orange highlights to a purple sky. While it was relatively still in the prison yard, a fast wind in the troposphere above blew the clouds across the sky. Birds flew around in the breeze, and weeds popping through the concrete swayed. A beam of direct sunlight shot from the clouds, momentarily lighting a section of the razor wire with a distinct gold. The audience sat in a bus-like configuration, and while they were stationary, the wind-directed movement above evoked a certain forward momentum, as through the tuner was driving the performance into the wall.

By enacting the non-musical, systemic atonal quality of the tuning, the human ear of the audience dials into the discordant sound, and in the act of listening, the spatio-temporalities of the immediate prison yard, inclusive of the 'constant, unnerving threat of violence as abhorrent and meaningless as humans are able to create', has an increased proximity. According to one audience member, 'We were in this courtyard environment which had the most disciplining kind of architecture, hard and arresting. The barbed wire at the top, the blank wall, and I felt like we were bound to these seats. It was an uncomfortable experience. But as the piece went on and it was quite mesmeric.'

Returning to Schafer's acoustic ecologies as an interpretive framework, the background *keynotes* of the first Act were defined by the morning bird song, the buzzing of insects, the wind, and the sound of mounting traffic in the distance. The foregrounded *signal sounds* were dominated by the acoustic discipline of tuning the instrument that really didn't want to be restrained. In terms of Schafer's concept of 'acoustic coloration', the echoes and reverberations that reflected from the hard and arresting surfaces of the prison yard were amplified by the bluestone and concrete before they escaped and were whisked away by the turbulent air above.

After being seated for 20 minutes, the daylight in the courtyard had brightened considerably, and the audience was encouraged to move back into the building for the second act.

Act 2: Phasing

On the ground floor inside D-Division, two pianists sat in position at two interlocked grand pianos. Beneath the octagonal atrium, the participants filed into the preconfigured seating on either side of the instruments. Seated on the ground floor, spectators were presented with clear views of the ornate Victorian skylight, from which filtered light fell onto the suspended corridors on the two levels above.

Figure 17: *The Accumulation of Cyclical Operations*, Act 2, D-Division Image courtesy of Greta Costello.

From one side, the hanging beam was clearly visible, overlooked by a fortified observation box that sat awkwardly at the eastern end of the atrium. On the opposite side, behind the second group of audience members, thick metal bars and a padlocked gate cordoned off half the complex on the ground floor. Once seated, a minute's silence was held, while the audience listened to the continued tuning in the courtyard outside, now accompanied by the morning song echoing from the birds roosting in the skylight above. Breaking the pause, the pianists commenced a 25-minute recital of Steve Reich's *Piano Phase*.

Figure 18: The Accumulation of Cyclical Operations, Act 2, D-Division Image courtesy of Greta Costello.

Once seated in the ground floor of the main building in Act 2, the defining *keynotes* shifted to the single notes of the prison yard tuning accompanied by the morning bird song above. For twenty-five minutes of the second act, the audience were drowned in the *signal sounds* of *Piano Phase* that, according to one audience member, began to 'transform the interior' through a 'complete inversion, where I suddenly saw the piano as something different, and the human interaction with the piano suddenly became this moment of freedom where the acoustics were liberated by that interaction.'[12] This audience account registers a *spatial inversion* that was potentially caused by the sonic, material and spatial *phasing* between the outdoor piano tuning and the indoor recital. The audience, I suggest, in phasing between the spaces of confinement, was first tuned into the single notes of the upright piano; when they were located within the recital of Act 2, they had already been attuned to the environmental surrounds. This provoked a cross referencing between instruments and the sonic practices presented within each act.

Similarly, the second conceptual operation of *Instrumentalising* is located within the dialectic produced within the *phasing* between spaces. This operation hones in on the semiotic potential of the piano as a cultural artifice to engage in the spatial politics of land, Indigenous Country, and the ongoing impact of colonialism in Australia. By phasing between the highly orchestrated, disciplining interior space of the abandoned prison and the prison yard, where a tuner battled against the decay of the decrepit piano, the swirling wind and non- human actants, the performance evoked resonances of 'disciplinary and knowledge practices between ongoing colonial regimes and Indigenous Australians'[13] that was perhaps provoked by an awareness of the disparity between Indigenous and non-Indigenous incarceration in Australia.[14]

By actively engaging in the relations between aesthetic practices, human and non-human interaction, and spatial politics, *The Accumulation of Cyclical Operations* questions how performance and architectural practices can be used to understand the issues of 'how we are positioned at the interface of different knowledge systems, histories, traditions and practices.'[15]

The act of accumulating the conceptual operations of *Spatial Inversions*, *Instrumentalising* and *Spatial Tuning* within the setting of a nineteenth century gaol provides insights into the limitations of traditional architectural and musical practices to control the dynamics of 'natural' environmental systems. Through an active engagement with the spatial politics of this contested urban landscape, *The Accumulation of Cyclical Operations* reinforces a critical standpoint that seeks not only to reflect and describe our relation to the order of things as validated by western knowledge systems,[16] but also to transform and imagine something different.[17]

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UAP (Urban Art Projects): Transgressions Between Making, Craft, and Technology for Architects and Artists

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Abstract

The experimental manufacturing and construction processes employed by art fabricators have the potential to inform new and innovative methods for making. However, they are seldom documented for the purposes of research, and thereby these innovations are rarely shared more broadly with complementary disciplines, such as design and architecture. This paper discusses these innovations in making through the work of a Brisbane art fabrication studio, UAP (Urban Art Projects). We present UAP's work as informed by research, but also as a process that informs research through innovative fabrication approaches. Using Bernard Tschumi's concept of transgressions in craft, this paper analyses three identified 'milestone' projects produced by UAP and how they have informed their fabrication processes.

Introduction

Art fabricators, sometimes called artist technicians, have had an increasingly substantial role in the production of artworks, pavilions, and bespoke street furniture. The uptake of commissioning art fabricators is due to a few, identifiable factors. One is a remarkably prosperous art market, especially in the last decade.[1] The other is the "post-skill era," which has meant the employment of a fabricator has become the acceptable norm and commonplace in the production of art."[2] Additionally, the changing scale of public art due to neo-liberal planning policies that have shifted the commissioning of public art to the private sector; where it appears, bigger is better.[3]

The scale of these projects is only made possible by fabricators such as UAP. As such, their impact on the art, design and architecture world has been to fabricate what was previously unachievable. This expansion of scope in public art sculptures is changing the nature of creative production, from one solely possessed by single artists.[4] It is, therefore, a reflexive position between artist and fabricator, where big art cannot exist without the other; the scale of contemporary public art sculptures is reliant on the supported, collaborated existence of both.

The current discussion about the role of art fabricators is concerned with whether artists should credit them, but this all depends on how you define art. Is it the idea or the physical outcome? This topic is not the basis for this paper. Instead, it focuses on how the craft, making, and fabrication processes are a form of research and can contribute to research on innovations in construction and fabrication approaches. Other than Patsy Craig's documentation of Mike Smith's art fabrication studio in London, published in the book *Making Art Work* (2003), little has been written about these studios that produce large scale public art, building facades, and pavilions. Craig describes Smith's making as a process of 'endeavour and enquiry.'[5] This paper aims to further Craig's research through the work of an Australian, Brisbane based art fabrication studio, UAP (Urban Art Projects). Additionally, a study of these processes outlines how these fabricators are helping achieve bigger, more complex sculptures and structures, and how these innovations in fabrication might influence the construction of the built environment, more broadly.

Background: Artists Technicians and Fabricators

There is a long history of artists relying on studio assistants, apprentices and artisans to assist in the realisation of their work. However, the notion of the artist as a skilled artisan was challenged early in the 20th century, most memorably by Marcel Duchamp's exhibition of a readily made urinal. Andy Warhol famously hired numerous staff to produce and create his works. Twentieth century art pushed the value placed on art away from its physical outcome and the artist as craftsman, toward the appreciation of concept, as Sol LeWitt put it, that "the idea itself, even if not made visual, is as much a work of art as any finished product."[6] In this post-conceptual era, ideas and vision are what is prized in art and not the ability to skilfully craft or make art. As a result of this, the role of the artist has been split into two, one as master creator and the other as a maker.

The division between artist as either creative visionary or maker is even changing art education, where universities either specialise in creating visionaries or makers.[7] As Mia Fineman writes, "As art with high production values has become increasingly common, the role of the artist has evolved into something closer to that of a film director who supervises a large crew of specialists to realise his or her vision."[8] Therefore, it is common practice that the owners of these fabrication businesses trained in art themselves, this includes New York based fabricator Konstantin Bojanov, and Matthew and Daniel Tobin who founded UAP.

This paper highlights the process of making art, which is often overlooked in favour of celebrating the idea, as Fineman writes, "We may be living in an era where concept is given more value than process… without that physical process, there would be no artwork to muse on." While the artworks themselves are widely discussed, the production behind them is rarely documented, let alone analysed for the purposes of research. The nature of producing the bespoke and creative nature of large scale art, means that every project requires a new, unique approach. With every project being different from the previous one, innovation is an indirect product from each work fabricated. We find that the work of these fabricators is informed by research, but it is also an act of research in the process itself.

Compounding the complexity of fabricating artworks is the increasing scale and scope of these projects. The Creative Industries, in the form of international festivals, biennales, exhibitions and art fairs are helping to fund larger artworks, creating a changing business landscape for these fabricators. Also, privately commissioned public art sculptures as part of neo-liberal city planning policies, are also causing an increase in both scale and volume of public art.[9] As such, even if artists were skilled artisans, few would have the resources or facilities to create art of such a scale.[10] It is scale then, as much as anything that has crystallised the role of independent art fabricators in the 21st century. There are a number of international art fabricators currently in operation; this paper focuses on this work within the context of and Australian owned fabricator.

UAP provides a case study from which to investigate the physical, social, cultural and economic impacts of innovations in fabrication processes. Their experimentations in fabricating processes are achieved in an environment where meeting deadlines, achieving commercial imperatives are also integral to their work. In this paper, we examine UAP's work in the context of broader social, cultural and economic influences. This survey highlights that advances in architectural fabrication do not occur in isolation, but are informed by government investment, significant cultural events, and cultural policy.

We found in this research that UAP often borrows know-how, technologies and tools from different disciplines and manufacturing processes as well as informing new fabrication processes. Having all these motivations in hand, this paper focuses on UAP and its milestone projects. Example projects from UAP are used to describe the development of their approach to fabrication, in its current state and their position on future processes. The discussion of UAP's work in this paper demonstrates the role of design-led manufacturing and that the creative industries are capable of driving change in advanced manufacturing and digital fabrication.

These projects represent specific milestones for UAP, beginning with their partnership with Lena Yarinkura on the Seven Dogs Project in Brisbane (2003 and 2010), then the King Abdullah University of Technology's (KAUST) Art Project in Saudi Arabia (2009), and lastly the Gehry staircase at the University of Technology Sydney (2015). Investigation of these projects reveals transgressions between making, craft and technology as key instigators of UAP's evolution and innovation. Moving from the mass produced to a mass customised, from a local to a global world, companies like UAP must continually find ways to cope with change and look toward the future to be competitive.

Transgressions Between Craft, Making and Technology

In a world of making, transgressions are necessary for evolution. As an act, a transgression provides moments of possibilities; where an idea is transformed, a rule is redefined, and a technology is revealed. Transgressions are part of the exploratory process of making, creating a pathway to discovery.

Borrowing the term "transgression" from Bataille's "theory of transgression" and using it for the first time in architectural theory, Bernard Tschumi associates the meaning of the term as a rebellious act.[11] For him, architecture is both about order and rules of configuring space as well as experiencing space and feelings. In his lecture at the University of West of England, he suggested that the first rule of architecture is to break it.[12] It is to propose something that people do not expect, to surprise the client, to give extra life to an idea. While breaking the rule, it is also about accepting the existence of the rule. In an early interview, Tschumi redefines transgressions as instigating or being linked to change in what architecture can or may be.[13] For him, it is about potentials of architecture, whether it is resultant of a temporal or political impact. Therefore, this potential creates a stronger connection to the materiality and socio-political disposition of architecture.

According to Jencks, the notion of transgressions is about transgressing boundaries and rules, and about desires of transgressing limits.[14] The way to achieve such motivation lies in the tension between the ideal and the real, and the transgressions between order and disorder, and between concept and experience. Architecture can only be successful if such transgressions occur. As such, Sheil suggests that; digital technologies, advancements in drawing and manufacturing, software, and physical tools allow transgressions to happen between the imagined and the constructed more directly.[15]

This transgressed process aptly describes the unique structure that forms UAP, where designers, architects, artists, curators, sheet metal workers, welders, project managers, and others involved in the fabrication of architectural and art based structures and forms, work under the same roof in a continuous flow of varied processes and operations. Companies like UAP might be simplistically seen as merely intermediaries or translators. However, examination of their ways of working and unique processes reveal the critical role they play in achieving artists' intent. It is through their collaborative approach to fabrication and manufacturing that provides a path to achieving the artists' intent in large-scale and often innovative outcomes. Working through new technologies and methodologies of making as an explorative process, they increase the political impact and time-based use of art works and architectural spaces through technical provocations and constant experimentations. Sheil also sees machines and tools as more than the essentials to solve problems, but as provocations. In his works, Sheil looks for new ways of utilising these developments by creating strange hybrids between appropriate and maverick uses of technology.[16] Such divergent use of technology is common in UAP's explorations while searching for the right path in achieving the artist's or designer's intent.

The meaning and the origins of the words "making", "craft" and "technology", suggest strong links of transgressions occurring naturally between them. In this paper, we define 'making' as a process of producing something that involves manufacturing, assembling, creating and inventing. We define 'craft' as an activity involving skills in making things by hand, and technology as a systematic treatment (from the Greek teknologia) and arts and crafts (from the Greek from tekhnē 'art, craft'). Due to the nature of their operations, UAP's daily practices incorporates all kinds of transgressions occurring across many layers. Working with artists, UAP translates artistic concepts into digital models in preparation for their full scale manufacture. While doing so, UAP undertakes whatever is required to build an artwork, creativity and invention to manufacture the unbuildable, or through handmade mock-up models that test materiality and intention or to use the technology in an innovative manner to create novel results.

The following sections of this paper present and analysis UAP's projects and fabrication processes through the lens of transgressions; whether it is a technology transfer to change the meaning of an artwork; a path to cross boundaries; or methodologies for exploring transformations from digital to analogue or vice versa.

UAP: Three Milestone Projects

Originally established as "Urban Artists", UAP started as a studio and workshop that could facilitate projects, work with artists, and realise art for the public realm. The studio and workshop provided space for creative collaborations, providing artists with space to develop ideas, investigate materiality, deliver projects, and extend their practices.

Projects at UAP are completed by a collaborative team of curators, designers, technicians, fabricators and makers from the handcrafted through to digital methods involving a range of materials and skillsets. Creating and making is realised in two levels, namely design and manufacturing. In the design level, UAP supports artists and designers in achieving their vision through technical and conceptual development, allowing artists and designers to visualise and solve the structural problems of producing their artworks and designs. UAP provides visualisation, structural and detailing support and as-built documentation utilising digital technologies, which is compatible with the technology employed by larger architectural practices. In the manufacturing processes, support is given through the use of the workshop space and tools, as well as experienced artisans assisting with vision and expertise on working with various materials, and on different manufacturing processes. The artisans skilfully create original solutions to address artists' unique design problems.

This research involved working with UAP's archives and identifying key milestone projects that highlight their making process as one of 'endeavour and enquiry.'[17] The purpose of this exploration was to highlight the transgressions between making, craft and technology experienced within UAP's design and manufacturing processes. The research into UAP, with an emphasis on identifying milestone moments, where certain externalities have changed the way they operate. The most significant externalities that were identified included; the importance of neo-liberal policies such as the Art-Built-in in the late 1990's, and the Queensland Advanced Manufacturing 10-Year Roadmap and Action Plan[18] in 2016 (highlighted as a dashed line in the timeline, see Figure 1). Events like the 2000 Olympics and the opening of international UAP branches continued to inform the development of new techniques and technologies into UAP's processes.

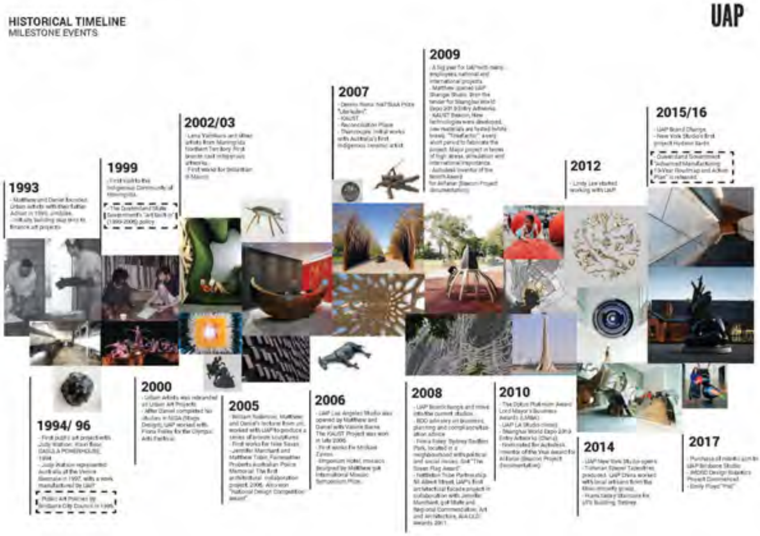

Figure 1: UAP Historical Timeline.

These key moments and projects also emerged as moments where transgressions occurred between making, craft and technology in UAP's history.

The archival research into the history of UAP found three main projects that highlight transgressions between craft, making and technology. They range in scale from urban planning to interior elements. All have created an important milestone for the company, as well as to their artists and the cities in which they are placed. These works are; Lena Yarinkura as an example of craft, KAUST Art Project as an example of making and the Gehry Staircase in relation to technology.

Craft: Works with Indigenous Artist: Lena Yarinkura

Lena Yarinkura is a is a Kune-Rembarrnga woman. She is an artist working from the Maningrida Community in Arnhem Land in Northern Australia. Her works are a continuation of her ancestry in weaving with natural materials, such as pandanus and wood. She makes sculptures of her experiences in her daily life, including her pets and their behaviours. She is an innovative artist that has developed a unique weaving technique and created an individual artistic intent in relation to her land and its interpretations.

Yarinkura initially collaborated with UAP, through an introduction from the Waanyi artist, Judy Watson in 1999. UAP presented metal-casting processes as part of a workshop held at the Maningrida Arts and Culture Centre. From this workshop, a long term relationship between Lena Yarinkura and UAP commenced.[19] In a reciprocal exchange between artist and fabricator, Yarinkura worked with cast metal for the first time, and UAP developed new casting methods by working with the forms and surfaces created by Yarinkura's woven sculptures. Initially, bronze cast sculptures such as the Camp Dog 2 were produced in 2003 (Figure 2). UAP's partnership with Yarinkura continued, resulting in a major urban art project scheme, Seven Dogs, at Brisbane Airport's Skygate, in 2010 (Figure 3).

Figure 2: Camp Dog 2, Lena Yarinkura, 2003. Aluminium, unidentified wood species, 600 x 500 x 150 mm (photograph courtesy of UAP, Lena Yarinkura©)

Figure 3: Seven Dogs, Lena Yarinkura, 2010. (photograph courtesy of UAP, image credit Scott Brown, Lena Yarinkura©)

The design process of the metal cast objects started with hand-woven designs Yarinkura created. These were then sculpted in a material that can be sand moulded, such as polystyrene foam. The sand moulds were used to form the metal sculptures by pouring hot liquid metals such as bronze or aluminium into them. The metal casts were then taken out of the moulds once they cooled down. This exchange of craft process and metal casting is an example of the research, by knowledge exchange, which informs and can be an indirect outcome from the fabrication of public art.

Making: KAUST ART

The second project to be discussed is the KAUST Art Project, located in Saudi Arabia. This project was a commission won through UAP's Los Angeles Studio in 2006. Won via an international tender, HOK was chosen in collaboration with UAP to produce artwork commissions that celebrate KAUST as a global university. The primary focus of the project was to interpret and present interdisciplinary art and design that stimulates creativity and interaction.[20] Therefore, UAP invited artists from all over the world to take part in this art project, such as Carsten Höller, Oliver van den Berg, Sopheap Pich, Iñigo Manglano-Ovalle, Subodh Kerkar, Donna Marcus, Dalziel & Scullion, Dennis Nona, Richard Deacon, Erwin Redl, Fiona Foley, Simeon Nelson, Nja Madhaoui, David Trubridge, and Jason Bruge. Each artist worked with an interdisciplinary team to provide a site-specific artwork for various locations in the KAUST site.

The scope of this project and the constrained construction timeline of only 30 months required UAP to develop innovative, efficient fabrication processes to meet their deadline. They also developed new ways of managing work in the Brisbane workshop and on-site; as KAUST had several artworks to be constructed at the same time. The explorations during the KAUST project resulted in experimentations with new materials such as white brass, and the use of new technologies both in the workshop and the design documentation departments of UAP. This required them to engage with new software to help streamline documentation processes, and given the manufacturing complexities of some of the produced artwork, UAP was awarded the Autodesk Inventor prize in July 2009 for their effort in documenting some of the artworks.[21]

Figure 4: Al Fanar/ Beacon, Daniel Tobin, 2009. (courtesy of UAP)

One of the major artworks of the project was the Al-Fanar/ Beacon designed by Daniel Tobin. It is a sixty metre high structure that is a contemporary interpretation of a light house (Figure 4). It has become the symbol of KAUST, defining the entry point to the harbour where the university is situated. Inspired by the marine life of the Red Sea, Al Fanar is constructed from Ancient Arabic Maritime traditions, in-region artworks and architectural detailing. Its highly complex structure is built from pre-cast concrete blocks that are in amorphous hexagonal sections. The interior space provides a gathering space with a play of light and shadows. It is also an example of a large scale sculptural and architectural work designed and fabricated by UAP.

Technology: Gehry Staircase

The third project discussed is the Gehry Staircase. Designed by Frank Gehry, the Dr Chau Chak Wing Building at UTS Sydney has a sculptural central staircase that works as a bridge bringing students together. UAP was commissioned to fabricate these stairs (Figure 5). Working with Gehry Partners, UAP explored fabrication methods for the sculptural staircase that required complex research and investigation into form, material, and structure to determine how best to construct this ambitious vision. The sculptural piece is built from hand beaten stainless steel metal plates that are welded together and then polished to achieve the smooth mirrored effect.

Figure 5: The Gehry Staircase, Gehry Architects, 2014. (courtesy of UAP).

As with many of Gehry's designs, the staircase was designed manually through an iterative process of cyclical testing. It was then digitally modelled for precision, representation, and manufacturing. However, due to the limitations of manufacturing processes especially in steel, it was difficult to achieve the complex forms of the staircase design by automatic manufacturing systems. The complex form of the staircase challenged UAP's existing capabilities. The manufacturing of the staircase involved dividing it into modular pieces which were built one by one by metal casting artisans, welders and polishers. The modular pieces were then assembled in the factory using a mock-up model; then they were placed on site. Transgressing a digitally modelled staircase by manually making it was a painstaking process, leading UAP to explore advanced manufacturing possibilities for the manufacture of future projects.

As part of this strategy, and in response to an increasing demand of complex architectural designs, UAP has acquired an industrial robotic arm. To further develop its capabilities and examine the affordances of robotic vision systems, UAP is currently undertaking a research project funded by the Innovative Manufacturing Cooperative Research Centre (IMCRC), in collaboration with QUT and RMIT.[22] The project is looking into research-led innovation to enable mass-customisation manufacturing of products, processes, and services for art and architectural fabrication in Australia.

Conclusion: Art Fabrication and Research Driven Processes

As the creative industries continue to flourish, influenced by neo-liberal planning and policies, the role of the art fabricator continues to grow in both scope and significance. While neo-liberal approaches to planning policy transferred investment in public art from the public to the private sector, its intention was as Michael Keniger wrote, to emphasise that building is ‘a cultural act as much as it is a physical one.’[23] Stuart Cunningham describes this economic shift where ‘creative production and cultural consumption are an integral part of the new economy.’[24] The role of the art fabricator is too often diminished by an emphasis on a sole author, perpetuated by a post-conceptual art world, that has yet to let go of 20th century practices in the creation of art. This paper has aimed to highlight the important contribution art fabrication has to make as a process that is informed by, and informs, research and innovation.

Through the analysis of UAP’s timeline, this paper presents two important findings. Firstly, that over time public art has progressed from an autonomous form applied to public architectural spaces, to architectural objects or sculptures that are seamlessly integrated into a project. This is exemplified through works such as Yarinkura *Seven Dogs* for Skygate (2010), Brisbane and Frank Gehry’s stairs (2015) in the UTS Dr Chau Chak Wing Building. Secondly, the complexity and scale of art works have compelled UAP to embrace innovations in fabrication technologies through works such as KAUST (King Abdullah University of Science and Technology).

UAP’s engagement with collaborative processes has come about from a reciprocal engagement between artist and maker. Artists’ and architects’ vision are pushing UAP to engage in experimental and cutting edge processes and technologies, while UAP has shared their processes and capabilities to push artists’ and architects’ material use and knowledge. This exchange of knowledge between visionary and maker demonstrates a clear transgression between craft, making, and technology. By documenting art fabrication processes, and analysing them further, there is the potential that the research and innovation by making, could be shared more broadly with construction and manufacturing industries involved with the built environment.

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Architectural Design Research and Housing

Chaired by Dr David Tapias Monne

Designing Affordability: Interdisciplinarity in Design Research as Methodology for Tackling Housing Affordability

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Abstract

Housing affordability is a widely debated issue in academia and media, however the discussion often tends to focus on singular issues, particularly those in the social sciences. A lack of interdisciplinarity in these texts, fails to convey a true understanding of the complexity and interdependent nature of the issues at play. In addition to providing design expertise, architects work alongside multiple disciplines to manage projects and support collective decision making. In research, these skills have the potential to move financial and policy debates into design research and into practice.

As Shane Murray[1] suggests architectural design research is both projective and integrative, and as an alternative to the clearly defined methodologies within economics and planning, it facilitates complex transdisciplinary arrangements to explore challenges in a holistic manner. A range of research works like that of EcoMOD and the Monash Architecture Studio, explore housing design through these architectural processes and design investigations, by situating their projects in the reality of socio-economic and environmental contexts to create new knowledge. Despite this, the implications for design research within the housing affordability context has not been explicitly established.

This paper begins to explore how the design knowledge of architectural research can create new insights into the issue of housing affordability, and posits that design research may present an integrative approach encompassing housing affordability from planning through to occupation. This idea is explored through discourse analysis and the author's own design research, asking if the interdisciplinary nature of design research has a place in the national discourse on housing affordability?

Introduction

Australia has one of the most expensive housing markets globally, and last year the median housing price reached almost 13 times the median salary in Sydney.[2]

In relation to this widening gap in housing affordability, the Australian Housing and Urban Research Institute has published a number of reports on the issues involved. Yates and Milligan posited that the percentage of lower income households in housing stress could exceed 1.5 million by 2042,[3] and Yates suggests a series of measures to increase the supply of affordable housing including initiatives and incentives, regulatory and planning changes, and assistance for disadvantaged households.[4] There has also been a focus on the ability of infill sites to deliver a variety of affordable housing options with a focus on leveraging existing infrastructure in established suburbs and creating higher density, diverse communities as opposed to urban sprawl on Greenfield sites which require a higher level of infrastructure input.[5] The Grattan Institute's recent report on housing affordability also highlights a number of factors affecting the high cost of housing in Australian including: taxation settings which encourage homeownership and investment in housing, while discourage downsizing; economic growth, rising household incomes and access to credit; immigration; and shifts towards city centres; supply falling behind demand; not enough medium density supply; planning regulations limiting development; and social housing not adding to supply.[6]

These research works highlight the interdisciplinary nature of the problem, and Yates and Milligan go on to suggest that the "causes of affordability problems are complex and diverse" and that "major driving factors can be found both within the housing system and beyond it".[7] Despite this greater need for interdisciplinary solutions, much of the work in research (like the above papers) are focused only on socio-economic aspects of housing affordability. Even those papers which explicitly state the need for interdisciplinary approaches, tend to focus across the areas of economy and policy.[8] A lack of interdisciplinarity in these texts often fails to convey a true understanding of the complexity and interdependent nature of the issues at play.

Comparatively, design has garnered very little attention in this academic discourse, despite numerous reports highlighting poor design as a major hurdle to providing affordable housing.[9,10] [See figure 1] Samuel and Hay suggest this may be due to the differing design methodology of architects in practice, and that they had "been largely excluded from debates on housing and home within the social sciences, including economics, because of their inability to speak the same research language."[11]

However, it is this unusual approach to research which makes design uniquely placed to address issues of housing affordability. As Friedman notes "design is by nature an interdisciplinary, integrative discipline"[12] and the designer is an analyst, a synthesist, a generalist, a leader, and a critic. Architects are not only skilled in the areas of design but they also must be knowledgeable in the areas of planning laws, building codes, environmental sciences and economics.

As a methodology for approaching housing affordability, Fraser notes "design research can best engender speculative thinking and experimentation through engagement with the normative practices of everyday life in the contemporary city."[13]

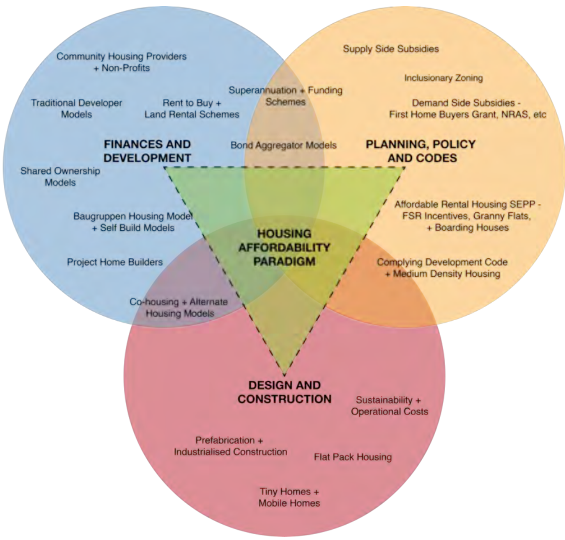

Figure 1: Housing Affordability Paradigm, highlighting areas of interest to the author so far.

Methodology

This paper employs an integrative literature review methodology, to not only compare the literature on the topic, but synthesize this with relevant information regarding housing affordability, examples and a case study of the author's own speculative design research into a new affordable housing model.

Literature was collated from a number of desktop sources, and terms used during this search include: housing; affordability; affordable; design research; architectural design; design process; interdisciplinary; and multidisciplinary. The literature included was mostly academic in nature, though some 'popular' or industry related articles have been included to show more generalised perceptions. Integrated with this literature review, a series of case studies were chosen as examples to emphasise or analyse the theories and ideas posed in the aforementioned literature. This culminates with a discussion of speculative research, which more closely explores the design research possibilities in housing affordability.

As Breslin and Buchanan note, the structure of a case study is to "determine a problem, make initial hypotheses, conduct research in gathering information and making observations, revise hypotheses and theory, and tell a story… [all of which] are acts that are strikingly similar to the work of a designer."[14] In this paper, the case study examples act as an intermediary, creating a bridge between the practical and academic discussion. Due to the relatively new approach of design research in academia and the lack of integration of design into the affordable housing discourse, Australian case studies displaying the proposed methodology for affordable housing were more difficult to come by. Instead the case studies in this paper were chosen represent an international perspective of design research as a methodology for housing affordability.

Interdisciplinarity

Design research requires a greater depth of knowledge than traditional design in practice, and Susan Roth notes "the distinction between project-oriented design research and the scholarly area of design studies reflects the extension of design from a form-giving activity to an interdisciplinary process dealing with complex systems and solutions."[15] It is this interdisciplinary process which makes design research suited to the issues of housing affordability which stretch across disciplines in a complex socio-economic setting.

Interdisciplinarity can be defined as "the quality, fact, or condition of […] pertaining to two or more disciplines or branches of learning [or] contributing to or benefiting from two or more disciplines" and can be considered as synonymous with transdisciplinary.[16] This is in comparison to multidisciplinary practice which is defined as "combining or involving several separate disciplines."[17] Jane Rendell further differentiates the two by conjecturing multidisciplinary research is "a way of working where a number of disciplines are present but maintain their own distinct identities and ways of doing things", while interdisciplinary research is when "individuals operate between, across and at the edge of their disciplines and in doing so question the ways in which they usually work."[18]

Alain Findeli's concept on interdisciplinarity states its primary task is "to construct a conceptual and theoretical framework for the research that is shared and acknowledged by all partners."[19] This reflects the nature of design research and its rationalisation of knowledge, but also refers to connected nature of the disciplines. This is particularly pertinent in approaches to housing affordability, as the language and methods used by architects, planners, financiers, developers, and builders often differs, and placing a conceptual framework around the issue has potential to integrate the players involved.

In addition, Trevena and Cattlin believe design research has the ability to "respond to a call for a new culture of decision making in a world of sticky problems, where participatory interdisciplinary acts and a new language of design can self-reflexively influence and engage with a complex politics."[20] It presents an opportunity to "engage meaningfully with planning and policy dialogue by offering redefined problems and a suite of flexible solutions."[21] In this way approaching housing affordability requires both multi and interdisciplinary methods, with multiple parties working together across private or community housing providers and government bodies, as well as interdisciplinary teams working within both housing providers and the government. It is here Bryant's notion that "by clarifying the lens of their own discipline, interdisciplinarity accelerates lessons in critique, and pushes divergent thinking"[22] is relevant.

Design Research and Housing Affordability

Architects have been using the methods and means of design for over five hundred years,[23] however in academic terms the idea of design research is somewhat more contemporary. Its meaning is often debated, as is its place in academia, however Nigel Cross stipulates that design can be research, so long as it is purposive, inquisitive, informed, methodical and communicable.[24] Fraser's definition whereby architectural design research must "involve the creation of projects"[25] can seem somewhat limiting, and instead we can look into the tripartite description that Christopher Frayling[26] (and subsequently Peter Downton and Findeli)[27,28] describe whereby design researchers have the ability to produce research *about* design, research *for* design, and research *through* design, or a combination of any of these. All of these types of design research involve some form of systematic enquiry, and as Friedman discusses must involve theorising and inquiry beyond the specific research at hand.[29]

Research about Design

Findeli states that research *about* design is "normally performed by various disciplines, other than design, according to scientific standards"[30] and as such this type of research utilises methods and approaches common with other disciplines using technical and quantitative measures like the sciences and engineering, or qualitative methods like social sciences and humanities. Also, Schneider notes this type of research most commonly covers areas such as the history of design, aesthetics, design theory and the analysis of design processes or activity.[31]

In contrast, research *about* design can also be theoretical and Murray considers it as research into "what design should be [and the] methods to achieve it" or "what takes place when design is undertaken, and then seeks to find methods to improve or refine the observed activity."[32] Friedman posits this type of research is necessary for all designers as a strong theoretical foundation for their practice, as "a broad understanding of general principles based on research gives the practising designer a background stock of knowledge on which to draw."[33]

This type of research has an indirect impact on housing affordability research, as it can elaborate how design and research processes may be best employed in the housing affordability discourse. ‘A Right to Build’, the self-build manifesto completed by the University of Sheffield School of Architecture and Architecture 00,[34] combines aspects of research *about* design with research *for* and *through* design in an interdisciplinary context. The paper examines research *for* and *about* design, encapsulating the current socio-economic and affordability issues facing housing in the United Kingdom, covering areas like land acquisition and ownership, finance, planning, density, and design processes. The authors build upon this knowledge, with a series of integrated design scenarios and frameworks as a type of self-build manual.

Research for design

The type of research most architects may be most familiar with in their everyday practice is research *for* design. It enables the design and as Findeli notes it is “highly relevant for design practice, since its purpose is to make sure that the various parameters on which the output of the design process depends are adequately handled.”[35] This type of research is usually project specific and may not be considered academically acceptable due to a lack of rigor or application to other work. This type of research has its place in the housing affordability discourse, as in all design research, as a way to contextualise the project in social, economic, political and geographical frameworks. Research *for* design may also cover a designer’s research into precedent studies, through which architects may gain new methods or ideas to incorporate into their practice. This is particularly relevant in designing for housing affordability, where designers can learn from interdisciplinary case studies that incorporate alternative development, financial, or political methods which can be enabled through architectural design.

Friedman suggests this type of research is ‘clinical’ and applicable only to specific conditions, as everyday designers do not have the time, theoretical background or inclination to create anything more than tacit knowledge within their works.[36]

This is reflected in the everyday practice of architects, or the work which is often produced in design studios at university. In America, Design-Build studios have become a popular means of conducting real world research and practice into affordable or disaster relief housing. Programs like DESIGNhabitat and Rural Studio at Auburn University in Alabama go beyond the basic research of a traditional design studio and are a manner of design research. However, it can be debated that despite these studios having elements of research *for* design in them, they often lack the rigorous and reiterative nature of PhD or post-doctoral academic research outputs. EcoMOD at the University of Virginia, also administered in a Design-Build format, may be considered a more systematic undertaking due to the continuous and reflective nature of their process. Not only does the studio participate in research *for* design, but the process continues through construction to post-occupancy, continually evaluating for the affordability and sustainability of the housing. This includes using decision making tools during the design phase, creating ‘control’ houses to compare results against, whilst working in interdisciplinary teams. This research therefore evolves into *research for* and *through* design, which is more rigorous in nature, as the project incorporates a methodical approach which is repeated and improved upon with each new project.

Research through Design

Today when we discuss design research, this is most commonly what comes to mind. Fraser's definition for design research fits more comfortably in this category whereby it is 'the processes and outcomes of inquiries and investigations in which architects use the creation of projects […] as the central constituent in a process which also involves the more generalized research activities of thinking, writing, testing, verifying, debating, disseminating, performing, validating, and so on.'[37] However, as Findeli notes, research *through* design also includes virtues of both research *for* and *about* design.[38]

Research *through* design is a type of applied research, and whether it is an industry related project or not, the design work still has constraints or real-world implications which need to be considered. It is this type of design research which has the potential to combine the interdisciplinary aspects of the research *for* design into a holistic body of work that contains embodied knowledge. Murray also notes the knowledge created in design *through* research is often tacit, unable to be easily understood to those outside of the profession.[39] Friedman notes that research *through* design must "consider the explicit ways in which design theory can be built."[40] In housing affordability, the architect not only needs to understood the greater interdisciplinary aspects of economics, planning, policy and development, but also need to be able to demonstrate the purpose and value of design and construction within their work and the greater discourse of housing affordability.

In fact, this type of research is more generalised than design completed in practice, which usually has little application outside the specific project. Rather, research *through* design is a framework for multiple projects or an area of research, and seeks to provide an explanation within a broader context. Friedman goes on to hypothesise it is this ability to theorise design which enables the designer to progress from repetitive singular projects to "broad explanatory principles that can help to solve many kinds of problems."[41]

In Australia, the Monash Urban Lab, formerly the Monash Architecture Studio, engages in "integrated, interdisciplinary and transformational research on urban architecture, urban design and urban planning."[42] Their DASH (Designing Affordable Sustainable Housing) project was born out of socio-spatial inequalities in Melbourne and, in conjunction with the Victorian Government Architects Office, the Department of Planning and Community Development and the Department of Human Service,[43] the project highlighted the disconnect between need for affordable housing solutions in policy and the lack of practical examples in the market. Ramirez-Lovering notes in his thesis that an integrated approach to the research was chosen as "design cannot be divorced from its socio-economic contexts,"[44] and the project drew from case study analyses, academic research, and investigation of industry practices to create new affordable, sustainable housing frameworks. Affordability in this case was both in value adding aspects of the design such as flexibility to adapt dwellings and resilient sustainability measures, as well as the reduction of operational costs and efficient construction methods. The researchers noted however that the building itself only contributed to up to 50% of the overall cost of the development, and affordability came from the many fields involved working together.[45]

Design Research for Affordability

Building on these examples and the methodologies described above, I am also exploring these issues of housing affordability, interdisciplinarity, and integrated processes through design research in my doctoral studies. During this process I have begun exploring issues of *research about design,* critically evaluating my own working process. This methodology is a personal design process but tends to reflect Goldschmidt's design process,[46] and as well as Dubberly's 'integrated design process and people-centred research'.[47] [see Figure 2] This self-evaluation of the way I design as an architect as well as a researcher, has made the process more rigorous. The reiterative nature also facilitates the integration of interdisciplinary issues, allowing multiple revisions of a similar design through differing lenses.

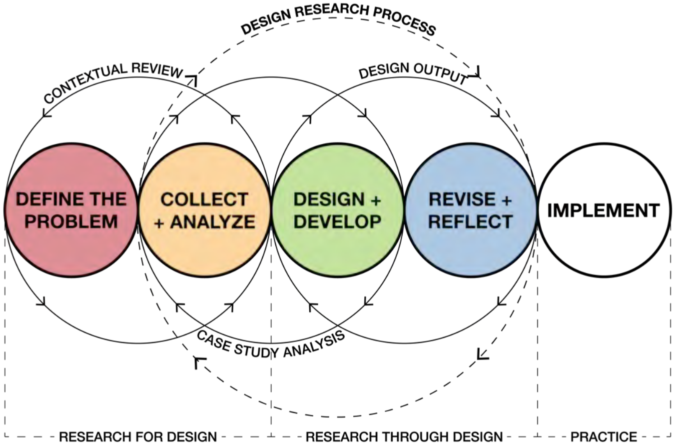

Figure 2: A diagrammatic representation of the author's design research process

The *research for design in relation to affordability* in the thesis takes on both established and less conventional research methods. Like many theses there is linear data gathering methodology which leads to more definite outcomes, however this type of research is mostly limited to the contextual and socio-economic areas of housing affordability which will later effect design choices and decisions. In addition to this, a case study methodology is used to gather further evidence as a type of *research for design.* Though common in architectural practice, case studies, often referred to as precedents, have the ability to be *explanatory,* but also *descriptive* or *exploratory*, as Yin suggests.[48] From Yin's typologies, it can be thought this type of case study or precedent is used for theory building as they are used as exploratory and explanatory examples from which more developed theories about housing affordability and industrialised construction are adapted. Eisenhardt also describes this method of building theory from case studies as being particularly relevant to new research areas where existing theory may seem inadequate.[49] These case studies begin to outline the precedence and theory from which the eventual *research through design* projects emanate.

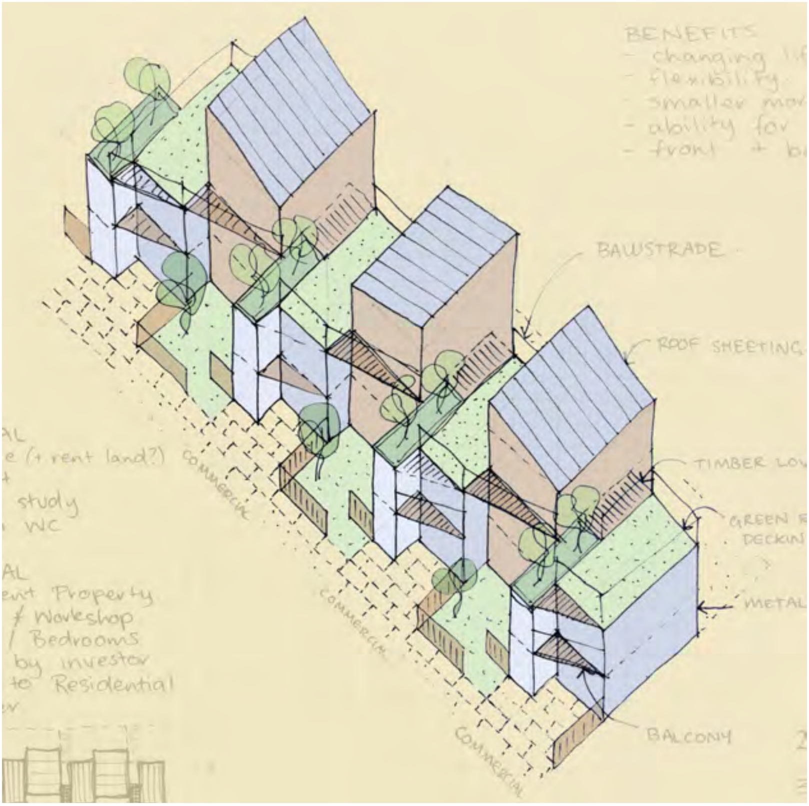

Figure 3: Design sketches (coloured) of mixed tenure housing model

These case studies explore issues within housing affordability and can be grouped into 3 areas of investigation. Unconventional land use and planning typologies are investigated through the HUD Code and Manufactured Housing Industry in America, as well as the exploration of community land trusts in Granby Four Streets. The Ikea and Skanska housing model Boklok and the architect-driven Nightingale model are case studies in integrated development models. Whilst innovative design and construction case studies include Res4 Architecture and their modern modular construction methods, and Elemental’s ‘half a house’. Each of these case studies and areas of interest, adds another layer of complexity to the research *through* design.

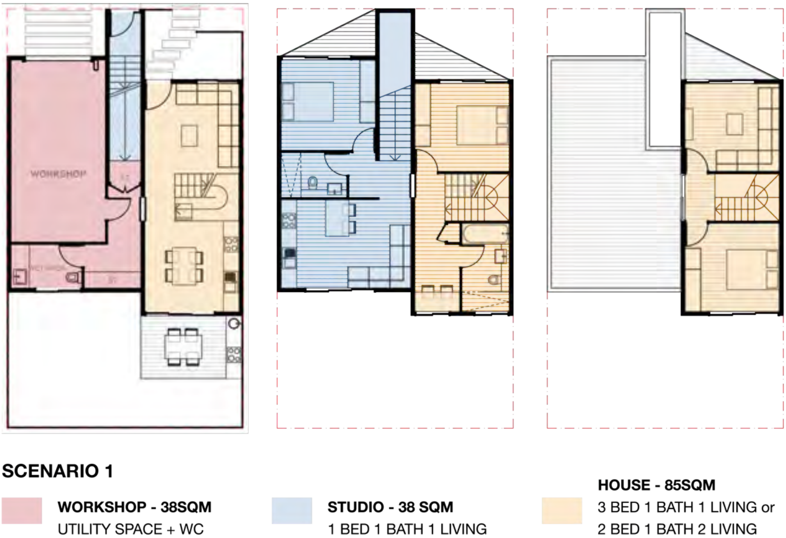

Figure 4: Plans of mixed tenure scenario for design project (Scale 1:250)

One research *through* design project is a 'Live-Work-Rent' housing typology [Figures 3-5]. The hybrid system is developed on the idea of expanding and contracting living arrangements. The contextual review in Australia indicated first home buyers are often those most affected in unaffordable housing markets, as they are most likely in their early 30's with limited income, in a couple with or without small children.[50] However as time progresses they often require more space as children grow, or the family requires alternative living arrangements. Finally, when the couple have retired and no longer require large houses, majors factor preventing downsizing is the lack of suitable or available housing in their existing localities, as well as the cost associated with selling and moving homes.[51]

This housing typology draws upon contextual and socio-economic information such as this as well as case studies, like the *baugruppen* models in Berlin, in an aim to address expanding and contracting living arrangements while providing flexibility in purchasing arrangements, investment opportunities, and ownership models. The dwelling includes three flexible areas: a garage which can double as a workshop; a studio apartment with balcony and direct street access; and a 2-3 bedroom house with backyard. The studio and workshop can be combined into the house to create a 3-4 bedroom house with garage, additional bathroom, and laundry, can act as rental investments for the owners, or can be owned by a separate investor and rented as additional space for the main house [Figure 4]. The plot of land is owned via Torrens title, though has the ability to be divided, with the garage and studio being owned by a separate investor or government via shared equity schemes. The design is simple and flexible with rooms designed to be large enough for bedrooms or living spaces with ample storage. This design is sited on an average 6m wide townhouse block, but could be adapted to multiple sites or typologies.

As noted in the design process outline in Figure 2, the design process was a reiterative one, and was more complex than a simplified diagram. The project began as a more traditional terrace house model for the 'Missing Middle' Complying Development Design Competition, however as further contextual research was collated on land use and planning, alternative development and ownership models, construction methodologies, and design case studies, the housing model and design evolved. Whilst this often means adding complexity to the architectural design, in this case it required a simplification of the housing design to suit to more complex ownership and financial models, as well as being adaptable for either a traditional or prefabricated construction methods. It aims to build upon the work of academics in the area of IHB and housing affordability,[52] and though still ongoing, this project utilises a design research methodology whereby the knowledge being produced isn't found in the architectural design but is embodied in the interdisciplinary aspects of economics, land ownership, and flexible living arrangements, providing a theoretical framework for future projects.

Figure 5: Isometric of design project with live-work-rent model

Conclusion

This paper begins to touch on the issues of design research, interdisciplinarity and housing affordability, and highlights areas where the opportunity for further research exists. The interdisciplinary nature of design research, whether it be *about, for,* or *through*, engages with and excels at dealing with the difficulties that are presented in our complex housing and socio-economic environment and requires further investigation.

This paper also briefly discusses how design research has the chance to bring the role of design back to the discussion on housing affordability, and the Commission for Architecture and Built Environment summarises this need affirming "design is not just about the aesthetic improvement of our environment, it is as much about improved quality of life, equality of opportunity and economic growth."[53] This lack of integration of design research and design-value in housing affordability theory that also warrants exploration beyond the capabilities of this paper.

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Applied Design Research Methods: Reflections on an Industry-linked and Multidisciplinary Project to Develop a Prototype Sustainable House

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Abstract

This paper reflects on the research processes and tools used in an industry-linked and multidisciplinary applied design research project (herein called LP13). The aim and main research question of LP13 was to develop a more sustainable and cost-effective prototype house for a suburban volume housing market in Australia in collaboration with an industry partner, a manufacturer of Structural Insulated Panels (SIPs). The reflection also involves a retrospective mapping and structuring of research tools and processes that may not always have been as clearly or consciously defined during the project. The aim of this reflection is to develop a better understanding of the research methods we employed, so that these can be communicated more clearly and potentially be used as a reference for other applied design research projects.

Figure 1: Suburban volume housing near Sydney (Photo: David Kroll)

Introduction

The body of literature available on design research in architecture has grown rapidly in recent years, with several recent book publications on the topic.[1] Reflecting the increasing relevance of the subject, the influential book *Architectural Research Methods* has been updated with a chapter on the relationship between research and design.[2] A survey of this growing body of literature, however, also reveals the diversity of the field and a sometimes confounding multiplicity of contradicting views.[3] This lack of an established methodology may suit the creativity inherent to design work and can also be seen as an opportunity for innovation. At the same time, a structured way to plan and describe the processes and tools used for a design research project seems essential for rigorousness and for communicating the research to other stakeholders such as industry partners or funding bodies. Samuel suggests that such 'tools' used in architecture to develop improved solutions are in fact research methods under a different name.[4] The following reflection therefore aims to describe the core research tools or methods used for the LP13 project.

The LP13 project was undertaken by the Innovation of Applied Design (IAD) Lab at the University of Sydney and established as an ARC Linkage by the lab director Prof. Mathew Aitchison. The focus of the lab is innovation-led research to develop design solutions for industry-linked projects, many of which deal with pre-fabrication. The core project team included Dr Sarah Breen Lovett and myself as postdoctoral researchers. Additionally, two PhD students from the University of Queensland, Gerardo Soret Cantero and Aaron Bolanos Cuevas, worked on research related to the structural, thermal and fire performance of the SIP wall system. The following account describes my understanding of the research processes and tools that we used by drawing on the material documented in the project archive and report. This paper therefore does not necessarily represent the views of the IAD Lab. However, the following observations are still intended to be useful as a case study for other applied design research in architecture.

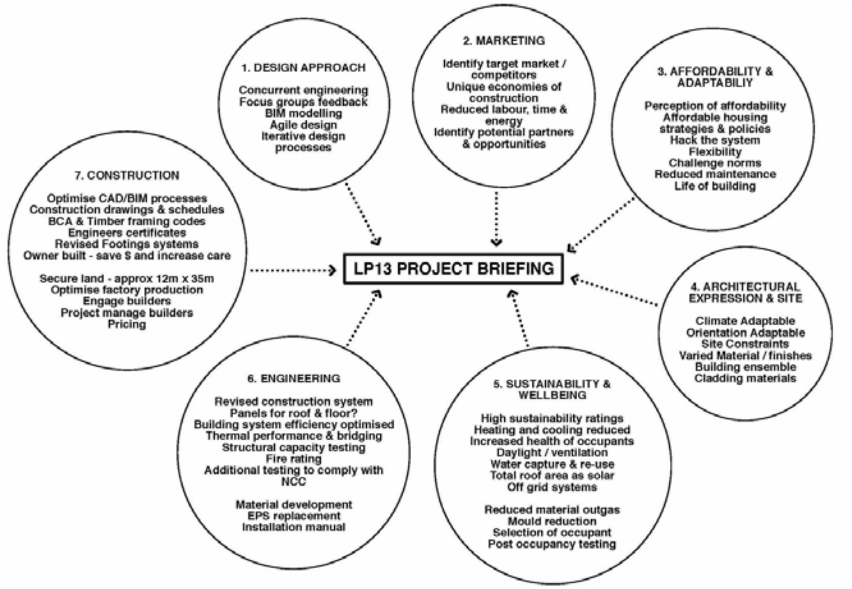

Figure 2: The 'wicked' design problem - visual mapping of briefing workshop outcomes

The main project was refined in initial briefing workshops with the LP13 industry partner (Figure 1). The industry partner wanted to demonstrate through a prototype house that it was possible to achieve cost-effective and more energy-efficient housing than what was currently on offer in the suburban volume housing market. The research was therefore a typical 'wicked' design problem with multiple competing parameters (Figure 1).[5] The challenge was not to develop a solution that only addresses one part of the problem – for example a house with the best possible performance or a house that is as cost-effective to build as possible – but instead to negotiate these conflicting demands in the context of a mass suburban housing market. To successfully address the problem, it was also not enough to use one research tool in the process but several, multidisciplinary tools were necessary to develop a solution that negotiates between these various factors. Several smaller research tasks were therefore identified and conducted over the course of the project to address several factors that were key to an optimised solution.

Project Plan

After initial meetings, we developed a project plan which was updated throughout the project (Figure 3). Since the project was the build a prototype house, the plan was based on work stages that also apply to other architectural projects. Our project plan for example also includes stages for briefing, concept design, developed design, construction documents, specifications, construction and then post-occupancy evaluation. These stages were mapped to the timeframe available for the project and the projected construction dates on site. While a similar program could be used for a conventional construction project, there are several aspects to this program that are design research specific.[6]

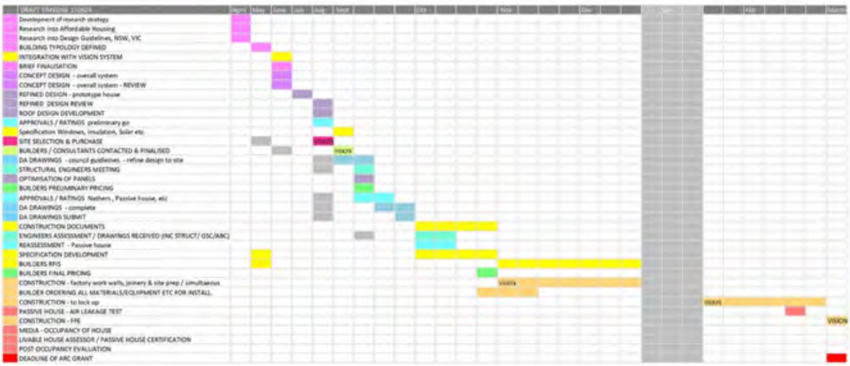

Figure 3: LP13 Project Plan

For one, the LP13 project plan starts with the development of a systematic research strategy. The project was not simply to build a house but it had to address a well-defined research question and problem that would require an innovative solution (how to design a more sustainable and energy-efficient prototype house for a volume house building market?). The design solution to be developed and built was directly linked to this question. The aim was that this solution would be innovative and that the built prototype itself would be a non-traditional research output. Innovative in this case did not necessarily mean that all aspects of it are new but that the overall house design could challenge the typical market offering in the suburban volume housing market and raise the benchmark. Furthermore, the project would contribute to knowledge through publications as traditional research outputs based on the required sub-tasks (for example the thermal testing) as well as on reflections dealing with other aspects of the project (such as this paper).

Figure 4: Prototyping of SIP system to be used for LP13

What also distinguished it from a typical construction project is that the prototype house itself could be regarded as a research experiment, in a sense that it is a test that confirms whether the original research aims were achieved or not. In other words, the house was itself seen as a test of the research hypothesis. For LP13, it would have been important for example to monitor and evaluate after construction, if the design had indeed been cost effective to build and is energy-efficient in its use. The project did not ultimately proceed to the construction stage for reasons outside of our control. However, for this paper, it is still significant that an evaluation stage was part of the original project plan to reflect this cyclical understanding of design research. The idea of this cyclical process is that the research question set in the beginning could be addressed in the design, could then be tested through the construction of the prototype house and verified in the post-construction evaluation. The outcomes and findings from this project could in turn inform new projects, and therefore have a broader relevance and transferability beyond this project alone. This kind of cyclical perspective on design research has been described by Kieran as “Planning Doing Monitoring Learning” and was also reflect in Bauhaus projects of the 20s such as the Dessau-Törten development that was built as an ‘experiment’ in housing.[7]

The research question itself was by its nature multidisciplinary. Addressing it adequately involved aspects that are considered part of various building related disciplines. To achieve an energy-efficient design, for example, involved skills from architectural science and engineering. Other aspects, such as challenging layout conventions in suburban housing, involved drawings and conceptual sketches – skills that are part of part of art and design disciplines. Other aspects of the problem again related to cultural, social and planning issues, for example, surveying and understanding of the different planning regulations and design guides. The nature of this project itself therefore demanded a multi-disciplinary approach and it would seem impossible to achieve a desirable outcome by only addressing one of these disciplines. For example, as purely an engineering and architectural science research, it may be possible to achieve an energy efficient building but it may not have any design or market appeal. Contrarily, if it is only driven by market and stylistic considerations without scientific simulation, it would be very difficult to have any certainty that the prototype would achieve high energy efficiency targets.

Research Tools

To develop a solution that responds to the overall research question ('a more sustainable and cost-effective prototype house for a suburban volume housing market'), different aspects of this complex problem had to be addressed. Table 1 maps some of the key research tools that were used for that purpose. For example, a survey of the 'affordable' volume housing market was necessary to better understand the targeted built costs and the kind of finishes and detailing that were possible. Energy modelling of this cost-effective prototype design was necessary to simulate the energy performance and ensure that it could achieve an ambitious target (Figure 6). Other tools included for example 1:1 prototyping of the wall system (Figure 4) and thermal testing (Figure 5) and an evaluation of 8 design options to select the fittest (Figure 7). The outcomes of each of these separate tasks contributed to achieving overall project aim. These tools were also specific to the project stage and more would have been added for the construction and post-construction. The diversity of these tools also reflected the multidisciplinary composition of the project team and some resulted in related separate research outputs.[8]

	Research Tools		Aim	Outcome
Pre-Design	Briefing workshops	with Industry partner, engineers and design team	Clarification of research problem and aims	Mapping of core aims from key stakeholders
Pre-Design	Market survey	of competitors in sustainable house building in Australia using SIPs and of affordable housing sector	Better understanding of the target market and cost targets	Identification of Competitor's Price range and mapping of specialisations
Pre-Design	Survey of design guidelines	relevant for suburban volume housing in Australia	Better understanding of planning context	Overview diagram with identification of guidelines and constraints relevant for prototype design
Pre-Design	Market survey	of suitable energy-efficiency standards and simulation tools	Identify most reliable tools for benchmarking energy-efficiency	Selection of energy efficiency benchmarking by using NatHERS, Passivhaus and EnergyPlus
Design	Co-design workshops	with industry partner, engineers and design team (Fortnightly)	On-going immediate feedback and develop a jointly supported solution	Design proposal with adaptable layouts
Design	Design choice feedback	3D modelling and stakeholder feedback for 8 external envelope options	To identify the solution that best addresses the project aim and question	Identification of an external envelope with skillion roof option as fittest solution
Design	Prototyping	1:1 mock-up of wall system in the factory	To clarify and test constructability	Optimised system with improved speed of construction
Design	Thermal testing	of wall system by PhD students at University of Queensland	To obtain real-world fire and thermal conductivity values	Adjustment of thermal conductivity simulation and optimisation of fire protection detailing
Design	Energy modelling	of preferred prototype design option using NatHERS, Passivhaus and EnergyPlus	To benchmark and simulate energy performance	Revised detailing and design to meet NatHERS 8-star rating and Passivhaus standard

Table 1: Key research tools used for LP13.[9]

Such a process of using separate smaller research tasks to inform and optimize a design solution is common in industrial design projects where multidisciplinary teams are often required as the expertise necessary to solve the overall problem is beyond the abilities of one person.[10] The LP13 project also required collaboration with other experts, for example with Passive House consultants Carlos Jimenez-Bescos and Peter Chisnall. Although architectural design practice also typically requires the expertise of multiple disciplines working together, such as engineers, surveyors and cost consultants, much of the discussion on architectural design research seems to neglect this necessity and also opportunity for synergies.[11] In the case of this project, the role of Sarah and myself as the main architectural design researchers often involved coordination of the research contributions from others in the team, such as the manufacturer and engineers, and integrating these into the overall design solution, which seems to be related to the design coordination role that architects also often hold in practice.

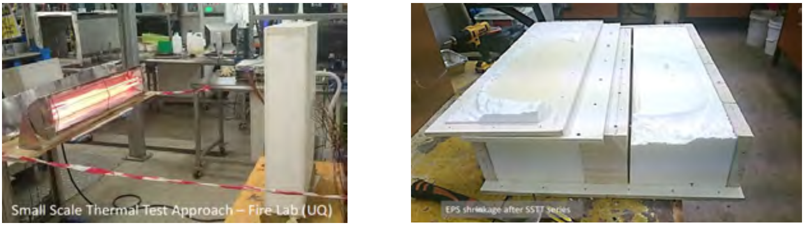

Figure 5: Real-world thermal testing of SIP system for LP13 by Gerardo Soret Cantero

This multidisciplinary approach on the project, however, also had other implications for the role of Sarah Breen Lovett and myself as architectural researchers. When required, we often had to be open to acquire new skills and knowledge that were outside of the typical core expertise of an architect – such as for example market research or energy-use simulation. It was not always possible to stay within our professional comfort zone, which could be daunting at times. Jane Rendell highlights this sense of unease when crossing disciplines but also sees it as an opportunity for innovation.[12]

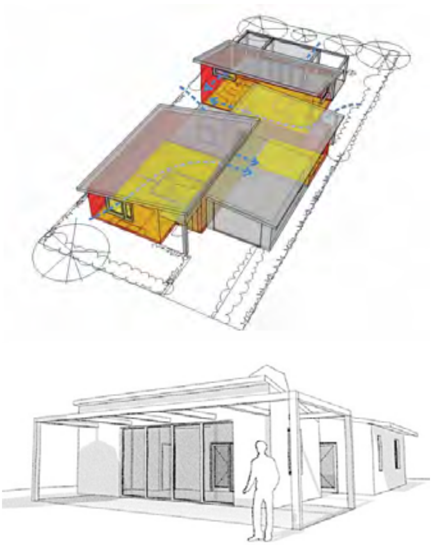

Figure 6: 3D models of skillion roof option with Passive House plugin (Design PH) for energy-use simulations

Conclusion

Reflecting on the research processes and tools we used has helped to clarify the steps we took to develop the prototype design. The complexity of the problem of designing a sustainable and affordable prototype suburban volume house could be addressed by using several more targeted research tasks that deal with aspects of the overall problem (energy-efficiency modelling, market survey, prototyping, 3d modelling of design options etc.). The results from these tasks then inform an optimised solution to respond to the design problem and question posed at the start of the project.

The nature of these sub-tasks required a multi-disciplinary team, as many were beyond the expertise of the architectural design researcher but in fact made the role of coordination even more important. The circular nature of the overall design research process was particularly relevant and applied to both the design process as well as the overall project. The design research question was addressed in the research strategy by separating it into smaller sub-tasks that could be tackled step-by-step and outlined in a project plan (planning). The strategy was then implemented in the design process through research experiments and tools (doing); these were then analysed, for example by using an energy-modelling tool (monitoring), and the design options were eventually optimised to reflect these outcomes (learning). Such a process is neither intended to restrict creativity, which is always required, nor does it automatically ensure innovation.

The complexity of wicked architectural design problems is an opportunity for architectural researchers to work in multidisciplinary teams. One of the roles of the architectural researcher could be to lead the design coordination and integrate the various contributions, similarly to the role of an architect in practice. It would seem silly to conceive of an ambitious architectural project that does not also require expertise from diverse areas of expertise such as art and design, engineering and architectural science, as well as humanities involving culture, society and legal frameworks. As in applied architectural design research, all of these areas typically need to be considered to various degrees and integrated to achieve a successful overall outcome.

What has become apparent to the author from working on this project, and what has implications for the field of construction at broader level, is that applied design research in architecture is inherently multidisciplinary because of the complexity of most design problems. While this conclusion is perhaps obvious, it still seems too often ignored in academia and practice. Just as it is difficult for one discipline alone to solve all the problems involved in constructing most contemporary buildings, complex design research problems and questions in architecture can rarely be solved successfully by one discipline alone, such as architects or engineers, and typically require collaboration with industry and varied disciplines. The roles in the research processes can and probably should be related to the roles held by these disciplines in practice. This multidisciplinary nature is an opportunity for the construction industry and those partners involved to find solutions for better buildings through collaborative research. This kind of collaboration is also an opportunity for researchers with an architectural background, as it makes their experience and training in design coordination essential.

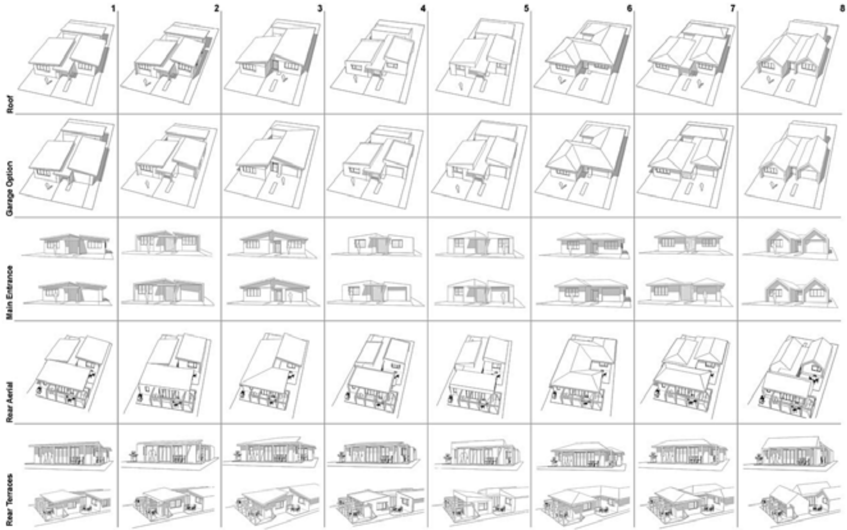

Figure 7: LP13 design studies matrix

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[1] For example: Professor Murray Fraser, *Design Research in Architecture: An Overview* (Ashgate Publishing, Ltd., 2013); Jules Moloney, Jan Smitheram, and Simon Twose, *Perspectives on Architectural Design Research: What Matters - Who Cares - How* (Spurbuchverlag, 2015).

[2] Linda N. Groat and David Wang, *Architectural Research Methods* (John Wiley & Sons, 2013).

[3] See for example: Groat and Wang, *Architectural Research Methods,* 21–57.

[4] Flora Samuel, *Why Architects Matter: Evidencing and Communicating the Value of Architects* (Routledge, 2018), 175.

[5] Horst WJ Rittel and Melvin M. Webber, ‘Dilemmas in a General Theory of Planning’, *Policy Sciences* 4, no. 2 (1973): 155–169.

[6] Till describes the view as a myth that a building project is automatically architectural research, unless it can be aligned with the general definition of research as a ‘systematic enquiry to create new knowledge’. Jeremy Till, ‘What Is Architectural Research’, *Architectural Research: Three Myths and One Model*, Discussion Paper (London: RIBA, 2005).

[7] Stephen Kieran, ‘Research in Design: Planning Doing Monitoring Learning’, *Journal of Architectural Education* 61, no. 1 (2007): 27–31; Andreas Schwarting, *Die Siedlung Dessau-Törten: Rationalität Als Ästhetisches Programm* (Thelem, 2010).

[8] For example: G. M. Soret et al., ‘Thermal Characterization of Building Assemblies by Means of Transient Data Assimilation’, *Energy and Buildings* 155 (15 November 2017): 128–42, https://doi.org/10.1016/j.enbuild.2017.08.073.

[9] This summary table is based on records in the LP13 project archive and the final project report.

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[11] This key aspect is not discussed, for example, in a recent summary on the state of architectural design research: Yasser Megahed, ‘On Research by Design’, *ARQ: Architectural Research Quarterly* 21, no. 4 (December 2017): 338–43, https://doi.org/10.1017/S1359135518000179.

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New Inner-city Living: Testing the Micro-context

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Abstract

In the Asia-Pacific city of the 21st century, high-rise building has become the dominant strategy in the push towards greater urban density, a phenomenon in an advanced stage. And yet inner city life allows for individual dwellings in low-density enclaves, which are still conceptualized and developed according to an established suburban paradigm. This paper identifies the micro-context of inner city ex-suburban locations as a territory for investigation of urban densification.

Beyond the move for density, other change agents within the contemporary city are becoming significant drivers of urban transformation. The need for mobility and transient occupation signal different ways of using the city. The age and ethnic structure of the population demands hybrid schemes for the contemporary use of space. The structure of the traditional family is radically evolving, putting more demand on flexibility of use within the household. These change agents necessitate a matching architecture that is adaptable and accepting of transformation at a small scale. Indeed, the small scale offers opportunities for densification beyond the current thinking that still conventionally associates single dwelling sites to single family groups.

This set of considerations fed the speculative thinking behind the One Room Tower, the outcome of the collaborative design research by Phorm architecture + design with Silvia Micheli and Antony Moulis, resulting in a built residential addition completed in early 2018. While engaging with the context of its locale, Brisbane's West End Estate, the project reveals the potential of the single house site as a micro-context for new strategies of development, calling into question the limited ways in which densification is currently carried out. Following the project's design process, this paper will reflect at a theoretical level on the urban and typological approach taken. It will also locate the One-Room Tower in the broader field of contemporary research on the relevance of the microscale to new forms of living for cities in change.

New Inner-city Living: Testing the Micro-context

In the Asia-Pacific city of the 21st century, high-rise building has become the dominant strategy in the push towards greater urban density, a phenomenon in an advanced stage. In Singapore, the Interlace (2013) by OMA/Ole Scheeren, Sky Ville (2015) by WOHA and Sky Habitat (2016) by Moshe Safdie Architects present different approaches to the big scale, as well as One Central Park (2017) by Atelier Nouvel in Sydney. In all these cases, the traditional residential tower, the icon of the urban densification in Asian cities in the late 20th century, has been re-thought in order to improve the relationship between private and urban spheres still retaining the highest level of density. The authorities of global cities in the Asia Pacific region have understood and accepted the value of this typology for the process of urban densification and have adapted their city planning rules to promote this strategy.

These new residential developments are putting pressure on the less densified adjacent areas, which in many occasions host individual dwellings on separate lots. These areas have often developed heritage values, with their traditional typologies and forms, avoiding any site amalgamation that could allow for high rise to emerge. This is the case of the traditional Tube-houses with their French colonial background in Ho Chi Minh City; the shop houses in Singapore and Kuala Lumpur and, in Australia, late 19th and early 20th century timber Queenslanders in Brisbane and the 19th century Terrace houses in Sydney. These inner-city enclaves, which are still understood according to a low-density paradigm, would benefit by adopting new development strategies in order to retain their character in such fast-growing urban realities. This paper identifies the micro-context of inner city ex-suburban locations as a territory for investigation of urban densification and presents the One Room Tower, designed by Phorm architecture + design with Silvia Micheli and Antony Moulis, as a demonstration project addressing this issue.

Densification and the Value of Micro-context

Professor Geoffrey London from the University of Western Australia has initiated a call for urban densification based on the recent documentation released for Perth and Melbourne. London mentions a report completed in 2011 at Monash University on infill opportunities commissioned when he was Victoria Government Architect (2008-14).[1] The design research report considers a range of design strategies and focuses on how design can provide attractive housing options for infill in suburban contexts.[2] While new models are vitally important, there are issues around community acceptance of greater urban density in Australian cities. At the end of 2017, the Swinburne University Centre for Urban Transitions released research identifying community response to urban densification in Sydney and Melbourne.[3] The survey showed that the transformation towards greater density generated community resistance, making evident that the broader support of a set of stakeholders, including government, community and industry is needed.

While London's arguments and examples are around the medium-density scale, unit-based developments and the context of middle suburbs in Perth and Melbourne, this research focuses on the opportunities in the micro-context of ex-suburban estates, a reality not yet considered but with significant implications. In this research, the micro-context is identified as the single residential lot understood as the traditional one-family property that, for its small size, cannot be subdivided. Under the pressure of the urban densification, the micro-context is also in a process of transformation. With Australian governments announcing a dramatic increase in inner-city and middle suburb infill in the next 15 years, the management of the single residential lot becomes crucial.

Beyond the move for density, the micro-context is affected by other change agents within the contemporary city, which are becoming significant drivers for urban transformation. The need for mobility and transient occupation signal different ways of using the city; the age and ethnic structure of the population demands hybrid schemes for the contemporary use of space; the structure of the traditional family is radically evolving, putting more demand on flexibility of use within the household. The mushrooming of bottom-up movements supporting small houses for inner-city life indicates that the desire for urban living is beginning to compete with the suburban dream.[4] From its beginning in 2005 in the US, the phenomena of the "Tiny house movement" has now spread all over the world, gaining popularity in Japan, Europe and Australia too. There are also the tiny houses on wheels (THOW) for those who want to be mobile and the cutting-edge research is now heading towards the experimentation of micro-houses arranged in stackable elements, such as the OPod Tube Housing.

These change agents necessitate matching architectural solutions that are adaptable and accepting of transformation at a small scale and that are approved and supported by the local authorities. Indeed, the small scale offers opportunities for densification beyond the current thinking that still conventionally associates single dwelling sites to single family groups. The design research carried out with the project and construction of the One Room Tower reflects on these issues around urban densification in the specific context of Brisbane and attempts to articulate a targeted strategy (see Figure 1).

Infill in Brisbane, or the preservation of the Queenslander

According to the South-East Queensland Regional Plan 2009–2031, Brisbane will accommodate 156,000 new dwellings to meet anticipated growth, of which 138,000 will be infill dwellings, located within the existing urban area:

> A significant proportion of future residential growth will be accommodated through infill and redevelopment within the urban framework and established urban areas. Prime locations for infill development are around urban activity centres that have existing facilities, services and amenities, and along public transport corridors and nodes where the public transport system can best service the additional population.[5]

While the document puts a lot of emphasis on the growth of the city's population and its connection to the city, little is said on how this infill strategy will be regimented and controlled. The case of infill in inner-city Brisbane is quite specific and as such needs tailored consideration, as the majority of the houses in its central areas are original character houses, known as Queenslanders. They are light timber houses with verandah edges, raised on stumps and protected by a pyramidal and gabled tin roof. Given their light materials and small dimensions, the architecture of these residential buildings is quite fragile. At the present, there are two popular approaches to infill properties occupied by a Queenslander: the "lift and add below" and the "extension". On the website of the Brisbane City Council "Altering character houses/buildings", they are classified as "building underneath the house" and "adding an extension". In the latter, Council "highly recommends" the strategy of the pavilion extension that "allows for the retention of the original form, its relationship to the ground, and the streetscape character of the earlier building. It [also] enables modern facilities and lifestyle preferences to be incorporated into the new extension".[6] Council also points out that the connecting link between the existing and new building allows for cross ventilation while providing a pleasant semi-outdoor transition from the old to the new parts of the building.[7] Despite Council extolling this strategy, the pavilion-typology is vastly underrepresented in built context. By far, the most popular strategy remains the raising of the house. Although it has marked effects on the character of the existing building, the "building underneath the house" can be carried out by local builders without significant design input and is supported by the real-estate industry as a cheap and effective means to add value to properties. Similarly, the "adding an extension" strategy allows for an increase in internal usable space, although it comes with more specific design considerations. There is a range of architectural responses to this strategy that attempt to respect the original building through measured design solutions. And yet, even in the best cases, the fragility of the Queenslander barely stands any direct alteration. However, both the “building underneath the house” and “adding an extension”, if not carefully designed, tend to distort the existing urban setting and compromise the relationships with the context. They also affect the inherent architectural language and typology of the vernacular.

Figure 1: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. © Christopher Frederick Jones.

The detached addition approach recommended by the Council, which at the moment is classified under the heading “extension”, is certainly not an established one in Brisbane. It is largely unexplored in the built form and, as such, needs demonstration projects to realize its potential and develop stakeholders’ engagement and support. One Room Tower, built in 2018 in one of the inner-city areas most subject to redevelopment, West End, stands as a manifesto of what we envisage will become a recognised strategy for the future. One Room Tower has received the House of the Year (Brisbane Region) and a State Award for Residential Architecture – Houses (Alterations and Additions) as part of the Australian Institute of Architects, 2018 Queensland Awards program for its ambitious urban and typological concept.[8] Its location on a corner block of one of the most popular parts of Brisbane inner-city area positions this building to become a potential precedent for future densification (see Figure 2).

Figure 2: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Context plan.

The Detached Addition: One Room Tower

One Room Tower is a small addition to the architecture of the City. A determinate form of indeterminate occupation, it is simultaneously intended as an urban artefact and utility. The project seeks to value permanence (continuity) within the urban condition, projecting a sense of relatedness through connection to the general “collective memory” of the West End Estate – a Rossian reminiscence.

Micro-context

One Room Tower tests the micro-context and its potential, taking inspiration from the small size of the block. Acknowledging concerns about the consumption of private open green spaces in the process of densification,[9] this project considers alternative ways of enhancing the backyard in urban areas. First, by the concept of “domestic urbanity”, the yard space is understood as an intermediary between the street and the house and, as such, needs to be articulated spatially. Here the garden and the built space enter a close relationship where they extend into one another by means of the articulation of the plan. A square platform, whose dimension of 5.6x5.6 are dictated by boundary set-backs, is twisted on the block generating a set of 4 corner gardens, providing opportunity for biodiversity and recreational activities. Platform and corner gardens merge into a unique surface organized at different levels, with sliding walls generate openings that foster, through diagonal views, the sense of unity and flow of space (see Figures 3 & 4).

Developed on the premise of “the site within the site”, this volume has the ambition of enhancing the space of the backyard and intensifying its utility. It is in the adjacency of the existing building and the new extension that the concept of “domestic urbanity” comes best into being. The twist of the pavilion allows for a concrete platform as interstitial space, that is, at once, the entry to the property, the entry to extension and the landing of the existing cottage’s stair. The confluences of these 3 pathways gives the platform a semi-public character, turning this area into a “piazzetta” onto which windows of both house and tower gaze (see Figures 5 & 6). And yet, the rotation of the tower generates deep perspectives, freeing the view into adjacent neighbouring gardens and the local street. The other corners, fragments of the original backyard in the conventional form we are used to know it, are maximized through the use of intense gardening.

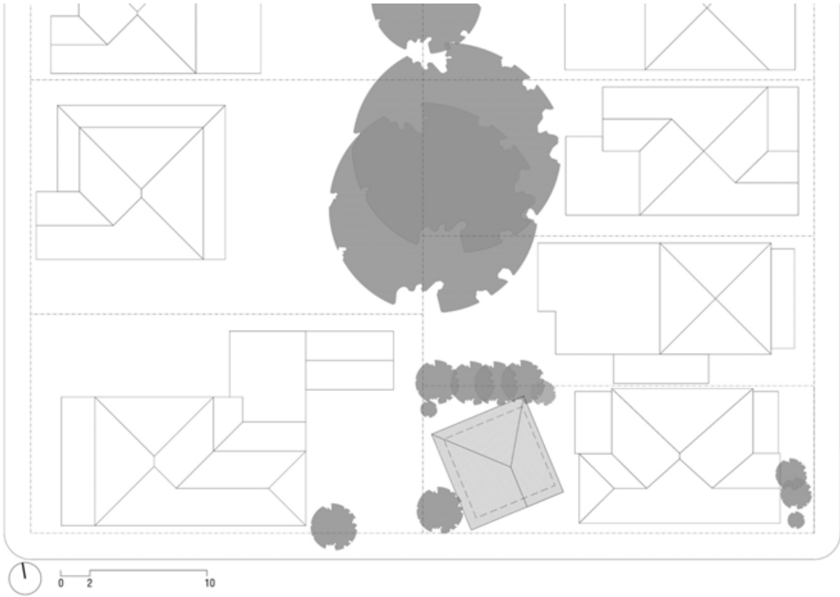

Figure 3: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Site plan.

Figure 4: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Corner Garden. © Silvia Micheli.

Figure 5: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Rear Garden and “piazzetta” space. © John Gollings.

Figure 6: Phorm architecture + design with Silvia Micheli and Antony Moulis, One Room Tower (2016–18), West End Estate, Brisbane. Rear Garden and “piazzetta” space. © John Gollings.

The elevated corner bay of the tower is a device for engaging the roof-scape of the surrounding context as well as the City and the suburbs in the distance.

The strategy of the domestic urbanity allows for variations of the type, according to the site dimensions, the position of the pre-existing house and the site cover potential. We envisage variants of the One Room Tower prototype in which similar kind of domestic urbanities can be achieved. In this sense, One Room Tower becomes a strategy of how inner-city private voids can be realized as infill.

Programmatic versatility

Because of the dynamism intrinsic to a city-in-change,[10] as Brisbane is, it becomes necessary to consider the programmatic instability of inner-city areas as a positive factor in the design process of infills. Therefore, in order to be sustainable, new additions need to cope with programmatic change over time. The architectural flexibility underpinning the One Room Tower concept implies functional versatility. With its sense of urbanity and lack of a totalizing residential dimension, One Room Tower allows for alterations, leading to new functional scenarios.

One Room Tower attempts to respond to multigenerational living and emerging social groups in demand of greater mobility and fluid aggregation models. The existence of two volumes within the site multiplies the opportunities for private and public uses, dramatically increasing the number of residents and functions per household in an area otherwise destined to undergo a process of depopulation. For example, their potential use as twin households for multigenerational living, as a house and workplace, as a house and shop or a gallery and office anticipate the kinds of future changes that might occur in the occupation of the inner city over the coming decades – allowing the built elements on the site to remain useful *in situ*.

Spatial Device

The One Room Tower is a detached pavilion with a central service core defining spaces of diverse area and volume (see Figures 7 & 8). A continuous vertical movement around the core provides access to a set of platforms arranged within the spatial whole. 5 levels exist between the grounded entry “doma” up to the final platform under the coffered roof space. Each platform spanning the void between core and frame, creates uniquely scaled spaces within the one room. This adaptable interior configuration is inspired by spatial and structural solutions learnt from the Metabolist agenda that relate infrastructure and “plug-in” elements.

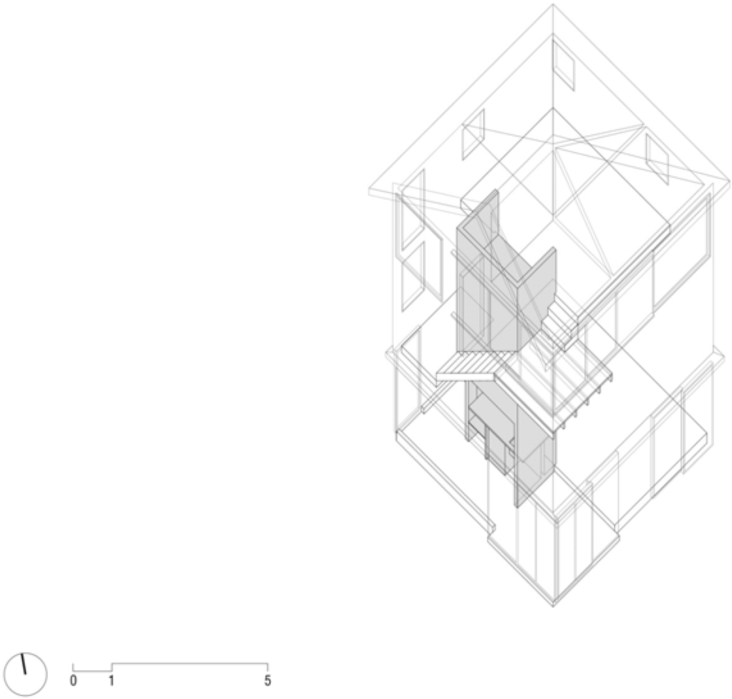

Figure 7: One Room Tower (2016–18), Axonometric.

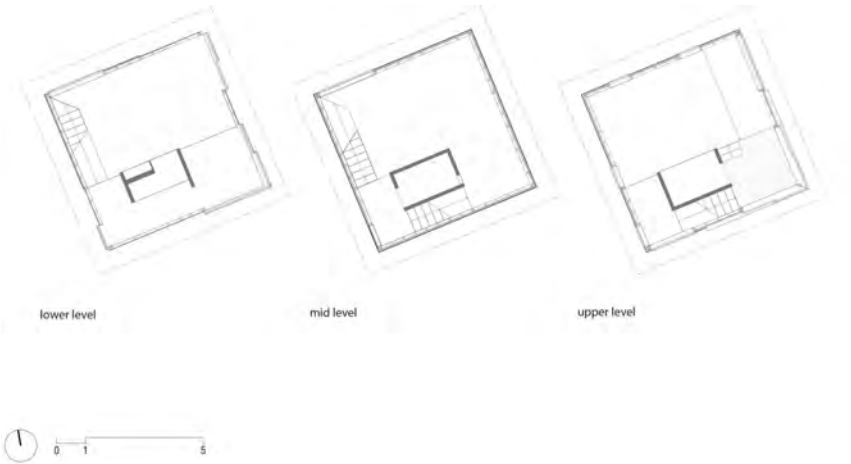

Figure 8: One Room Tower (2016–18), Plans.

All service runs pass through the core and all wet area elements (sinks and other amenities) are housed within it or directly attached (see Figure 9). In potential variations of the One Room Tower, this configuration can be altered either by vertical extension or by the re-positioning of the core relative to a surrounding frame or envelope. As a device for relating the experience of occupants to the surrounding context, the envelope facilitates the twin narratives of exterior and interior, overlapping them in the choreography of openings which introduces the landscape and cityscape into the room.

House Preservation

The strategy of the detached addition is an effective means to preserve existing character houses in situ, whose potential is still to be fully recognised by both authorities and community. Surrounded by extension projects recently carried out or in progress that have adopted either the “building underneath the house” or “adding an extension” strategy, One Room Tower aims to provide an alternative model to insert the “contemporary” into the pre-existing urban condition. It does so in a way which is, at the same time, enlivening and respectful – a demonstration of how the making of greater density can play an integral role in reinforcing the historical character of the original urban fabric (see Figure 10).

Suspended in conversation with the urban dimension of the Estate and the character of the existing house, the One Room Tower asserts its autonomy by offering a genuine design opportunity for the contemporary interpretation of the context and its occupation. In order to carry out this objective, the tower has been designed as a typological recoding of the traditional Queenslander, with which it establishes a considerate dialogue. The vernacular character of the worker’s cottage is thus re-formulated at a formal, linguistic and technological level. Yet, the overall result is out of the ordinary.

The elevation of the tower responds to the prevalent local typology by the making of a contemporary architecture which nonetheless displays familial characteristics. Whilst the tower still maintains the essential “tripartite” constitution of hipped roof, timber framed bodice and understorey, albeit a translucent floating one, its continuous vertical spatial ordering is in stark contrast to the horizontal planar raft of the existing Queenslander typology. By positively accepting and fully exploiting the latest height limits established for inner-city areas by the Brisbane City Council, One Room Tower introduces a new understanding of the vertical dimension in domestic living spaces of Brisbane.

Figure 9: One Room Tower (2016–18), Core and Frame. © Christopher Frederick Jones.

Figure 10: One Room Tower (2016–18), Street Elevation. © Christopher Frederick Jones.

For the tower, a traditional vocabulary within a new syntax has been considered. The bastard gable, off-centre on the street façade, and its conventional folds gain a new sense while sitting on the unusually vertical volume of the tower. The same applies to the cladding: with the twisted position of the volume combined with the arhythmical arrangement of the upper openings, the uneven run of the unpainted cedar weatherboards provides a new wall texture.

At a technical level, the raw tectonics of the Queensland vernacular enter the dynamic of the project allowing exploration of the spatial ideas of “core” and “peripheral frame”. The exposed Laminated Veneer Lumber (LVL) are here used as exposed studs and joists and refer to the traditional Queenslander construction technology. The panelling of Oriented Strand Boards (OSB) is left as an exposed finish too, providing a vibrant texture in contraposition to the smoothness of the studs.

One Room Tower as an urban prototype

The strategy of infill within micro-contexts for greater density through miniature tall structures is flourishing in Asian Pacific cities, with the Imai House (2014) by Katsutoshi Sasaki + Associates, Okazaki and the Double Helix House (2015) by Onishimaki + Hyakudayuki Architects in Tokyo being prominent examples. In the book *Designing High-Density Cities: For Social and Environmental Sustainability* edited by Edward Ng, Chye Kiang Heng and Lai Choo Malone Lee talk about the concept of "inward densification",[11] describing the way in which cities are now developing within their boundaries. Their argument is that "buildings and places become repositories of successive interventions [such that…] a true complexity and a meaningful variety may arise from the gradual accumulation of elements."[12] This is an important lesson on urban growth for Australia, where suburban sprawl and tabula rasa have been the main models for urban densification.

One Room Tower brings into practice through a built work a method to valorise the micro-context, ready for consideration by the community, government and construction industry. In social terms, One Room Tower is a living experiment and has the ambition to become a structure able to accommodate different future scenarios within a rapidly changing inner city location. At the broadest level, One Room Tower adds to the professional effort to develop Australian cities through layering – and give consideration to contemporary interventions that could meaningfully add to the story of inner-city urbanisation.

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ADR18

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Chaired by Dr Dagmar Reinhardt

Research Recreation

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Abstract

My PhD research, '*Catseye Bay* design techniques' explores the *how*, rather than the *what* of a practice. My research is producing questions, such as: How does this practice know what to do? And, as the doing of a practice is its way of thinking, how does this practice think?

Research to date has highlighted that critical to *Catseye Bay's* practice is a way of working that immerses in experience to generate design techniques.

Experience provides dynamic and emergent conditions in which to experiment. As a 'way of doing' that is not ordered or oriented in advance, techniques open up a way to think method differently in my research, enabling a creative process to emerge.

My creative practice research has highlighted that these techniques are enabling the production of a generative relationship between how I am practicing and what I am immersed in. I would like to use this paper as an opportunity to experiment with describing what I am practicing in as a holiday. Whilst on a recent holiday, I noticed how recreation was enabling my practice to think in a distinct way. The title of this paper poses the ideas that recreation enables something in research.

Research recreation highlights something particular about how a practice produces knowledge, emphasising research as a creative process and knowledge as a production. As distinct from approaches to research that privilege processes of identification as the basis of knowledge, research recreation opens up to a different sense of knowledge. The intent of developing this paper is to pause and reflect on the design techniques that my practice generated whilst on holidays and to ask what is recreation enabling and producing in my PhD research and what might it offer design research more broadly?

Introduction

As a way to start developing this paper, I opened iPhoto and flicked through photo streams from January 2017 and January 2018, when, in the height of summer, I had taken leave from my design practice and PhD research to surf the east coast of Australia.

The practice that I assumed I had left is called *Catseye Bay*. *Catseye Bay* is an emerging commercial design practice based in Sydney, Australia. Since opening in 2015, *Catseye Bay* has designed things; soft joints, unstable tables and a modular storage system that finds angles of repose; and interior designs that use furniture and light to make room and a range of off the shelf exhibition systems. These projects have been published in professional industry magazines and featured on international design websites.

My PhD research is called '*Catseye Bay* design techniques'. As distinct from a PhD on or about a practice, my PhD is positioned as a project in *Catseye Bay*, as a young practice creates a dynamic space in which to explore and experiment. My creative practice research focuses on the *how* rather than the *what* of a practice. Key research questions include, how does this practice know what to do? And, as the doing of a practice is its way of thinking, how does this practice think?

Research to date has highlighted that critical to *Catseye Bay's* practice is a way of working that immerses in experience to generate design techniques.

As distinct from methods that orient and order doing in advance, techniques are engaged and generated by the dynamic and emergent conditions in which I practice in. I would like to use this paper as an opportunity to experiment with describing what I am practicing in as a holiday. Whilst on a recent holiday, I noticed how recreation was enabling my practice to think in a distinct way. The title of this paper poses the ideas that recreation enables something to happen in research. This proposition was affirmed at my PhD in progress reviews, when multiple panellists commented that I look like I am having fun.

Research recreation highlights something particular about how a practice produces knowledge, emphasising research as a creative process and knowledge as a production. As distinct from approaches to research that privilege processes of identification as the basis of knowledge, research recreation opens up to a different sense of knowledge. The intent of developing this paper is to pause and reflect on the design techniques that my practice generated whilst on holidays and to ask, what is recreation enabling and producing in my creative practice research and what might it offer design research more broadly?

Holidays

This paper is informed by experiments I conducted while on two holidays. Both involved surfing during the month of January. A desire to surf every day (and if possible twice a day) meant that advance planning was difficult. Surf conditions are emergent, produced by the interaction of multiple forces, tide-swell-wind and the decisions of other people, I did not expect to be able to know when and where I would surf. Or what I would do, when I was not surfing. Instead of using a fixed schedule to make decisions about when and where to go, I stayed in my van.

These holidays allowed me to experiment with living differently. The question of when and where to surf was not answered according to a regulated lifestyle that predetermined that “I only surf at sunrise” or “I only go to my favourite break”. Rather, these questions became openings that enabled me to experiment with how I would respond.

I noticed that this enabled a type of thinking that was different from how my practice thinks when my time and action is regulated. Holidays allowed me to see my practice differently. I assumed that I had taken leave from my design practice and PhD research and then I realised that I had taken them on holiday too.

Recreation

In posing the notion of ‘research recreation’, I am taking up the dual definition of recreation as an ‘activity done for enjoyment when one is not working’ and ‘a process of creating something again’. I am interested to open up the value of the thinking that recreation enables in both these ways simultaneously.

In order to produce the following reflection, I flicked through photos that I had taken whilst on these holidays in January 2016 and 2017 and selected images that pointed to an activity of thinking that could not be contained within the photograph's frame. Some images were selected as a key frame from a set of photographs that sought to record what was happening from different angles and moments in time. Other photographs were one-offs. The fact that I took these photographs back then at that time indicates to me now an awareness of the value of these recreation actions and activities in relation to practice and research.

I use the selected images to write about the activity that was happening. Referring to the images jolted my memories of being immersed in different processes. I then reflected on each written description, asking how and what each activity had enabled in my creative practice research. I then arranged the descriptions into three groups of design techniques. These are titled with words that have been offered up by my practices of surfing, designing, thinking.

Reflection on Design Techniques

Entering

Little Cove. Reading on the beach. The dry sand became wet. Seeking higher ground, I scampered up a rocky face, trying to find some feature which could hold my body and things. A shelf-like ridge, for my towel. A slim crevice, I twisted my t-shirt to make a cotton ball and wedged it in to hold my t-shirt. Like the small of a back, the small of a rock held the sunscreen, like this, like this and what about this?

Figure 1: Entering at Little Cove, Queensland (2017).

In this example, the rising tide functioned as a dynamic force transforming the beach I was sitting on into a beach for swimming in and causing the rock face to be produced in relation to my scampering body, wedged t-shirt, hung towel, held sunscreen. The surprise of this situation disabled assumptions of what I would do. I entered a process that was not trying to solve or resolve what could be framed as a problem. I became immersed and played in this dynamic relation. This process highlighted how I experimented with the sunscreen to try out different relations between bottle and rock. This was a way to work in multiple directions, as distinct from settling on a single resolution.

I was at The Farm. A National Surfing Reserve. We needed a table to prepare lunch. The base of my surfboard became something like a table. Its curve caused the avocados and lemons to roll down its slippery surface, I playfully directed them to rest on the fins, making a kind of blade that holds or a vertical shelf.

Figure 2: Entering at Killalea State Park, New South Wales (2017).

In this example, as designer I was immersed in the situation and responding to a need that emerged in this dynamic. I worked with forces that the situation made available. It was my interaction with the arcing of the surfboard, the rolling of the avocados and lemons and the holding of the fins that produced something like a table on which to prepare a salad. The type of thinking that this technique enabled is different from approaches to design that operate in a more theoretical or abstract mode. Designing a table, for example, may involve processes of identification (of need, of use), definition (size, ergonomic proportions) in advance of doing. In describing the surfboard as something like a table, it evades the force of representation and enables the design itself to remain in process.

Entering in surfing and designing, refers to techniques for getting into a wave and becoming immersed in a dynamic unfolding, in which it is not possible to know what you are going to do in advance.

Quivering

Mystery Bay. A campsite. Pretty much half way between Sydney and Melbourne, where friends from each city were meeting on New Year's Day. Melbourne arrived first. As Sydney drove in to the woodland, Melbourne was lying on a log reading a book at the entrance to the National Park. He said that he had been there all day, had no phone reception and was worried we wouldn't find each other. He gave us directions to the site which he had tried to save. As we drove along the dirt track there were trees, trees, trees, and then surfboard, camping mat, jacket, sleeping bag, drinking water, Ikea bag, a car arranged around what looked like the charcoal from last night's campfire.

Figure 3: Quivering at Mystery Bay, New South Wales (2016).

The arrangement of things functioned as an attempt to keep a clearing in the bush open. Like a mechanism to keep an elastic band stretched, this action exhibited an awareness that the opening could snap closed and be filled with other people and their things at any time. This awareness of a kind of dynamic instability was operative; it enabled a kind of thinking and doing that did not try to make sense but rather entertained a kind of non-sense in design. Hesitant and funny. This thinking could be described as inefficient and demanding ways of working that ranged close to not working at all.

Seven Mile Beach. The carpark. Active and buzzing. We reversed the van, right into a thick bush. Climbing into the back, propping the rear doors open. Like blinkers that blocked out activity and people and brought in the bucolic, the bush. Nowhere to be, nothing to do, no parking meter to count and cost time. We relaxed into this space that we, the van, the bush had produced. The volume of the van muffled the sound of the parking cars, until an ice cream van sang like a bird.

Figure 4: Quivering at Seven Mile Beach New South Wales (2016).

Writing this description enabled reflection on how driving on a road encourages a fast and directive movement while this experiment with parking a van offered up an encounter with what happens when we open up to other ways of moving, pausing and negotiating how we think and do. My movement in this process was relaxed as I found a way of hanging out in the situation. Here, the colloquial phrase ‘to hang’, short for ‘hang out’, which in the context of social relations, refers to a meeting that is less serious than getting together or dating. It enables the potential of spending time and casually exploring something whilst remaining open to the fact that it may or may not become more.

Quivering in surfing and designing, refers to techniques for making moves in unfolding processes that are partial, incomplete and moving in multiple directions.

Floating

Crescent Head. The camembert, softened by the warm air. Oozed onto the plate. The cheese yellow matched the lemon yellow, highlighting the hand- painted motif. Hand-painted. Cheese-painted. Almost like a third lemon - the base of the cheese aligned to and pivoted off the painted pair.

Figure 5: Floating at Crescent Head, New South Wales (2017).

I was drinking a negroni, and I placed my glass to rest on top of my book. It was Winter by Ali Smith. I noticed its relation to the exact colour on the background of the label on the sunscreen bottle. The red in the watercolour illustration on the cover of my book joined in the relations, making it possible to sense a kind of resonance between things.

Figure 6: Floating at Bryon Bay, New South Wales (2017).

It is more difficult to describe these experiences in which I allowed myself to be engaged in something and to do nothing. The Negroni, the sunscreen, the book, the cheese, the paint. Resonated and shimmered. Piqued my interest and I enjoyed it. At the time I did not seek to understand, identify or orient; however, as suggested by their inclusion in this paper, I have selected these things as points of interest by taking these photographs. They were potent in an affective way.

Floating in surfing and designing, refers to techniques for maintaining a kind of buoyancy in experience, by being sensitive to things that happen.

Research

The intent in writing this paper is to pause and reflect on the design techniques that my practice generated whilst on holidays and to ask, what is recreation enabling and producing in my creative practice research? Erin Manning's text, *Against Method* has become useful in extending my ideas around research recreation and to open up what recreation might offer design research more broadly.[1]

In the first paragraph of *Against Method,* Erin Manning discusses 'research-creation', the Canadian term for creative practice research. Manning goes on to question the value of method to/in research recreation and critiques how academic institutions have been a force of regulation in the creative practices. Thinking 'method' as a form of regulation, 'to make an action or process regular', draws in external forces of management and control, assumption and expectation. Manning proposes that new processes in 'research-creation' can only be produced if process is not regulated from outside its own evolution. Method can have a limiting effect, constraining the movement of creative process by fitting it into a pre-existing structure.

In reflection, it would not have been possible for me to regulate the action or process, that is, the thinking through doing that recreation enabled. I did not know that research was going to happen whilst I was on holidays.

Recreation has fostered a sense of 'how to act' in my practice, inviting a sensitive engagement and open participation with forces. An example of this is how *Entering* in surfing and designing, refers to techniques for getting into a wave and becoming immersed in a dynamic unfolding, in which it is not possible to know what you are going to do in advance.

In a recent PhD progress review, I shared that how I was explaining my research process had shifted from "this is how I did it" to "this is how it happened". The emphasis on the happening of research draws attention to how recreation may open up a way to think method differently, enabling a creative process to emerge.

Recreation enabled my practice to experiment with moving in ways that were different as design techniques were generated and engaged by the specificity of the dynamic and emergent conditions that I was in. In my creative practice research, techniques are enabling the production of a generative relation between how I am practicing and what I am immersed in. Techniques open research up to uncertainty and the potential of seeing what happens when someone or something is doing.

Recreation created new ways for my practice to engage in experience, enabling my practice to generate design techniques that may not have been otherwise able to develop in aspects of my commercial practice, when my time and action is regulated by briefs and outcomes, schedules and deadlines. By contrast, research recreation can be inefficient and demanding, hesitant and funny; it’s a way of casually exploring and spending time.

The processes of research recreation cannot be framed by a question or a problem or oriented to an aim as this preorganises what might happen according to predefined expectations, i.e. what is already known, as distinct from going on holiday. Looking back on my holidays and the photographs I took, I see this enabled me to experiment with how my practice could think differently.

In developing this paper, my intention is to open up ideas of research and explore what was emerging through my PhD by looking at photographs I had taken while on recreation. As the doing of a practice is its way of thinking, recreation enabled my practice to produce a kind of knowledge in the making. The knowledge that my practice produces is in process.

‘Research-creation’ and research recreation share a common inflection, which highlights something particular about how a practice produces knowledge, emphasising knowledge as a creative process and a production. As distinct from approaches to research that are based on processes and principles of identification as the basis of knowledge, research recreation opens up to an outside of change and movement where there is a different sense of knowledge. The conjunction of research and recreation opens research up to experimentation by enabling the creative potential of practice to invent new ways of thinking and doing – through recreation and through re-creation as a creative act, time and time again.

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Finding Byaduk: thinking objects as prototypes of affective telepresence with digital data

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Abstract

The Finding Byaduk creative residency is an experimental project, aimed at exploring speculations around the phenomenology of digital data representations of a landscape, and the design of interfaces and embodied expressions. Part of this process also adapts ethnographic methodologies in articulating and capturing visual descriptions of the site. The creative brief is developed as a thought experiment[1] with 'affective telepresence' – finding means to remotely convey the qualities of a place using environmental sensors and exploring poetic roles that digital connected technologies might play through the design of embodied expressions and/or interactions. The final unpacking of an exemplar artefact serves to document the phenomenological nuances and development journey of this project, and in so doing, contribute discourse towards speculative design practices and interrelated methodologies in creative practice.

The following themes scaffold the thinking and development of the project: critical and speculative design, data telepresence, and the design of ambient interactions. This paper will present the project's journey through these lenses.

Introduction

Critical and speculative design practice are modes of creative approaches that seek to engender a pluralism in design discourse.[1] Attempts have been made to delineate differences between the two, as with the positing of a third approach – associative design – to juxtapose the different motivations, narratives and outcomes of each category.[2] The salient point within these sub-fields of what is collectively known as critical design is the agency of engagement and the poetics of participation, indirect or otherwise, as integral to the design's intentions. The rousing of the individual's awareness as necessary, experiential entanglements speaks to the nature of speculative design practice: it invites a degree of questioning on the part of the interactant as to the work's cultural, social, and/or political critique. From a phenomenological standpoint, there are linkages to Umberto Eco's articulation of 'openness' in creative work: to recognise the power of delicately balancing "the merest order within the maximum order", and to have the observer draw out interpretations of the work. Similar notions of openness have also been articulated in other fields.[3] In distributed computing, boundary objects describe a theoretical concept of artificially intelligent agents possessing adaptable plasticity.[4] In addition, Gaver et al. posits the consideration of ambiguity in design to evoke "subjective experiences and attitudes onto new situations", thus inviting discourse through such designs.[5]

These concerns and concepts, set against the current backdrop of pervasive, digitally connected domestic devices generally known as the Internet of Things (IoT), present new possibilities: can such modes of creative practice provide timely re-figurings to explore new ways to design with connected, ubiquitous digital technologies?

An opening brief was thus set: using appropriate technology, publish a digitised data feed of a measurable quality of Byaduk. Design and prototype engagements with this data to elicit poetic responses to the place. Consider where these designed objects will inhabit. In a concluding phase, let them live in people's homes as domestic objects, interview the inhabitants to find out how they have embedded themselves into the participants' lives (note: this paper will also not discuss the concluding phase, as it is yet to be conducted).

It is important to note that while there might arguably be a perceived ambiguity or reluctance to situate this project either as a work of 'art' or 'design', this is in contrast a conscious decision to position the project outcome as 'anti-disciplinary', focusing on the documentation of the creative practice research journey, and contribute to the discourse and experimentation in critical design studies, particular towards the vernacular of digital data and our interactions with it.

Observations

The following is an ethnographic account of my encounter with the township of Byaduk, through photography and writing completed during my residency. The aim was to record a phenomenology of the place through the perspective of a visitor – myself. Three separate long weekends were spent during the spring of 2017 and late summer of 2018. The observations were recorded mostly through the result of walking around the town.

Byaduk is a small township, an hour's drive south of Hamilton. The Australian Bureau of Statistics 2016 Census reveals a population of 123.[6] As with most towns in the Western District of Victoria, Australia, the main street – the Hamilton-Port Fairy Road – is a well-used roadway for locals traversing between Hamilton, Port Fairy, and Warnambool. A regional bus stop fronts the local general store. Perhaps as a clever attempt at dry humour, the store sells wooden carvings of ducks.

Figure 1: The old Byaduk church (right) and hall (left), off the Hamilton-Port Fairy Road.

The residency took place in the heart of the township, at the old Byaduk church and hall (see Figure 1), a place now converted to an artist space. Possums scampered on the roof at night. The sounds of magpies, crows, kookaburras and cockatoos filled the morning. Sheep grazed on an adjacent paddock. The local oval – the Byaduk Recreation Reserve – has an immaculately-maintained white picket fence with an equally pristine lawn. The wind is ever-present, heard through rustling gum trees, tin roofing, and two large palms planted on the church grounds. Mornings were bitingly cold, felt particularly along the open passageway separating the church and the hall. Occasionally, cars stop by the small recreation park and public toilet nearby. Across the main street, a resident's large front yard displays a collection of farming equipment and curios for sale. A statue of Sergeant Simon Fraser sits next to the neighbouring Mechanic's Institute.

Peppered around the township are heritage signages offering short stories of Byaduk, written by a resident who grew up there. One such sign erected next to a stone bridge spoke of the bridge builder who lived in Byaduk throughout its construction, worried that his tools might be stolen should he leave them onsite. Another sign at the now-defunct swimming pool described its activity, and of families from neighbouring towns congregating there.

In the hall building, the still, dusty interior reveal moments frozen in time (see Figures 2 and 3). Inside the church, stained glass windows spill coloured light onto the mostly empty space, the pews having been long removed, with the thin red carpet remaining, evidence of its endearing presence captured in old monochrome photographs.

Figure 2: Enlarged prints of old photographs from the 1900s adorn the dark, wooden walls of the hall.

Figure 3: A cradle roll hung on a wall, with a smaller cradle certificate (below right), carefully protected by a plastic sheet.

In this landscape, the air, light, temperature and smells of the place become foregrounded, as with tiny traces of human activity. Innocuous objects such as wire and discarded containers commanded my attention.

Figure 4: Taking a walk around the vacant plots, past crumbling lava rock walls near the old Byaduk Church.

I was led on a tour by the proprietor and curator of the old church (see Figure 4). We walked around neighbouring fields, ducking huge, prickly hawthorn bushes that sprung up around places where skips once stood (see Figure 5). We came across the footprint of a house that burnt down from an accidental fire. Further on, I was pointed to traces of circular stone formations in the ground, hinted towards a remote possibility that these remnants might be related to the engineering efforts of indigenous Australian settlements, potentially of the Gunditjmara people.[7] It was impossible to verify these speculations without expert knowledge on the spot. Subsequent research revealed the proximity of Byaduk to the surrounding Mt Eccles lava flow, or Budj Bim, as it is known to the Gunditjmara people, which perhaps justified the speculation as to the presence of indigenous history in Byaduk.[8] The walk ended with a collection of more found objects – three glass bottles (see Figure 6), a piece of burnt bark, part of a sheep's jawbone (see Figure 7), a lava rock (see Figure 8) and a decorative cast iron grille (see Figure 9).

Figure 5: Discarded bottles were found, mostly on the ground.

Figure 6: Found Object #1: Two of the three glass bottles retrieved, some with more residual dirt than the others.

Figure 7: Found Object #2: Sheep's jawbone. When found, half of it was in the dirt, possibly untouched since the animal died, which explains the slightly mossy and earth-tinged lower portion.

Figure 8: Found Object #3: Lava rock, a common geological feature found everywhere in the wider Mt Eccles region.

Figure 9: Found Object #4: Decorative cast iron grille, painted. This belonged to one of the hall's ventilation portholes on the southeast wall.

Furthering the Observations

The walks, and the experience of encountering the objects in situ, presented an ideal opportunity to conduct visual and reflexive ethnography through photography.[9] While not central to this experimental project, it is important to note the contribution the walks and photographs had in capturing the "empathetic engagements" of the found objects.[10] This in turn afforded phenomenological revisitations of the place to occur whilst working in the studio. The subsequent review through the notes and imagery of the photographs provided a sufficiently vivid means to recall the environmental conditions of Byaduk, which resulted in the decision to sense and measure environmental phenomena as part of the creative brief.

The found objects also had stories to tell. As they sat in the studio, looked at, manipulated and talked about, their material culture revealed themselves over time. For example, the embossed "HALF PINT, NO DEPOSIT NO RETURN" wording on two of the glass bottles were recognisable to those who saw it, because they were synonymous with childhood memories of bottled milk, and of the activities that unfolded around the use and re-purposing of those bottles. Casually discussing the etymology of the embossed phrase brought up personal stories, or invited speculation based on encounters with similar objects. Thus, the richness that each mundane Byaduk object possessed pivoted the project towards exploring their semiotics and material culture: these found objects are conversation pieces. A new question emerged: could conversation pieces also become conduits for ephemeral digital data? Can they couple stories of the now – the environmental effects of Byaduk – with their semiotical richness and cultural, historical connection with Byaduk? Could this approach of using found objects identify a typology in working with poetic, digitally connected things?

To test these thoughts, two activities unfolded after the walks and object collection activities. The first was to construct the environmental sensing apparatus, followed by the process in which the found objects become coupled with the sensor readings.

Sensing Byaduk – the "Listening Post"

An environmental 'listening post' was built – a bespoke sensing apparatus that collects and streams readings back to an Internet server. The setup was designed to provide a physically minimal footprint and intrusion to the surroundings. The types of sensors were chosen to capture key environmental effects (see Figure 10). Cellular network connectivity was also matched to Byaduk's network coverage. The gear was housed within a weatherproof enclosure, modified to allow exposure for the wind sensor element. The solar panel was mounted on the corner of the roof of the hall, with the sensor enclosure located below (see Figure 11).

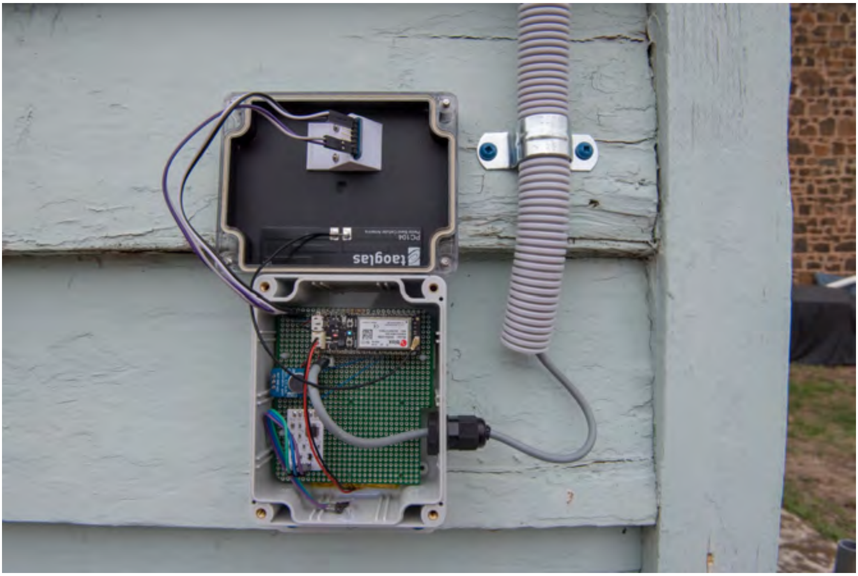

Figure 10: Inside of the sensing unit, comprising wind, sound, temperature, visible light, infrared (IR) and ultraviolet (UV) light sensors, along with a battery-powered microcontroller and solar charging circuitry.

Figure 11: Sensing unit, mounted at eye level on the northeast-facing wall of the hall building to maximise available sunlight.

Code written for the microcontroller prioritised power consumption. A 10-minute sampling rate was chosen, which balanced solar recharge rate, battery life, and the cost of wirelessly transmitting sensor payloads to an off-site server. To help address the 10-minute sampling rate gap, an interpolation algorithm was applied at the server, resulting in a steady stream of data, at the cost of introducing a 10-minute delay.

The "listening post" became operational early in the project. Besides troubleshooting, the ability to inspect the data feed also allowed time for creative reflection. The readings are accessible anywhere in the world using a desktop and mobile web interface (see Figure 12). This data was also logged to a MySQL database, providing longer-term storage and analysis options.

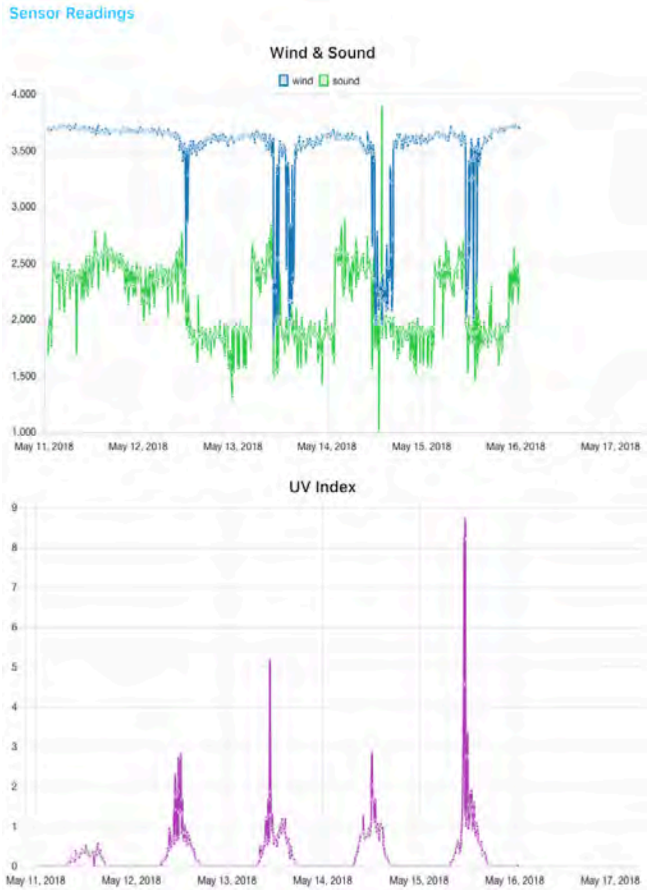

Figure 12: 7-day data plot of wind, sound and UV index of Byaduk. Light (visible, IR and UV) and temperature readings were expectedly regular, with dips in readings correlating to nightfall and overcast/rainy days. Sunny days registered a UV index between 8.5 to 10.4, closely matching the readings reported by the Australian Bureau of Meteorology.

7-day data plots of the localised sensor readings revealed readily-discernible patterns (see Figure 12). Temperature readings registered typical day/night cycles. The study of the consistency of the patterns in the data also provided a way of reading unique environmental events: during a bushfire that engulfed neighbouring Terang on 18th March 2018, the light readings recorded were significantly reduced due to the smoke-filled sky.[11] The microphone was intriguing in its irregularity, potentially picking up noises that might have been transmitted from the building's response to the climate. The technology used in the wind sensing elements struggle at night to maintain a core working temperature to accurately measure wind, skewing the night readings. Plans are set to upgrade the wind sensor.

The "listening post" connects to a customised, open-source data processing software platform, running custom code libraries developed to integrate the microcontroller platforms and data processing logic.[12] Since 2015, this composite system, coined *IoTa* (an Affect-centric Internet of Things), was put together with flexible data-centric prototyping in mind and continues to be developed and tested through other digital data-oriented creative research and teaching projects.

Telepresence and data processing is impacted by problems of representation and uncertainties – technological glitches, inaccuracies, and/or the limitations of current technology.[13] This was evidenced in the sampling rate decision and wind sensor readings. The experiment proceeded with this awareness, recognising that future iterations of the sensing apparatus will improve to be sufficiently fit for purpose, through better available technology.

With the sensors effectively 'online', the attention turned to the 'expression' and possible interactions that the data could enact.

Objects for Finding Byaduk

The 'finding' of Byaduk began as a semiotical process to locate each found object's embedded meaning(s). Like the heritage signs scattered across Byaduk, could the objects embody a narrative of the town through their materiality?

The glass bottles were selected as the first items to work with in this exercise. Caked with dirt and yellowed from the years of neglect, they were originally vessels. Poetic undertones of the glass bottles possessing a figurative ability to 'contain' captured streams of digital data emerged. A creative, speculative exploration commenced, to consider the aptness of the various data feeds: is it light quality? Sound? Wind?

It was a serendipitous discovery that led to the first result of this project. During the second stay of the residency, as I completed the installation work on the sensing units and solar panels, I have placed the bottles outside on a table. The glass bottles, in their upright position, became wind instruments as a gust arrived, resonating with soft howls just as one might hear by blowing across the top of a bottle neck. It seemed natural that wind emerged as the environmental quality to respond to these bottles, partly due to its omnipresence in the township. The poetry of the relationship between wind and glass bottle also played an important part in selecting this coupling: the futility of storing or catching wind in any vessel, against the affective experience of listening to a singing glass bottle in the wind.

The task thus proceeded towards constructing a mechanism that would allow an artificially-modulated wind source to move air around the top of the glass bottle, in a bid to recreate the wind conditions as reported by the data feeds. This first object is titled “Wind” (see Figure 13).

Figure 13: The first designed object in the Finding Byaduk project. Chuan Khoo. Wind, 2018. Plywood, brass tubing, custom electronics, computer code, found glass bottle from Byaduk.[14]

The mechanism was designed to be inconspicuous, concealed inside a plywood box and driven by an Internet-connected microcontroller. Multiple attempts were made to engineer the ideal mechanism (see Figure 14). The microcontroller instructs a stepper motor, driven by a low-noise driver, to reciprocate a brass stem in an up-down motion. A quiet 18.2dB fan motor is mounted on this stem, its noise level comparable to a person breathing. The glass bottle sits on top of the wooden box, directly underneath the fan (see Figure 15).

Figure 14: Multiple attempts were made in developing this mechanical system before arriving at the current setup – here, articulated linkages and servo motors were tested and rejected, due to excessive noise that detracted from the sonic elements of the work.[15]

Figure 15: Close-up of fan and reciprocating stem sub-assembly. The fan speed is driven by the wind data along with the rate at which the stem is reciprocated.[16]

After the server processes the readings from the "listening post", it sends the *Wind* object updated fan speeds, and reciprocating stem movement rates, which in turn control the air flow near the neck of the bottle. The reciprocations take anywhere between 5 and 20 seconds to traverse. The shifting distances and traversal speed between the fan and the bottle opening modulate the quality of sound generated – from a resonant howl to a light, gentle roar of white noise that is almost imperceptible. A miniature, sonic simulation of wind emerges, of Byaduk.

Interactions

The primary interaction with the re-purposed Wind object is that of wind data driving the device. The interactions in this case do not necessarily imply conventional human-centric engagement and manipulation through an interface that requires a high degree of constant attention and cognitive load. Fields and thinking within ubiquitous computing, namely calm technology and ambient interaction, suggest, from a design and human-computer interaction (HCI) perspective, the necessity to stratify and prioritise layers of information presentation based upon intelligently-determined situations, and a nominal 'user' at the centre of this concept.[17] This project is, in essence, an attempt to revisit these conversations, and to approach this through ambiently interactive, semiotic interfaces, temporarily removing the ostensibly problematic term 'user' for the purpose of engendering open explorations on what it means to represent and embody data from a distance.

In some ways, the outcomes of Wind – an ambiguous expresser of wind conditions in Byaduk, is not unlike the work of Gaver et al. in relation to "threshold devices" and ludic engagement, which espouse a methodology that foreground modes of interaction design "motivated by curiosity, exploration and reflection", and, importantly, poetry.[18] What the Finding Byaduk project further seeks is to refine a platform to explore these typologies of interaction design, and specifically focus on the exploration of poetics, uncovering semiotical language that could buttress the impact of sensory and data telepresence. The subtext to this experiment, which is not covered in the project but worth mentioning for future exploration, is also in context to the state of the art today, a decade after the "threshold devices" were conceptualised. With the onset of increasingly accessible machine learning approaches in computing, and the agency these algorithms possess, much more avenues to bridge poetic interactions with digital data will be possible.

Reflections & summary

The Finding Byaduk project continues, with the aim to work on the remaining found objects to produce more poetic embodiments of digital data expressed through them. At this stage of the project, here are the summary points to posit:

- The combination of the walks, the experience of encountering and collecting objects in situ, and seeking ways to sense the landscape provided an opportunity to conduct visceral and a pervasive, digitally-augmented sensorial ethnography as a means to help gain insights and allow revisitations of a place
- The re-purposing of the found objects act as an integral part of this creative experiment. The objects are essentially 'thinking objects' – fully-realised thought experiments that are interacted, interrogated

with, coexisted and experienced to generate greater empathy for the data they are representing

- The designed 'thinking objects' could also possibly become reflective tools in design ethnography – could they be offered as an 'inversion' of a cultural probe, embedding such devices in the communities to engender slower, deeper opportunities in ethnographic research?
- The project offers some initial insight into developing a creative practice that encourages reflexive modes of making and experimentation, that sits between common themes of openness and interpretation through ethnographic methods, critical and speculative design practice, and the phenomenological theories of affordances and signifiers.[19] In particular, these fields recognise tensions and opportunities in describing and representing phenomenological encounters as parameters for discourse, and not purely as transcribed documentation of experience.
- This brings about questions in considering the making of such speculative art-design objects as a way to augment existing design research and design ethnography methods. Where and when can these 'thinking objects' exist in the design process, and how should they be considered and worked into the larger body of creative research practice?

In summary, through the experimentation and reflection of the different phases, the project has shaped itself to become an investigation into the poetics of digital data representation. As we head past the epoch of pervasively connected, functional data-processing devices, can we begin to view the IoT landscape as a new territory to mediate and nurture poetry through such digitally-augmented objects?

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14 Figure 13. The first designed object: *Finding Byaduk: Wind.* Photograph: Chuan Khoo.

15 Figure 14. Multiple attempts in developing the mechanism. Photograph: Chuan Khoo.

16 Figure 15. Close-up of fan and reciprocating stem sub-assembly. Photograph: Chuan Khoo.

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#digitaldisobediences….but Architecture [gardens of earthly delights]

Co-signed manifesto. Curated by new-territories and Presented by Dr Lian Loke

Biennale of Venice 2018 / Bembo Pavilion

> In power games, [apparatuses could be considered] relationship strategies supporting types of knowledge and supported by themselves."
>
> Michel Foucault, 1994, Dits et Ecrits

We can't remain satisfied with protest. This historically operative way to challenge the organization of power is now naïve, childish, self-complacent and unproductive.

Should we suspect that digital "art" is meant to be used as a glamorous lure, a blue sleeping pill, to entertain those who produce it, just as turpentine intoxicates the painter, and, for its consumers, to help maintain their belief in the illusion of positivism, progress, emancipation through science and novelty gadgets… Trapped in a post-science world without even knowing it, one already described by Rabelais in the middle of the Quattrocento…

Should we suspect the apparent direct opposites of these Mephistopheleses, the regressive moralists and semiologists who turn their indignation into capital to recoup their 30 pieces of silver, using correct consciousness as a flagship, commoners and common goods as their willing victims, promoting "bottom-up" processes on the condition that they be the masters of ceremony… in their Prada suits… the intellectuals denounced by Chomsky who safeguard the system, its means, meaning and authority,… but nevertheless claim, by virtue of their indignation, the magnificence of their position… of their forgery…

Should we reveal that these two paradigms are simply the Janus faces of the same system… in a symmetrical convergence of interests and benefits? Could we develop a paradigm other than the interplay between the cynic and the clown?

Should we denounce our academic standing as a wasp-like trialophile position of expertise, operating and reproducing the new disciplinary vogue for our daily three obols, the standard rate for courtesans and heliasts at the time of Cleon? Are we trapped in false debates between hereditary abstractions and social formalism, or even, the counterpart of all this, trapped in the empty speeches of gala socialism? Has the empathic penitence of our silence rendered null and void the articulation of our experimentation? Should we denounce the Melian nymphs' pride and foolishness and subject them to their weak suffering? Should we suspect that, in the amnesty's aftermath, we will have to pay the fine in exile, drink the conium, or even accept being forgotten in our escapist digital swan song?

How to embody the performative polymorphism and inheritance of our techno-social economies and language, to vectoralize the fiction of identity egotism towards new sortitions of assemblies, at a time when the similitude of appearances is dismissed as "filer à l'anglaise"? at a time of Computationalism, when space is quantized with subjectivities? Should we suspect that our own graft is, in fact, the suspect, suggest another game, one we could lose… "Try to remember. It was in the gardens at Marienbad.…"

These rules of predictable “ANCIENT REGIM” world, in the sense of the division of labor, delegation of power and concentration of data bases, needs to mask their powerlessness, their impotency, through this managerial debate, fake conflict and disputatious storytelling / the computer geek vs. the political clown… defining niches and territories from where they could operate, both of them spreading ‘’the traditional and compliant speech of the masters.’’

We are in the midst of a paradigm shift, to quote Thomas Kuhn, between two inherently incommensurable systems. The old system that uses technology to reproduce and perpetuate top-down processes (which they falsely claim to oppose)…. and a new system that needs to discover its potential, its limits, constraints, intrinsic logic… to re-negotiate the scenario of thinking and doing… “””but””” architecture… the means and the meaning, rearticulating “le vivre ensemble” and the “common good”… for protocols more disruptive than linear, more heuristic than deterministic, more anthropo-technological (Sloterdijk) than purely dedicated to accuracy, performativity, expertise, now analyzed as one symptom of the copy-based syndrome…

Digital Disobedience can be described as an alternative frame of thinking about the application of novel tools in our contemporary discourse. Architecture as a discipline is on the verge of a decisive moment: automation and artificial intelligence will bring more change to the entire practice than even the revolutionary introduction of computational tools did in the last quarter of a century. This brings along an entire set of questions, which Digital Disobedience attempts to ask. The answer is not the main issue here, rather the set of opportunities presented in the critical interrogation of our current, and future relationships to novel ecologies emerging in society, economy and technology. How will we, as architects, respond to this rapidly progressing change? Is being docile, in expectance of the best a sufficient position to maintain? The collective of architects on display here refuse to be usurped by a neoliberalist position on computational design and architecture and rather support an idea that fosters a speculative approach to the future. A position that embraces change triggered by technological progress in the methods of materializing architectural entities. A future in which robots and human form novel modes of machines infused with aspects of morality and inquisitive intelligence. A post-capitalist future that embraces the radical change in our social texture triggered by the possibilities of a world governed by deterritorialized entities in which we expand, repurpose or accelerate aspect of our culture and technology for the benefit of our world at large.

How is one to digitally disobey? Would the ultimate disobedience be to automate design, to automate intuition? While the profession would decry the idea of automating intuition anathema, to a laymans eye such intuition has already been automated. Turing-complete neural networks are able to intuitively (a justifiable term as even their programmers do not fully understand the logic of their working) synthesise everything from Monet to Shakespeare, creative works that would be impossible to describe with conventional programming. To a philistine, Van Gogh might appear to have been automated. ArchFakely proves poor architectural writing has been automated in a literary project that has no aspiration to be read, as no-one reads the text of the data-set on which it is modelled anyway. As cultural content is generated faster than we could ever consume it, and content that does make it to an audience is consumed instantly, do we really find pause to absorb its meaning? Is digital disobedience this acceleration? The the skimming of latent-space in order to shift from “computational design” to the “computational derive” through a snowcrash of endless difference? Have machines already learned to model the tastes and desires that might guide this meander? Is digital disobedience a reluctance to be spoonfed? A resistance to the state of the art? After forgetting how to code and critically engage with the machines that generate their visual culture, will architects forget their own canon? Will fake histories emerge, channeling popularly held belief and melting what was once thought to be immutable historical fact into a toxifying generative adversarial goo?

This is a shift from imposing our will/intention on, or within, the systems of computation, to embracing the dissolution of the binary distinction of the intuitive and systemic. While computational design seeks to embed intuition into the self-organizing algorithms of complexity theory, this is being superseded by the emergence of a computational intuition – ‘what kind of subjectivity the heuristic bits dreams ?’ Rather than computational architecture’s attempt to shift from invention to pseudo-orchestration, this shift/glitch questions the subjective/objective division established between architect its technological matrix. Is this a symptom of a wider blurring of digital/material, robot/human, emergence/intuition, process/artefact, where these participants all interact on the same plane, rather than considering the robot as either the slave of savior, or vice versa?

‘’Libidinal Economy’’ of J.f. Lyotard as well as ‘’Capitalism and Schizophrenia’’ of Deleuze-Guattari, as the ‘’#ACCELERATE MANIFESTO for an Accelerationist Politics’’ of Alex Williams and Nick Srnicek, as well as ‘the specter is still roaming around’, one of the first book of Zizek, are describing the hiatus, the hypo_crisis situation of lefties, drinking red wine at the e-flux carnival, during the performative election of oval room populism… As actor of the world of today, in the zeitgeist of absurdism and cutting edges daily announcement of new gadgets, new saving energy, new electric car, new Viagra, new climate threads and ignorances, using sciences, paradoxically, as a new obscurantism…….in post-human, post-queers, post-dummies…for permanent ‘’newspeak” propaganda… what means to be an architect…in terms of apparatus, knowledge and strategies of knowledge, re-articulating fabrication within specific organization of the ‘’means of production’’ which re-question the know-how, the will and the process, in another distribution of task-power, authorship, bottom-up strategies, in term of trespassing “the true and the fake, the rigor and madness, and… the forbidden”.[1]

Did somebody say time break!

Bangkok, New-York, Melbourne, Athens, Stuttgart, March 2018

Francois Roche (New-Territories), Ezio Blasetti - Danielle Willems (MÆTA DESIGN), Matias Del Campo - Sandra Manninger (SPAN), Roland Snooks . Benoit Durandin . Stephan Henrich . Gwyll Jahn (ide.ai)…

Few words /

-Socio Parade Moralism Vs Workerism

-Oedipal Haptic Vs Blind Machines

-Symbiosis Vs AutoPoesis

-Heuristic Vs Linear

-Disobedience Vs Compliance

-Artifact Vs Determinism

-Disruptive Vs Causal

-Psychotic Vs Compliance

-Singularities Vs ‘’deja vu’

-'Pataphysic Vs AI

-Anomalies Vs By-product

-Necrosis Vs Permanence

-Ecosophy Vs Ecology

-Artifacts Vs Expertise

-Paradigms Vs Paradigms

-Paranoia Critic Vs Voluntary Servitude

-Profane Vs Institutional

-Gafa Big Data Vs Democratic Social Contract

-Digital_Analogue Vs Digital_ Fetishism

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ADR18

Responding to Context

Chaired by Dr Duncan W. Maxwell

Neptune's Fishbowl: Australia's First Post-Modern Building?

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Abstract

Robin Boyd's Neptune's Fishbowl in South Yarra (1970) was his last building. At the time it attracted thunderous criticism, based on public and professional misunderstanding by those who thought Australia's major critic of 'Featurism' in architecture, and a devout Modernist, had jumped ship to design what some dubbed the nation's first Post-Modern building.

But that was not the case, and I will argue a different view of that history by placing the building and relevant architectural literature of the period in context with Boyd's design. This account is told from the point of view of that years of the design and construction of the building, dating from around 1969 to 1972. It reflects the currency of debate at the time surrounding Modernism, Post-Modernism, Boyd's Featurism and notes the rise of the Venturis in America.

In that period, there was no clear definition of a Post-Modern architecture, and the 'death' of Modernism would not be pronounced by Charles Jencks, albeit with tongue firmly located, until 1972 — but by 1972 the Fishbowl had been built, operating, and demolished.[1]

Figure 1: Neptune's Fishbowl (1972).[2]

Prologue

As we approach the 100th year of Boyd's birth in 2019,[3] there will be an increased focus on his written and constructed output and the place he holds in Australia's architectural pantheon, and this, his final building, sets a fresh benchmark from which to appreciate his inquisitive nature.

Some recent commentary regarding the building, contains incorrect assumptions which can lead to ambiguous and fallacious analysis, especially to do with an understanding of Post-Modernism, Boyd, and the Fishbowl. These issues need clarification and correction.[4]

This is a rare opportunity to obtain original evidence from the source including archived data and analysis which can be interpreted by reference to the original project files which are held in the Grounds, Romberg and Boyd Collection archives located at the State Library of Victoria. In this discussion I will refer to Neptune's Fishbowl, its registered business name, by the title we used in the Romberg and Boyd office at the time 'Fishbowl'.

It is confusing and puzzling that many commentators and historians, including architects, regard Robin Boyd as a staunch conservative Modernist who worked humbly within a rigid doctrine. He did not.

I propose a different view of that history, by placing the building and relevant architectural literature of the period in context with Boyd's design, and explaining Boyd's ability to think in advance of conventional exploration.

Declaration

This is an insider's testimony of the creation and construction of the Fishbowl during the years 1969 for design and 1970 for construction, up until Boyd's death in 1971. I worked in Boyd's small office at the time and was single-handedly in charge of the project from conception to completion during my 1970 thesis year at Melbourne University leading to registration as an architect in 1971. It was also the first free-standing building I had been responsible for in my career.[5]

Fishbowl was managed as a typical project in the Romberg and Boyd office at the time. The building design was Boyd's idea, and he delegated the concept to me as his selected project architect/assistant, to take control of the building from concept development, design progress, documentation, and project construction, including all dealings with the client—as was his normal practice.

In the time I worked under his tutelage, he took each project as a challenge to imagine and express a creative new investigative concept. Some were based on his reaction to site, others to his clients, his intuitive development of the design brief was not static, and he was not absorbed with a need to gently prod away at a given design outcome when the enjoyment of innovation and inspiration beckoned. It was not an excessive ego at work either, simply a delight in what he exerted as a creative obligation, to discover something innovative each time for each project for every client.

Boyd was also brave. In 1969, when I received those instructions for the Fishbowl from the Boss, (the name we called Boyd), I was 22 years old, in my fourth year as an undergraduate architecture student at Melbourne University, with a one-year-old child and working and studying full-time. I would sometimes attend to my fulltime university course, but for fear of losing my job, I spent most of my days working as an apprentice, where I was learning more with Romberg and Boyd than from formal academic studies.

The Clients

Boyd took on two clients of long standing for this project. He had worked on many plans with the Shelmerdine brothers—Ross and Peter—who were entrepreneurs, real estate investors and restaurateurs, and the Romberg and Boyd office files were full of their unbuilt dreams and schemes, although most did not attract a fee because Boyd did not send an invoice.

Boyd and the Shelmerdines had successfully built the Gold Door Restaurant in Collins Street, the John Batman Motor Inn overlooking Albert Park, a cliff top house for Peter at Portsea and a scheme for the Mitchelton Vineyard—among others—and at about this time I managed a renovation for Ross' daughter at their Toorak house.

For Fishbowl, another successful restaurateur, Richard Frank, who was married to Lillian, a famed Toorak hairdresser and socialite, teamed up with the younger brother, Peter Shelmerdine, to launch a local version of the nascent McDonald's (hamburger) brand, but this time for fish and chips.

Their plan was to establish an international chain of take-aways adopting Boyd's design for a huge ultramarine coloured ball (or half a ball if it was to be placed on the façade of an existing shop), so a series of alternate sites and propositions for the concept was documented. The food was to be fast, fresh, and affordable. Only the South Yarra Fishbowl was built, opening in 1970 and closed in 1972.

Design

In Boyd's office, as his assistants, we were to ensure that the design would be, 'one idea, simply carried through'. There was a standardised technique for drafting using pencil, ink pens and tracing paper, and an 'office standard' for lettering and notations on documents. It was his normal way of operating, he would invent a design proposition, usually on sheets of A4 paper using his (left) hand drawn pencil sketches, with notes in his small handwriting, which he would hand to his selected office worker with a minimum of instructions—and that person would then take control of the project.

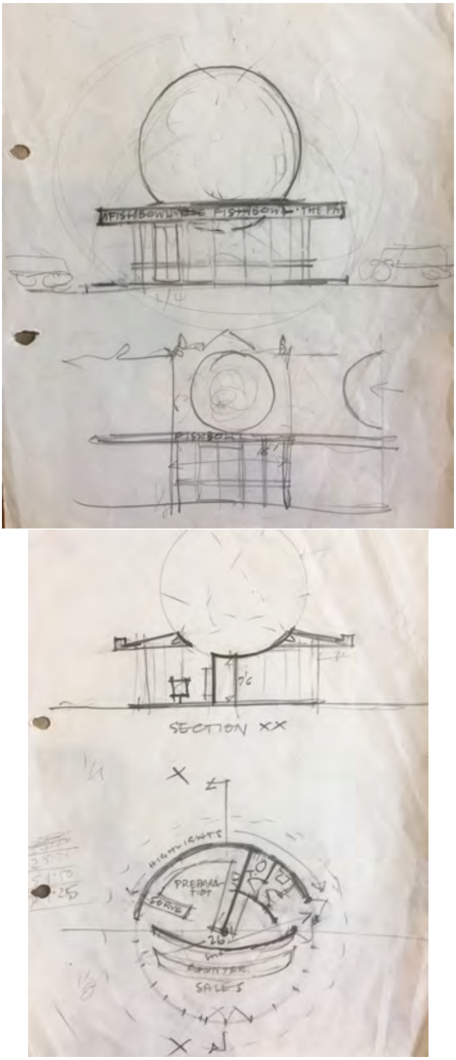

Figure 2: Robin Boyd design sketch (1969).[6]

Once a project was allocated, Boyd expected that person to organise and control its development and ensure its making, all the while keeping him aware of progress, but not demanding too much of his time. He was a busy architect.

The responsibility he thrust on his staff entailed dealing directly with the clients, developing the concepts, instructing, and coordinating consultants, developing the designs, documenting, and detailing the project (entirely), writing the specifications and producing the details, tendering the project for construction, and organising the contracts, and finally administering the contract and providing on-site control for the construction.

For the Fishbowl, it was no easy task, huge 6 metre diameter translucent balls on top of a building were not common at the time (or now), and there were no engineers available who could tackle the task to design such a structure. The steel cylindrical building base was designed by engineers Wearing-Smith and Gloury, but designing the ball was more complex.

I had researched options including a triodetic dome which is a 'space frame' concept and approximates Buckminster Fuller's, which had been tested as a roof built over a reservoir in Ipswich, Queensland. There was also a 'K' dome which was manufactured by Viking Industries, and was essentially a small 'igloo' of fibreglass which could be used for emergency shelter and temporary habitation such as for mining settlements, but neither was suited to the project.

It was a complication of the design that we wanted a fully rounded ball, not a geodesic structure, so each element (triangular as it evolved) was to be formed as part of a sphere. We did not favour a steel sub-frame, it was to be all one material, and it was to be translucent so lighting could be used at night to highlight the ball. And of course, it was required to be structurally sound, weatherproof and fire resistant.

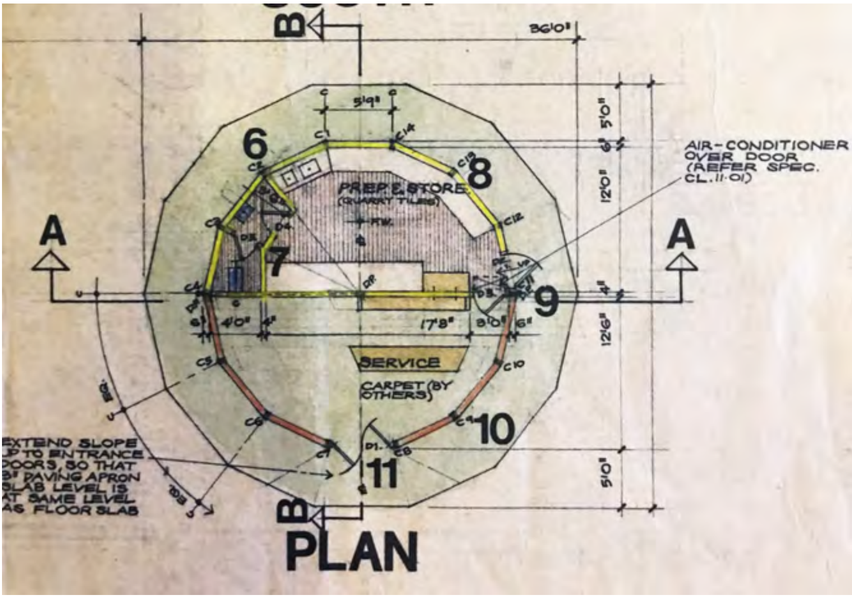

Figure 3: Neptune's Fishbowl, working drawings plan by Norman Day (1970).[7]

Construction

On 31 July 1970 the building contract was signed between the clients, (Peter Shelmerdine and Richard Frank) and the builders (Johns and Lyng Pty Ltd), and construction started on site. There was an ongoing problem to obtain a final building permit, the authority, Prahran City Council, was not satisfied that the ball was proven as structurally sound, causing Boyd to warn his clients that there may be a compromise required where the ball would become a simple structural cube!

A quotation for the supply and installation of the ball had been supplied by Trimview Polymarble and Fibreglass in July 1970, but in August 1970, we were still seeking proof of its structure, and I sought the assistance of my Melbourne University structure lecturers—Allan and Beth Coldicutt—who directed me to their colleague Dr L. Schmidt, at the University's School of Civil Engineering. He produced a design for a snub nosed dodecahedron which was produced as an image generated by the University's IBM 70-44 computer. His fee was $125.00. and the Council was satisfied.

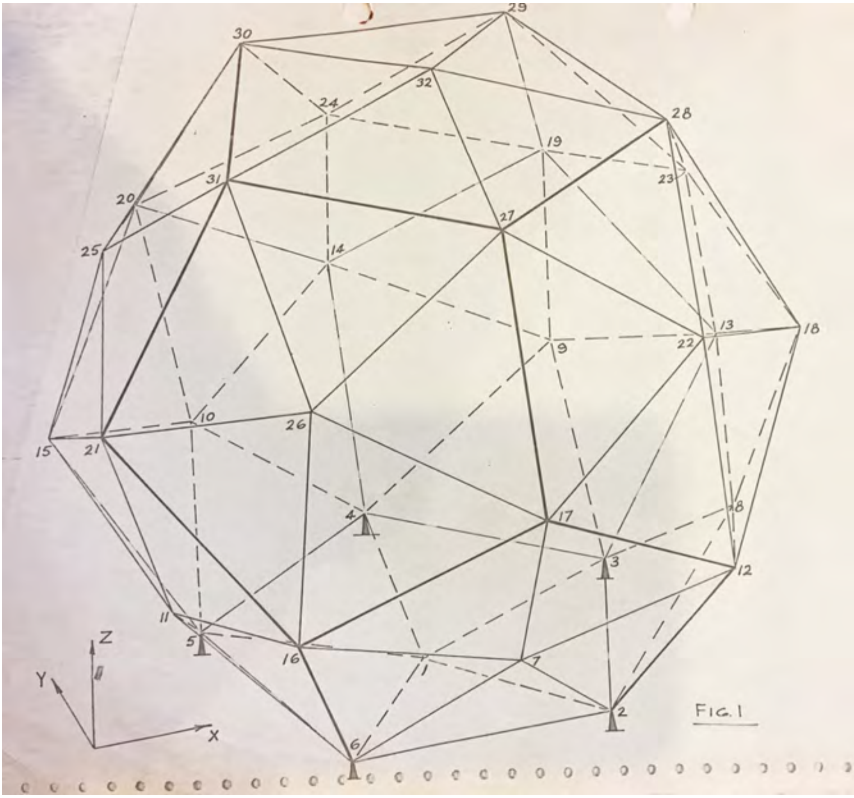

Figure 4: Drawing of Fishbowl sphere (1970), produced on an IBM 70-44 computer by Dr L. Schmidt, at the University's School of Civil Engineering, University of Melbourne.[8]

The proposal was still to be tested, the construction of fibreglass triangles with short flanges which would be bolted together and weatherproofed was risky. By trial and error, a means of construction was found, the angles for the flanges were estimated by drawing a triangular section at full scale at an outdoor carpark and I simply measured the angles so they could be drawn and then prefabricated.

Finally, in November 1970, an adventurous couple of German tradesmen, the Hiemann brothers from Bayswater North, agreed to supply and build the ball for a sum of $1,314.68 and erect it on site. They did so by pre-fabricating each fibreglass triangle in their workshop then delivering them to site for assembly. Assembly went ahead on a Sunday morning, when it was decided to place the bottom 25% of the sphere into the building frame and connect it to the location plates where it would act as a positioning cradle on which the rest of the sphere could be erected. The balance of the ball would be assembled on the carpark tarmac then craned into position and bolted onto the lower section.

I was on site to watch the work and called Boyd to invite him to witness the final assembly. He lived close by, in Walsh Street, South Yarra, and arrived soon after our call, the crane was in motion and a ¾ ball suspended above the building ready to settle into the pre-built section.

When it was lowered into position it did not fit, it had tapered under its own weight to form an ovoid shape, a misshapen egg not a sphere, and it misaligned with the lower section by more than a metre. Mr Boyd went home.

Later that day the resourceful Hiemann brothers had developed a technique to spread the upper section of the ball using scaffolding props, and it dropped correctly into position. Boyd visited again and went home not so much pleased as consoled.

Architypes

There has been speculation about the source for Boyd's design for the Fishbowl which we can consider against the evidence. Some authorities have suggested links to POP art and others to obscure buildings in Europe and elsewhere.

It was not as has been suggested,[9] a Buckminster Fuller geodesic dome, nor was it conceived as that type of structure. Others have suggested there is an exemplar from the Brussels Expo 1958, they are presumably referring to the Atomium pavilion which was the centre of that Expo and built to celebrate the coming atomic age, designed by architects André and Jean Polak. However, that 1958 building is a collection of spheres (atoms) supported on a cylindrical framework (electro-bonds), unrelated to Boyd's concept, although the cylinders do contain moving escalators which foreshadow Boyd's Expo 70 Space Tube, which was an exposed tube located below ground level, housing a moving walkway and exhibits.

Figure 5: Atomium Pavilion, Brussels Expo58, architects Andre and Jean Polak (1958).

Another commentator has suggested a connection between the Fishbowl and Venturi, Rauch and Scott Brown's 'The Big Apple', which they designed for a Times Square exhibition in New York, (1984), although I doubt there is any relationship or that the Philadelphians employed Boyd's design concept as a precursor.[10]

Figure 6: RICOH Pavilion, Expo 70 Osaka, Japan.

The most likely paradigm building, if there was one, was built by the RICOH company for the Expo 70 exposition in Osaka.

Boyd had been commissioned to design Australia's pavilion fitout for the 1970 Expo (and for the 1967 Expo in Montreal), within the framework of a strange kangaroo shaped building designed by his ex-employee and then Federal Government employee, architect James McCormack. Boyd had more than a passing interest in Japan and Japanese architecture, he had written a book on *Kenzo Tange* (published in 1962),[11] and another *New Directions in Japanese Architecture* (1968).[12]

On a number of occasions, he travelled to Osaka during the Expo project, and had seen the creation of pavilions in process, including the small RICOH camera company building which was an inflated ball atop a cylindrical building. It may have influenced his conceptual thinking for the Fishbowl, it was certainly in currency at the time he designed it.

Typology

One commentator maintains that Post-Modernism, "is evident in a wide variety of building types",[13] which is summarises as — suburban houses, entertainment facilities, roadside buildings, ships, and shopping centres. But that is not accurate.

Any building can be Post-Modern if it has been designed as such, there is no building typology that applies, rather a theoretical attitude to outcomes which is held by the designer.

At the time in the 1960s and 70s, the development of a Post-Modern culture (including for architecture) had more to do with the Western world looking back into itself after the disaster of the Vietnam War, the rise of feminism, the maturing of the generation of Baby Boomers and, in America and South Africa of course, the increased movement for racial equality. It was by that definition—a political movement. The West had lost confidence in its culture of hegemony and sought to rediscover its primal values, creative directions were focussed on local conditions rather than the universal.

It was an inward-looking movement where we suspended our view of an over-confident collective future so we could check on our own particular backyards, which meant in architecture a reassessment of heritage and modest construction whilst replacing conventional Modern values with localised principles.

Modern and Post-Modern

(These comments are made in relation to the climate of concerns in the later 1960s, as they reflect on the attitudes of that period, without adopting the benefits of hindsight from the date of writing. The intention is to represent the critical development of architectural change that occurred at an early stage when Modernity was challenged by Post-Modernity and I reference the writings of the Venturis and Jencks, because at that time, they lead the debate.)

Other commentators have difficulty with the Venturi's analysis of a shift from Modernity to something else, executed through their writings which celebrated a suburban ordinariness, and so they miss the essence of Venturi's divergence, especially when it comes to explaining the Fishbowl.

That misreading may have occurred through overlooking the Venturi's *Learning From Las Vegas* (1972),[14] and the more compelling, *Complexity and Contradiction in Architecture* (1966),[15] along with other texts including *Iconography and electronics upon a Generic Architecture: A view from the Drafting Room,*[16] or *Architecture as Signs and Systems: for a Mannerist Time.*[17]

The Venturis had built a few noticeable buildings by 1969, of which Boyd was aware, including Robert's mother's house the *Vanna Venturi,* Pennsylvania, USA (1964), and *Guild House*, Philadelphia, USA (1964), along with the *Leib House (No 9)*, New York, USA (1967) and *Fire Station Number 4*, Columbus, USA (1968). Before his death, Boyd had commissioned and edited an article written by Peter Corrigan who was then located in the USA, 'Reflections on a new North American Architecture: The Venturi's'. [18, 19]

There has been supposition too about the categorisation of the building as 'Post-Modern', which should be scrutinized and set against relevant texts of the period including those of Venturi and Scott Brown. Their treatise, *Complexity and Contradiction in Architecture*, was published in1966 and another, *Learning From Las Vegas*, in 1972, the year after Boyd died.

Just to put the sequence right, and reflecting on the state of architectural debate at the time, the term Post-Modern, at least for architecture, was yet to be utilised, and was not coined in mainstream architectural literature until 1977, by Charles Jencks in his book, *The Language of Post-Modern Architecture*.[20]

In that book, it was Charles Jencks' grandiose hypothesis, and he was demonstrably writing metaphorically, that, "Modern Architecture died in St Louis, Missouri on July 15, 1972 at 3:32 PM (or thereabouts), when the infamous Pruitt-Igoe scheme, or rather several of its slab blocks, were given the final *coup de grace* by dynamite."[21] Regardless of the polemical tone of that declaration, it was written seven years after the Fishbowl was built and the Pruitt-Igoe implosion occurred two years after the Fishbowl had been demolished.

In the late 1979s, Jencks listed thirteen conditions of architecture that from that period of analysis would constitute a Post-Modern position, starting with multivalence—which is a way of saying more is more (or better), thus denying the contradicting Miesian chant of 'Less is More'[22]—which was to disparage the simplicity of minimal Modernism. He argued architecture should be both complex and contradictory, and the past, which emphasises history, was to be embraced.

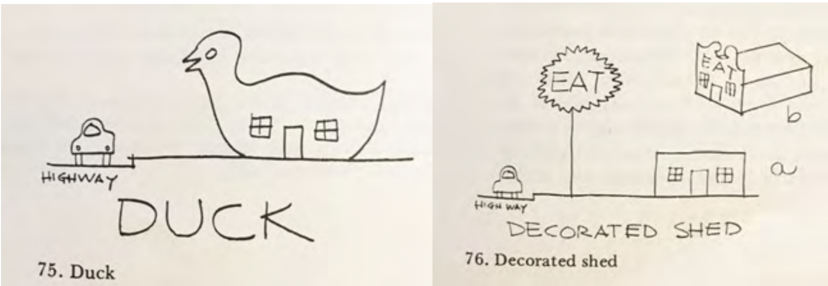

Figure 7: [75] Duck diagram and [76] Decorated Shed.[23]

Architecture, Jencks asserted in the late 1970s, should contain codes and symbolism which would enrich its expression, which is also an empowerment for populace-analysis, where the public view (unsophisticated) would hold validity with the professional. It would incorporate a pluralist expression, using traditions and eclectic concepts that were ordinary, but would also be universal due to its public positioning.

Buildings should become part of their context and belong through design but also through the process of design. Participation of stakeholders, clients, users, and the general public in the creation of architecture was a given, as was the need to prove sustainability.

Ornament, decoration, and metaphors could express basic community concerns, and it can do so with humour, provide a critical discourse, and explain the process of place making as part of its strategy.

Fishbowl was a simple idea, one idea simply carried through. It was not an historical reinterpretation nor aiming to be complex or contradictory and it was not of itself decorative, rather it was a clear concept—perhaps more in the world of POP art that abstract expressionism—but nevertheless did not fulfil much of Jencks' conditional criteria

Boyd's Writing

Boyd had written extensively about his concepts of Modernism and Featurism, he argued that the Fishbowl design was an 'ideas' concept, by which he meant—Modern—in that it did not approach Featurism nor was it what we know as Mimetic architecture, i.e. a duck.

Figure 8: Duck building, Flanders, Suffolk County, New York (1931), by Riverland duck farmer Martin Maurer.[24]

He wrote, "the Featurist can adopt one or both of two techniques: cloak and camouflage. ...Cloaking (veneering) changes the appearance of materials, and camouflage changes their apparent shapes. It … "breaks up the whole thing into a number of smaller things".[25] The designer is trying to, "find order in a confusion of functional requirements and conflicting economic demands, to blend separate parts into a whole, single unified concept".

Architecture lecturer E C Parker commented,[26] that plastics express structure, function and truth (almost a playful update on the Vitruvian 2000-year old mantra – *firmitas*, *utilitas*, and *venustas*). And McQueen has noted that Boyd, "…could have adapted these arguments to justify the huge blue fibreglass fish bowl".[27]

By contrast, Venturi had argued for the exclusion of the idea of a duck building, the simple iconic communicator, to be replaced by his symbolic semiotic decorated sheds, which Jencks would later describe as multivalent and anti-Minimalist, containing a collection of multiple values, complex, contradictory, ornamented and the opposite of Modernists creeds.

Throughout his writing, Boyd touched on ideas of adornment and elaboration, using the epithet 'Featurism' to describe them, which alludes, in literature pre-dating his death in 1971, to notions resembling Venturi's 'decorated shed'. Ironically and as if by architectural and theoretical osmosis, in his original edition of *The Australian Ugliness*,[28] Boyd drew a sketch of a huge sawtooth roofed factory located on suburban wasteland with an ornate Featurist façade for the reception/offices – his own decorated shed and published in 1960.

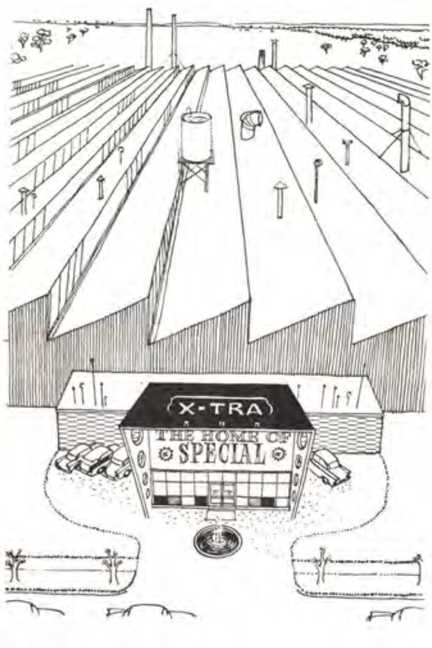

Figure 9: Robin Boyd hand sketch.[29]

One Idea

Groves argues that Boyd had, "formerly been a vehement critic of postmodern (sic) architecture",[30] which cannot be right. The term was not used in architectural writing at the time and Boyd had not referred to post-modern at all in his writing, even while he was discussing Featurism. He died in 1971 before the term was propagated, mainly by Jencks.

Boyd explained at the time that the Fishbowl is, "one idea simply carried through", and "Red Barn is not a Featurist so much as an 'idea' building".[31] In his ABC Boyer Lectures of 1967, Lecture 2, Boyd explained, "…the architect has devised some orderly shape, structure, system or theme which is suited to the nature of the building and will hold all the parts together. He has had an idea…The idea, the order which he picks, is the essential creative act of architecture".[32]

The Fishbowl concept is not one of Venturi's sheds, and thereby not Post-Modern. It may be POP art, where a commonplace object has been celebrated, and it may be POP architecture, where the light fittings of suburban fish shops is honoured. But it is not a decorated shed and, in any case, by Venturi's theory, a duck building is not Post-Modern.

Figure 10: National Fisheries Development Board building, Hyderabad, India (2012).[33]

It is closer in fact to being a 'duck' building in that it represents a single idea rather than the façade of a collection of ideas. Boyd noted (after it was built) the dome looked like those glass ball held is string baskets common to many suburban Australian fish and chip shops, a singular unifying idea.

The noted leftist historian, Humphrey McQueen, has written of the Fishbowl, "For that construction to be considered Featurist, it would have had to have been decorated with gilded seahorses".[34]

What defines this building as a continuation of Modern architecture is that it does not rely on ornament, it is interpretive of a creative hypothesis, and the idea is not literal or illustrative, but singular.

Endnote

Neptune's Fishbowl opened with a cacophonic and kaleidoscopic carnival - a mini-Moomba parade—on a steamy 24 November 1970. There were decorated teams of marching girls in the middle of Toorak road, jazz and brass bands roaring, horns and streamers, with an open truck decked out like a ship-on-wheels, which had been choreographed by Lillian Frank who was married to Richard, a partner in the venture.

On theme in the 'ship' was 'King Neptune' dressed in a cloud of sliver, white and blue chiffon, who was portrayed by the irrepressible designer Freddie Asmussen Also on board was what appeared to be a nude mermaid wearing a silver fish-tail, although the blonde tressed model Barbara Challinor modesty wore pink silicon breast pasties.[35]

Red Cross charity workers toiled in a hot and steamy marquee on site's carpark delivering each guest with a red goldfish in little plastic bag 'fishbowl' container and served champagne and seafood snacks. For their effort the Red Cross raised $700.

When he was asked about the design of the Fishbowl on that day, Boyd was quoted as saying, "Some people will hate it and some people will love it. This is better than not being noticed at all".[36] For my part, I attended with as much time I had spare and then headed to Melbourne University to delivery my final architecture thesis.

The building survived past Robin Boyd's death in 1971 but was demolished in 1972 following a breakdown between the two business partners. It was designed as a kit of parts, which could be simply dismantled and reused on another site if required. The triangular sections of the ball were removed to a winery in central Victoria, probably the Ross Shelmerdine-owned Tooborac vineyard, although he also owned the nearby Mitchelton winery (for which Boyd had designed an unbuilt set of buildings).

Fishbowl was a testament to Boyd's delight and courage, at the end of his short creative life he was dealing with financial and professional difficulties, along with complex and contradictory creative demons let loose by the Venturis. But with this project he fearlessly exposed the possibilities of his imagination with an absence of creative trepidation and within his understanding of innovative Modernity.

Most of all, the building is a narrative of a vision executed, where the curious Boyd, who was regarded as a staunch but progressive Modernist working humbly within a rigid doctrine, came to a point in his creative life where he conceived and originated an outrageously unique design for a humble fish-and-chip shop in suburban Melbourne.

References

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[1] The proposal was to call the business simply 'Fishbowl', but company registration investigations at the time showed that a small fish shop business in Queensland had already registered the trading name, and subsequently was found unwilling to relinquish it (or maybe just wanted more money to sell the rights). In any case, it was Boyd who guided the owners of this new Fishbowl to simply append 'Neptune's' to the name, and to represent the extra name by a level of subterfuge by incorporating it into the graphics of the "F" of fishbowl, meaning it was all but lost in the signage.

[2] Figure 1: Photo by Peter Wille.

[3] Born 3 January 1919 in Armadale, Melbourne. Died Melbourne 16 October 1971.

[4] See my references below to commentary included in the catalogue Goad, *Robin Boyd*, 11,124.

[5] At that time the office consisted of Robin Boyd, Fredrick Romberg in Newcastle, Berenice (Missie) Harris (who dated from the Romberg period of the 1940s), Paul Couch, Bill Williams, (both draftsmen, not graduate architects, in fact Bill had been a bricklayer), student Karl Fender, recent architecture graduate of Melbourne University) Linley Vellacott, industrial designer Les Jones working on Expo 70, architect David Maughan, students Abe Paluch, and Peter Wilson (later Bolles Wilson in Europe, who spent a Christmas period with us), along with two or three office administers including Sonja Gibbons and Gayle Redmond.

[6] Figure 2: Grounds, Romberg and Boyd Collection, Manuscripts Collection, State Library of Victoria

[7] Figure 3: Grounds, Romberg and Boyd Collection, Manuscripts Collection, State Library of Victoria.

[8] Figure 4: Grounds, Romberg and Boyd Collection, Manuscripts Collection, State Library of Victoria

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10 Goad, *Robin Boyd*, 124.

11 Robin Boyd, *Kenzo Tange*. Makers of Contemproary Architecture Series. (New York, NY: George Braziller, 1962).

12 Robin Boyd, *New Directions in Japanese Architecture.* (New York, NY: George Braziller, 1968).

13 Derham Groves, “Feng Shui: Intuition, Not Just Superstition. Architecture: Superstition, Not Just Intuition,” *Academic Journal of Feng Shui 1st Symposium*. University of Technology Sydney, Australia, (May 2017). http://ajofengshui.co.nf/wp-content/uploads/2017/05/Groves_Derham_2017_Feng_Shui_Intuition_Not_Just_Superstition_P.pdf

14 Robert Venturi, Denise Scott Brown, and Steven Izenour, *Learning from Las Vegas: The Forgotten Symbolism of Architectural Form*. (Cambridge, MA: The MIT Press, 1977).

15 Robert Venturi, *Complexity and Contradiction in Architecture*. The Museum of Modern Art Papers on Architecture. (New York, NY: Museum of Modern Art, 1966).

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18 Peter Corrigan, “Reflections on a New North American Architecture: The Venturis,” *Architecture in Australia* 61 (1), (February 1972): 55-67.

19 Boyd had been the Editor of the magazine prior to his death when the article was submitted for publication.

20 Charles Jencks, *The Language of Post-Modern Architecture*. (New York, NY: Rizzoli, 1991).

21 Jencks, *The Language of Post-Modern Architecture,* 9.

22 Elie Haddad, “Charles Jencks and the Historiography of Post-Modernism.” *The Journal of Architecture* 14, (4) (August 2009): 493–510

23 Venturi, Scott Brown and Isenour, *Learning from Las Vegas.*

24 Figure 8: Photo courtesy of Beth Savage, source: NPS

25 Robin Boyd, *The Australian Ugliness*, (Melbourne: Cheshire, 1960), 10–12.

26 EC Parker, “Practical Plastics.” *Practical Plastics*, (May 1956).

27 Humphrey McQueen, “Post War Australia - Boyd’s Featurism.” *Surplus Value*, (September 20, 2013). http://www.surplusvalue.org.au/McQueen/p_war_aus/Soc-Cu/pwar_aus_sc_boyd_featurism.htm

28 Boyd, *The Australian Ugliness*.

29 Figure 9: Boyd, *The Australian Ugliness*, 30.

30 Groves, “Feng Shui”.

31 Robin Boyd, “Letter to Martin Elks,” published in *Transition*, no. 38, (1992): 190

32 Robin Boyd, “Artificial Australia,” *The Boyer Lectures*. (Melbourne: Australian Broadcasting Commission, 1967)

33 Figure 10: AFP PHOTO/Neah SEELAM. Source: http://nfdb.gov.in/

34 McQueen, “Post War Australia - Boyd’s Featurism.”

35 Asmussen was Head of display at the Myer store in Melbourne, responsible for their famed all-year story windows (which later became annual at Christmas). He, and his coterie of ‘Freddie’s Boys’, were the declared early trailblazers of the gay scene at the time and embraced by Melbourne society especially through the patronage of Dame Merlyn Myer. Dame Merlyn was the mother of Ross Shelmerdine’s wife – Marigold.

36 Max Beattie, “Bare Breasts for a Day, and Then Just Fish.” *The Age*. (November 25, 1970).

Welcome Shelter – Procuring Design Research in the New Zealand Landscape for Tourism

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Abstract

This paper explores the research leading to, through and resulting from the design of the Longbush Ecosanctuary Welcome Shelter. The design of the architecture was the central creative component of a doctoral research project that focused on the following question: how is the relationship between architecture and landscape augmented by landscape definition and scenography in architectural design for contextual recreational tourism in New Zealand?

This paper proposes that the New Zealand landscape has been in a continual state of transformation since the collection of islands became inhabited and particularly that this process of transformation was markedly accelerated following European colonisation. The landscape as a result in New Zealand has been ‘constructed’, both in its physical form and in the imagination of its inhabitants. The architecture designed critiques the complex and contradictory relationship humans have with the environment in New Zealand and is used as a mediating device in its perception.

The lenses of landscape definition and Picturesque scenography have been instrumentalised through the design of the architecture. These lenses expand upon an existing body of knowledge collected within the previous work of the architect.

The design develops framing and programming tools drawn from the architect’s existing oeuvre to communicate this notion of a constructed landscape through the creation of visual and performative scenes. These tools are used to destabilise the hegemony of Picturesque and colonial definitions of landscape, instead offering more problematic representations and experiences of the landscape through the use of the architecture.

Through the design of the architecture, a reflective examination of the architect’s prior practice has occurred. It became clear that the tools developed and applied have grown from quietly persistent seeds in the architect’s previous work. The design of the Welcome Shelter was used to bring these preoccupations to the fore.

Figure 1: Patrick Reynolds, The Welcome Shelter, 2015, Photograph. Reynolds Licensed, 3647 Auckland NZ.

Introduction

The Longbush Ecosanctuary Welcome Shelter is an environmental education and volunteering hub designed and constructed by the author near the provincial town of Gisborne, New Zealand. The architecture is a collection of small timber enclosures clustered beneath a large steel and fabric canopy. The buildings are carefully positioned to provide protection to an outdoor classroom space that follows the topography under the large roof. The architecture stands in the last part of the ecosanctuary to start its environmental regeneration and acts both as an entrance for visitors and a rallying point for locals actively working on the restoration of the native environment. The building was designed and built by the author, using donated materials and a large volunteer team. As a result, the project was built on a zero budget and entrance to the ecosanctuary remains free of charge for all who wish to visit.

This paper does not attempt to present all parts of the project, but instead focuses on the development of landscape and scenographic themes in and alongside the architect’s practice through the design and construction of the Welcome Shelter. The project was generated with the express purpose of repositioning the architect’s practice trajectory, but also to provide a vehicle for greater examination of themes that were recurrent in that practice.

The paper will specifically explore the adaption of colonial notions of the Picturesque landscape and scenography in the design of the Welcome Shelter. The impact of these colonial ideas on Māori through legislation, occupation and cultural colonisation is briefly touched on here, but it remains a topic outside the scope of this paper due to its scale.

Prologue of a practice

Two intertwined streams of the architect’s practice moved through each other in the lead up to the Welcome Shelter. The first was professional architectural practice through Salmond Reed Architects, and the second was experimental installation architecture through the after-hours design collective Oh.No.Sumo. The Welcome Shelter is drawn from, and extends, the work carried out in each of these strands of the architect’s practice and as such, they require introduction here. Each of these strands begins with a pivotal studio paper taken by the architect as a student, which sparked an interest in landscape and scenographic themes.

In 2006 the architect took part in a studio paper led by Rosangela Tenorio and Adrian Welke. Welke is a director of the acclaimed Australian architectural firm, Troppo Architects. His influence in the studio and his presentation of the Bowali Visitor Centre, in Kakadu National Park, Australia, were shockingly radical to the author as a student. He presented a vision of architecture that was more collaborative and socially engaged than any other that the architect had been exposed to at that point. Welke described a mode of operation where architects acted as lightning rods for participation.

From 2008 to 2012 Oh.No.Sumo created architectural installation projects that did not fit within the bounds of conventional commercial practice and aimed to establish an inclusive mode of operating as an architect. The design collective was made up of James Pearce, Patrick Loo, Katherine O’Shaughnessy and the author. Three projects were pivotal in the development of the author’s architectural practice:

the Cupcake Pavilion, Paper Sky and Stairway Cinema. Cupcake Pavilion was a temporary laser-cut cardboard structure that facilitated a fundraising bake sale for the Auckland Children’s Hospital. Paper Sky was a temporary 300m2 origami ceiling made of 20,000 paper modules hand-folded by volunteers and hung as an undulating cloud. Stairway Cinema was a temporary micro-cinema created for the St Paul Street Gallery Curatorial Season and installed on a busy Auckland street.

Figure 2: Authors Own, Cupcake Pavilion, 2008, Photograph. OH.NO.SUMO. Auckland NZ.

Figure 3: Authors Own, Paper Sky 2009, Photograph. OH.NO.SUMO. Auckland NZ.

Figure 4: Authors Own, Stairway Cinema, 2011, Photograph. OH.NO.SUMO. Auckland NZ

These projects were rapid experiments. Common themes and interests emerged quickly. For instance, to make the self-initiated projects work without financial resources, all the projects utilised sponsorship and volunteers. Each project used a different formula of sponsorship and volunteer labour as a viable model for collective architecture was sought. Framing scenes to view performances, and perform within, became a fascination of the architect. For instance, the Stairway Cinema, was not only a space to view short films, but was also a place to be viewed. An exchange occurred between those who viewed the films, and those who viewed the performance of viewing.

There were also difficulties faced in these projects. The nature of the temporary installations also meant that design themes of interest to the architect were relegated. This included a desire to engage more meaningfully with the ground plane and the exploration of more complex planning arrangements over larger areas.

From 2008 to 2011, the architect was also engaged in architectural practice at an established firm in Auckland, specialising in architectural conservation. Much of the work carried out in this practice by the architect related to a single project, St. Thomas Chapel at Matthews-in-the-City, Auckland.

Figure 5: Simon Devitt, St Thomas' Chapel, St Matthews-in-the-City, 2011, Photograph. Devitt Licensed.

The chapel was an entirely interior piece of architecture, itself creating a smaller interior within the South Transept. The interiority of the project restricted the types of connections the architecture could make. There was no long view. The scale and interiority of the project began to spark questions about how the architect could deal with the opposite situation—an expansive and available landscape. The design of exterior and semi-exterior experiences was the next necessary step in the development of the architect's practice.

Between the experimental installation projects and the interior focus of the professional projects, the architect began to develop recurrent architectural fascinations but also became acutely aware of the limitations placed on the projects. The architectural practice under development needed to be disrupted in order to shift the trajectory of its research and expand its agency. The Welcome Shelter was this disruption. It is overtly ‘outside’—engaged with the landscape in its design and program. It frames both visual and performative scenes, while developing new procurement strategies with sponsorship and volunteers.

Defining the New Zealand landscape scene

Landscape definition is the carefully considered characterisation of landscape through the prioritisation and communication of certain qualities over others, towards the presentation of an agreed and cohesive narrative. Landscape definition occurs through an on-going process of cultural construction, which is often shaped by political and economic interests using conventions adopted from creative arts.

Transformation of the landscape

For more than 100 years, the communication of New Zealand’s landscape definition has been conducted by a government marketing agency—known today as Tourism New Zealand. Drawn from early representations of New Zealand in landscape painting, the editing and compositional devices of the Picturesque have defined the mediation of Tourism New Zealand. The representation of the New Zealand landscape provided by this agency has been formative in terms of the public construction of a generic New Zealand landscape definition premised on the ‘100% Pure’ marketing campaign.[1]

But this campaign has not accurately reflected the scale of environmental change that has occurred in New Zealand since colonisation. Park argues; “this is one of the most ecologically transformed countries on Earth”.[2] When settlers arrived from Europe, they did not come to a virgin primordial land with no sign of human occupation.[3] Māori had already established a civilisation here and with it, they had begun to transform the environment with earth forming, agriculture, targeted hunting and, of course, architecture.[4] But following colonisation the transformation of the environment accelerated. Park quotes William Pember Reeves’ description of the transformation that took place: “the consuming passion of the New Zealand settler to make grass grow where it did not grow before… a hewing down and sweeping away of beauty, compared to which the conquests of the Goths and Vandals were conservative processes.”[5] Large swathes of native forests were felled and even larger areas were burned.[6] In the place of the bush, settlers created pastures enriched by the singular event of burning the bush to the ground.

Figure 6: Frederick Ashby Hargreaves, Remains of a forest after a burn off, c.1890, Photographic print. Collection of photographic prints and negatives, Rip Station, Tapuwaroa Valley, Gisborne. Ref: PAColl-3047-1-01. A.T.L., Wellington, N.Z. Licensed.

The environment had been transformed forever. Accessible landscapes that did not provide Picturesque scenes were not protected. It is for this critical reason that landscape definition is not just a question of philosophical theory, but of demonstrable physical consequence. In an environment where such destructive human intervention was present, the representation of the landscape as pure and primordial is questionable.

Figure 7: Charles Heaphy, Mount Egmont, from the north shore of Cooke’s Strait, New Zealand, 1842, London, England: New Zealand Company/ Smith Elder & Co. Ref: C-026-004-b. A.T.L., Wellington NZ. Licensed.

In the years that followed the European colonisation of New Zealand, the landscape was actively defined through the lens of the European Picturesque.

Park and Pound have both asserted that our understanding of the land, and its definition, will be forever tinted by the Picturesque views of early colonial artists.[7] Painting was not only a way of imaginatively constructing a landscape definition, but also a powerful tool of cultural colonisation.[8] It overlaid a colonial lens on the land, claiming it, taming it and re-imagining it. The Picturesque representation and touring of the landscape following colonisation was politically biased in favour of the European government and representative of its power in the cultural, economic and legal definition of the landscape. It was a tool of colonial domination in the way it appropriated the land and cleansed its representation of any disquieting friction. The architecture depicted in these early Picturesque scenes was compliant with this subconscious agenda by either presenting European architectural forms as occupying forces in an uncannily familiar landscape or describing Māori and their architecture through the lens of the exotic.

Instrumentalising the Picturesque

The wilful fiction created in Picturesque images produced during the early years of colonial settlement has been persistent in the cultural understanding of the New Zealand landscape. But this fiction is particularly problematic when considered in relation to sites of environmental restoration, like the Longbush Ecosanctuary. This landscape is by no means primordial and should not be idealised as such. Longbush is a constructed landscape in which both environmental processes and human intervention exist. At Longbush, when house pits were dug, when the bush was burned, when the hills were farmed, when the exotic species were planted, when earthworks were carried out, when the reserves were protected, when the weeds were removed and when the native species reintroduced, it was done with human intervention. Successive occupants of this land have constructed it, and in doing so reflected their cultural approach to the environment at each stage. The Welcome Shelter is the latest exercise in shaping the land and redefining our approach to the landscape. The design takes the tools of the Picturesque and uses them to try to communicate this complicated, contested and ultimately constructed landscape definition.

In the contemporary consideration of Picturesque tools for the formulation of architectural designs, there is an opportunity to refocus the futility of the Picturesque painter's search for the ideal and removed, into a search for the real and connected. Rather than continuing to step back from the pictorial landscape image to appreciate it as an ideal, contemporary architecture could prompt a connection between people and the landscape through the scene—physically drawing them through the frames created in the landscape. This is the approach adopted in the design of the Welcome Shelter. By designing these frames as a set of porous architectural membranes, the occupant can be immersed in the substance of the environment, with all its vagaries and inconsistencies. The architecture frames the acquisition of visual scenes, moving the visitor through its layers to understand its composition and meaning, while finding new agency in shaping the landscape as a facilitator of physical change in the form of conservation works.

Picturesque techniques are hijacked in the design of the Welcome Shelter. The physical and visual devices explored include the framing and editing procedures involved in composing a Picturesque scene, as well as the inclusion of specifically meaningful items such as livestock, rural workers and architectural ruins. Each of the devices is applied in the design of pictorial and performative scenes at the Welcome Shelter. However, they are co-opted with skepticism. Instead of applying these tools with the aim of replicating an idealised colonial Picturesque landscape, they are applied to highlight the discomforting, contradictory, contested and complex landscape definitions that are a reality in the New Zealand environment today. In this way, the architectural design confronts the pacifying colonial force of Picturesque landscape definition and offers instead a subversive version of its gaze, producing unresolvable and deeply conflicted scenes. By co-opting the techniques of Picturesque scene making, visitors to the Welcome Shelter are subtly asked to question the landscape definitions presented, while retaining their shared cultural knowledge of how to read and perform within these scenes. The result being not a benign compliance with an aesthetic code, but a wilful commandeering of framing techniques to critique the contemporary understanding of landscape through architectural design. The Welcome Shelter rejects the search for the ideal, instead favouring continual questioning of our embodied role within the environment. The developing field of mainland sanctuaries provides a space for this to happen. The cultural and environmental contradictions of these sites provide a suitable test ground.

Designing and constructing the Welcome Shelter

Three critical aspects of the design and construction of the Welcome Shelter are addressed here.

Interpretive models

The design of the Welcome Shelter began with a generative process making a series of interpretive models. Interpretive models are made to represent abstract concepts and evolve iteratively. The architect developed this technique through the design of the Welcome Shelter to apply architectural methods of understanding and inquiry to concepts that do not fall neatly into the literature of the discipline, or span across disciplines. The making of the models is a process of understanding and translation, but importantly, is based on an understanding that architects often gain understanding through the codes of architectural production. The need for this type of modelling surfaced in the creation of the Stairway Cinema, where the architect found that societal tropes were most easily critiqued by making rudimentary marquettes. The development of interpretive models in the design of the Welcome Shelter expands this approach.

By crafting the models, the author aimed to clarify how landscape definition could be communicated in built forms using scenographic techniques of masking and framing. The importance of body position when engaging with a landscape scene was made explicit through making and viewing the models. Employing materials commonly found in construction (masonry, dressed timber, rough sawn timber, metals and plastics), these models engaged with the fabric of architecture.

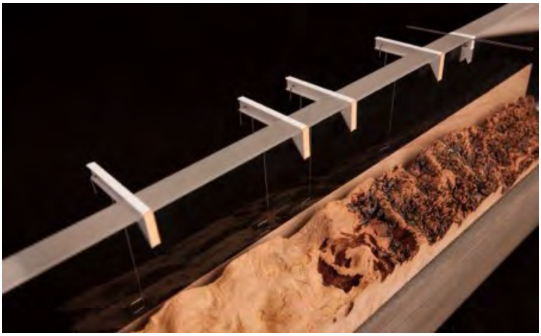

Figure 8: Authors Own, Interpretive Model different landscape definitions incorporated into the model.

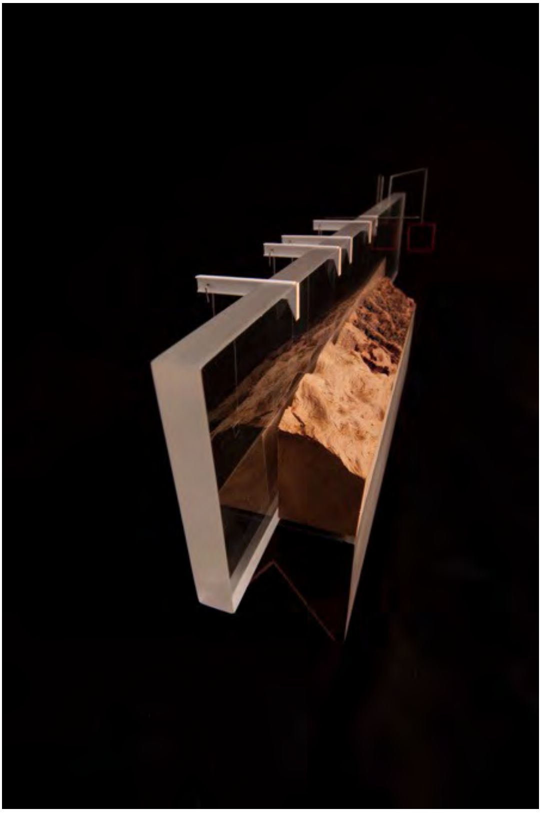

Figure 9: Authors Own, Interpretive model, reflected landscapes.

The models developed ideas of an occupiable series of frames that could be used to generate architecture. The making of the models also confirmed that two-dimensional visual scenes created to communicate the constructed landscape of the Longbush Ecosanctuary could be expanded upon with three-dimensional activation of the building, not only after it was complete, but pivotally during its construction.

Instead of a passive visual consumer, the visitor is transformed into an active physical participant in the co-creation of the architecture (in the short term) and the wider landscape (in the long term) through the procurement model and program adopted in the project.

Occupation of the frame

It is important to note that while Picturesque landscape design was concerned with shaping the land itself, and Picturesque painting traditionally attended to the optical consideration of landscape by viewing space in a two-dimensional representation, this project has chosen to develop the dynamic three-dimensional qualities of Picturesque touring through the physical occupation of the frame. The architecture of the Welcome Shelter was designed as a repository of frames for viewing that are passed through and experienced as a result of the viewer's movement. The frames were created by the architecture. In this way the presentation of the Longbush valley was curated using a physically embodied evolution of both Picturesque touring and Picturesque scene making for painting.

Figure 10: Simon Devitt, Welcome Shelter lookout, 2015, Photograph. Dewitt Licensed.

Moving between each frame and passing through the picture plane means that the viewer activates the scene and is situated within it. Instead of denying the presence of alternative land uses on the properties that bound the ecosanctuary, in correspondence with the '100% Pure' campaign, the Welcome Shelter masks and reveals parts of the surrounding landscape in framed scenes that deliberately juxtapose different land uses and histories to communicate a richer landscape definition. These scenes reject the imperial hegemony that underpinned Picturesque images and do not seek to present an idealised vision of the colonial landscape.

Instead the scenes presented by the Welcome Shelter are purposefully conflicted, challenging and contradictory. Framed by the architecture, they force the viewer to question the scene, its curator's motives and the unsettling friction that exists when a number of parties engage in the cultural construction of the landscape.

The position of windows, columns, parapets, trees, paths and spaces between enclosures were considered in detail. The effect of each element on the composition of scenes was drawn in plan, elevation and critically in perspective. Static elements of the architecture were placed next to semi-active elements, such as the drawbridge door, and imagined with the continually changing growth of the neighbouring 1769 Garden at the ecosanctuary and wider regenerating bush. The compositions became dynamic imaginative constructs. Scenes were designed for the first day of the Welcome Shelter's use and the change in their character was imagined through the life of the ecosanctuary.

Figure 11: Simon Devitt, Scene 2: View to the southeast, 2015, Photograph. Devitt Licensed.

A developing procurement model

A non-traditional procurement model that utilises volunteers and sponsors while also transforming the role of the architect was applied in the development of the project. The Welcome Shelter is the largest public building created in New Zealand by volunteers with the support of sponsors, but without a government construction grant. Over the course of one year, 88 different sponsors gave to the project and 88 volunteers laboured on the site with the architect. The procurement model created to realise the project extends existing ‘live’ project methodologies in that it enables architecture to be realised without existing capital, without incurring significant debt (that would need to be repaid though ticket sales) and without the difficulty of securing a government construction grant. The truly grassroots approach of this project demonstrates that substantial pieces of architecture can be created by activating the latent potential of the community. In turn, this community can benefit from access to the landscape attraction free of charge and visitation can be focused on culturally understanding and physically constructing the landscape.

The role of the architect in this procurement model expands beyond the traditional to encompass areas of sponsorship, logistics, marketing and construction.

Figure 12: Simon Devitt, The architect/ builder, 2015, Photograph. Devitt Licensed.

The procurement model foregrounds the architect’s role at each stage and crucially embeds the architect in the decision-making team from the start of the project. The expanded role of the architect presented within the Welcome Shelter project does not currently exist elsewhere in the practice of architecture in New Zealand.

This procurement model was applied for the first time at a significant scale in the realisation of the Welcome Shelter. But this way of delivering architecture comes directly from the architect’s previous experience in installation projects. In projects like Cupcake Pavilion, Paper Sky and Stairway Cinema, different mixtures of volunteer construction and sponsorship were tested. Each time a little more was learnt and the precise methodology of securing such support was refined. In the Welcome Shelter project the architect extrapolated this experience into the delivery of full scale, permanent, architecture. This scaling up was highly successful in enabling the project. It also solidified that self-generated projects of this type, realised through sponsorship and volunteering, are a central characteristic of the architect’s practice, rather than simply a means to an end.

Conclusion

Longbush Ecosanctuary is defined by this project as a constructed landscape. The land is not presented as pure or profane, but instead as a result of human intervention in its physical form and cultural understanding. This landscape definition is communicated through the scenes framed by the architecture of the Welcome Shelter, as well as the scenographic performances enabled by its program. The framed scenes use the physical forms of the architecture and the landscape to collect objects, textures and conflicted cultural connotations into curated views.

Furthermore, the educational and conservation programs provided at the Welcome Shelter enable visitors to actively participate in the future construction of the landscape at the ecosanctuary through the embodied performance of their visit.

Each scene and performance prompts consideration of the way we have, and the way we wish to, engage with the cultural construction of the environment.

Through the design of the architecture landscape definition and scenography have provided a way of looking into a particular role for architecture as a linkage between humans and the landscape. These lenses were distilled and applied as tools in the design of the architecture. They provide ways of framing and curating views through the form, planning and orienting the architecture on the site, creating performative experiences through the development of program and treating procurement as part of the design process. They allow for the complex and contradictory cultural understanding of landscape through architecture.

The project crystallises recurrent themes and methods in the architect’s practice, highlighting not only where that practice has been, but critically establishing a renewed trajectory for where it might go.

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[8] Pound, *The invention of New Zealand: art & national identity.*

Hot and Wet: Architectures of the Equator

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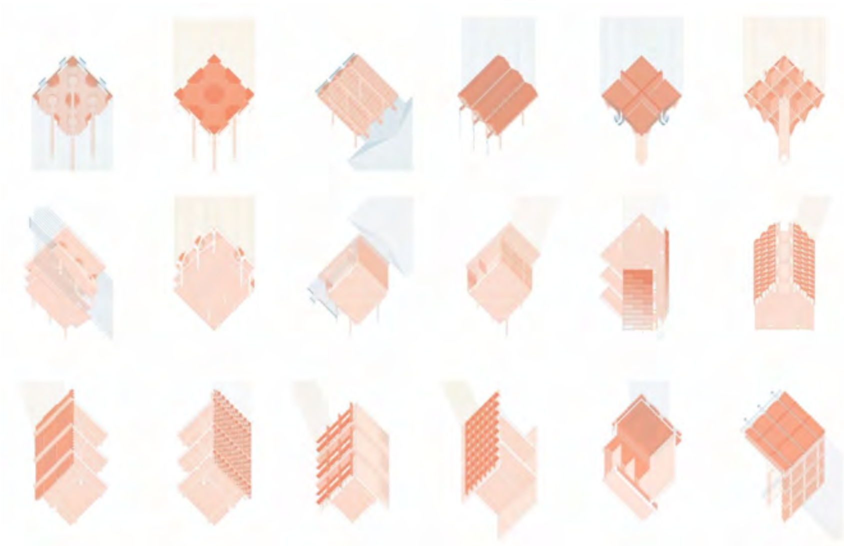
Abstract

The architecture calibrated to the atmosphere of the equator is fundamentally at odds with the temperately conditioned design sensibilities of the northern hemisphere.

The legacy of the Global North's historic hegemony continues to influence how the equatorial is perceived: largely through an exotic paradise or pestilence ridden landscape. Architectural discourse has long deemed the equator as a condition to be tempered; an atmospheric problem that requires a temperate fix. Contemporary architectural responses, centre on performative and efficiency improvements, continue to purvey these prejudices as a foundation of their discourse or simply import temperate strategies as an atmospheric replacement.

This paper investigates a theory of spatial depth and climatic gradient as key to developing buildings for the rapidly densifying urban equator. Through various architectural strategies, loosely categorised as deep envelops, the core ingredients of space, material depth, and solidity are employed to produce atmospheric calibration specific to the hot and wet equatorial city. Explored through a series of architectural precedents traced from the 1930's to the 1970's, these strategies demonstrate an architectural approach that is leaky rather than sealed, dark rather than light, deep rather than thick, perforated rather than closed.

The knowledge gained through the precedent is then applied as translational research, alongside investigations into contemporary lightweight materials, software simulation and digital fabrication techniques, through the oeuvre of singular design practice based in Singapore. This paper seeks to expand the discourse on equatorial architecture, by returning agency to architectural practice via expressive and atmospheric languages and techniques relevant to the hot and wet.



Equatorialism: The Architecture of the Hot and Wet.

> "[The equatorial had] strange rhythms… [first] the sun glared in the sky like an angry god… then suddenly the monsoon blew westward… in a heavy ceaseless downpour that drenched everything… it was still hot, with a stuffy vaporous heat… [everything became] wastes of stagnant water with a stale, mousy smell… Naked Burmans in yard-wide hats of palm-leaf ploughed through the paddy-fields… there was hardly a pause in rain [until later]. [Later] the fields dried up, the paddy ripened… It was the beginning of the short winter."[1]

Informed by a worldview that has its foundations in theorisations from Parmenides, Piny the Elder, Aristotle, and Vitruvius onwards, temperate sensibilities have long rendered the equatorial[2] atmosphere[3] as an almost singular problem: too hot (and too wet) to dwell within. Greco-Roman thinkers deemed the tropics as irrepressible and hostile, unfit for inhabitation: Parmenides described it as a single "burned" zone, Piny the Elder considered it a Ring of Fire; Aristotle, in his text *Meterologia*, cemented Parmenides' climatic divisions, by defining of the "Torrid Zone" as parched and lifeless.

Vestiges of these seemingly simplistic theorisations continue to persist, albeit transmogrified through various periods of history. As encounters with the equatorial shifted from anecdotal to experiential, notably during the Age of Discovery and the subsequent colonial endeavour, pejoratives of the equatorial atmosphere evolve into complex metaphors expressing the equatorial state of excessiveness, as untamed paradise, or pestilence-ridden. It is an affront to temperate order, and justification for the temperate's "right to command the whole world"[4]. Alfred Russell Wallace's *Malay Archipelago* portrays the equatorial atmosphere as brimming with exotic, threatening creatures (see Figure 1); Henri Rousseau's landscapes express a paradise of immense proportions, abundant with intimidating overgrowth. George Orwell's 1934 text *Burmese Days* pointedly extends such prejudices – the tangibility of the equator appears immediately corporeal – as commentary of colonialist sensibilities, where exoticism is shorthand for primitivism; the equatorial problem requires salvation, if not replacement through temperate civilisation (and architecture).

More contemporaneously, in Columbia University's 2016 journal, *Climates: Architecture and the Planetary Imaginary*, Eva Horn vividly recounts this in her essay, "Air Conditioning: Taming the Climate as a Dream of Civilization":

> "I had no idea the tropics were that hot… This was not air as I knew it – it was more like a semi-liquid medium, a gel, moist, hot, suffocating… [only in] dry, artificially cooled air of climatized spaces… [can you] rush and work as hectically as you would in Berlin, London or New York"[5].

Legacies of these prejudices also percolate through architectural discourse – specifically with tropical modernism, where architecture finds value in tempering the equatorial condition. Tropical modernism, emerging in the post-war years, is significantly defined by two seminal tomes: Maxwell Fry and Jane Drew's *Tropical Architecture*, and Otto Königsberger's *Manual of Tropical Housing & Building.* While researched through practice within the equator, this movement was largely codified within the temperate metropole of London, at the Architectural Association's Department of Tropical Architecture, and its subsequent iteration at the University College London. Its body of research, widely disseminated among post-war equatorial practitioners, continues to constitute the framework of contemporary discourses and approaches to Tropical Architecture[6], implicit or otherwise.

Shaped by the ideologies of functionalism, and the promises of technologies and science, Tropical Modernism prioritises the equatorial climate as a quantifiable and solvable hindrance with architecture as solution to its developmental problems and aspirations. Tropical Modernism presents itself as altruistic experiments in enacting the modern in a seemingly primitive, pestilence-ridden equator.

Through an analysis on historic vernacular architecture, taxonometric evaluations on the equatorial, and the reliance on sun-path diagrams, detailed calculations of thermal transmittance, and solar-shading coefficients (see Figure 2), both texts conceive the equatorial's future as a performance problem. Tropical Modernism thus becomes an approach to recalibrate temperate architectural objects, through mechanical technologies and performative rubrics, in largely anti urban contexts.

Inevitably, it invites this consideration: the equatorial would thrive should it be more temperate-like; if only it were cool and ventilated enough and its landscape manicured and disciplined. Taken to its logical extreme, modernity becomes conflated with temperate sensibilities; as Horn notes, modernity has become synonymous with the "independen[ce] of such negligible things as air temperature or the degree of humidity". One sees this in major equatorial cities globally, where temperate strategies are imported as atmospheric replacements (glass towers sprout from the cities of Jakarta, Singapore, and Lagos alike). The logical conclusion is a complete exchange of the tropical climate with an air-conditioned one, sealed in the prophylactic envelopes that dot the urban equatorial landscape in an aesthetic ethos of efficiency, transparency, and dematerialized precision through glass.

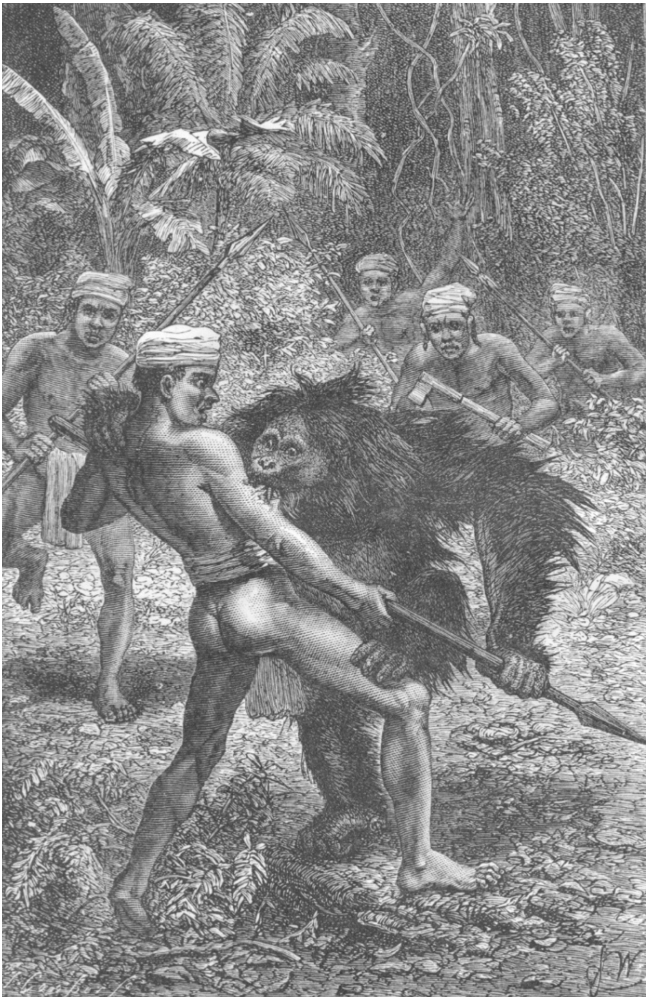


Figure 1: The equatorial as a place of pestilence and fear; extract form Alfred Russell Wallace's *The Malay Archipelago*.

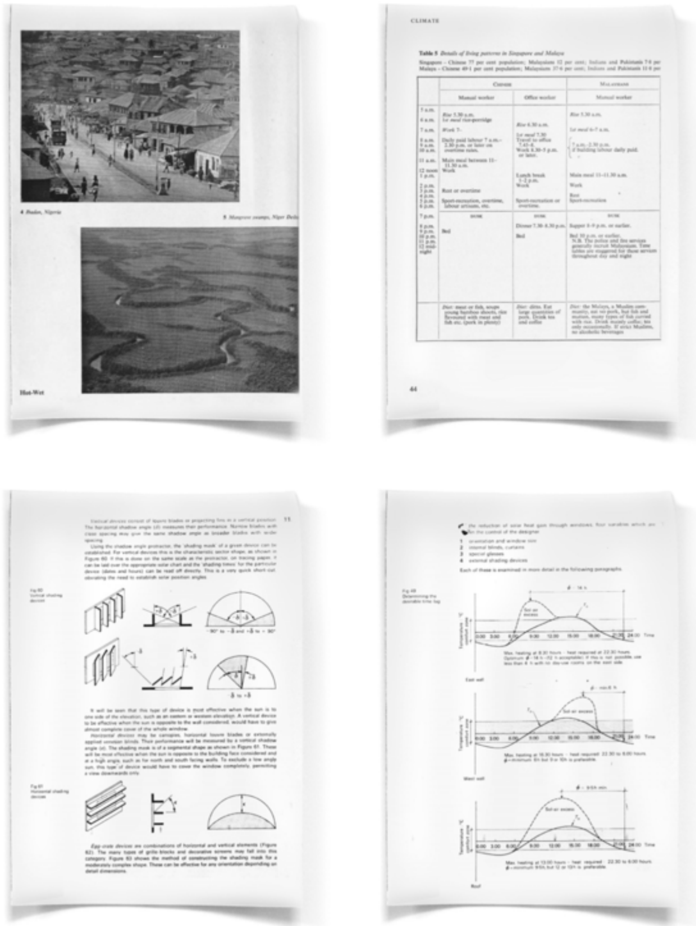


Figure 2: A technocratic approach; extracts from Maxwell Fry and Jane Drew's *Tropical Architecture* and Otto Königsberger's *Manual of Tropical Housing & Building*

While the affiliated post-colonial school of Critical Regionalism attempts to avoid the inherently temperate-centric biases of modern architecture through its validation of nativism, its discourse remains strongly shaped by performative concerns. Its emphasis on site specificity and contextuality is often framed in performative, and similar anti-urban terms – this is implied in Kenneth Frampton's summary of the movement's approach, as an "architecture [that is] a tectonic fact [fitted into the] three-dimensional matrix of topography... [where] light is invariably understood as the primary agent."[7] While its equatorial adherents, including Minnette de Silvam, Ken Yeang and Oscar Niemeyer practised in urban environments, the movement largely cites their oeuvre through a lens of the object, where individual pieces of architecture are valorised rather than located in urban contexts.

The future of the equatorial is urban[8], and the "unthinking uncritical acceptance"[9] of temperate-centric biases in the equatorial is a disservice to architecture. This paper operates as a counter-narrative to the normative approaches of temperate superimposition upon the equatorial, and accordingly chooses to privilege alternative architectural approaches that emerge from that condition.

Revealed through four precedents across the equatorial belt, one finds a sampled history of architects and modern architecture deeply embedded in their contexts, one that advocated a nuanced understanding of the equatorial atmosphere. Developed within urban locales, modern building technologies (particularly innovations in concrete-casting) were deployed to produce an approach embodying confidence, calibration, and ornamentation – moving beyond mere performance. Within the work two architectural tropes, manifested as big roofs and spatialised envelopes, are found and loosely categorised as *deep envelopes* for this paper. Here, the atmosphere of porosity and amorphous layering is prioritised over delineation and sealed enclosure, and substantialness over technological dematerialisation[10].

The exploration of these historical precedents, traced from the 1930's to the 1970's, investigated alongside contemporary design, construction techniques, and materials, are part of a body of translational research that shapes four contemporary projects from the author's design work. This paper seeks to return agency to architectural practice, via expressive and atmospheric languages and drawing techniques that are relevant to the hot and wet, rather than through simply solving a misplaced temperate problematization, one that assumes both the excessiveness of the equatorial, and it being solved through air mechanical systems and performance only architecture.

The Hot and Wet Big Roof

The Pasar Johar[11], designed by Herman Thomas Karsten, is a dramatic big roof located in Semarang, an Indonesian city of 1.5 million people on the north-eastern coast of Java. Intersecting complex urbanism, commerce, and modernisation, it is claimed to be Southeast Asia's largest covered market at its opening in 1932. Through a porous envelope spanning three city blocks, it aggregates small-scale merchants within an urban figure of grand proportions.

Combining modern structural systems[12] with poetic calibration to the equatorial climate (see Figure 3), the big roof sits atop funnel-shaped columns towering 8.5 meters tall. Unlike Robert Maillart's preceding structures, or Frank Lloyd Wright's later Johnson Wax Headquarters, porosity is a defining feature of Pasar Johar. Its complex roof is an aggregation of smaller planes, each rhythmically-punctuated by oculi that illuminate and ventilate simultaneously (see Figure 4); its imposing scale dramatically reveals a large pool of steamy Javanese air permeating from street into sectional intricacies within the large roof above. Upon closer inspection, the oculi reveal imprints of rattan formwork on their undersides, an intersection of technology and the tactility of vernacular craft.

Lacking a physical envelope, the market's threshold is implied through its big roof, and the shadows it casts. This changes throughout the day and is particularly ambiguous in the diffused light of midday; the bleaching quality of the equatorial sun at the periphery gradually tapers into the dark undersides of the lower market. Here, edge is ill-defined, shadow is prioritized over luminosity, and porous cover over enclosure (see Figure 5).

Five-degrees north of the equator on a different continent, the big roof takes on a symbolic relationship with its context. In newly-independent Ghana, a laboratory for equatorial exuberance and "radical modernity" emerged[13]. Under its first post-independence Prime Minister, Kwame Nkrumah, the nation's identity manifested the values of scientific socialism, pan-Africanism, and Cold War alliances directly through its architecture. This was theatrically demonstrated within the grounds of Ghana's 1967 International Trade Fair (ITF), where a decidedly-modernist masterplan played host to symbolically-charged architectural objects and pavilions.

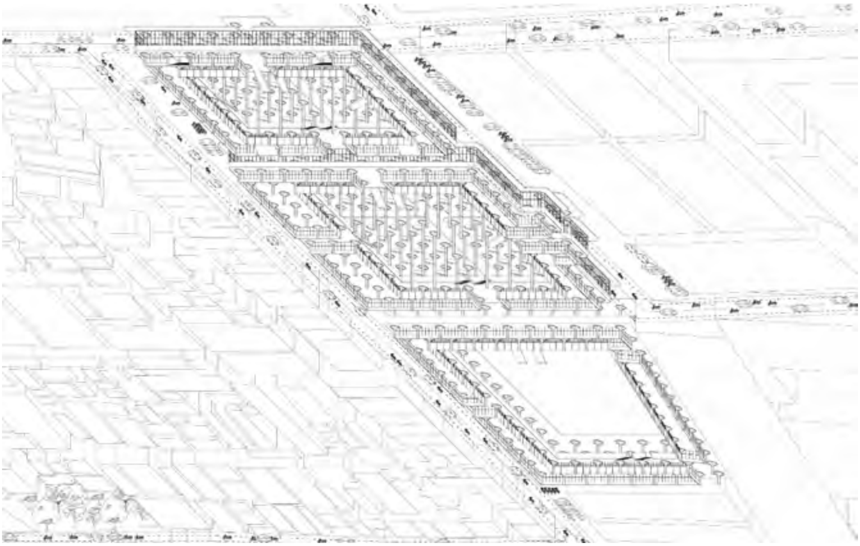


Figure 3: A typological big roof, aggregating and condensing the equatorial market over three city blocks.

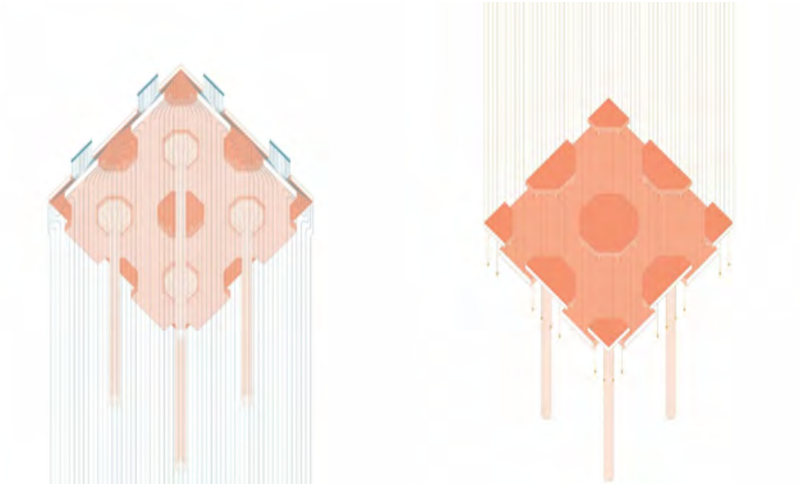


Figure 4: Channelling dense Javanese air – rhythmically-punctuated oculi that illuminate and ventilate.

The fair’s exhibition hall, articulated by its sculptural double-skin roof, potently demonstrated the intersection of technology, imagery, and atmospheric calibrations. Co-designed by the Ghanaian architect Vic Adegbite, and the Polish architects Jacek Chyrosz and Stanislaw Rymaszewki, the building’s pre-eminence was further reinforced by the landscape of grand entry ways, ramps, and bridges that it hovered over (see Figure 6).

Expressing a pan-African zeitgeist, the big roof’s dramatic thickness was sculpted in a diamond profile, alluding to the vernacular Ghanaian thick thatch roof. Its large-span reinforced concrete structure was infilled with corrugated galvanized sheets, creating a lightweight design that paid homage to the ubiquitous modern material of the equatorial, while demonstrating its aesthetic and performative potential. Designed not to counteract the equatorial atmosphere but celebrate its phenomenological qualities through dramatic expressions of the movement of hot air and the drainage of rain (see Figure 7), the roof’s elegant cantilever demonstrates Ghana’s technological and cultural ambitions (see Figure 8); it symbolically crowns the equatorial air of Ghana.

Figure 5: Amorphous thresholds, where shadow is prioritised over luminosity

Figure 6: An elevated deck, espousing optimism in a pan-African zeitgeist.

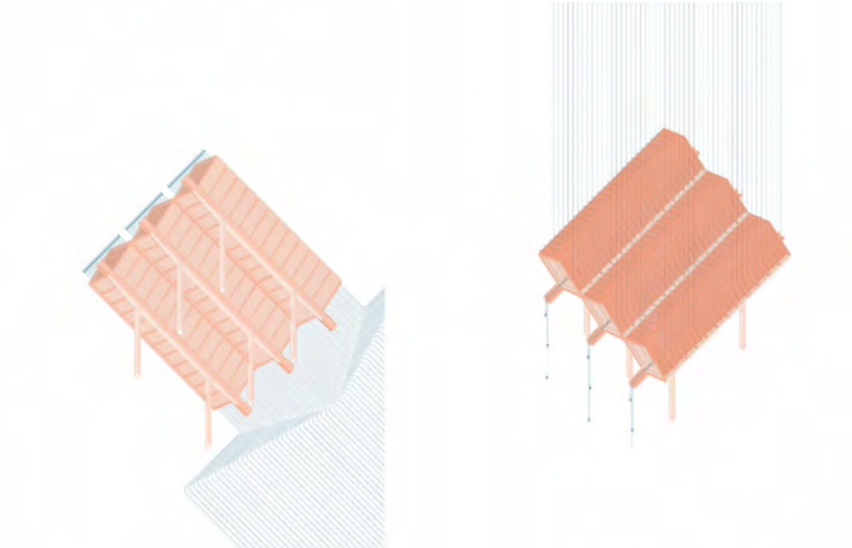


Figure 7: The mediums of atmosphere rain, air, and breeze suggest a palette of elements formally arranged to evoke the vernacular.

Figure 8: Cantilevered rain spouts, celebrating an equatorial identity.

The Hot and Wet Deep Elevation

As urbanism in equatorial cities intensify, the city's formal expression shifts from the horizontal to the vertical; the elevation becomes the primary filter between atmosphere and architecture, as well as the surface of symbolic and ornamental resonance. Traces of this are demonstrated in two exquisite projects – the Sequis Center in Jakarta, and the Golconde Dormitory in Pondicherry.

Commissioned by the financial arm of Subud[14], an Indonesian spiritual movement and designed by Hassan Roland Vogel in 1978, Jakarta's Sequis Center is a 12-storey volume that sits diminutively within its dense urban context, dwarfed by increasingly towering neighbours (see Figure 9). Its opaque aesthetics, rich in symbolism, manipulates the equatorial atmosphere expressively in counterpoint to the temperate-centric language of commerce adopted by adjacent glass-enclosed structures. This is materialised through the building's envelope, formed from parabolic glass fibre-reinforced concrete panels, a then-novel technology specifically licensed from Pilkington[15]. It forms an outwardly-protruding elevation that creates a spatialised thermal buffer, while also sheathing the interior from the ubiquitous monsoon downpour (see Figure 10). Derived from a common trope in Indonesian vernacular architecture – the dramatically-pointed pitch roof – the façade's panels are a synthesis of modern and vernacular. Roof is transformed into elevation, miniaturized, multiplied, and arrayed to form a spatialised elevation of complex optics, porous yet opaque, that envelops an otherwise banal office building (see Figure 11). The panels are highly performative, allowing the building's windows, visible only from street level, to remain without coatings or reflective films – an ironic realisation of the modernist penchant for transparency and optical clarity. Together, the interior wall and the exterior veil form a paradoxical engagement, where the transparency of modernism participates with equatorial demands for shade, jointly establishing a voyeuristic relationship with the urban. Expressing an equatorial resistance to the temperate, the Sequis Center provides an alternate vision for the equatorial city: shady, layered, porous, and material.

Figure 9: An opaque envelope, set within the growing equatorial city.

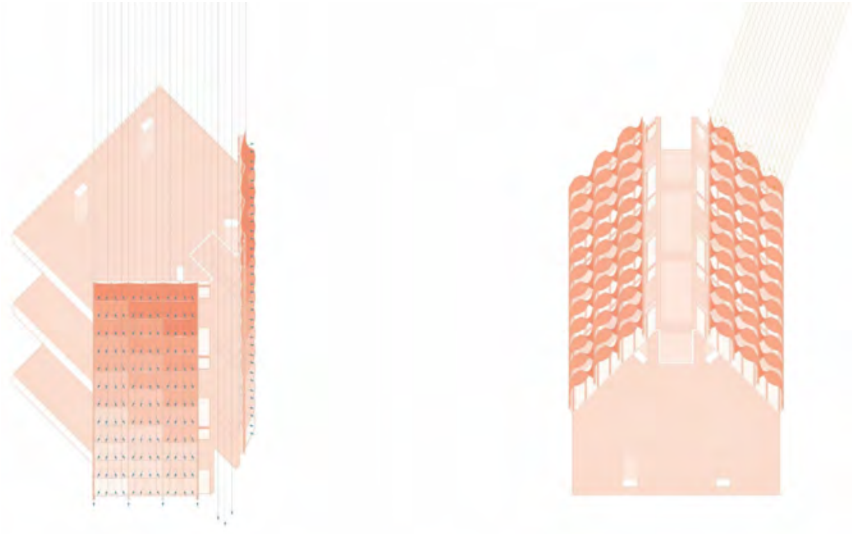


Figure 10: Parabolic fibre-reinforced concrete panels, sheathing the interior from the ubiquitous monsoon downpour.

Figure 11: An assemblage of the pointed and pitched roof, miniaturized, multiplied, and arrayed across the building in elevation.

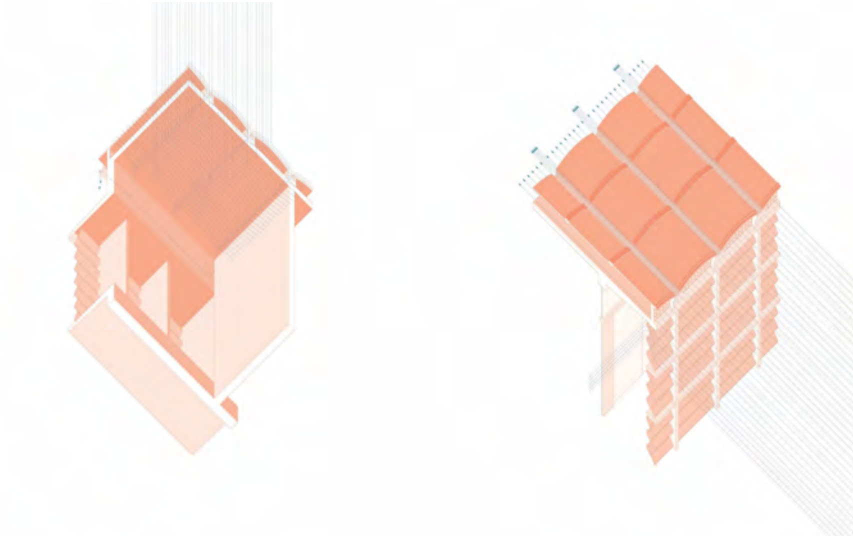


Figure 12: A vaulted double-skin roof, a breathable thermal buffer with integrated drainage.

Figure 13: In precise alignment to the tropical sun-path, in collision against the Pondicherry's grid.

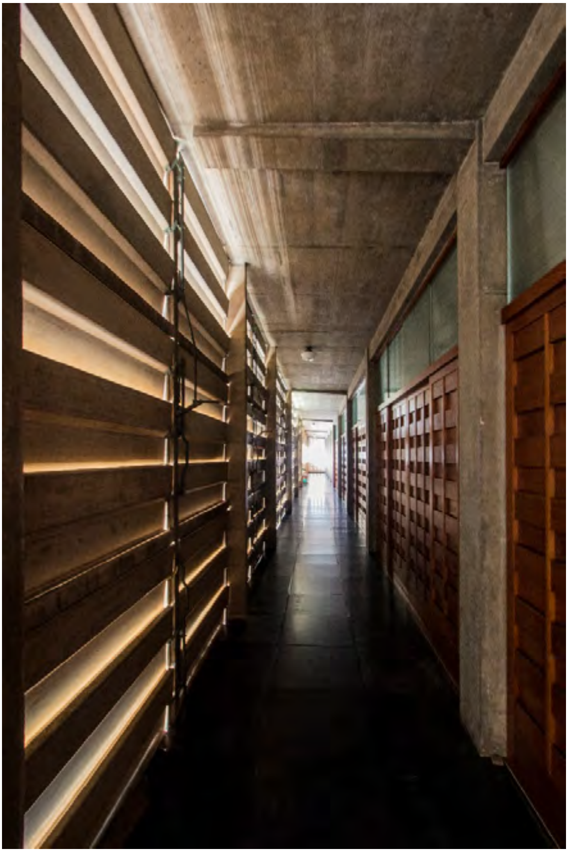


Figure 14: A thickened lamination of spaces and elements, of different scales.

The synthesis of elevation and form, as demonstrated in the Sequis Center, points towards the promise of a totalised architectural expression of the equatorial. This begins by liberating the fifth-elevation from singularly functional concerns[16], and finds completion in the expansion of architecture's scope towards *Gesamtkunstwerk*[17]*.* The Golconde Dormitory, designed by Antonin Raymond, Francois Sammer, and George Nakashima for Sri Aurobindo Ashram[18] between 1935 and 1942, reveals a holistic approach to equatorial architecture.

Employing gestures similar to the earlier-mentioned Ghanaian example, the dormitory's roof amplifies the equatorial's atmosphere for phenomenological delight. Expressed through an aggregation of enlarged ceramic roof tiles – vaulted in section – it is a double-layered entity that channels the monsoon rain through the roof via integrated drainage (see Figure 12), creating immersive aural atmospheres, while also establishing a breathable thermal buffer. Here is a roof that performatively, and programmatically eschews the domain of mechanical systems, the reality for most contemporary buildings.

The Golconde Dormitory presents a comprehensive architecture, beginning with a straightforward massing – a bar building displaced about a vertical stair core – that addresses critical performative and symbolic concerns. It exists as an object-like formation in collision with the city's grid (see Figure 13), a sanctuary amidst the dense chaos of colonial urbanism, achieved through precise alignment to the tropical sun-path along the east-west axis. Serendipitously, three courtyards emerge, furthering performative and symbolic goals – the northern courtyards heat up in the afternoon while the southern courtyard remains shaded, creating a pressure differential that encourages airflow between the architecture. They establish an equatorial Eden, but on terms defined from within the equatorial, rather than through temperate conceptions.

Internally, the architecture is a thickened lamination of spaces and elements of differing scales – adjustable lightweight fibre-reinforced screens, verandah-like corridors, teak sliding screens, dormitory rooms (furnished with custom-designed furniture) and screened window-bays (see Figure 14). While they function holistically to modulate atmosphere, the architecture's raison d'être was the "materialization of [self-apotheosis]"[19]; its construction a meditative ritual for its inhabitants. The community's ascetic inclination reveals itself through subtle yet considered details: unfinished concrete to modulate air temperature, glare-minimising anthracite floors, and Nakashima's teak and rattan woodwork espousing a language of tactility and ventilation.

Figure 15: An anamorphic elevation calibrated between ornamental patternmaking and pragmatic concerns.

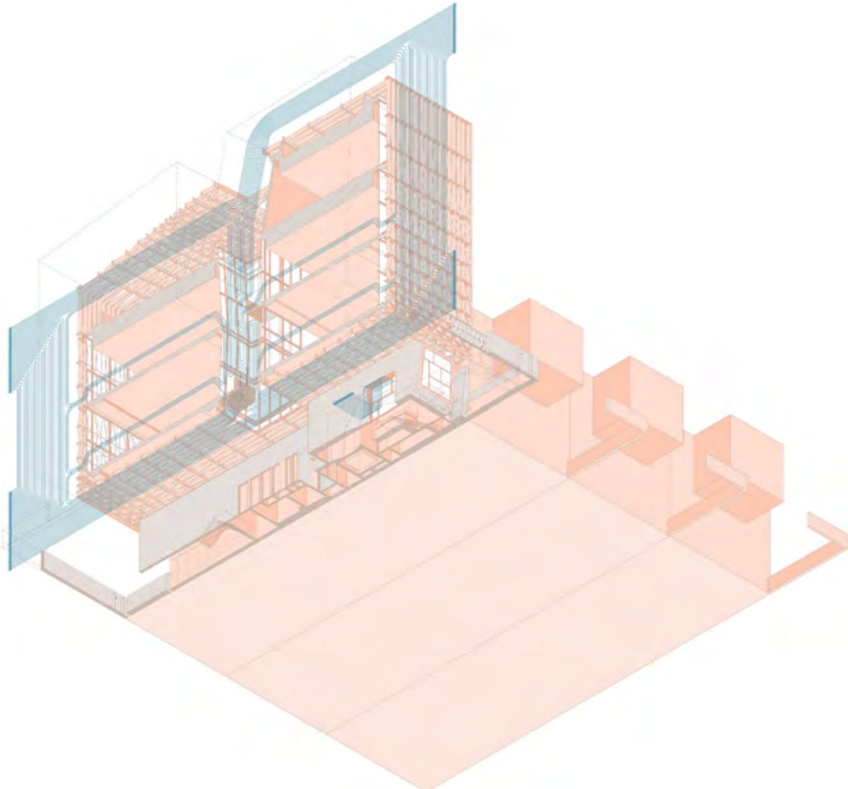


Figure 16: A continuous deep envelope in section, mediating atmosphere and context.

Sampling the Equatorial

These historical precedents provide a foundational grammar to the author's design work, mined for their critical reconfiguration of modernist tropes as it confronted the equator, embodying pattern, volume, mass, and porosity in deceptively simple architectural formations. Novel materials and construction logics permeate these works, enabling a complex intersection between context and atmosphere.

These contemporary projects seeks to continue and extend the discourse raised in precedents, by actively approaching the equatorial as an atmospheric medium to work through and with, to produce a more attuned and sensorial architecture that calibrates atmosphere and context in subtle yet evocative ways, despite the constraints of dense urban environments. While the previous precedents were manifested through then-novel concrete innovations, the following projects investigate contemporary lightweight materials, digitally-controlled fabrication techniques, and software simulations to build upon this earlier era of fruitful architectural creation.

A Simple Factory Building is a response to the heaviness of the equatorial atmosphere, by creating a spatial envelope that calibrates and filters air, sound, temperature, and views, akin to that of the Sequis Center and the Golconde Dormitory.

Placed 1200mm proud of the window wall, and continuously looping in section, a lightweight Dryvit EIFS[20] brise soleil defines the building's elevational identity, an anamorphic entity calibrated between ornamental patternmaking and pragmatic concerns through digital software tools (see Figure 15 and 16). Front elevation, roof, rear façade, and ceiling are merged in a singular spatial and sectional envelope, that adjusts porosity[21] and privacy in relation to internal programming (see Figure 17). Here, the EFIS system, a low-cost temperate and repairable cladding solution, is transformed into a refined and performative veil for the equatorial atmosphere.

As demonstrated in Pasar Johar, a subtractive approach can powerfully adjust and express the equatorial atmosphere, calibrating visual perception and revealing the movement of air. Located within an urban block of finely-spliced plots, *A Simple Factory Building* adopts the parti-wall typology of its neighbours to produce a contiguous block. Its four double-storey massing is however elevated and carved to reveal an interior open-air courtyard, linking interior workshop spaces to their urban surroundings, while amplifying cross-ventilation between front and rear volumes through zones of negative pressure. This carved space, glazed in bronzed glass, becomes a counterpoint to the opacity of the veil, and the rough-hewn concrete shell elsewhere, forging a dialogue between advanced and crude construction techniques (see Figure 18).

In a region fascinated by glass, transparency, and atmospheric replacement, the scheme offers a counter-narrative, a meditation on the potential of an orchestrated layering of spatial conditions and atmospheres. Closed and open, shadowed and reflective, permitting view and creating interference – the project illustrates that architecture can be a robust and powerful engagement to its equatorial atmosphere.

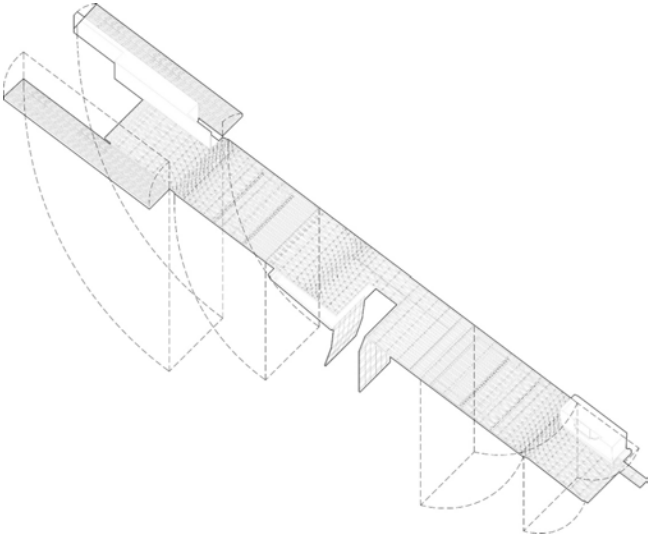


Figure 17: The unfolded elevation.

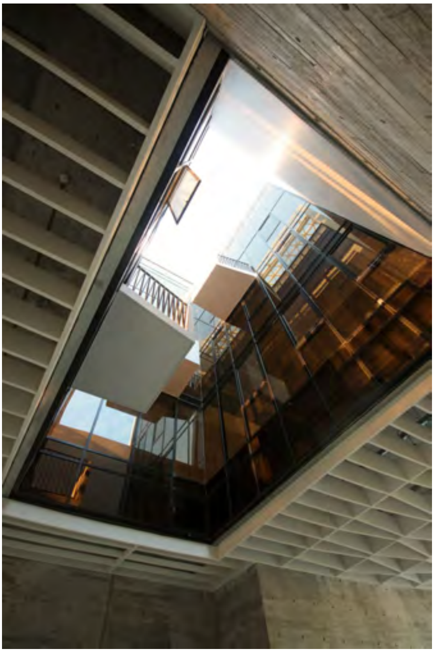


Figure 18: A dialogue between advanced and crude construction techniques.

Figure 19: A hut set within and about the urban jungle.

Figure 20: A camouflaging envelope, upsetting normative conventions of scale.

Land-scarcity is the dominant narrative in Singapore, and its urban sensibilities prioritise density as opportunity[22], even as it strives to maintain an illusion of landscape and atomisation through setback lines[23]. The *Hut House*, a modest extension to a colonial bungalow, emerges from this ethos. Its simple massing, expressed through a spatialised envelope of expanded-mesh panels, is an idealised hut carved and chamfered by setback constraints (see Figure 19), working in tandem with verdant vegetation to amplify acoustic and visual camouflage in a strategy reminiscent of Jakarta's Sequis Center. Behind this totalising envelope are fenestrations positioned to different alignments and sizes, serving to undermine normative conventions of scale. An object-like entity emerges, peeking above the plot's lush vegetation. The *Hut House's* panels are subtly tapered, creating a rippling that reimagines the performance and aesthetics of Ghana's ITF Exhibition Hall in elevation. While visually less complex than *A Simple Factory Building*, its envelope nevertheless establishes spatial depth through the changing scales of its expanded-mesh assembly, the operability of the envelope (where windows are present behind), and its interface with protrusions for views (see Figure 20).

Ghana's ITF Exhibition Hall and Pasar Johar reveal an elemental architectural lexicon that celebrates the equatorial atmosphere: the roof unifies, and attunes one's sensibilities towards this, while the plinth becomes a symbolic elevation of this atmosphere. These tropes are employed within the *Stereoscopic House*, a waterfront bungalow with close adjacent neighbours. The scheme's primary device, a continuous spatialised envelope spanning all five elevations, mediates these concerns (see Figure 21).

The tight site demanded a stacked programme approach; its deep plan was bifurcated through a highly-sectional and pervasive big roof. This established a central courtyard that afforded visual and atmospheric connection between all floors. Materialised through a herringbone ironwood wrapper (sourced in Indonesia), and interspersed with operable perforated aluminium screens, this envelope is never fully opaque. It is a breathable and permeable surface[24] that entwines the domestic with the equatorial. This vocabulary creates the opportunity for angular-pitched overhangs and skylights – the former calibrates views towards both seascape, and landscape of an adjacent golf course (see Figure 22), while the latter, like the oculi of Pasar Johar, shape internal atmospheres through diffused and reflected daylight (see Figure 23).

Materially, the silver-patinaed ironwood is juxtaposed against a polished travertine plinth, and the machined translucent channel glass and transparent sliding windows between them. The latter conflates interior and exterior thresholds when fully opened; the equatorial air becomes elevated, and crowned by a bold roof.

Figure 21: A unifying and continuous big roof.

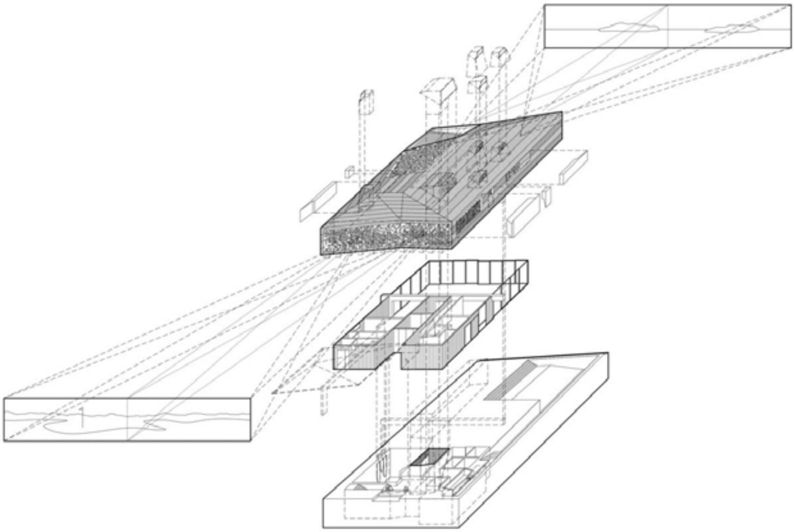


Figure 22: A calibrator of atmospheres and views.

Figure 23: Internal atmospheres through diffused and reflected daylight.

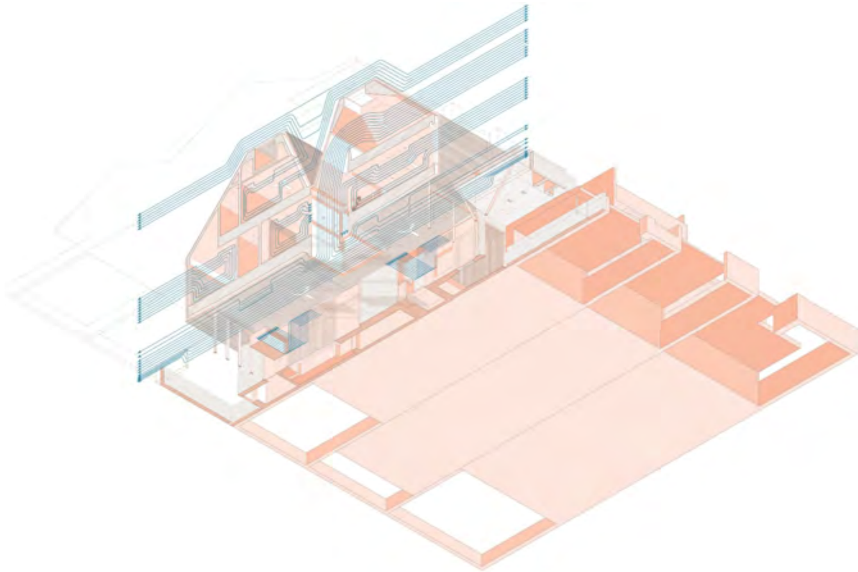


Figure 24: A section-driven design.

In *A Simple Terrace House*, one sees the cumulative influence of the historic precedents and the authors translational approach to design. Sandwiched within an urban block, the project adopts and refines many tropes employed within the *Simple Factory Building*, most significantly its section-driven approach (see Figure 24).

Consequently, the house's massing consists of two elevated pitched volumes, each containing private domestic spaces, that are arranged to form an open-air courtyard that bifurcates the home (see Figure 25 and 26). Through this, the naturally-ventilated ground floor, housing the home's reception space, establishes a periscopic relationship with the rest of the house. Performatively, this becomes a device that amplifies the effects of the ground floor's cross-ventilation and creates thermal stratification. Akin to the passive-cooling strategies of Pasar Johar, cool air collects on ground level, while hot air from the ground level and bedrooms are pushed upward through the courtyard as exhaust. As it was the case in Golconde, the house seeks to be a totalised product of the equatorial; this periscopic space, and the equatorial atmosphere it works with, becomes a celebrated architectural element, emphasised through the house's reduced palette of materials: off-form concrete and sculptural timber elements – most notably the louvered ceiling of the ground floor (see Figure 27), and a timber staircase that sectionally parallels the periscopic element.

Externally, the building's elevation and attic are performatively analogous to the double-layered roof of Ghana's ITF Exhibition Hall, functioning as a thickened layer that calibrates the movement of air. Its outermost layer, a continuous aluminium grate screen, wraps the two pitched volumes along one axis – an economical solution to thermal and visual privacy. Like the *Stereoscopic House*, the homogeneity of the envelope consolidates the house as a unified entity, while allowing for varying degrees of porosity and cross-ventilation through its secondary layer of masonry and fenestration. This screen also addresses the perennial challenge of long and narrow plans, that of maximising daylight penetration, while mitigating excessive thermal gain – it calibrates and camouflages a series of skylights and ventilation windows about the attic.

Superimposed with slight breezes and aural atmospheres from a nearby nature reserve, the equatorial atmosphere permeates the domus, in a manner reminiscent of the scenographic tropes of colonial bungalows. Materials, tones, and volumetric complexity are pared-down to amplify the atmosphere of light, ventilation, and thermal comfort, in a design that engages the hot and wet equator.

Figure 25: A porous continuous aluminium screen wrapping two pitched volumes along one axis.

Figure 26: The equatorial atmosphere as foreground.

Figure 27: Hot air as sculptural forms of air-flow.

Projecting the Equatorial

Normative architectural representations – the axonometric, and the plan – are tainted by temperate biases towards exterior enclosure, and the distinct separation between interior and exterior, by prioritizing the view from above and delineations of edges.

The worm's eye axonometric affords an alternative between the precision of orthographic projection, and the sensorial atmosphere of space. The worm's eye express the performative and atmospheric potentials of an equatorial underside, while revealing spatial richness and elevational complexity that would be camouflaged through a normative planometric projection, or simply obscured by the big roof if seen from above.

Likewise, the unfolded elevational model which includes roof and undersides, highlights the deep envelope as an architectural assembly to allow for porosity, view, shade and air to breathe across its surface. Calibrated with ornament and pattern, the deep envelope is a set of filters calibrated to its respective equatorial atmosphere.

As evinced in the four precedents, and the work of the author, the equatorial atmosphere demands an architecture that is concerned with deep, porous and amorphous envelopes, not only for its performative outcome, but also because they address the symbolic and ornamental – essentially transcending mere concerns and discourses of efficiencies. Mining, sampling, and redrawing historical precedents, through expressive and considered orthographic projections promises to reveal and distil forgotten architectural languages and techniques relevant to the hot and wet, while unravelling normative temperate prejudices that percolate the discourse of the equatorial, setting the foundations for contemporary practice.

References

[1] George Orwell, *Burmese Days* (Penguin UK, 2009), Chapter 5.

[2] The Author's research is framed about the atmospheric output of the *equatorial* – the hot and wet; the classification of the tropical climate is not sufficiently attuned to this lens, for its inclusion of the tropical savannah climate, which experiences a pronounced dry season that demands a differently-calibrated architecture.

[3] Atmosphere rather than climate is the preferred terminology in the Author's research, as the former encompasses the latter, while also taking into account other phenomenological concerns.

[4] Vitruvius, Ingrid Drake. Rowland, and Thomas Noble. Howe, *Ten Books on Architecture* (Cambridge: Cambridge Univ. Press, 1999), Book VI, Chapter I.

[5] Eva Horn, "Air Conditioning: Taming the Climate as a Dream of Civilization," *Climates: Architecture and the Planetary Imaginary*, 2016, http://averyreview.com/issues/16/air-conditioning.

[6] Certainly, there are post-colonial narratives that resurrect vernacular forms of architecture, as a resistance to the forces of modernisation, technological solutions and the temperate prejudice, but these are beyond the scope of this paper.

[7] Kenneth Frampton, *Modern Architecture: A Critical History* (London: Thames & Hudson, 2014), 314.

[8] United Nations, World Cities in 2016 (United Nations, 2016), 4.

[9] Ralph T. Walker, critical of temperate hegemony within the discourse of modernism, deemed the International Style as such following the seminal MoMA show that catalogued that movement. Alexander Tzonis, Bruno Stagno, and Liane Lefaivre, *Tropical Architecture: Critical Regionalism in the Age of Globalization* (Chichester: Wiley-Academic, 2001), 20.

[10] There is an equally powerful postcolonial discourse seeking to resurrect the local and the indigenous as a counter-narrative. This paper looks not within this important counter-narrative, but within the fringes of architecture along the equator that tried to reconcile modernism, atmosphere, and aesthetics right before the advent of air conditioning.

[11] Literally, Johar Market, *Pasar* is Indonesian for bazar or market.

[12] Pasar Johar bears structural similarities to Robert Maillart's beamless mushroom-slab construction technique, first deployed in 1910 in the Zurich's Giesshübel warehouse, and subsequently in Altdorf's grain storage facility in 1912.

[13] Ukasz Stanek, "Architects from Socialist Countries in Ghana (1957-67): Modern Architecture and Mondialisation," *Journal of the Society of Architectural Historians* 74, no. 4 (2015): , doi:10.1525/jsah.2015.74.4.416.

[14] Subud is framed about the practice of *latihan*, a highly-individualised meditative exercise, the process of which must be enabled and initiated by another practicing member of the movement, in a formal ceremony referred to as the "opening". The purpose of the latihan is to attain awakening by the Power of God, leading to spiritual reality free from the influence of the passions, desires and thinking

[15] "Riwayat Singkat - Brief History," GRC Widjojo, 2004, , accessed April 08, 2018, https://web.archive.org/web/20110220043605/http://www.grcwidjojo.com/about_history.htm.

[16] The previous section, "The Hot and Wet Big Roof", explores projects that achieve this.

[17] A total work of art; Peter Behrens wrote, "Art is symbolic… its diversity leads towards the infinite, the unfathomable… architecture is bound to the earth, but through its spirit it seeks a unity with the cosmic whole".
Christian Hermansen and Mari Hvattum, *Tracing Modernity: Manifestations of the Modern in Architecture and the City* (London: Routledge, 2004), 162, 164.

[18] Sri Aurobindo Ashram is a spiritual community founded in Pondicherry by Sri Aurobindo, that advocated a spiritual practice called Integral Yoga, in the pursuit of attaining divine life on earth

[19] Antonin Raymond writes, "the purpose of the dormitory was not primarily the housing of the disciples; it was the creating of an activity, the materialization of an idea [of the human life evolving into the divine], by which the disciples might learn, might experience, might develop, through contact with the erection of a fine building."
Georges Van. Vrekhem, *The Mother: The Story of Her Life* (HarperCollins Publishers India, 2000), 274.

[20] Exterior Insulation Finishing System: Light weight fiberglass stucco over expanded polystyrene

[21] Envelope thermal transfer value (ETTV) calculations for the building's envelope design indicate a 28.25W/m2, for full height glazed single pane window walls; exceeding the thermal performance standard Green Mark Platinum for new air-conditioned office buildings in Singapore.

[22] Vimita Mohandas, "Land Is a Resource That Must Be Managed Carefully: Heng Swee Keat," Channel NewsAsia, March 18, 2017, , accessed April 11, 2018, https://www.channelnewsasia.com/news/singapore/land-is-a-resource-that-must-be-managed-carefully-heng-swee-keat-8251928.

[23] The Singaporean narrative of a "garden city" demonstrates the lasting legacies of temperate conceptions of the equatorial as an exotic paradise, while paradoxically also implying the ability to discipline and contain nature, espousing an ingrained attitude towards the equatorial aligned with the temperate sensibilities of its former colonial masters.

Timothy P. Barnard, *Nature Contained: Environmental Histories of Singapore* (Singapore: NUS Press, 2014), 296.

[24] The ironwood timber plans are joined by battens and biscuit joints, and are offset from their internal elements, creating an air gap between internal and external elements that reduces thermal transmittance and allows for effective rainwater runoff.

ADR18

Disruptive Action Research

Chaired by Prof. Michael Tawa

RISE: A Case Study for Design Research in Informal Settlement Revitalisation Interdisciplinary Design Research in Informal Settlements

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Abstract

This paper reflects on the strategies and challenges of RISE (Revitalising Informal Settlements and their Environments), an on-site slum-upgrading program focusing on human and environmental health. RISE is a five-year action research program that adopts an integrated approach to water-sensitive revitalisation of informal settlements and investigates its environmental and human health impacts. Funded by the Wellcome Trust and the Asian Development Bank, the program's primary goals are to improve sanitation, mitigate flooding and improve dwelling and open space provision. Beyond health research and assessment, the program includes the development of a series of integrated urban design interventions for two pilot sites and 24 informal settlements in the cities of Makassar (Indonesia) and Suva (Fiji), based on a design philosophy of community engagement, multi-functionality, and adaptability. The solutions are co-developed with communities through an extensive process of co-design and engagement with work from a diverse interdisciplinary team, which includes experts from engineering, ecology, hydrology, architecture, landscape architecture and community engagement. The design interventions will take place in three rounds. The first round uses the pilot sites as a proof-of-concept to test the effectiveness of the design approach in informal settlement revitalisation. The second includes the development and implementation of interventions in six settlements in each of the cities. In the third, the design process is iterated for the remaining six settlements in each city. The paper examines aspects of the action research in the design and delivery of revitalisation projects, focusing on the pilot project in Makassar. It reflects on the development of the intervention for a small community located in the subdistrict of Batua in Makassar, Indonesia and the challenges that informed the final design.

Introduction

The challenge of informal urban settlements and health

Urbanisation is a major demographic trend globally. Informal settlements, which constitute much of the Global South's urban growth and one billion people worldwide, are generally established through processes that occupy undeveloped land.[1,2,3] The land can be high-risk, of ecological and biodiversity significance, and often unsuitable for residential development because of proximity to waterways and floodplains, steep hillsides, and interstitial spaces[4]. Along with poor environmental and socio-economic conditions, informal settlements are especially vulnerable to ill health. Beardsley and Werthman remarked that beyond climate change, "there are few greater challenges to widespread planetary health and security than the vast proliferation of [informal] settlements".[5] Over the past decades, the predominant strategies for addressing informal settlements have shifted from relocation and clearance to on-site upgrading and improvement.[6] However, although there is broad agreement that on-site revitalisation has better social and community outcomes, a number of challenges emerge from supporting communities in place.

This paper discusses the strategies and challenges of RISE, an on-site slum-upgrading program focusing on human and environmental health. On-site revitalisation presents a combination of issues relating to land ownership and tenure, along with servicing challenges and environmental risks such as flooding.

A Global Challenge - Planetary Health

A growing body of evidence shows linkages between human health and the health of the environment.[7] The planetary health approach explores the interdependency of the health of human civilization and the state of natural systems.[8,9] The RISE Project takes planetary health principles as its modus operandi, exploring the interlinking and interdependencies of changes to the built environment vis-à-vis health outcomes.

Human and Environmental Health Challenges in Urban Slums

Human health issues in slums are significant. UNICEF and WHO have reported that more than 663 million people lack access to safe drinking water, and 159 million rely on surface water for their water consumption.[10] 2.4 billion people lack access to sanitation facilities. Inadequate water supply, sanitation and drainage in crowded environments lead to faecal contamination of soil and water,[11] which predisposes residents to diseases, intestinal inflammation, stunted growth, and poor cognition.[12] Studies have shown that drinking water and sanitation facilities at the household and community level affect diarrhoea prevalence among children under five,[13] along with mothers' behaviours (such as handwashing) and education levels.[14] Though subsistence agriculture and animal keeping can benefit low-income families, sources of bacteria and contamination within the environment - such as soil in chicken coops, and greywater used for irrigation - can cause ill-health.[15,16] Meanwhile, settlements close to waterways and water-logged or poorly drained areas are subject to mosquitoes, rats and other vectors, increasing risk of vector-borne diseases.[17,18,19] As urban populations expand, the prevalence of vectors and their related diseases does too.[20]

The RISE Project

The RISE project seeks to repair informal settlement environments by providing an alternative, water-sensitive approach to their revitalisation. It examines informal-settlements and the conditions affecting human and environmental health and proposes integrated strategies for their revitalisation. The project, comprising an interdisciplinary team working in partnership with local communities, NGO's and Governments, focuses on 26 informal settlements in Makassar (Indonesia), and Suva (Fiji). The project sites are variously characterised by combinations of tidal inundation with occasional storm surges, fluvial and pluvial flooding, and poor drainage. In addition, sites suffer from intermittent water supply of varied quality and inadequate or absent sanitation systems. This results in high rates of exposure to environmental faecal contamination.

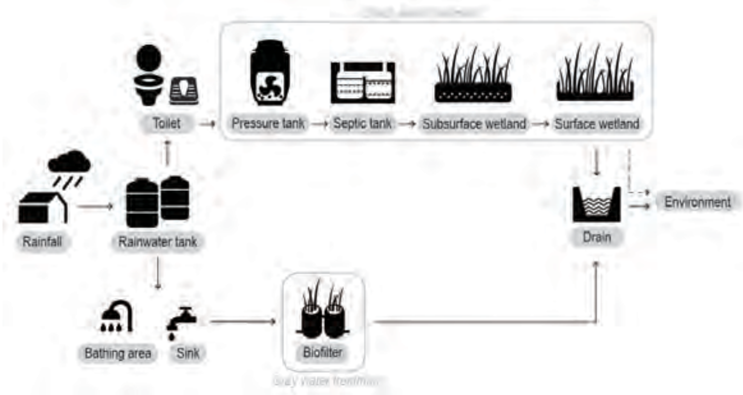

Figure 1: The RISE water sensitive cities system.

The RISE Approach

Within the context of planetary health, the team views the cumulative effects of the water cycle in informal settlements as a critical factor aggravating the associated challenges of poor environmental quality and human health. Funded by the Wellcome Trust's 'Our Planet Our Health' initiative and the Asian Development Bank, RISE will address these challenges by developing and implementing precinct-based interventions resulting in a sustainable water-supply, increased sanitation, improved flood protection, environmental stewardship, and greater resilience to effects of climate change. Design is a common ground for scientists and practitioners to bring scientific knowledge into decision making about landscape change.[21] The project will use a range of tools and methods from both science and design practice to design and implement this adaptive water-sensitive urban infrastructure (Figure 1). These include environmental modelling (i.e. catchment hydrology) and action research supported by design research principles. Action research - a method used for improving practice – involves action, evaluation, and critical reflection. Changes in practice are implemented, based on the evidence gathered. [22,23] This is particularly appropriate for the RISE project, which involves the site-specific improvement of environmental conditions - specifically related to factors influencing the health of the community. The design interventions of the RISE project operate on varying scales – from dwelling, to neighbourhood, to precinct. They include built elements, such as sanitation and rain harvesting facilities, green infrastructure, and community engagement models for households, focus groups and communities. Through these multi-scalar, site-specific water-management systems, the project targets human and ecological health challenges to mitigate water-borne disease.

The paper examines aspects of the action research into the design and delivery of revitalisation projects, focusing on a pilot project in the subdistrict of Batua, Makassar. The following sections reflect on the development of a small community pilot project and the challenges that informed the final design. The work discussed is the result of a collaboration between RISE researchers and practitioners in Melbourne and the RISE team in Makassar between August 2017 and May 2018.

The Makassar City Context

The city of Makassar is located in South Sulawesi in Indonesia. The city has a land area of 17,577 hectares and a population of 1.4 million people,[24] expected to increase 20% by 2020.[25] High population density and limited land availability place constraints on the city's existing sanitation system.[26] Water supply is also a major challenge, with distribution infrastructure limited and supply intermittent.[27] When mains water is unavailable households use alternative sources such as rainwater, bore water and shallow wells for non-potable uses. Population growth and urbanisation exacerbate these conditions. Water cycle management is particularly important to the outlook of Makassar's informal settlements, with many of them located in tidal areas, along the coast or rivers,[28] and who are even more vulnerable to the above issues.

The Batua Pilot Project

The Batua pilot project was developed to demonstrate the types of interventions envisioned in the RISE program to its key partners: central and local government, ADB, academia and the communities. The pilot helped the project team and stakeholders understand the processes required to deliver the intervention, and the implications, costs, construction timelines, and other operational aspects. The lessons from the pilot will guide the design and implementation of the project in the main twelve sites in Makassar.

The site context

The local water catchment defines the precinct-scale (Figure 2). It is bounded on three sides by canal inspection roads, which service a city water supply canal (wrapping around from North to East), and a stormwater canal (running East-West and framing the site to the South). The neighbourhood (Figure 3) has 47 residents, with an average household size of 4.27 with an average of 2.45 children per household. Most men are employed as day-labourers and women are homemakers. The site is informally subdivided into 22 parcels, half are developed with housing (Figure 3). This is mixed in quality, and most are raised on stilts for flood protection.

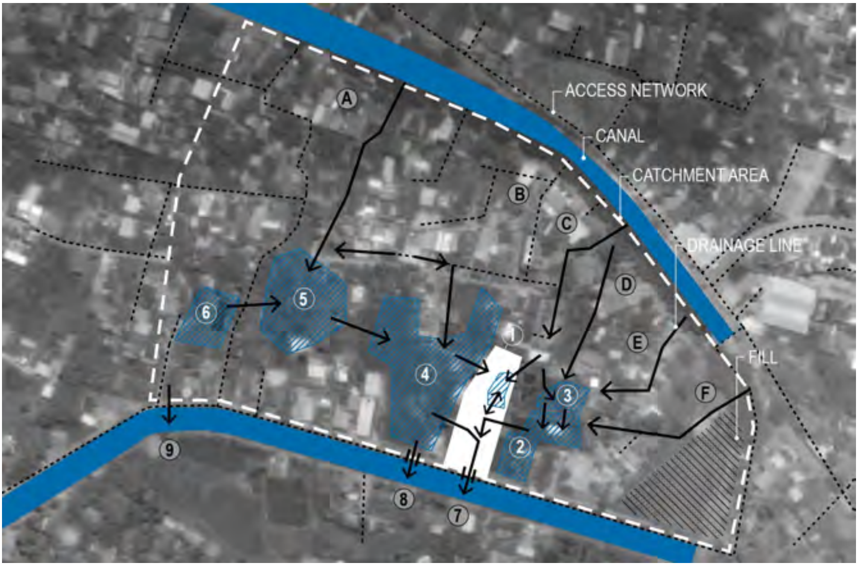

Figure 2: The Precinct is marked with a dashed white line, and the pilot site is shaded in white. Waterways and catchments are indicated in solid and hatched blue, respectively, and existing culverts discharging to stormwater canal (not all functional) are shown at 7, 8, and 9.

Figure 3: [Left] Aerial view showing site layout. The stormwater canal (at top) shows signs eutrophication caused by the presence of excess nutrients, such as sewerage; [Right] Typical view of dwellings within the pilot site.

Integrated Urban Design Approach

The project team conceived the design as a holistic and integrated approach to improving access to water, wastewater treatment, flooding and access simultaneously. The team included experts from engineering, ecology, hydrology, architecture, landscape architecture and community engagement. Figures 4 and 5 capture the final proposed intervention, developed by the project team with the community and local government.

The participatory process ensured community support of the proposal, and resulted in community contributions – such as land donation and community contracting for construction works. As a result, the access easement is extended from three- to five-metres through land donation to accommodate the green infrastructure, vehicular access, and to support future growth of the settlement. The community reviewed the design, ensuring project delivery without demolition of existing structures.

The process also resulted in the local government funding elements outside the scope of the RISE program. These are part of a second construction phase, completed in the remaining one and a half metre-wide strip of donated land (Figure 5). The works include permanent access (stairs and ramps) to houses and undercrofts; trees, benches and open spaces for improved public amenity; path lighting; a solid waste management system; and the sanitation management system for the anticipated future development.

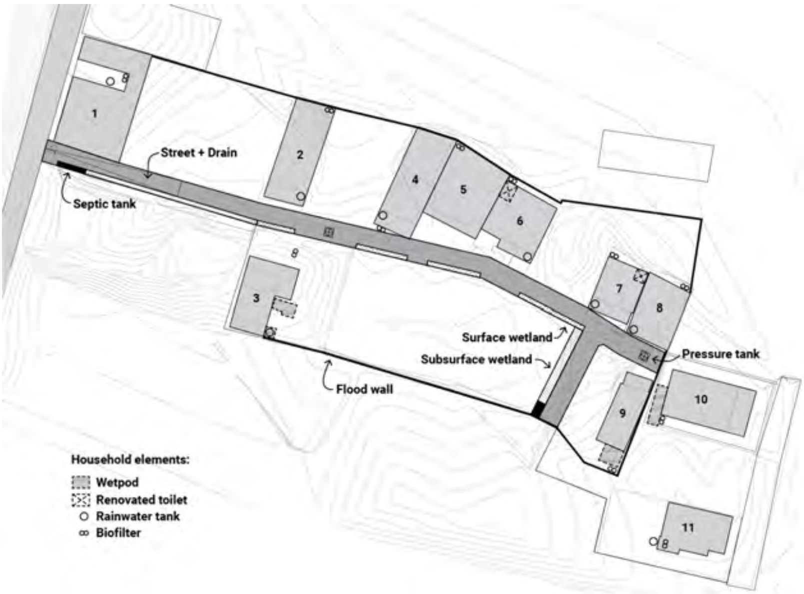

Figure 4: Plan of the water-sensitive cities approach for Batua, Makassar. (North oriented to right).

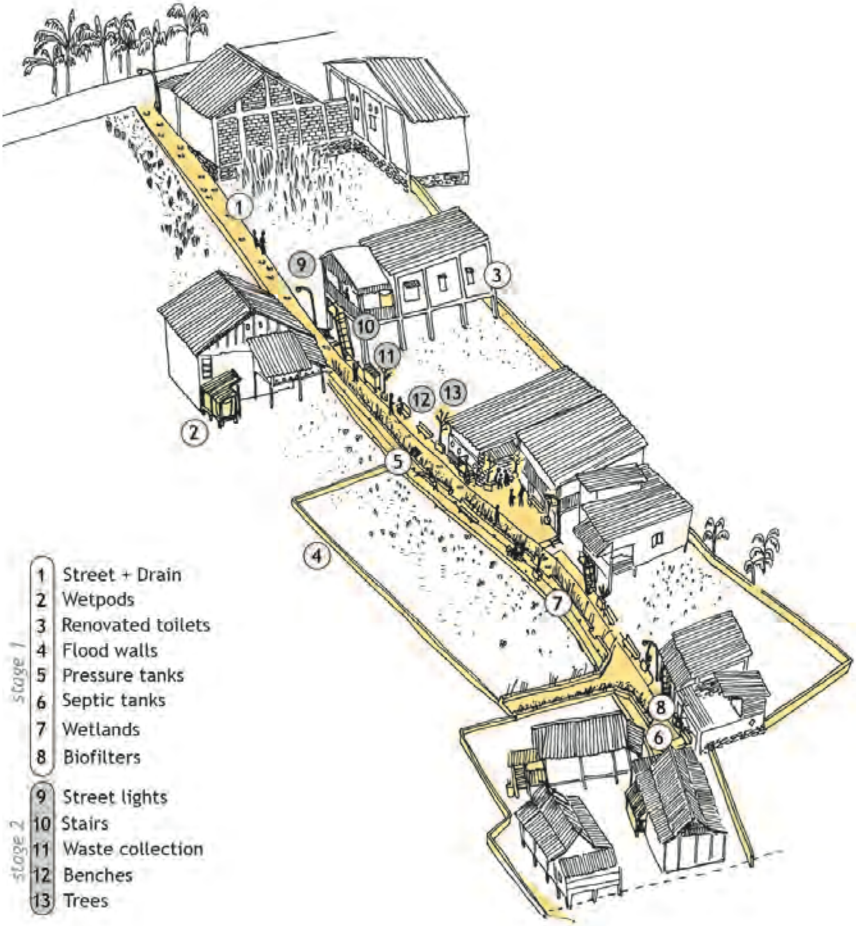

Figure 5: Axonometric of the water-sensitive cities approach for Batua, Makassar. Intervention in yellow, illustrating Stage 1 elements funded by ADB and Stage 2 elements funded by local government.

Drainage Strategy

The precinct-level hydrological analysis shows several connecting areas drain into the site, with water discharged to the canal through a culvert. The site is regularly flooded during the wet-season, which residents report occurs during heavy rains when the canal overtops. Floodwaters reach a maximum depth of 120cm, and remain up to three days before draining. During the wet-season residents use rafts and erect a makeshift elevated pathway constructed of bamboo.

Figure 6: The neighbourhood [left] is flooded during the wet-season [right].

Although the project team acknowledged that flooding was a larger regional challenge, beyond the scope of the RISE intervention, a series of external (precinct) and internal (neighbourhood) changes could improve the situation and reduce contamination pathways.

The hydrological analyses inform a range of water management interventions for precinct flood protection and drainage (Figure 7). These include a flood diversion wall to the western side of the site, and a series of new culverts with floodgates to control drainage into the canal. Meanwhile, water management interventions for the settlement are integrated, including a flood-wall, a raised path with covered drain, an improved culvert to the canal, and natural surface drainage (Figure 7). These strategies are complemented by the precinct-level improvements.

The path is elevated one-metre above the lowest point of the site (Figure 8). This allows its surface to be trafficable most of the time - for pedestrians and motorcycles, and for emergency vehicles. It also recognises community aspirations for neighbourhood development, which include future access extension to the east and the process of infill.

Figure 7: Flood protection strategies at Precinct and site levels. The Precinct is marked with a dashed white line, and the pilot site is shaded in white. Waterways and catchments are indicated in solid and hatched blue, respectively, and improvements such as floodwalls and culverts in yellow.

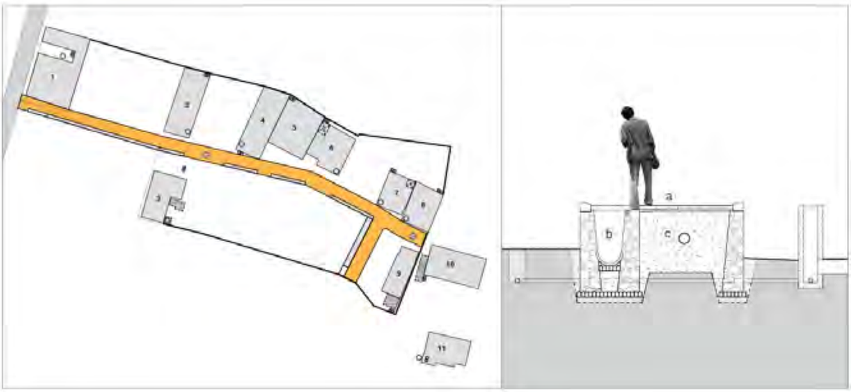

Figure 8: Integrated drainage within path and at-grade drains for surface water.

Sanitation Management Strategy

While most of the houses have private toilets with manual flush, some are in poor condition. The blackwater runs into belowground tanks, which are unsealed and allow effluent to leach into the soil contributing to the contamination of shallow wells. Greywater and solid waste are discharged to the surrounding environment. They mix with floodwaters during heavy rains, compounding the risk of well contamination and overall public health impacts.

The project includes toilet improvements to two dwellings and three new 'wetpods' (consisting of a toilet, a bathing area, hand basin and rainwater tank). A range of different wetpods were developed to suit access requirements, and orientation of dwellings. Through the co-design, these were discussed with households and adapted to suit houses on the site (see Figures 9 and 10).

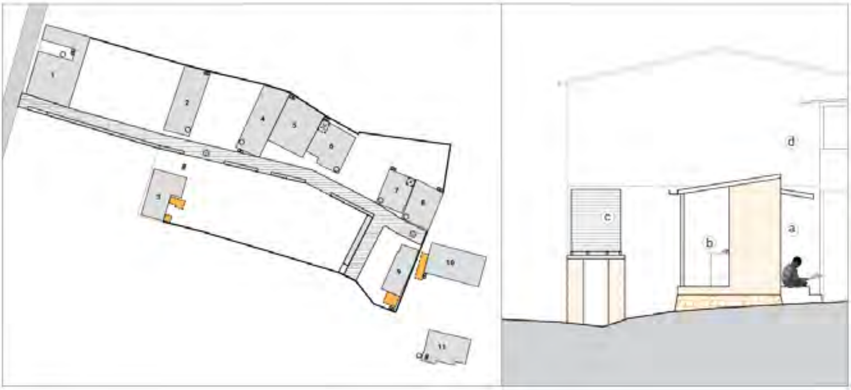

Figure 9: [Left] Wetpod strategy illustrated in plan shows new wetpods in orange, provided to buildings 3, 9 and 10. [Right] Section showing a wetpod with detached rainwater tank adjacent to an existing building.

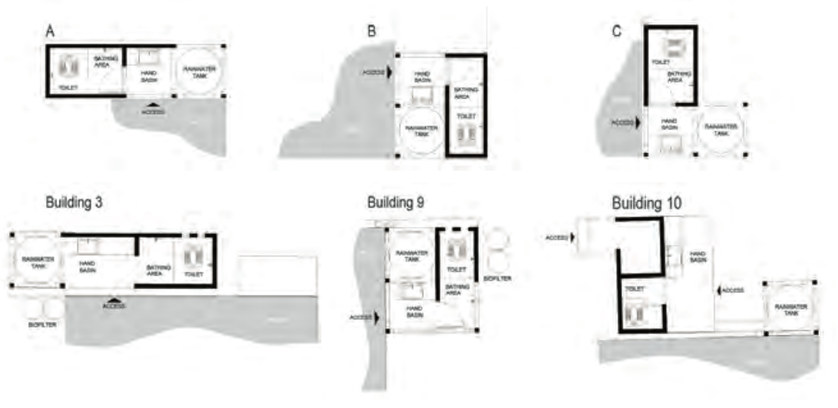

Figure 10: A, B and C demonstrate the original wetpod types and the plans for buildings 3, 9 and 10 illustrate how the wetpods were adapted to address the existing configuration and household requirements.

All existing, new and improved toilets are connected to the blackwater treatment system (Figure 11). This purifies the effluent before discharge to the environment. Effluent from household toilets flows by gravity into two community pressure tanks (each servicing five to six houses, Figure 12), and is pumped to a community septic tank (Figure 13). Effluent then flows by gravity into sub-surface wetlands for secondary treatment, and to surface wetlands for final treatment before discharge into the covered drain along the elevated path. The core infrastructure - pressure tanks, septic tanks, subsurface and surface wetlands - are located along the path, safe from regular inundation. The wetlands are in narrow, easy to maintain, boxes along the road (Figure 14) with breaks accommodating access to existing, and future houses. Household greywater is piped to individual biofilters for purification, then to the covered drain. The biofilters are two joined 200-litre drums, which are readily available and allow compact, replicable treatment (Figure 15).

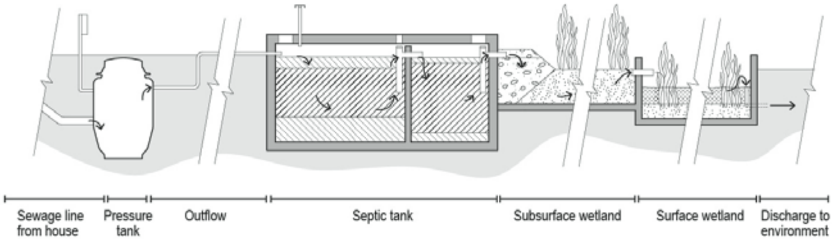

Figure 11: RISE blackwater treatment train.

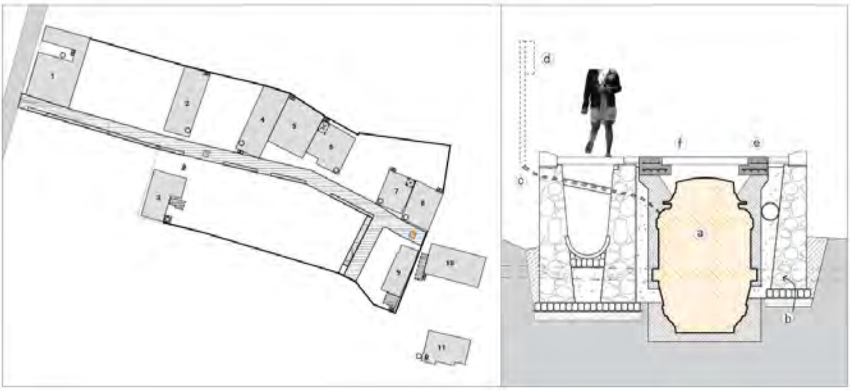

Figure 12: [Left] The settlement receives two pressure tanks within Phase 1; [Right] Community pressure tank within path profile.

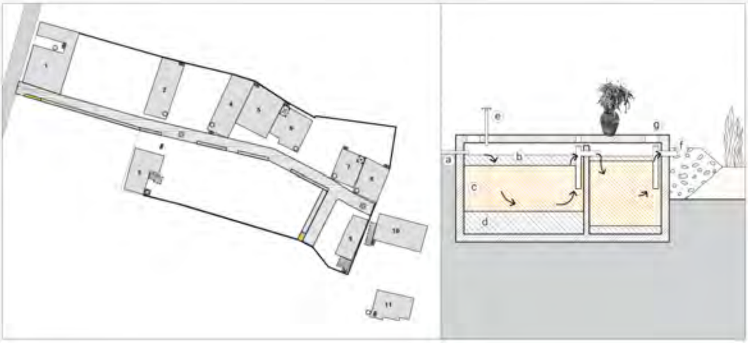

Figure 13: The septic tank is located in the donated one-metre strip to the West of the path.

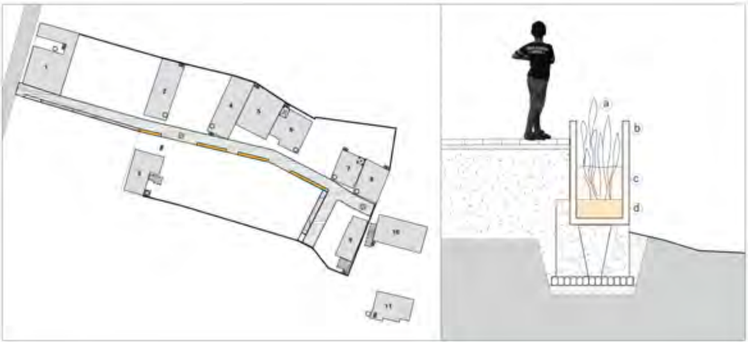

Figure 14: The surface wetlands are located in the donated one-metre strip to the West of the path.

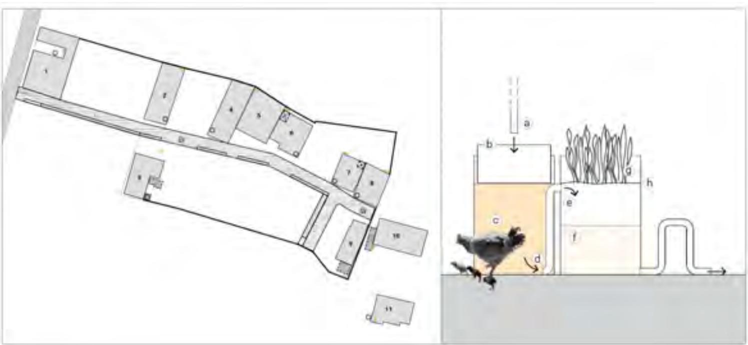

Figure 15: The greywater treatment biofilters are located adjacent to each house and constructed from readily available 200-litre drums.

Water Supply Strategy

Only a few houses have direct connection to municipal water, others have connections via other households or businesses. Although households drink bottled water and boiled mains water, residents have identified this as a significant cost.

The project improves access to potable water. Municipal supply is piped to lot boundaries, and households are responsible for their own connection. Each house receives a rainwater tank, which supplies water for washing, bathing and flushing toilets (Figure 16). The tanks can reduce both the costs of water supply and surface water runoff to the site.

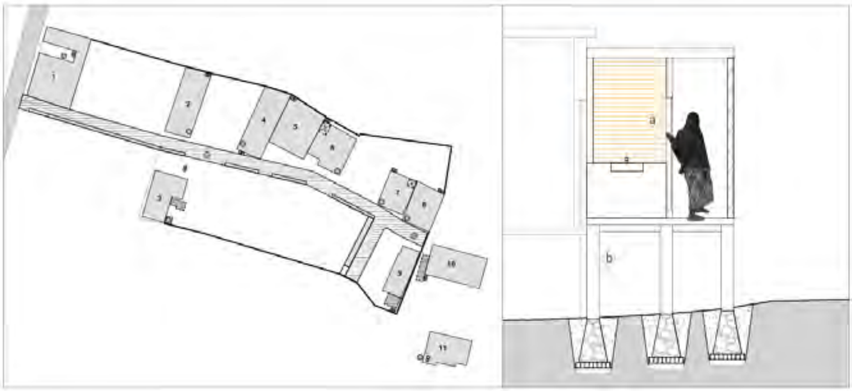

Figure 16: Households receive rainwater tanks to diversify water supply and reduce stormwater runoff.

Challenges

The RISE pilot project in Makassar responds to a range of challenges at play when conducting design research within the informal settlement context. These include a combination of socio-political, technical and environmental issues. The following section outlines some of the challenges encountered and how the response to these informed the design approach and decision-making process for the pilot site.

Socio-political challenges

The socio-political issues encountered vary in scale, from the local community, and the local government, to the capital works funding.

Ambiguous land ownership and title boundaries

The complicated land tenure and ownership arrangements within the site - resulting from an informal subdivision process – meant that property boundaries were neither orthogonal nor legible, and in some cases exceeded. The project team approached this in a number of ways: establishing a common understanding of property boundaries through an onsite boundaries mapping exercise, and through community visioning sessions to understand the community's aspiration in terms of public infrastructure and amenity.

Lack of public land

There was little available land for public amenities and for infrastructure delivery in the pilot site, a condition typical of resource-constrained settlements. In this setting, donation was required for the provision of green infrastructure and public amenities beyond the private realm. While the community were enthusiastic and supportive from the outset, the team encountered some resistance due primarily to a lack of comprehension of the overall benefits. To guide this process and the tensions associated with land donation, effective communication and engagement with community was essential. Through this process, households voluntarily donated one-metre of land adjoining the path, so the path could accommodate vehicular traffic, public amenity and water and sanitation infrastructure.

Exemplar slum upgrading programs

Reference to and alignment with similar existing government programs proved to be helpful in delivering the design. The Neighbourhood Upgrading Shelter Program (NUSP) projects,[29] implemented in Indonesia since 2005 has established a positive precedent of community land donation and co-contribution to projects. Referring to NUSP and understanding its operations facilitated the process of community consultation leading to boundary delineation and land donation.

Government stakeholder engagement

Like many informal settlements in developing cities, the neighbourhood established on low-value land caused by difficult access and hazardous flood conditions. Because of the infrastructural focus of the intervention, the team engaged with multiple government groups to resolve planning issues: from State level, such as land-use change, to Provincial level, such as flood gate implementation along a canal under Central Government jurisdiction. In addition, engagement with sub-district authorities was important to understand operations and maintenance of public infrastructure. It has been important to develop good partnerships with Government ministries from the beginning to ensure support of the strategies and vertical coordination between government levels to achieve a good outcome.

Donor funding requirements

The capital works funding, supported by the Asian Development Bank (ADB), was constrained to elements directly relating to the delivery of the water infrastructure and had a number of protocols relating to its use (for example, exclusion of works to houses). Because of the community visioning exercises and workshops with local government, co-funding with the city of Makassar was explored for financing additional infrastructure and elements. To ensure timely delivery of the works, unaffected by political cycles, the team developed delivery through two separate civil works packages with clearly marked responsibilities and funding lines.

Technical challenges

The pilot project revealed a range of technical issues relating to the detailed engineering design and delivery of the project and its timeframes.

Working in data poor environments

Limited data is available on the physical environment, for example cadastre information, water quality, groundwater condition and recharge levels, river flows, and water consumption patterns. In most cases, data record periods are not continuous, or are inaccurate.[30]

Construction constraints

The water-sensitive approach within the informal settlement context is novel and requires a high degree of construction precision in specific locations to ensure achievement of effective gravity flows.

Environmental challenges

The pilot project revealed a range of environmental issues relating to the locations of settlements and their physical environment.

The project highlighted the environmental impact of urban settlements, particularly when considering improvement in-situ versus relocation. The process of informal development in the pilot site, land reclamation via infill, caused the loss of a retention basin. The neighbourhood remains vulnerable to climate change impacts on the hydrology of the larger catchment. The project team developed a precinct-wide hydrology response to ensure the minimisation of catchment impacts on the site, while ensuring that responses would not exacerbate hydrological issues in the region.

Some conclusions and strategies for further work

The challenges encountered in the pilot project in Makassar, alongside a similar pilot project in Suva not discussed in this paper, provide valuable lessons for future work in the 24 RISE settlements in Indonesia and Fiji. In order to deliver a large number of interventions in these unknown and dynamic environments the team must develop cohesive methods and tools for action. The final section outlines some of these strategies.

Build strong technical and community engagement and co-design teams in country

As the intervention involves a new approach to decentralised infrastructure provision, the team is committed to procuring and training in-country technical staff for detailed engineering design, construction and supervision to meet requirements and specifications. In addition, without baseline information to inform hydrological modelling and design interventions, the team is developing tools and infrastructure for data collection and management. These include field mapping and documentation frameworks partnered with the community (to determine property boundaries, flood levels and contamination sources), and training the local teams to use drones to capture frequent geometrically corrected aerial photographs of the site which can be used to document changing conditions such as development and floods.

Develop early and continuous engagement frameworks with community and government stakeholders to ensure buy-in and ongoing support for the project

As resource constrained governments struggle to keep up with the pace of development of informal settlements, they often ignore new developments. Land regularisation and infrastructure provision in the context of informal settlements requires new planning approaches and communication and engagement frameworks with numerous public authorities (central, provincial, state and local).

Develop models or templates for adaptation to local context

The team is developing guidelines for the adaptation of nature-based water-sensitive technologies to dense, informal urban settings. This will include using hydrological models to understand catchment hydrology and dynamics to ensure appropriate responses. The process for adapting these responses to specific conditions across a diverse and complex array of contexts will require effective dialogue with communities and stakeholders. Co-design processes are integral to develop trust, common visions and ownership for the projects. The team is developing guidelines for these processes from lessons learned. These include tools and procedures for community engagement ensuring informed consent and inclusion. This should include a kit of parts for physical elements of water sensitive cities - wet-pods, wetlands, septics, flood mitigation and drainage - relating to site topography, land availability, water stressors and contamination exposure. Then, streamlined design options can easily accommodate community and household preferences.

This paper has reflected on the approach, challenges and strategies of the RISE project undertaken by the ICL. It examined aspects of the action research in the design and delivery of slum revitalisation projects, using as an example the pilot project in Makassar. Given the challenging project contexts and requirements, robust and resilient approaches are necessary. The lessons from this pilot phase have instituted a firm foundation and strategies that will be significant in the next round, which will iterate the process within the first 12 neighbourhoods across the two cities.

Acknowledgements

This paper draws on lessons learnt from the research activities of the ICL on the RISE project. It incorporates information from a range of project documents, including mission reports, technical drawing sets, and engagements with communities. These documents included contributions from the project team – Diego Ramirez-Lovering, Michaela Prescott, Hesam Kamalipour, Mohamed El-sioufi, Tony Wong, Peter Breen, Kerrie Burge, Christian Urich, Ashley Wright, Dasha Spasojevic, Brendan Josey, Erich Wolff, and Mahsa Mesgar - with support from the Makassar In-Country team including Ihsan Latief and Jane Wardani. The authors extend their sincere gratitude to local leaders, city and national government counterparts, and in particular, to the pilot project community for their time, support and contribution to the program.

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New Geographies of Violence

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Abstract

This paper examines the design research methodologies of Studio Grandeza by analysing the material, discursive and representational qualities of their two latest design research projects.

In recent years, architectural discourses have shown an increasing interest in tackling global issues that go beyond the traditional scale of the built environment. The two analysed projects designed by Studio Grandeza in 2017, *The Plant* and *Valparaiso Post-Liberal* (in collaboration with Miguel Rodriguez-Casellas) explore the idea of the installation as a "one-to-one architectural model" that stages, performs and debates new geographies of violence in the neoliberal era.

The Plant, exhibited at the Wagga Wagga Art Gallery in 2017, interrogates the forces that have re-shaped contemporary Australian agricultural landscapes. Established as a 'travelling parliament' through a combination of found, adapted and designed objects, *The Plant* incorporates human and non-human actors into the decision-making process for the future management of the Travelling Stock Routes.

Valparaiso Post-Liberal was exhibited at the XX Chilean Biennale of Architecture and Urbanism. The installation challenges the incapacity of liberal bureaucratic institutions to recognise and incorporate cultural heterogeneity and otherness into the production and transformation of urban landscapes. The installation enacts an electoral process in which 272 political proposals, subject to public scrutiny, imagine the transformation of Valparaiso into a Post-Liberal urban prototype.

Questioning the passivity of cultural consumerism and challenging the binary relationships between audience and artwork, the two installations move beyond traditional forms of architectural representation and invite the audience to perform an active role in the production of space.

The research methodologies described in this paper seek to provide new perspectives to the debates around practice-led research. We narrate a process in which research, discourse and design are articulated and juxtaposed through a process of collective discussion and hedonistic creation.

Introduction

This paper examines the design research methodologies of Studio Grandeza by analysing the material, discursive and representational qualities of their two latest design research projects, *The Plant* and *Valparaiso Post-Liberal*.

Both installations were exhibited in 2017. This paper describes them as one-to-one scale architectural models that stage, perform and debate new geographies of violence associated with late capitalism practices. Situated within the field of critical spatial practice, these works contrast the presence of spatial violence with the seduction of luxurious and excessive atmospheres, thus confronting the audience with an ambiguous magnetism.

Ultimately, the spatial interventions aim to turn the audience into performers. These onlookers are included into the core of the production of space and are invited to participate in the construction of alternative political narratives and to discuss the ways we can live together in a fast-changing world.

In this paper, we will make a close reading of the two projects and narrate how research, discourse and design have been articulated and juxtaposed in multiple ways. A multiplicity of meanings has been constructed at the intersection of uncertain realities and feasible fictions. In light of this, the narration of the events will take place at this intersection. Research material, political positions, design processes and fictional readings of the works will help us to better illustrate the projects and our intentions.

None of the presented projects in this paper started as a self-directed enquiry, but as a discursive and critical response to specific curatorial questions and commissions. As we will see in both cases, the research questions formulated by the curators took us to the periphery of the research projects that we were working on. This apparently fragile position meant that the projects were simultaneously informed by previous research works and open to further study and artistic interpretation. Thus, the gaps between our knowledge in the field and the proposed questions represented a space of uncertainty where creativity, collective discussion and design converged.

In order to respond the curatorial questions, we appropriate the use of the performative strategies that once were used in architecture to question the cultural and political assumptions of its time (like the political theatre of Bertolt Brecht, who called himself an architect). We combine this with the aspirations of the Situationists of making artistic creations that perished in the impact that they produced; and with the irreverence and apparent absurdity of the Dada gesture, which was capable of challenging artistic conventions and position the audience in a state of pleasant discomfort. Through an architectural pastiche that comprises different architectural, artistic and linguistic expressions (from different movements and times) we intend to talk, with the most serious absurdity, about the present.

Case Study One: *The Plant*, Wagga Wagga Art Gallery, 2017

Contextual Framework

The Plant, displayed at the Wagga Wagga Art Gallery in 2017, was one of the works that the New Landscapes Institute commissioned to nine artists and architects to reflect on the past, present and future of the Australian Travelling Stoke Routes.[1] The curatorial team contacted Grandeza when they came across "Transhumance",[2] a previous research project about the contemporary situation of Spanish transhumance, a semi-nomadic shepherding practice with a presence on the Iberian Peninsula since the early times of animal husbandry.[3] The curatorial team was interested in having international input for the discussion. The conversations about this project started as a twofold request. Firstly, they commissioned us to design a series of artefacts as physical support for the research, which the chief curator, Joni Taylor, had produced for the exhibition.[4] A series of maps, texts and audio interviews would need to be integrated into the installation. Secondly, the curatorial question required us to develop those artefacts as an artwork. The installation would reflect on our own research about the contemporary condition of the Australian Travelling Stock Routes. More specifically, they wanted us to unravel what the contemporary plant was. The plant is a term that refers to the ensemble of human, animal and technological resources involved in the tradition of moving stock across the country, facilitating the transportation of food, energy and shelter.

After the first conversations with the curators and other artists, we noticed that many of them were sentimental about Australian agricultural landscapes. There was a nostalgia for the paths (the stock routes), which were shaped over the course of time through the movement of cattle flocks. These routes were shaped in the form of long horse-driven routes at the beginning of the colonial times, and the recommendation of the indigenous population, who better knew the country, was fundamental in many cases to find the best corridors to access pasture and water. For us, their romantic perspective represented what Zygmunt Bauman describes in his posthumous book as a *retrotopia*: a form of utopia that idealises the past for the simple fact of being past, a common trend amongst Western cultural thinkers.[5] This perspective wasn't unfamiliar; we had seen it expressed before in the cultural and artistic practices that respond to environmental and picturesque landscapes. But instead of approaching the project from an eco-nostalgic perspective, we decided to reveal and stage the contradictions and the violence hidden behind the seductive beauty of the Australian countryside.

During the twentieth century, a constellation of pioneering farming and transportation technologies shifted the scope of the Australian Travelling Stock Routes from a territorial to a planetary scale.[6] Today, the movement of livestock across time and space operates 24/7 – in one continuous season.[7] The farming industry has become autonomous and flexible, adapting to post-Fordist modes of production. Trains, trucks, vessels, drones, helicopters, cattle crushes, portable fences, refrigerated chambers and supermarket trolleys are part of a broad constellation of technologies, which allowed us to re-think the material qualities of a globalised plant. As Rosi Braidotti suggests, "To say that nature-cultures today are fully integrated into a technological apparatus that maximises profit, states in the obvious. But coming to terms, psychically, socially and ethically, with that statement is a problem of an altogether different order and scale."[8] We must not forget that those technologies are fuelled by a multiplicity of subjects that operate as "the other" of one another in an atomised and sprawled social landscape, inhabited by farm owners and workers, sometimes exploited backpackers in search of visa extensions, Aboriginal communities struggling for recognition of their land, and environmental groups trying to return nature to its pristine and untouched condition, amongst others.

Figure 1: *The Plant*. Installation at Wagga Wagga Art Gallery

Our installation *The Plant* operated as a synecdoche of that productive landscape, understood as a nature-culture continuum. It was an inhabitable architectural one-to-one scale model that staged the material qualities of the contemporary Australian agricultural landscapes. *The Plant* also provided the space for an uncommon political encounter that aimed to gather artists and researchers with the subjects that are being expelled from the picture of an increasingly technologized rural environment.

Installation and Performance

Merino Chairs comprises a previously unknown chair species that can live both indoors and outdoors. Their skeletons, made of a light, foldable aluminium structure, are combined with a synthetic fur body. It is a light and portable creature with a cosy look, a hybrid specimen that represents two mirrored trading routes. On the one hand, millions of Australian Merinos travel overseas aided by sophisticated technologies for livestock transport.[9] On the other, tons of synthetic components that become imitation sheep fur are shipped to Australia in containers. Thirty square meters of synthetic fur were bought in Wagga Wagga, one of the cities in Australia that delivers large amounts of sheep product into both national and international markets.[10] We used the synthetic fur to fabricate thirty Merino chairs. If Androids dream of electric sheep,[11] these Merino chairs dream about grazing on surreal landscapes, which stand in contrast to the pastoral picturesque and the rural techno-aesthetics of a nature-culture continuum, known as Anthropocene.

Figure 2: *Merino Chairs* grazing

An Aboriginal artist, a French professor, an Argentinian architect, and the Grandeza members constructed the chairs. They did so at 3 am, inside a fibre-glass cabin, within an archetypical Australian caravan park located in the outskirts of Wagga Wagga. The ambience was that of a clandestine workshop where illegal workers were exploited after-hours. We already felt inside a one-to-one architecture model. The caravan park was a fibre-glass representation of the Australian suburbia, reduced in scale. With the help of some disturbing fluorescent lights, six people constructed thirty Merino chairs the night before the exhibition opening. Aided by the rhythm of techno music, cocktails and any other necessary substance (like a pizza ordered by telephone), they completed the mission just in time. By the time the pizza arrived, the chairs had been finished, and the six people had started to perform an improvised post-punk version of the Quixote inside the cabin. Using the Merino chairs as props, they enacted a surreal theatre play that didn't go unnoticed by the pizza delivery boy, who said, "I see you are enjoying". Combining joy, collective hedonism and the serious discussion of the project's multiplicity of meanings while working on it is representative of our way of approaching design and research as a collective act of creation.

Figure 3: *Merino Chairs* set-up.

When the thirty *Merino Chairs* arrived at the gallery on the opening day, a cattle crush on wheels, dressed-up as a media machine, was waiting for them. A cattle crush is a technological artefact that immobilises animals in order to safely and efficiently manoeuvre them. Having it in the gallery was the result of a different interaction between us and the social landscape of the region. After several conversations with some local friends and farmers, one of the biggest national suppliers of farming technologies decided to let us use it for the installation. Its presence in the gallery surprised local visitors, although they were familiar with it. On the other hand, visitors from urban areas where captivated by the tangible precision of its violent function. Situating such an object inside a cultural institution incited visitors to interact and play with it, transforming an object of efficient production into a toy, which in turn positioned the visitors as performers.

Figure 4: *The Plant*. Installation with Audio Interviews.

And the object of desire that completed the ensemble was *Margarita* (Daisy in Spanish), a cow-table on wheels. Its relationship to the cattle crush is still unresolved today. Even if *Margarita* has always been attracted to bondage aesthetics and practices, her punk soul still resists the authority of the machine. Although representing animals' reification by farming industries, the mob composed by the *Merino Chairs* and *Margarita* had an embedded aspiration for political emancipation. Inspired by the Pedagogical Missions,[12] *The Plant* is ultimately a nomadic artefact that travels outside the gallery to incite political encounters and debates. On the last day of the opening weekend, *Margarita* acquired autonomy and was accepted as part of a community of artists, architects, curators, lawyers and activists that gathered around her to discuss the past, present and future of the Travelling Stock Routes. Travelling outside the gallery with them, she proved to have the tactile qualities of a living creature, the gracious appeal of a domestic animal and the sensual qualities of a carefully hand-crafted piece of furniture. As in a Fellini film, people in town knew her by name and the local kids played with her as if she was indeed alive.

Figure 5: *Margarita*, closed.

Figure 6: *Margarita* and the *Merino Chairs* at the Travelling Stock Route. A political encounter.

Figure 7: *Margarita*, open (detail).

Figure 8: *Margarita* grazing by the River.

Case Study Two: *Valparaiso Post-Liberal*, XX Chilean Biennale of Architecture and Urbanism, 2017 (by Grandeza and the architect and writer Miguel Rodriguez Casellas)

Contextual Framework

On the occasion of the XX Biennale of Architecture and Urbanism in Chile, the curatorial team invited us to answer an “unpostponable”[13] and provocative question: “Why did the UNESCO heritage project for Valparaiso fail?”. Answering that question would open the door for us to participate in the Biennale. In this case, the curatorial team knew about our previous research project *Immaterial Company Towns*, a work that studied the rapid urban transformations of Valparaiso (an important Chilean seaport city). The piece *Immaterial Company Towns* was exhibited at the 1st Chicago Architecture Biennale in 2015, as part of the *Indo Pacific Atlas*. Although that project was not explicitly related to the UNESCO heritage project, some of the reasons for Valparaiso’s rapid transformations were not unrelated to it. Once again, we dusted off a previous research project and expanded on it to answer a different question.

During its industrial peak, Valparaiso’s harbour became an entry point to the city for alterities coming from all over the world. This was the melting pot that fuelled the consolidation of an eclectic, picturesque post-industrial landscape that appears today in every heritage postcard. In turn, the economic exploitation of newcomers’ anxieties established the city’s bohemian character. Today, Valparaíso is neither prosperous nor untouched by gentrification processes due to real estate speculation and tourism. Moreover, the city is unable to both reconcile with its productive industry (the port) nor fit UNESCO standards.[14] In 2016, a report written by Juan Luis Isaza (a Colombian expert in heritage management) stated that Valparaíso’s project was “calamitous”.[15] The conclusion not only summarised the institutional miscommunication and unclear hierarchical relations between UNESCO, Chilean government and municipality; but also reported the dreadful conservation of the city's architecture. Isaza's observations were not far from the generalised concerns that we had heard before, but his report made us realize that the socio-cultural landscape of the city was not part of the desired heritage postcard.

We responded to the curatorial question by claiming that the failure of Valparaiso as a heritage city was a symptom of the lack of epic aspirations in the political and social projects of the twenty-first century. It was, in the end, the failure of neoliberalism and a sign of its exhaustion. If the picturesque postcard was so important, we wanted to open it and transform it from within into a spatial diorama. We wanted to recover the presence of the expulsed subjects and to assert their role in the consolidation of Valparaiso's cultural identity.

Figure 9: *Valparaiso Post-Liberal.* Installation.

Installation and Performance

Valparaíso Post-Liberal appropriates three key concepts of neoliberalism (namely urgency, unavoidability, and the demonization of the state's apparatus) to propose a new political, institutional and collective subjectivity. We proposed a "public trust" (a property trust) as the main axis of a parallel state in charge of transforming the current tourist playground into a productive territory. In turn, the validation of excess and clandestinity – two foundational elements of the port's bohemia – would be the focus of an urban rebranding. On this occasion, the one-to-one architectural model was simultaneously a space designed to "promote" the foundation of the parallel state, and a clandestine club inspired by those dissonant atmospheres expelled by the heritage project. Through their participation in an electoral process, the new citizens would collectively define the agenda of the alternative political apparatus.

On the wall, a mural conformed by 4080 postcards composed a vandalized version of the archetypical heritage postcard. The postcards were stamped at the front with golden seals of epic violence stolen from the classical European tradition (where the ideals of emancipation that once inspired revolutionary projects in America emerged). On the other side of these postcards, 272 political proposals provided the epic tone to the political aspirations of *Valparaiso Post-Liberal* (ranging from short poems exacerbating Valparaiso's social and aesthetic contradictions, to exhortations that dismantled the neoliberal common sense). Here, the visitors were invited to select their preferred political proposals and send them to the Chilean government. The civic mobilization took place in a setting that reflected the features of both a luxurious boutique and a bohemian nightclub.

Figure 10: *Valparaiso Post-Liberal.* Mural detail.

Figure 11: *Valparaiso Post-Liberal.* Electoral process.

On top of a reflective gold floor (that introduced the metaphor of the parallel universe) there was a second-hand desk painted in gold and bulleted where the visitors deposited their votes. This desk embodied, at the same time, the traces of violence from dismantling the bureaucratic system (the bullets), and the promise of emancipation of the deposited votes. Hidden inside a drawer, a speaker played the voice of Alejandro Arellano, a retired journalist and victim of the violent expulsions engineered decades ago by the Chilean dictator Augusto Pinochet. After a euphoric welcome to visitors, Arellano's voice proclaimed the political ambitions of the parallel state.

While vandalizing the bureaucratic desk we approached again the Dada gesture and moved away from the language of architectural representation. The day that the desk, already painted in gold, was shot at the headquarters of the PDI (Chilean Investigations Police) by the officer and architect Renato Román, the project reached its greatest poetry. The exercise of creative violence had moments of great beauty: between bursts, the shot pattern was assessed as if it were a work of art. This act (which summarizes the seriousness with which we approached even the most absurd aspects of the project) turned us, without knowing it, into performance artists.[16]

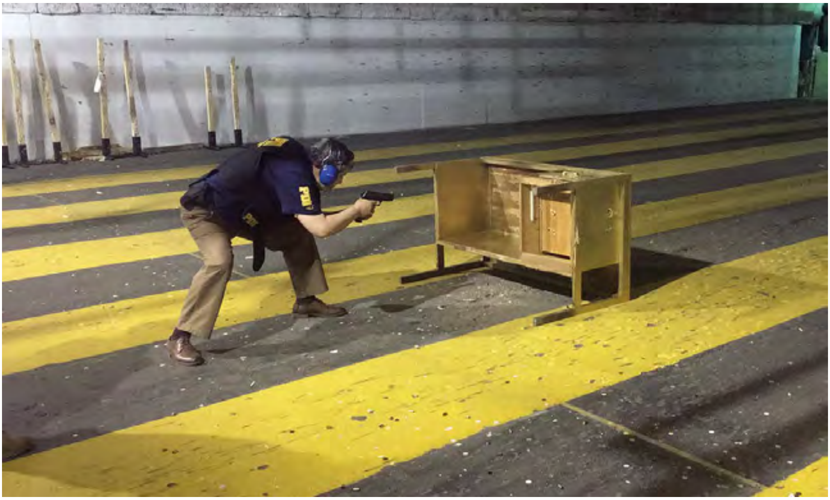

Figure 12: *Valparaiso Post-Liberal*. Shooting Session.

Figure 13: *Valparaiso Post-Liberal*. Nightclub atmosphere.

Conclusions

Architectural Discourse

Currently, the re-politicization of academic work within architecture schools runs the risk of becoming another of the recurrent searches for novelty. For instance, what was seen after global capitalism's last crisis as a necessary dissociation between architectural discourse and marketing (namely, that of the icon and the starchitect) has now led to a new trend that embellishes political violence with social management languages of political mitigation.[17] In this framework of "architecture as the solution", concepts such as resilience (extensively used in current academic discussions and publications) appeal for the adaption to, or self-recovery from, the effects of ecological or political devastation, without questioning or altering the institutional roots that cause it.

Parallel to these social alleviation trends (epitomized at the 2016 Biennale of Architecture in Venice: *Reporting from the Front*), architectural discourses have also shown a growing interest in tackling spatial issues that go beyond the traditional scales of the built environment. An amalgam of global-scale topics has popped-up parallel to the non-disciplinary questions of our time. Anthropocene, climate change, mass extinctions, hyper-surveillance, migrations, sovereignty, borders, belonging and transits are only some of the recurrent topics that nurture a generalized feeling of embodied disempowerment, which fuels the determinism of a technologically driven planetary annihilation. According to Rosi Braidiotti, 'new necro-technologies operate in a social climate dominated by a political economy of nostalgia and paranoia on the one hand, and euphoria and exaltation on the other'.[18] Even the post-apocalyptic visions of our "inevitable" extinction have entered the architectural debates.[19]

Following these discourses, different forms of architectural representation try to catch up with the emerging disciplinary concerns. Aided by the development of a myriad ways to collect data and ever-more-precise mapping technologies, ubiquitous cartographic representations filled with filtered data and aerial photographs on a territorial scale populate architectural publications, biennial exhibitions and academic works. Those large-scale forms of Cartesian representation relay on the accumulation of data. They exemplify a new paradigm of objectivity for a discipline that has historically navigated the tensions between the construction of objective truths and the formulation of subjective realities.

While accepting the challenge of the peripheral condition in which architecture is positioned when reflecting on these topics, we reject the depiction of a world ruled by an unstoppable and technologically-driven Anthropocene. In those depictions, human subjectivity either disappears or is constrained by external forces. We acknowledge the vulnerability of traditional architectural languages when addressing the scales of representation of the territories and transits that we inhabit today, but we also discard the estrangement of these new forms of Cartesian representation. Contemporary forms of political violence require alternative forms of spatial representation; and commonly forgotten forms of subjectivity need to be recognized, acknowledged and included in the picture.

One-To-One Models

The installations of Grandeza Studio explore an alternative form of architectural representation that understands the constructed environment as a superposition of real-scale models. As Olafur Eliasson explains in his short essay “Models are Real”, we need to acknowledge that all spaces are steeped in political and individual intentions, power relations, and desires that function as models of engagement with the world. No space is model-free.[20] The awareness of simultaneously inhabiting multiple forms of real-scale models (social, political, architectural) should not generate a sense of loss or disempowerment. On the contrary, the idea carries liberating potential as it makes the renegotiation of our surroundings possible. The conception of space as static and clearly definable thus becomes untenable – and undesirable.[21] We embrace this conception and construct architectural installations as models that dislocate, decontextualize, and relocate the objects and subjects that configure our environment.

We search for alternative narrative constructions capable of including multiple perspectives, subjectivities and interpretations to open the door for new understandings of the human experience; and challenge, collectively, the way we live together in a fast-changing world. Through her philosophical enquiry on the post-human predicament, Rosi Braidotti urges us to rethink with imagination about the present: “The issue of the Anthropocene is compounded by the combination of fast technological advances on the one hand, and the exacerbation of the economic and social inequalities on the other, making for a multi-faceted and conflict-ridden landscape. In some ways, just referring to the Anthopocene is not enough, because we cannot solve our problems with the same thinking that we use to create them. […] We need more conceptual creativity, more theory rather than less, and a renewed trust in the cognitive and political importance of the imagination.”[22]

Impact and Interpretation

When José Luis Pardo describes the impact of the 1960s Situationist artistic manifestations, he states that they weren’t produced with the intention of being interpreted. Rather than transcending the instant of their emission (in order to posthumously become part of notorious art collections) those works aimed to produce an impact and perish in the collision.[23] In recent years, the word “impact” has gained relevance again, to the point of becoming a meme in the discussions about academic research. Its influence on the computable accounting of individual performance seems to be just another threat to the increasingly bureaucratic existence of academics. We use this impasse (in which the meaning of the word is still being debated by the academic apparatuses) to rescue the Situationist reading of the term and re-politicize its meaning. Moreover, we embrace their avant-garde ambition of blurring the boundary between life and art, by embedding ourselves in collective research processes that celebrate discussion and hedonist production. Meanwhile, we question the prevalence of individualistic and competitive forms of knowledge production.

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Architectural Spaces of Engagement and the Cultural Interface – Disrupting the Great Hall

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Abstract

Meaningful engagement practices are increasingly becoming a vital factor in the inclusion of historically marginalised sections of the community. By reflecting on a decolonising research framework, the creation of architectural spaces of engagement will become more important and commonplace. By utilising these recent frameworks, the focus of this article places a lens on how cultural exchange in the designed environment can incorporate concepts of academic scholarship outside architecture to reflect on design learning outcomes. Indigenous Australian scholar, Martin Nakata stipulated the concept of the cultural interface in his book, *Disciplining the Savages, Savaging the Disciplines.*[1] This article will investigate a method of engaging architecture and Indigenous methodological scholarship. A methodology is outlined to query the architectural spaces of engagement idea and how it interacts with cultural interface. A concept framework that can influence conversations of cultures, communities and individuals. Describing these conversations conceptually and through a case study will engender its physical, intellectual and emancipatory qualities to promote impactful agency and transformational change. The cultural interface notion will be applied to a recent design research exercise with Indigenous high school students from around Australia. As part of a university summer school for Indigenous high school students, a shelter was designed, fabricated and installed to engage with a university's primary ceremonial place as an act of resistance and reconciliation. The project implemented various concepts of engagement through the acknowledgement of different histories and participation. The lessons learnt from the exercise will inform future engagements, particularly the activation of the cultural interface to centre peripheral voices through spaces of engagement.

Spaces of Engagement

A critical component of architecture is the engagement process. A fundamental issue of architecture, in a settler-colonising state such as Australia, is the presence of built forms designed to represent the coloniser's home architectural style. These spaces still occupy high visibility and reverence in a state that has evolved and transformed in many ways. This paper will explore the concept of spaces of engagement, interactions between societal interests that influence broader events and forces.[2] These interests can possess specific 'ethno-histories' to construct local place through narrative strategies [3] or a space where local narratives can contest hegemony of existing structures. [4], This can enable participation in decision making processes and the articulation of oppositional politics, [5] promoting diversity in cultural participation and enabling engagement with counter-sites of knowledge.[6]

Architecturally, an example of spaces of engagement occurs with spaces such as contemporary memorials, where visitors are framed as actors and not just viewers.[7] These types of examples can transform the experiences community to influence multiple aspects of society. Artist Daniel Boyd and Edition Office Architects are currently commissioned to design the new memorial *For Our Country* at the Australian War Memorial.[8] A compelling design component is the incorporation of soil samples from all Aboriginal and Torres Strait nations to become part of the ceremonial space and symbolise unified First Nations voices. [9] The many spaces of engagement enact the significance of Country to Aboriginal and Torres

Strait Islander service personnel. This example space of engagement captures the counter-sites of knowledge in a cultural context, adding further weight to the designed environment. Regarding the creation of spaces of engagement, research frameworks utilising Indigenous methodologies [10] can inform wayfinding considerations.

Cultural Interface

Recent developments in meaningful engagement practice has coincided with the increased visibility of Indigenous scholarship and its associated community-focused outcomes. A critical concept within Indigenous scholarship, the cultural interface represents contested space between knowledge systems where things are not black or white, Indigenous or Western. [11] This term describes the process of engagement and exchange between cultures, communities, individuals, animate and inanimate objects. Words, statements, actions, gestures and sounds associated with engagement can be enunciated, received and translated into an architectural language. Trained professionals in architecture have a responsibility to respect, foster and privilege these qualities of engagement to communities who may historically have less association with the profession. Research concepts outside architecture substantiate this process to inform a framework of methods that could alleviate deficits of such associations. Nakata broadens, and deepens concepts of enunciation and translation[12], focusing on Indigenous ontologies and epistemologies within Western frameworks. These notions are described in the following way:

> constituted by points of intersecting trajectories. It is a multi-layered and multi-dimensional space of dynamic relations constituted by the intersections of time, place, distance, different systems of thought, competing and contesting discourses within and between different knowledge traditions, and different systems of social, economic and political organisation. It is a space of many shifting and complex intersections between different people with different histories, experiences, languages, agendas, aspirations and responses.[13]

Architecture encounters the cultural interface through its representations and the experiences of the many central or peripheral stakeholders. Moreover, investigating the cultural interface facilitates in-depth, strategic explorations of voices of difference for incorporation into the architectural design process.

Decolonising place

When engaging with the designed environment, the cultural interface is a checklist of considerations to decolonise space, parallel to concepts such as Lefebvre’s right to the city. [14] which is described as a right to political space, [15] Occupying, defining and designing of actual participation in decision-making processes requires agitation, disruption and negotiation. The relationship between architecture and spaces of engagement through an Indigenous research framework has seen these rights fought on many occasions. The fight in many Indigenous contexts however, relates to one fundamental idea, rights to land.

The cultural interface is a space of contested knowledge systems[16] composed of cultural, community and individual scholarship, providing agency and acknowledgement of the tensions, complexities and ambiguities of multiple positions.[17] The cultural interface has connections to other concepts such as third space[18] and contact zone theory[19] through the expression of language, and the capacity to enunciate and translate communications in a contextualised setting. Inherent in Indigenous ways is its evolving relationship to the settler-colonising paradigm. This can lead to the uncovering and introduction of new narratives that add value to the conditions of the design process and its outcomes.

Challenging Binaries

Nakata challenges the notion of an Indigenous perspective, it draws on principles that privilege lifeworlds as a *complex terrain of political and social contests*.[20]. Acknowledging personal and professional obligations between two homogenous worldviews, the black (Indigenous) and white (setter-coloniser). Indigenous (black) issues, most commonly afforded low visibility within the settler-colonising system, means the conversations are challenging to start, sustain and evolve.

The cultural interface promotes a framework of exploration, research, analysis and synthesis that not only acknowledges narratives of oppression and subjugation, but also celebrates achievement and progress. The resulting dissemination enables more visibility of peripheral stories and opportunities for reciprocated exchange with participants of the perceived dominant system. This is a dialogical exchange between systems of difference, in a dynamic space between ancestral and western realities. [21] This exchange decolonises the colonial paradigm by empowering participants previously unheard. Complicating matter is how these worldviews with multiple realities are influenced by, and occupy settler-colonising western ways of being, knowing and doing and its interaction with Indigenous ways. Opportunities abound to claim and reframe the western ontologies to inform possibilities of exchange with local Indigenous narratives.

An 'Indigenous way'

The 'Indigenous way' can be both used as the approach to address inclusivity of Indigenous communities in conversations and conversely used to reveal specific community and individual customs. Contextualised designed environments allow exchange of cultural ways, acknowledgement and celebration of a local community and its individual stakeholder narratives. The championing of agency in expressing a 'way' can privilege stakeholder voices when offering commentary on architectural issues, and its impact on Indigenous/non-Indigenous narratives. In architecture, communications between stakeholders requires deep listening [22] to ensure the enunciations from the one participant is heard, translated and disseminated with the recipient and vice versa. Practical strategies of engagement can aim to identify narratives of key participants in the project to enunciate aspects of their existence in the intersecting spaces of the cultural interface. This proposition conveys a method only applicable to a specific community, at a point in time and space

Nakata's definition provides wayfinding devices to occupy a continually swirling middle space from both the viewpoint of the marginalised and its positioning within a dominant society. The articulation of the cultural interface privileges the differences and commonalities in ways of being, knowing and doing. The premise of the term interprets culturally contextualised learning passed from generation to generation and activates its use in contemporary living. It strengthens the capabilities of cultures, communities, and individuals to activate the narratives relevant to the exercise. This adds a layering of information to existing academic and community scholarship from not only Indigenous-focused standpoints previously lacking visibility, but also other standpoints that may relinquish their own visibility. Activating a space of engagement can lead to innovation and evolution of knowledge systems with the interface of cultures.

Case Study – A Space Of Engagement Within A University Ceremonial Place

The following section relates the cultural interface to a recent design research exercise with Indigenous high school students from around Australia. As part of a university summer school for Indigenous high school students, a shelter was proposed, designed, fabricated and installed to engage with a university's primary ceremonial place as an act of resistance and reconciliation. The project implemented various concepts of engagement through the acknowledgement of different histories, Indigenous research frameworks and participatory action research experiences. The lessons learnt from the exercise will inform future student engagements, particularly the activation of peripheral voices to a centred platform through spaces of engagement.

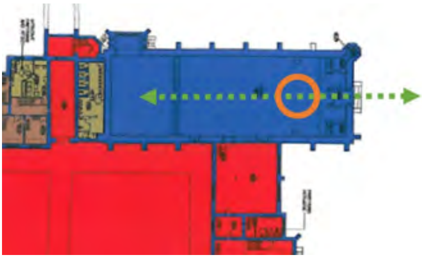

Figure 1: Engaging with the Great Hall.[23]

Ceremonial places within universities are sacred spaces, especially universities founded during the colonial era. The predominantly sandstone infrastructure prevailed as the main building material representing grandness and stature. It could be recognised as a representation of empire-building actions such as invasion, dispossession, occupation and control of territory, with the Indigenous cultures unjustly displaced to the periphery.

Indigenous cultures

Broadly, traditional Aboriginal communities who occupied and maintained the land, on which the University of Sydney campus is built, inhabited spaces in clan groups in relation to other clan groups. Critical use of language and respect for protocols between the groups across many generations created spaces of engagement, crucial to on-going custodianship of Country and reciprocated actions such as trade and cultural management.

While the cultural interface between Indigenous and settler-colonising cultures enacted many permutations, many forms of public colonial architecture disregards the accommodation of difference. The role in representing Aboriginal histories is to inherently build on the emancipatory narrative of such a space and weave ideas through the designed environment via the cultural interface.

Context

University ceremonial places invoke thoughts of the cultural interface relative to Indigenous and settler-colonising ways. The role of architectural researchers, educators and practitioners can recognise the opportunities for dialogue in this stream of thought. Places such as the Great Hall at the University of Sydney, built in the 1850s as the first university building of New South Wales colony,[24] stipulates a settler-colonising architectural narrative imposed on sovereign Gadigal territory. Designed in the Gothic Revival style in 1854 by Colonial Architect Edmund Thomas Blacket, the Great Hall was proposed as an example of grand permanent infrastructure [25] The space is disengaged with the local condition, a hill top gesture that exemplifies an imposing sense of grandness for heightened exhibition of power and privileged status.

Figure 2: The Great Hall.

The exercise

In January 2018, an exercise was devised and implemented to share these ideas with the next generation of potential architects, planners and designers. Indigenous high school students from around Australia were invited to participate in the university summer school program, as a method to engage youth with higher education pathways. The student exercise, funded through the university, encountered the student narratives of knowing and being for to facilitate richness to the project.

Technologically, the installation drew on the traditional shelter typologies of Far North Queensland, indicative of connections to Country for the lead teacher. The space of engagement of this architectural typology is reminiscent to the geodesic domes of the mid-20th century by Buckminster-Fuller. Comparisons between architectures find commonalities and differences that can be synthesised to create a new dialogue.

Figure 3: Shelters from different cultures intersecting at the cultural interface.[26]

The designed shelter composed of ten inter-connected components, with each component approximately 1.6 metres in diameter creating five negative openings around the perimeter and one above to enable views outside the space. This information was provided to the students from the beginning, however, constant checking in with them ensured the project proceeded in an organic manner. Furthermore, the brief evolved to cater to each student narrative, with each contribution to the shelter a key component of participatory research. The emancipatory, decolonising qualities of culturally relevant critical engagement allowed student freedoms to enunciate 'self' within project frameworks. The cultural interface engenders methodology that provides value for the design research project by engaging with the lifeworlds of each participant and their immediate contextualised environments.

Participants

Ten Indigenous high school students from ten different communities across Australia in years 10, 11 and 12 expressed interest to participate in the program prior to the event. Three disciplines were selected based on student choice. Students who prioritised architecture, design and planning were accepted by the university to take part in the exercise.

Figure 4: Negotiating the space.

It was not an expectation that students had prior background knowledge in design, parameters were set out to assist the design development. All participants were briefed about the creative nature of the architectural design disciplines. This ensured the design ideas called on their own cultural narratives as drivers for cultural expression in a designed environment.

Day One

The dialogical exchange with the students commenced with an on-site meeting in the university's ceremonial place. The students were first time visitors to the empty and imposing space, only occupied by the materials, statues, portraits and settler-coloniser history. The university's current narrative on the materiality of the place with connections to Aboriginal country has informed alternative ways to view the space. Imparting this story to the students provided a framework to strategise a disruptive narrative through architecture. The imposition of architecture on traditional Aboriginal lands utilised materials from near and far Countries will connections to First Nations communities with rich histories.[27] This dialogue created a space of engagement for how their position within the vast space could be interpreted, to their own narratives, and its incorporation into the design exercise.

Figure 5: Emphasising the narrative through architecture.

Emphasis was placed on recyclability of materials as part of the ephemeral installation through engagement with a local recycling place that engages with communities through workshops. Simply portraying the impact of waste on the environment, on Country, was highlighted through recycling materials for the facades and interiors. The structure re-used all-weather corflute panels from the graduate exhibition, two months prior, providing a renewed use for the landfill-bound material.

Day Two

A site visit to the local area with rich Aboriginal histories highlighted connections between the local cultures, and its constant negotiations with the settler-colonised space through architecture. The presence of culturally rich streetscapes displays empowering qualities adds to the visibility of narratives on the margins.

The events of day two concluded with the high school student producing preliminary design ideas for each assigned component. The provision of time and space to each student empowered each to engage with their own narratives and how the stories would be shared and negotiated in the façade of the shelter. The proposition to define the 'self' as an enunciative being allowed the students to self-determine that own agendas and aspirations.

Day Three

With each student engaged with the participatory nature of the exercise, 'Self' narratives were projected onto the component framework to break down the traditional/contemporary binary, a key component of the cultural interface. One student harnessed these qualities to create a façade that defined connections with Country in regional New South Wales. This uncovered and displayed physical, social, emotional and spiritual qualities on many levels.

Day Four

The shelter and its façade narratives began to materialise as all participants anticipated the exercise's relocation from the studio to the university's ceremonial place. With the students, we constructed the shelter in the centre of the procession aisle, purposefully disrupting the narrative of the ceremonial place to privilege the voices of Indigenous cultures in a settler-colonised environment.

Figure 6: Disrupting the narrative.

After completing the installation, all participants gathered in the shelter to de-brief, appreciate and celebrate our project. The circular shape equalised the micro-environment to promote a space of engagement with each other. The openings reinforced the space of engagement providing framed views to the materiality of the ceremonial place – the marble floor below, the sandstone walls to the sides and the timber roof structure above. This realisation for the students engendered satisfaction in the exercise, further contributing the calmness of the space within the shelter.

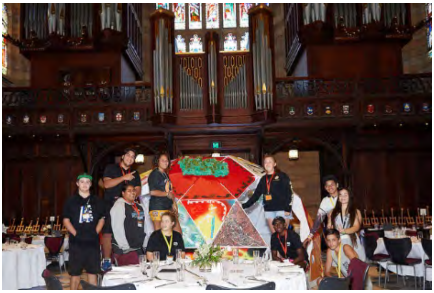

Figure 7: Completion.

The function of the shelter during the celebration ceremony allowed all participants in the wider program to experience the shelter, its disruptive qualities and its methods of engagement with the ceremonial place. This contextualised space of engagement applied principles of the cultural interface to democratise the space and foster reflective narrative-enabling moments. Architecture inherently facilitates these moments and can overtly or subtly encourage thoughts and emotions to create new knowledge.

Figure 8: Celebration Ceremony.

Conclusion

The engagement displayed qualities of the cultural interface with the negotiation of ideas from each student worldview, promoting the intersections between Indigenous and settler-colonising ways as a physical manifestation.

The student engagement approach created spaces of engagement for narratives to be shared in an architectural sense. In creating a full scale ephemeral structure, the collaborative method fostered physical, social and emotional engagement between the students, and the architecture school representatives.

The design of the shelter and its realisation created spaces of engagement, enabling caution, reflection, celebration, excitement and satisfaction. Student stories were revealed providing insights to states of being, knowing and doing, uncovering realities beyond the black and white binary. The conditions of identity portrayed through their façade designs indicated an interface with many cultures, past and present and future.

Architecturally, the boundaries between binaries become blurred, with many spaces of engagement interchangeably linked with each other on many interrelated levels. The cultural interface contends that the lived experience of a culture cannot only be determined by one overarching state of being [28], but considers the many interstitial, oppositional and intersecting spaces. It allows participation from many different knowledge systems, backgrounds and perspectives, entailing inclusive frameworks to innovate and produce contextualised discourse.

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ADR18

Digital Craft

Chaired by Dylan Wozniak O'Connor

The Culture of Crafting: Exploring the relationship between the Hand and the Machine in Digital Stone Sculpture

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Abstract

This paper will examine subtractive design and fabrication methods of dry stone self-supporting structures and its relationship to traditional stone crafting and fabrication techniques. The research aims to reform the value of 'crafting' through the machine generation of specific geometry of catenary arch structures in dry stone interlocking stone modules. Looking into traditional methods of stone crafting and how emerging technology of today is being used to reconstruct stone sculptural structures in the context of digital stone crafting. It will investigate the value of robotic technologies in the design and construction process in comparison to hand crafting and sculptural techniques focussing on the artisanal qualities of sculpting stone. Two sculptural prototypes in natural stone will be exhibited 'Catenary Tales' and 'Archi-Twist', both designed in Sydney and manufactured as part of the Digital Stone Project workshop and Garfagnana Innovazione in Italy utilizing 7 axis robotic carving machines. This research describes the relationship of crafting with the hand and the machine resulting in sculptural prototypes as part of design research.

Introduction

The art of fabricating, making, crafting and the traditional sense of the artisan has been diminishing due to the dramatic changes in technology. The advancement of the industrial revolution in the mid to late 19th century saw the rise of new building techniques and materials which were primarily based on structural steel construction. The modern aesthetic of the time further diminished the place of traditional stonework and ornamentation in modern structures within the building arts. As described by McCullough industrialisation made "practices like craft something no longer to be taken for granted, and further degraded the stature of the artisan." [1]

The philosophical nature of the Arts and Crafts Movement in the late 19th Century, was a reactionary vision standing against materialism and the machine. John Ruskin's second chapter on the Nature of the Gothic in his book, *The Stones of Venice* where he developed the Arts and Crafts dissent against 19th Century industrialisation. "Men were not intended to work with the accuracy of tools, to be precise and perfect in all their actions. If you will have that precision out of them, and make their fingers measure degrees like cog-wheels and their arms strike curves like compasses, you must unhumanise them…"[2] Here Ruskin describes the relationship between the man and the machine eluding to the relationship between the maker and his methods of making.

Industrialisation has influenced stone crafting techniques where the 'artisan' or stone mason must acquire new skills to work with developing automated machine technologies. This paper will describe the design and fabrication of two sculptural prototypes manufactured as part of the Digital Stone Project artist residency. Each artist, architect or designer works with a block of marble to design and fabricate a sculptural form. Here the "digital/virtual world is employed to imagine a new language of form. Computers replace chisels. The artist's optic nerve pulses a stream of information to and from the hard drive placed at the artist's fingertips.

Fibre optics finally delivers the information to the marble's new master. Soon the marble is interrupted by a robotic arm and its articulated dance across the stone's surface. The robot follows the artist's coded instructions and through this surrogate it begins to articulate the imagined form."[3] This interplay between the material and method will be further explained through the two sculptural prototypes based on catenary forms.

Traditional Stone Crafting Techniques

Historically master stone craftsman and sculptors had acquired instructional skill through constant refinement of their craft which was then communicated through models or inscription onto the stone material itself usually at 1:1 scale. "The 'master builder' who would be involved in making decisions about the application of geometry and selection of material."[4] The material itself give much meaning to the final result as the formal design method used. For example in the selection of stone to carve the statue of David from 1501-1504 during the Renaissance period, Michelangelo travelled to various quarries to find a large block of Carrara marble quarried forty years earlier in the Apuan Alps of northern Tuscany. "The marble had to be of "good quality, white and beautiful, and without faults,"[5] To an architect or sculptor's eye, some "visually attractive features of stone blocks are flaws, leaving them structurally fragile".[6] Thus the carving away of a block of stone also requires knowledge into the material properties and many master stone craftsman and masons have this knowledge through years of acquired skill. This knowledge in current day stone sculpture utilizing automated surveying and carving methods is greatly appreciated and should be integrated with initial design and crafting methods rather than relying solely on form finding techniques without consideration to material strength and quality.

The artisanal quality of crafting blocks of stone or masonry is reliant on structural properties. For example considering the nature of the brick, Louis Kahn explains. 'You say to the brick: "What do you want brick?" And the brick says to you, "I like an arch".[7] Here Kahn is describing and honouring the material properties in relation to how it behaves and performs in an architectural context**.** Enabling the material to behave as it wants depending on the contextual constraints. In a similar way Italo Calvino in Invisible Cities describes a conversation between Marco Polo and Kublai Kahn where Kublai Kahn asks "Why do you speak to me of the stones? It is only the arch that matters to me." Polo answers: "Without stones there is no arch."[8] Calvino here is referring to the definition of lines of gravity rather than to models or structural forces but he captures carefully the relationship between material and structure that is investigated in this research and resulting prototypes.

Catenary Structures

The geometry of the sculptural prototypes for this research are based on Catenary curvature. The word catenary is derived from the Latin word catena, which means "chain". It is based on the delicate balance of opposing forces that gives rise to a certain amount of structural stability. A chain suspended from two points will always try to form a catenary. This happens because the chain is hung in a state known as "pure tension," so it will always adjust itself to find this balanced state. Only tension forces can exist in the hanging chain; inverting the shape into an arch reverses those into pure compression forces. All that compression force acts along the curve and never at right angles to it. "The connecting faces of voussoirs in catenary arches are approximately, but never precisely, normal to the line of thrust. This makes the inverted catenary very stable, particularly for spanning a horizontal distance."[9] For example Spanish Catalan architect Antoni Gaudi (1852-1926) created hanging chain models as extraordinary formal and structural design models based on catenary curvature. Gaudi made a famous scale model of the loads and thrusts involved in the structure of his building Colona Giuell church. He hung cords in loops to correspond upside down to the placement and shapes of piers and arches of the vault.

Catenary curvature is mathematically based on a hyperbolic cosine or catenoid. Both inspired and developed from this structural analysis perspective, catenary curvature was used as a basis to model the overall macro geometry and the micro geometry of the interlocking contact surfaces.

Robotic Stone Crafting Techniques

Fabrication methods utilizing industrial robotic arms currently allow for more precision and accuracy in cutting and crafting stone shown in case studies such as the stone components for the restoration of the Basilica la Sagrada Familia in Barcelona and in many stone based sculptural and design studios integrating artisanal value into architecture, art and design. Self-supporting modular blocks of stone structures are amongst ancient building techniques that survived unchanged for centuries as can be seen in dry stone 'trulli' houses in the Puglia region south of Italy. They were designed to be easily assembled and disassembled due to the contextual issues of habitation and settlement at the time. Whereas previously manual cutting stone to precise measurement epitomized a laborious task[10], the integration of automated workflows early in the design process enables efficient machining practices contributing to changes in the construction industries and adding value to digital crafting methods. This is due to the recent advancements in software technologies from 3D modelling and scripting environments to machine code. Material integration with structural analysis and advanced subtractive fabrication techniques of cutting stone modules are being explored by a number of researchers [11] [12] [13] [14] [15]. The following will focus on the design and fabrication of two sculptural prototypes.

Design and fabrication of "Catenary Tales"

The sculptural model for 'Catenary Tales' stems from original research on 'Stereotomy of Wave Jointed Blocks' published by Weir et al (2016). A wire cutting workflow was developed corresponding to ruled surface geometry generation in a parametric modelling environment. The blocks were modelled with interpolated curvature at various amplitudes for increased structural capacity. Here EPS foam prototype blocks were robotically fabricated using a 6 axis Kuka and hot wire end effector. Then taking these same blocks and adapting them to stone fabrication of a sculptural prototype to be exhibited as part of the Digital Stone Project 2015 exhibition 'Marble Codes'.

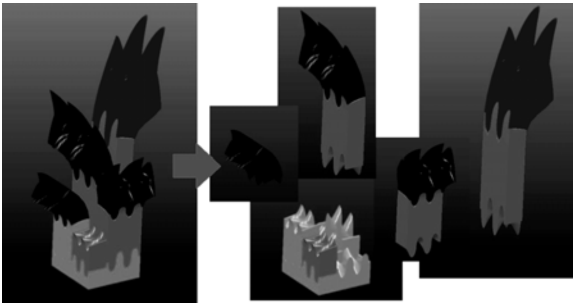

Figure 1: 3D model renders of 'Catenary Tales' showing grouping strategies of modules developed with Gabriel Ferri of Garfagnana Innovazione 2015.

As shown in figure 1 an initial twelve part structure modelled in Rhinoceros 3D was remodelled and regrouped to form a five part structure to reduce machine time and also contribute to its structural stability. At the time of the modelling process, no digital structural analysis was performed and the structure itself was modelled based on an intuitive sense of equilibrium in form taking into account the self-weight of stone.

Figure 2: Left: Marble Roughing process with saw blade on 7 axis robot Right: Changed end effector for CNC milling process.

The selection of the stone is of paramount significance not only aesthetically but in terms of structural capacity and strength. The decision was made to have darker coloured marble and the base leading up to a gradient of white Carrara marble with fewer veins at the tops of the structure. The grey marble 'Venato Orto di Donna' is said to have the most structural variations in veining so can potentially be an issue during fabrication and transporting. As shown in figure 2 the block of stone is 1st set up on the machine to be roughed out with a saw blade followed by a tool change to a diamond CNC mill end effector which also vary in size and carving capacity due to model and machine movement constraints.

Figure 3: Left: 3D model render, Middle: CNC milled stone, Right: Final exhibited Sculptural prototype at the Marble Codes Exhibition in Florence.

It is interesting to highlight the fact that some of this original geometry was modelled using ruled surface geometry, however the machine time limitations meant that modules had to be grouped together as shown in figure 3. The finishing and assembly of the modules were all completed by hand. This included matching and fitting the parts together. Here a classical approach to sculpture, a carbon copy technique was used to highlight parts of the sculpture which were not fitting and sand them down to an appropriate fit. Material and machining tolerances were taken into consideration as approximately 1cm of marble was left to sand down with pneumatic tools and mechanical grinders as shown in figure 5. The exhibited sculpture includes final hand polishing and buffing to bring out the colour and texture of the marble.

Design and fabrication of “Archi-Twist”

Further developing the model in a parametric environment to integrate a more systematic approach to designing the interlocking wave geometry, ‘Archi-Twist’ was generated with an overall macro geometry of a catenary arch. The catenary cuts were then modelled as part of the same grasshopper definition. Options to twist, untwist, lengthen and add more or less cuts were integrated into the definition as shown in figure 4. The decision was finally made to use 5 parts to make up the arch due to machine time limitations of 25 hours or 5 hours per part. As in the previous prototype ‘Catenary Tales’, material tolerances were allowed for in the form of offsets from the contact surfaces.

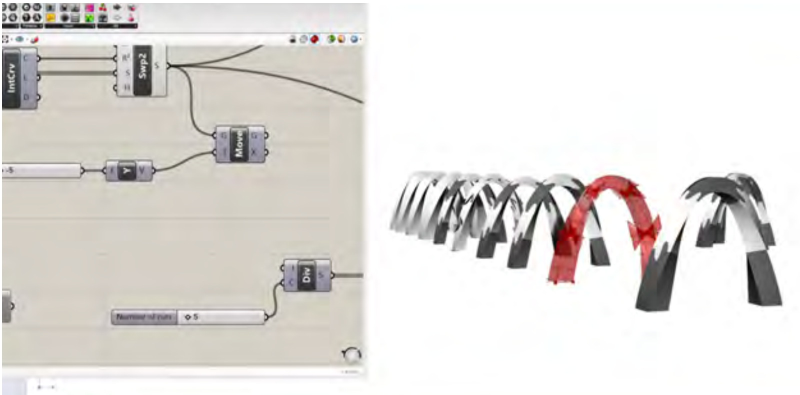

Figure 4: Parametric design process for the geometry generation for 'Archi-Twist'

Once the model was completed, a .STL file was sent to the fabricators Garfagnana Innovazione working with Digital Stone Project to realise all the artists' and designers' work. This also included colour preferences and other specifications for additional material and milling time.

Figure 5: Hand finishing of 'Archi-Twist' with both powered and traditional stone finishing tools.

The significance of the hand finishing process is heightened as the need for the blocks to fit together is of primary importance for this project. The freshly cut machined parts did not automatically fit together as there was extra material to accommodate for machine and material errors. As shown in figure 5, the collaboration of the hand and the machine is what makes with project retain its artisanal qualities and the skill of hand finishing marble. Professional sculptors were on hand to both teach and assist in the final finishing stages so that the less experienced artists and designers can learn their craft of hand finishing and final details. It also enabled the artists more time to 'feel' the stone and understand how it behaves and reacts to certain conditions. The 'Archi-Twist' model was designed to accommodate human lifting capacity so that it can be easily assembled and disassembled. During the finishing and assembly process however, assistance was required to hold the structure in place when applying sanding force with the power grinders and polishers as shown in figure 5. An alternative at the stage would have been to use clamps.

Figure 6: Left: 3D rendering of model, Middle: cut blocks of stone ready for hand finishing and assembly, Right: Exhibited Sculpture at the Digital Stone Project exhibit 2017.

As shown in figure 6, the final assembled sculptural prototype looks very similar to the modelled render with some minor variations due to material and machine tolerances as well as human interaction with the hand finishing of the marble. The aim of the Digital Stone Project workshop is "bridging art and technology by creating new opportunities for artists to engage in state-of-the art digital tools for the realization of innovative works of art in stone."[16]. Comparing the two prototypes fabricated in a similar method one can assume that with repetition and refinement of the skill of hand finishing we can maintain the otherwise lost tradition of sculpture. The same can be said for traditional sculptors and artisans where learning the digital modelling process can allow for potentially faster prototyping of their initial designs so they can concentrate on the final hand finishing and detailing process. This can also be achieved with the machines with extra time for set up processes, tool changes and calibration.

Conclusion

With increased quality of feedback between design, matter and making, the efficiency in the processes of robotic technologies will increase. Coupled with computational design tools the technology is no longer relegated to the repetitive production of the assembly line and is instead being employed for the mass customisation of non-standard components. This can indeed be utilized to produce complex spaces dealing with complicated constraints and environments. Complex geometry such as the catenary curvature joinery systems can be integrated within designs more efficiently and precisely to detailing found in traditional construction techniques due to fabrication possibilities. The instructional techniques employed by master craftsman and artisans can be potentially integrated within new emerging robotic technologies in order to maintain the relevance and significance of the discipline. It will establish itself as a model to reform the value of 'craft'.

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Machining Aesthetics: Tool Making as Design Research

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Abstract

This paper examines tool making as a form of design research. With the widespread availability of open-source electronic prototyping platforms and its knowledge, designers are no longer the end user of emerging technology and digital toolsets. Instead, we see a surge of designers dappling in the discipline of software, material and mechatronic engineering, escaping the constraints of existing computer numeric controlled (CNC) tools through designing and fabricating novel machinery. This paper presents three case studies from a master level design studio led by the authors. The results of each project include a novel CNC machine supported by a series of material prototypes that acts as evidence of the agentive capacity of the tool to deliver design outcome and its potential application in the industry. Through examining tool making in architecture education, critical making is seen as drivers in design processes that has agency associated to it which delivers emerging tectonic and effects; we call Machining Aesthetics.

Introduction

Recent software and hardware advancement have allowed designers to engage design, directly with technology. Open-source electronic prototyping platforms have allowed designers to tinker with electronics and build reasonably stable and complex mechatronic systems without prior training as engineers. Designers can implement and modify the logic of a device using open source software[1]. This inversion of workflow flattens the knowledge structure of electronics and democratises physical prototyping of technology[2] enabling designers to make bespoke machinery or tools to expand their design repertoire[3]. As the need to script, the primary aim is to escape the “pre-set” computational or fabrication strategy presented by existing tools to gain greater freedom in design; leading to novel techniques, emerging forms and material expressions. This emerging hacker culture constructed feedback loops to create a unique platform for design enquiries[4].

Underlying this phenomenon is increased recognition that the use of parametric software and conventional CNC machinery are slowly defining our design repertoires; the way we design and its outcome. This paper presents three case study projects consisting of novel machines, series of material prototypes typically at 1:1 scale and design intervention or application as a proposition of ideas stem from the emerging material research. The case studies explored three strategies of innovation in tool making; hacked, embedded and hybridised system. We asked, how can these strategies act as design agencies to generate residual effects for implementation in architectural design?

The projects explore emerging aesthetics of machining effects produced by the bespoke tools to create what Deamer refers to as the contemporary tectonic evolution of surface intricacy[5]. These material outcomes carry a sense of agency for design, evidence through the three strategies. This research contributes to our understanding of digital craft within the contemporary practice and examines how tool making can facilitate design research.

Making as pedagogy

Making in this context is not just an act of reproduction but a creative act of gaining knowledge in design, which involves the construction and transformation of meaning[6]. In the process of making, technologies play a vital role in the formulation of tacit knowledge precisely because as toolkits and probes, they act as what Ratto called transitional objects[7]. They have an agency to deliver knowledge and facilitate critical thinking processes; Ratto termed this critical making.

Papert discussed the need of “messing about” with materials to construct active learning through the incremental building of knowledge[8]. The use of “computer as material” removed the black box mentality towards technology. Instead, its programming language and software are seen as materials integral to the construction of artefacts; capable of solving real-life problems, like wood or metal. Recent software and hardware advancements have further allowed designers to engage directly with technology. Open-source electronic prototyping has enabled designers to tinker with electronics and build reasonably stable and complex mechatronic systems either from scratch or through hacking existing software and hardware. Online questions and answers forum become a domain for knowledge exchange useful for the novice and expert user alike to debug common problems, resolve technical hurdles and build new knowledge. The technology binds the users together, but it is the knowledge of these open source environments that enables an active engagement between design and technology[9].

In order to understand technology as an operative design agent, there is a need to position technology, not merely as a tool that is a means to an end but also as a component to carry specific conceptual thought processes that enable designs to emerge. Ratto situated the hacker culture within scholarly activities that examined making as a social, technological engagement[10]. He suggested that through making, the maker not only “writes” with material to construct the logic of a system but also makes sense of the relationships between the user and technology; the process of making sense of these relationships is the critical process of enquiry. In other words, technology carries with it agency to fulfil certain creative design task. Ratto makes a clear distinction between critical making and constructionism[11], suggesting that while constructionism focuses on how reflexive practice can improve the quality of the material world, critical making extends beyond this to explore how engagement with material production can improve the conceptualisation of our world. The ability to intervene and have an impact on social life is a key aspect of critical making. In architectural design, this aspect of learning is often excluded from the teaching of technology for a number of reasons. The predominant reason is that many educators see technology as a separate silo to social engagement. Ratto pointed out, “there remained a strong disconnect between these more material forms of engagement and the conceptual work being done on technology, the built environment, and society”.[12]

As Papert pointed out, technology can be used as “material” that has a role as a transitional object. The “transition” refers to the exploration of ideas through making, where the design knowledge generated is carried through to the making process. Here, technology as a toolkit is seen as having an agentive capacity to be able to enhance social communication; it can carry and deliver knowledge.

Machining Aesthetics

The three case studies discussed in this paper are the results of a master level design studio at the University of Melbourne under the studio agenda of Machining Aesthetics. Led by the authors, the studio investigates the role of tools and technology in the design process. For the past two years, students have been working on a simple design brief: Design a "machine" that makes architecture. The typical project team consisted of three to four students working collaboratively throughout the 12-week period. Design Studio provides a relatively constrain free environment for material experimentation, where architectural conventions could be questioned, revisited and scrutinised. While typical design studio focuses on pushing the boundary of the spatial and programmatic convention, this studio questions the way we build architecture and explore emerging spatial conventions through fabrication procedure and its workflow.

The studio introduced tool making as the starting point of an architectural design project. The objective was twofold. Firstly, while there was a clear programmatic and straightforward design brief such as a pavilion or façade envelope design, the approach to the architectural brief was purely from a making perspective – a "wicked" problem where the solution can only be discovered through making[13]. The boundary of making in each project is defined through build precedent studies and specific industrial fabrication procedure which act as probes for the design process. Secondly, we wanted to encourage the students to escape the pre-set conditions of existing tools to discover novel techniques and design potentials. While the case studies address various architectural issues such as lighting control, shade and façade design, we are interested in how technology (in this instance, numeric controlled devices) can be used to solve not just architectural problems but produce design agency that is outside of the convention. Here, the material system and the fabrication process play a key role in facilitating such agencies.

Introducing tool making in the design studio had its limitations, primarily owing to time constraints and the depth and breadth of knowledge that the students needed to acquire to complete the design and fabrication of their system. The students had to utilise and work across a range of software and physical toolkits such as Arduino Microprocessor, Arduino Integrated Development Environment (IDE), electronic prototyping platform (including jumper leads, breadboards, resistors, relays and servos), and other CNC equipment. At the start of the studio, all participating students had some prior parametric design skills using visual scripting software but had little or no electronic knowledge and making skills. To make the hardware more accessible, we introduced the students at an early stage, to the programming language of Arduino IDE, based on C/C++. Arduino IDE is an open-source platform with a widely used programming language. More importantly, the code library is shared online and therefore, accessible to students. We saw this as an asset for students to tap into the shared online code and build up technical know-how in a reasonable time frame. In this case, the students needed only to understand the underlying structure and language to access and understand most codes.

Hacking tool: Morphic Intelligence

Morphic Intelligence designed and hacked into an existing 3d printing machine to explore stitching as a fabrication technique. The project explores the minimal surfaces, and the spatial opportunities provided when fabrics are pinched together and stretched. The design team is intrigued by the simple aesthetics of a pinched surface and how it can be driven by a numerically controlled code to produce extreme effects. The project examines how diffuse light can be moderate between the two surfaces to create a differentiated effect for an interior environment, refer to Figure 1.

Figure 1: [Top] Textual variation through the incremented pitching process; [Bottom] 1:1 Prototype used to explore the diffuse lighting quality.

A dis-used three axis Duinotech^{TM} Mini 3D printer was hacked and modified as the base of the CNC machine as shown in Figure 2. The 3d printer extrusion nozzle is replaced with a tag gun which is modified so it can be actuated numerically using a lever arm attached to a stepper motor. Figure 2 illustrates the actuating motion of the tag gun mechanism. A number of different stitching devices is explored, and the tag gun is chosen because the manual action of the internal mechanism can be actuated with reasonable ease. Two frames are mounted on the base of the modified machine which slides along the linear guide rail. The modified device is driven by a RepRap Arduino Mega Pololu Shield (RAMPS) which numerically controlled the three stepper motors identified as 1, 2 and 3 in Figure 2. The pinched positions are generated in Grasshopper 3d v 0.9.007 and translated to native G-code using Marlin firmware via the Arduino Megaboard. The bespoke stitching machine can control the X-Y movement of the tag-gun, Z-direction movement of the frame and actuated the tag-gun.

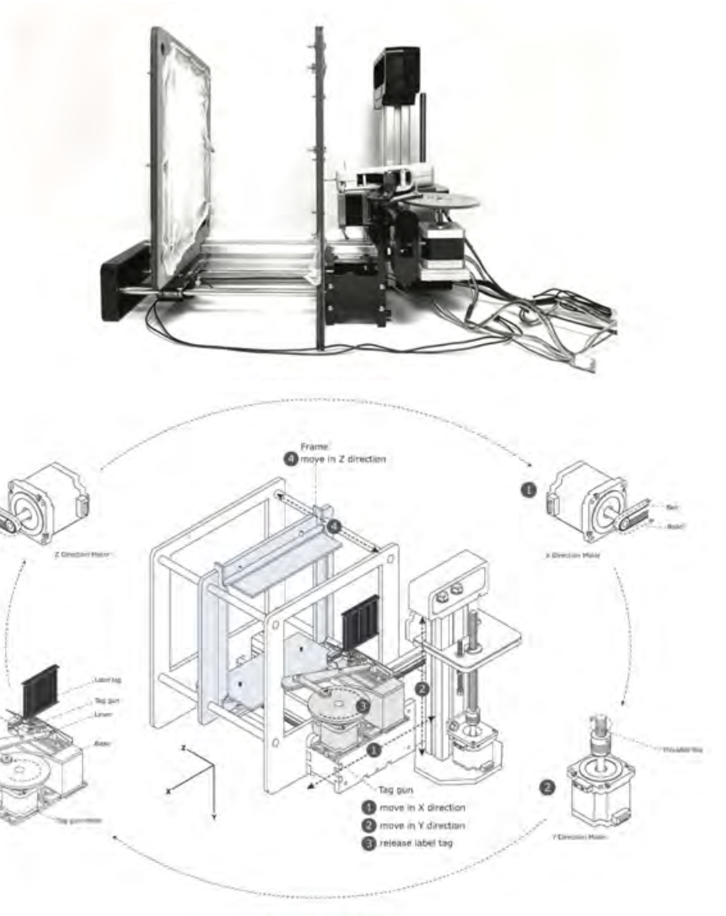


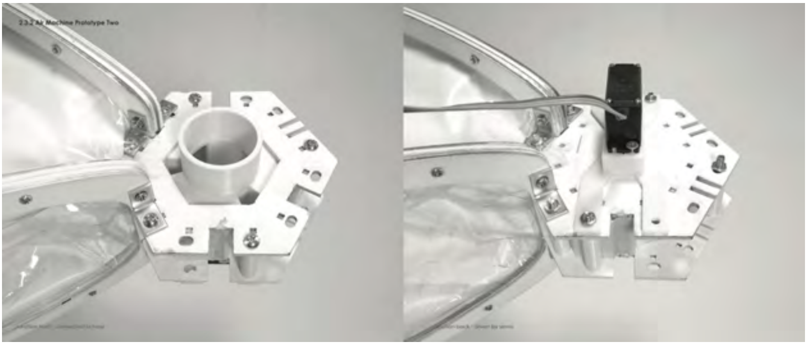
Figure 2: (Top) Hacked CNC stitching machine; (Bottom) Diagram of machine parts and tag-gun actuated motion.

Embedding NC device with the material system: Pneuma

Pneuma (Figure 3) is a pneumatic device that regulates airflow to inflate or deflate a double-skin polyvinyl chloride (PVC) inflatable structure. The project used air to control the penetration of sunlight and view through the inflatable structure. In this paper, our discussion will focus mainly on the making of the air control unit. This project was developed iteratively through a series of fabrication experiments. The design team reflected on the system and questioned how such a structure could be used to regulate daylight and view as a soft façade or building cladding system. To make the project more ambitious, we prompted the students to incorporate light sensors to better regulate the system and limit the amount of sunlight. For initial stage of the design, all the information that the students received was researched from various sources of literature, precedent studies, and online making instructions from Instructables™; no new knowledge was generated, but a great deal was learnt in a short period.

Figure 3: Pneuma prototype showing inflation of cell at various stages.

Innovation happened when the team started to embed a second opaque layer (Figure 3, left) within the inflatable structure, which could be deployed to block out daylight. From this moment onwards, the design was in the bespoke territory. Through critical reflection of the making process, the design trajectory moves into the realm of research where the solution was not known. The team had to design the control device from scratch while prototyping and struggling with air leakage and moving components. The hardware design was reasonably straightforward in which a servo is used to adjust the rotation angle to open and close multiple air paths as "gate", refer to Figure 4. However, embedding electronics required another layer of learning.



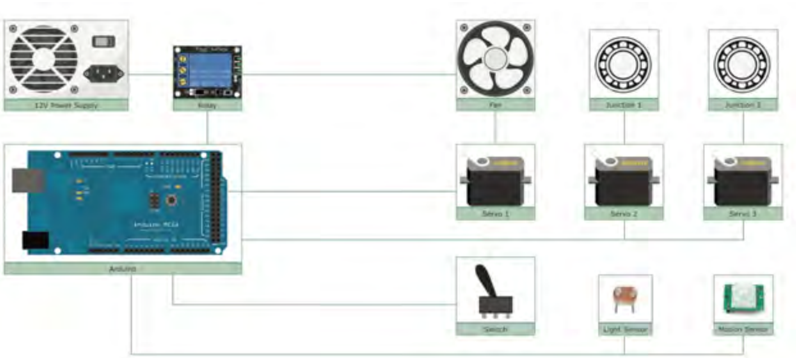


Figure 4: (Top) Servo controlled ‘gate’; (Bottom) Input and output circuit of Pneuma.

The open-source nature of the code meant that once the fundamental principle was understood, the code could be modified to suit the design. The tinkling process with the electronics provided a useful learning experience for the team, mostly trial and error, including burning out the servos and the usual mess of ensuring the circuits are connected logically. It took the team six iterations of hardware and software configuration and reconfiguration to improve the system incrementally. The initial iteration of the system required input data using Firefly, a Plug-in to Grasshopper. Frustrated by an external device, the team starts to code the sensor activation and ‘gate’ timing directly in Arduino IDE, which enables the system to be a standalone device with its own power supply; a step closer to develop the research into industrial application. Figure 4 illustrates the circuit workflow of the system.

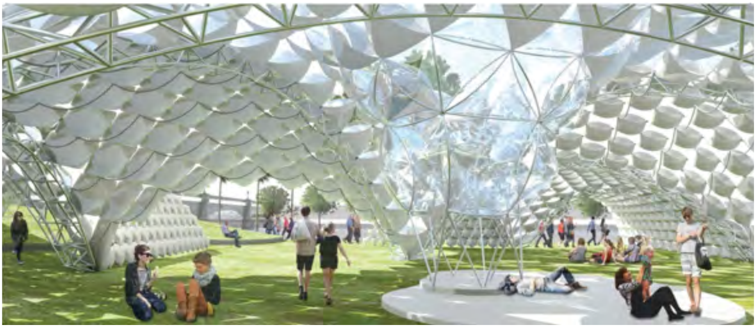


Figure 5: (Top) 1:1 prototype; (Bottom) Design proposal utilising prototype as design enquiries.

A 1:1 full-scale prototype with six connecting cells was constructed to test the feasibility of the concept. The prototype maintained a 10 minutes inflation and deflation cycle. The prototype acts as proof of concept for the speculative design of a temporary summer pavilion as illustrated in Figure 5. The design explores the material system as a lightweight inflatable roof structure that can control and regulate daylight to produce a subtly differentiated interior environment. Details from the 1:1 technological envelope, including the arrangement of pipes and duct, is developed as part of the reading of the structure and is inherent to the nature of the system.

Hybrid fabrication: FOAM

FOAM is a CNC formwork for sprayed Polyurethane Foam (SPF). The machine, designed to sit on the façade of a building utilised an elastic fabric formwork. This project hybridised three conventional building systems to develop a new fabrication methodology. Firstly, fabric casting techniques; an architectural expression used by Miguel Fisac and later by Mark West and Kenzo Unno[14]. The second building system is slip forming which is a construction system developed for rapid concrete casting, primarily used in vertical multi-storey concrete structures[15]. The formwork typically rises continuously to allow for continuous pouring of the concrete. Thirdly, the External Thermal Insulation Composite System (ETICS) is utilised mainly as an economical way to insulate buildings in Europe and the USA. The system is often used to retrofit existing building stock. Research and development in halogen-free flame-retardant compound on ETICS allows the system to meet European standard[16]. In recent years, researchers have explored SPF as an additive manufacturing technique, primarily with the use of robotic manipulator arm; for example, the Print-In Place (PIP) fabrication technique developed by Keating et al.[17].

Figure 6: (Left) 1:1 wall prototype of FOAM; (Right) Pivot mechanism of the FOAM.

Two main components make up this novel machine. Firstly, the arm actuators shown in Figure 6-right generates a controlled pattern through a custom script in Grasshopper and Firefly plug-in. The arm actuator is a mechanical end effector with three axes of control that create a series of pinch point to the fabric; the rotation angle of the end effector also informed the thickness of the formwork. Within these parameters, the depth of insulation, as well as the topography, can be algorithmically controlled and generated by the designer. The second is the casting bed unit that provides a perimeter frame that acts as the mould for the casting process; refer to Figure 6-left. The mould utilised a fabric mesh, and its elastic property has a direct impact on the final form. The effect of gravity on the SPF as it cured and the deformation of the mesh caused by the arm actuators add further complexity to the system; this is compounded by the need to maintain a degree of relaxation in the mesh to control the depth of the cast better. The design team digitally stimulated the making procedure with the arm actuator and the casting bed unit. The design underwent three iterations of prototyping and refinement before the last machine was tested to produce a 1:1 scale construction prototype as shown in Figure 6. The iteration process allowed the system to be refined and calibrated to ensure the pivoting arm actuators apply sufficient force to the fabric to act as a mould for the SPF.

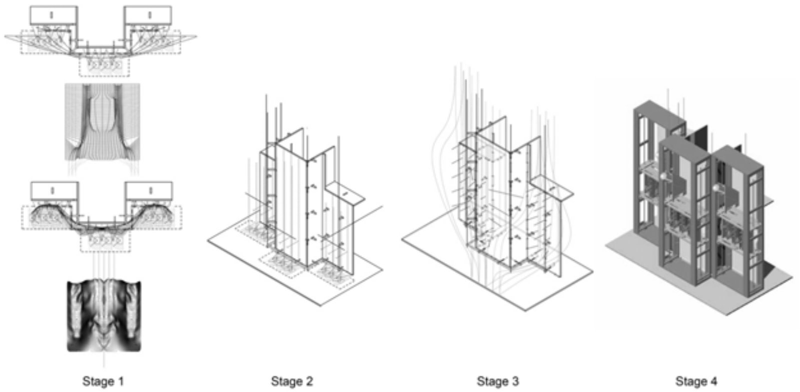


Figure 7: Fabrication workflow of FOAM.

In practice, FOAM operates on the outer facade of a building. Figure 7 illustrates the casting procedure. Before stimulating the design, the base geometry is digitally modelled; it is then subdivided into chunks to suit the operating height of the machine for algorithmic manipulation [Stage 1]. Tool paths are generated based on the mapping process along the vertical plane of the façade [Stage 2]. This process is calculated based on two elements. Firstly, the arm actuators and the tool paths vector along the mesh surface. Secondly, the pneumatic force acting on the mesh by the expansion foam simulated in Kangaroo Physics. Based on these two criteria, the tension on the mesh negotiated the two effects and controlled the overall geometry of the SPF [Stage 3]. As the first layer is cast, the machine moved vertically up similar to a slip forming system to cast the next segment [Stage 4]. The previous constructed result is scanned and feedback into the algorithm for the surface geometry to be extrapolated for the next section. This continuous feedback system provides a constant designing procedure within the fabrication workflow.

Through physical material experiment, the team soon realise that the dimple effect on the surface which create negative curvature surface not only acts as a control device for the system but also produces a residue flowline that allows surface water to track across the surface. This becomes the primary generator for the design of the façade, and the design is reduced to a series of spline curves, as illustrated in Figure 8.

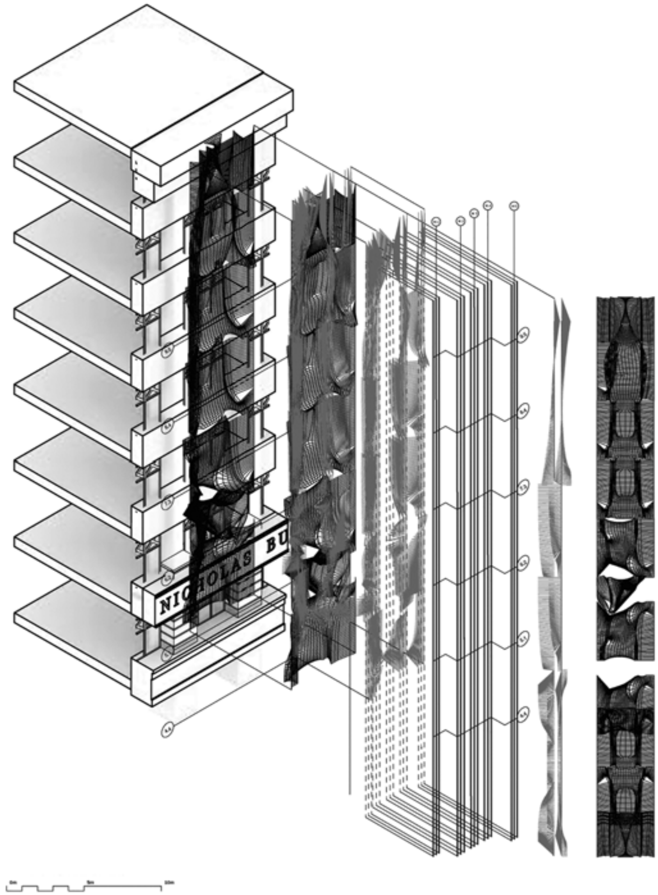


Figure 8: FOAM design application on an existing facade.

Discussion: Machining Aesthetics as agencies of design

The case studies discussed above provide tangible evidence, in particular, the physical prototypes, of how tool making through design and material experimentations could facilitate productive dialogue between design and the making procedures. Architectural form in these case studies become an emerging factor dictated by the tectonic procedure[18] of the technology.

In the case studies, technology is either hacked, embedded or hybridised to create new material systems which generate agencies for design; it is the agentive capacities of these strategies that are of interest for this research. The hacked system works within the parameter of the original system and re-proposed it for another usage as exemplified in Morphic Intelligence which creatively re-orientate the conventional X-Y plane of a 3D printing system to perform stitching action on a

Z-Y plane. On the other hand, the embed strategy imposes a layer of technological control over a conventional double skin ETFE façade system; allowing the system to increment its effect over time instead of a mere on/off scenario. The hybridised system borrows useful techniques from the various systems and re-integrates them into something new. In the authors' opinion, this strategy is probably the most complex and perhaps the most fertile ground for future research. This strategy requires active designing of the system to negotiate the design problem and its outcome.

The visual effects of the outcome naturally retained the mark of the machine. As Deamer observed, the neutral relationship between tools and material often yield "unanticipated and often materially transformative results."[19] This unpredictable and unexpected material outcome holds an element of risk that Marble[20] and Kolerevic[21] have attributed to the workmanship of risk; a term borrowed from Pye's examination of craftsmanship[22]. The research in this paper highlighted that this reading might only be part of the story. While the mark of the machinery may contribute to the aesthetic quality of the prototype, they also become useful design strategies that enable the designer to capitalise on its effect. For example, in FOAM, the dimple is used as a generative node for a series of flow lines across the surface. In Morphic Intelligence, the pinch effect controls the level of diffuse lighting is multiplied to extremity only made feasible with the used of custom CNC machinery. In Pneuma, the entire soft façade system becomes a spatial apparatus in choreographing the interior effects. It is in this set of aesthetic value that we defined the term, machining aesthetics.

Conclusion:

This paper presented three strategies of innovation in tool making. Through these strategies, the case studies examine the design agency associated with tool making and how it can facilitate design research alongside providing solutions to design problems. When there is a need to search for new knowledge that goes beyond the standard toolsets offered to the designer, tool making can be a useful research methodology for design research; utilising technology as material for constructing knowledge and a means to search for design potential and resolution. The process of making sense of the relationship between spatial requirement, effects, materiality and fabrication is the critical enquiry that is demonstrated in the case studies. These vital enquiries allow us to make the design research applicable to practice and extending it into the social domain; to engage technology with the built environment and society.

Acknowledgement:

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Teaching Digital Fabrication in Non-digital Context.

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Abstract

The paper describes an experience of teaching aspects of digital fabrication at Monash Art Design and Architecture (MADA) which curriculum, traditionally, is not related to the architecture of the digital paradigm. As the paper will show, it is possible to achieve high level of educational outcomes even with students with no or very limited theoretical and practical background in the discussed area. The outcomes were achieved by following a teaching method designed to address reflective, implicative and aggregative relationships between actors, environment and artefacts of research in design context.

The paper offers an insight into the teaching method, where the aforementioned relationships are translated into various modes of knowledge transfer and acquisition. The course starts with a series of seminars. During each meeting, students are presenting and discussing a number of case studies reflecting on different aspects of digital fabrication. Next during workshop class, a few implicative exercises structuring the seminars material are carried out. Finally, during laboratory classes, the previously gained knowledge, hands-on experience with CNC tools and iterative design process are connected in aggregative teaching mode.

The paper concludes with a critical analysis of the achieved educational outcomes is presented, followed by a discussion on the teaching method itself.

Digital Fabrication and Architecture

In his book, Jan Slyk notes that between an architectural concept and its realisation there is an area of discontinuity much bigger than in any other design field.[1] Digital fabrication brings a promise of covering this discontinuity with a digital data. A Consistent and an interchangeable one, that merges two previously distant product development environments: the Computer Aided Design (CAD) and the Computer Aided Manufacturing (CAM). The idea of digital manufacturing implies that a project created in this uniformed digital environment delivers a full set of information required for a production process. Without any data translation or design alteration. This is often referred as a “push-button” fabrication.

For over two decades architects are increasingly exploring this paradigm, both in research and professional practice. The original cause was strictly formal. With the development of CAD tools, a simultaneous development of architectural forms could be observed. Projects generated in the digital environment have, over time, become increasingly complex. Difficult to describe with the traditional, analogue tools. As an effect, a need for a new craft was created. A one which would allow for a fabrication of bold visions of architecture. Excellent, early examples of this phenomenon include Barcelona’s Olympic Fish by Frank Gehry and Kunsthaus in Graz by Peter Cook and Colin Fournier. Both these designs addressed a number of unique construction problems with revolutionary, at the time of realisation, solutions in prefabrication. Solutions achieved by establishing a direct link between a digital architectural model and a CNC manufacturing processes. With time, growing understanding of various CAM tools and processes led to an extensive use of these in architecture. That in turn, resulted with a reverse situation where what is easily achievable with CAM, informed what is designed. To the point where architectural discourse is discussing an emergence of new aesthetics[2,3].

These two aspects of digital fabrication in architecture are equally important research areas and literature already offers a number of different views of these issues. From purely technical and material considerations[4], through design for digital manufacturing[5], up to theoretical investigations of CAD-CAM relationships[6]. Given the importance of these issues, digital fabrication of architecture became an essential research and increasingly teaching component in many leading architecture schools. However it has been noted that teaching in these new, digital areas often relies on individuals, digital practitioners, pursuing their own research and design ambitions[7]. Without a doubt these countless explorations, experimental pavilions and structures, offer an insight into what and how we design and build. On the other hand 'there has been very little written about what students are actually learning'[8] through these ventures and 'concepts for a holistic incorporation of digital fabrication into the architectural curriculum are still rarely described in literature'[9]. Finally analysis of, author's own research and experiences in teaching digital fabrication allowed to observe that on a regular basis only a fragmented knowledge and an incomplete skill set, required for a specific task, is being delivered to students. Leaving them with no theoretical nor practical expertise to benefit from in their further studies and professional practice.

Teaching Digital in Non-Digital Context

Given the realities of operating in the digital paradigm of architecture, an ability to acquire and transform an information into a knowledge and adapting it to various design scenarios, is of most importance. In order to equip students with the same skill an adequate teaching method has to be deployed. Teaching objective has to be shifted away from an outcome pursuit, back to understanding design and research processes. Creating student focused environment of knowledge acquisition and transfer. This requirement becomes extremely vivid when a course is not a part of a standard teaching curriculum of a given university. This is the case described in this paper. During author's Architecture Innovation Fellow residency at Monash Art Design and Architecture, he ran a digital fabrication course with a group of students, some of whom had no previous experience with any aspect of the digital paradigm. In order to operate in this difficult context and achieve teaching outcomes, an authorial *design-research* teaching method was adapted and deployed. Theoretical background of this method is described in the section 3 of this paper. Section 4 offers description of teaching agenda, process and outcomes of the digital fabrication class at MADA delivered in 2017.

Design-Research Relationships

The author's approach to teaching in areas where students are not literate, is based on study of relationships between design-research elements and the resulting knowledge transfer. Treating the knowledge transfer as a course ultimate outcome, allows to trigger it by choosing adequate teaching modes.

In his paper[10] Christopher Frayling advocates the need to integrate design and research activities. He offers a framework of relationships between these elements, dividing them into three categories: [1] *research into art and design*, where scientific research on art and design, aimed at acquiring knowledge about existing works and studies, [2] *research for art and design*, aimed at building the knowledge base to be used in the design process, [3] *research through art and design* where design and development is used to generate knowledge about the process itself and the components that make up a project. Detailed description of these design-research activities in more utilitarian context, thus applicable to architecture, is given by Imre Horváth in his work. He names these: [1] *research in design context*, [2] *design inclusive research* and [3] p*ractice-based design research*[11]. He observes that these are driven by different types of relationship between actors, environment and artefacts of the process (fig1).

Reflective where elements, actors, artefacts, or environment are self-contextualised. For example, the purpose of the study is to seek a link between past and present work of an architect (artefact/reflection/artefact). *Implicative* where a unidirectional connection is expressed between each element; actor and artefact, artefact and environment, finally environment and actor. Each of these dependencies may go the other direction. For example, the purpose of a study is to understand the influence of a digitally fabricated precedent on one's design methods (artefact/implication/actor), of the digital paradigm on a built form (environment/implication/artefacts), of critical architectural practices on a CAD/CAM development (actor/implication/environment). *Aggregative* relationship creates a complex network of links and interdependencies between elements. Becoming a design-research context for each other. For example, the purpose of a study is to understand relationship between the work of an architect and CAD/CAM tools (artefact/aggregation/environment). Both the changes in a design caused by tools and the development of CAD/CAM solutions required to manufacture it, have to be considered.

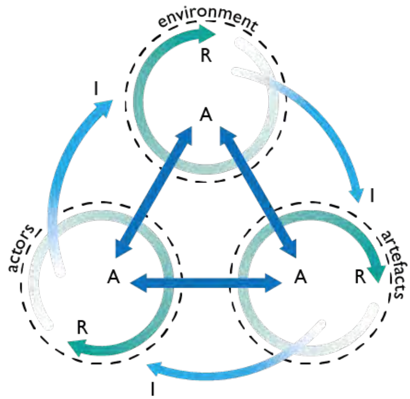

Figure 1: Scheme of relationships between entities of design-research: (R)eflective, (I)mplicative, (A)ggregative. Based on Horvath, I 2007, Comparison of three methodological approaches of design research, Guidelines for a Decision Support Method Adapted to NPD Processes.

The above described theoretical framework offers a flexible pedagogical tool. One in which a quick assessment of student's competency level in the given teaching area allows to adapt and reorganise teaching curriculum and methods. A course designer, after formulating a set of clear teaching outcomes has to decide, which entity of design-research; actors, environment or artefacts the given skill, knowledge, ability, etc., belongs to? Does it require previously acquired knowledge or expertise? Is it required in order to gain knowledge? Answering these questions allows to decide when and which from described relationships needs to be triggered ergo which type of design-research activity needs to be recreated in the classroom. This is illustrated with the matrix below (Figure 2).

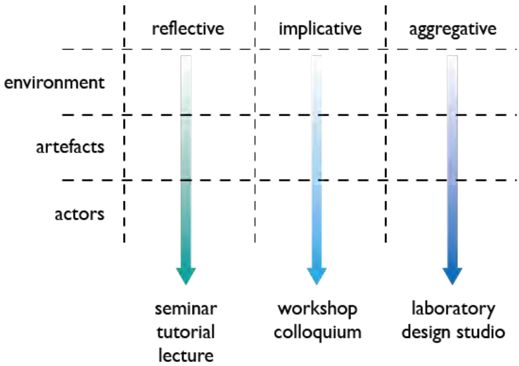

Figure 2: Course design matrix. By positioning given teaching outcome; skill, knowledge, etc. within environment, artefacts and actors and recognising its relations with the other elements of curriculum, the time and mode of delivery can be determined.

Digital Fabrication Course Design

Formulation of the desired pedagogical outcomes and adequate teaching methods is based on both the aforementioned theoretical base and author's own experience in teaching of digital fabrication[12]. The teaching objectives formulated in a process included; [1] awareness of available digital fabrication technologies and their integration methods, [2] classification of digital fabrication techniques according to the material's method of treatment, [3] awareness of the principles of digital fabrication devices operation, data formats and control protocols, [4] ability to prepare proper prototype fabrication documentation, [5] knowledge of recent trends in the field of architecture and digital fabrication, [6] awareness of digital fabrication techniques development trends, [7] ability to shape the concept of the prototype, [8] ability of appropriate technique selection to fabricate an object, [9] development of methods for assessing effects of work. Testing these ambitions against the course design matrix and timeframe allowed to develop an adequate teaching curriculum, modes and a delivery flow (fig3).

The class was offered as an elective studies unit to a group of twelve students, composed mainly from 4th and 5th year master's students and two 3rd year bachelor's students. The course was delivered over twelve weeks, during 2nd semester of 2017 academic year at MADA. Class was meeting once a week for three hour long sessions coordinated by the author. At the same time students were expected to spend at least another six hours a week on self-study and project development. Students lacking an expertise could also take part in two supplementary, off-class tutorial activities; [1] CNC operation ran by fabrication laboratory technicians, [2] intro to parametric design ran by the author. None of these additional activities offered additional credit and were delivered on ad hoc basis. Finally once a week author held two additional consultation hours.

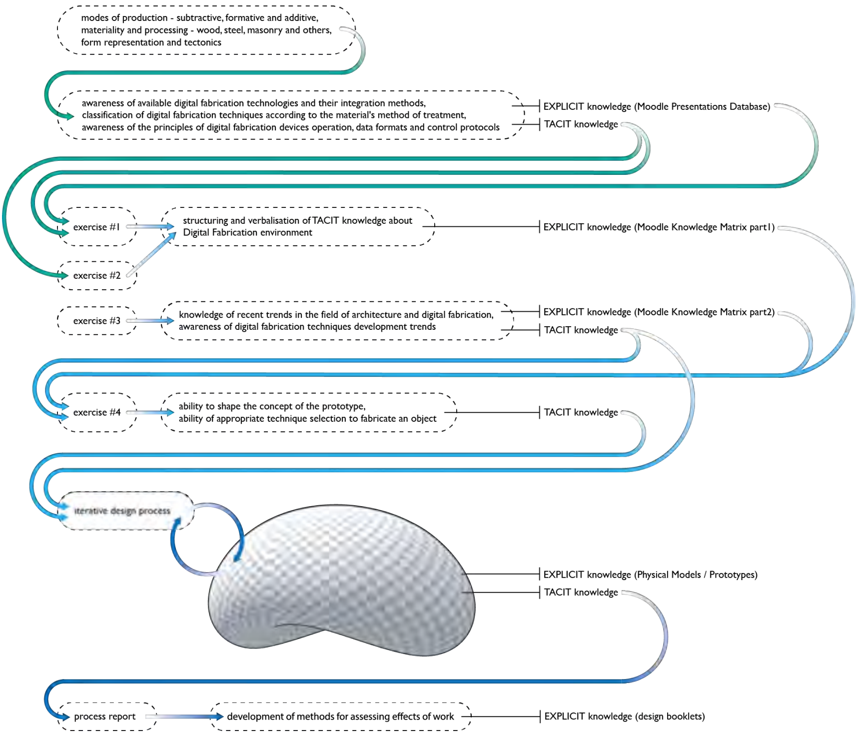

Figure 3: Digital Fabrication course objectives, teaching methods and outcomes, presented as a knowledge (both tacit and explicit) flowchart.

The first three weeks were devoted to generation *reflective* knowledge about digital fabrication environment. These three meetings took form of seminars. Each seminar was devoted to different technical and material aspects of digital fabrication: [1] modes of production - subtractive, formative and additive, [2] materiality and processing - wood, steel, masonry and others, [3] form representation and tectonics. During each class, every student had to present a 10 minute long in-depth case study that was followed by quick question and answer session. Each class was then concluded with a moderated discussion. After each session students were uploading presented material to the course's Moodle site. This allowed to create a database which students could use later on. Moreover tutor supplemented the uploaded material with additional comments, links and references clarifying some of the issues discussed during a class (Figure 4).

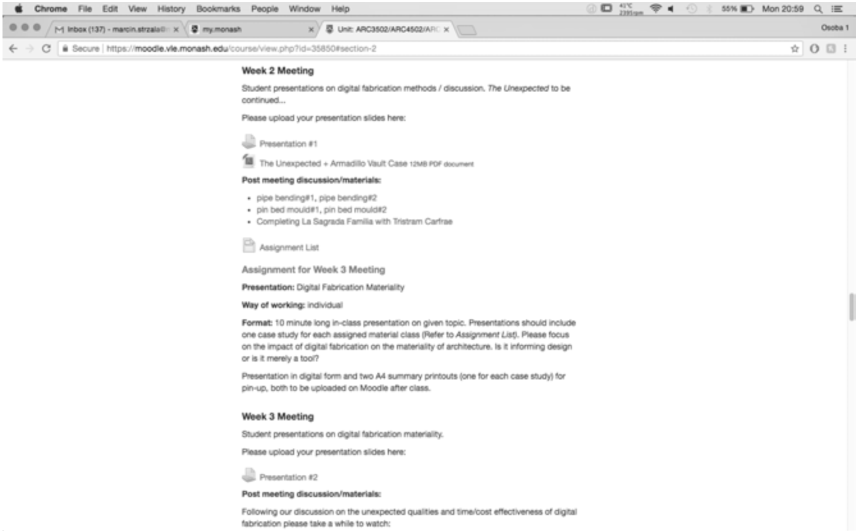

Figure 4: Typical Moodle entry consisted of; in-class activities description, student assignment upload, authors presentation, post meeting discussion, materials, links etc. and description of an assignment for the next class.

The second part was designed to trigger implicative processes. A single workshop classes consisted of a series of exercises. In the first one, students were given small sheets of paper with sentences describing tools, processes, materials etc. discussed during seminar part. Using the previously gained knowledge, students had to arrange these into materials/tools/methods matrix drawn on a pin-up wall (Figure 5). In the second exercise participants were given another set, this time of blank sheets of paper. Students had to take turns and pin-up comments on various aspects of the matrix, creating SWOT analysis of discussed area. These two activities allowed to structure previously gained knowledge and verbalise of these parts of it which remained tacit. In the next exercise tutor, distributed among the students over a hundred A5 photographs of digitally fabricated architecture precedents. These had to be recognised from the existing matrix point of view and pinned in a proper area of it (Figure 6). In the final exercise, the students were introduced to the classification of digital fabrication techniques as proposed by Lisa Iwamoto[13]; sectioning, teaselling, folding, contouring and forming. Following short discussion in sub-groups of four, students had to assign previous precedences to one of these techniques. The session closed with an activity introducing *aggregative* process. Each student sub-group was given a visualisation of an abstract architectural scale object and asked to sketch/propose how it could be built using all five fabrication techniques, defining digital fabrication processes, materiality and tectonics.

Figure 5: Students had to recognise and discuss placement of elements within the knowledge matrix.

METHOD	subtractive	formative	additive
definitions			
technology			
SWOT			
examples			

MATERIAL	wood	steel	masonry	other
characteristics				
technology				
SWOT				
examples				

Figure 6: Scheme presenting all aspects of digital fabrications reflective knowledge covered during the workshop session.

Finally, during the last five weeks a design/laboratory working method was used. The previously gained knowledge, hands-on experience with CNC tools and iterative design process were connected in *aggregative* teaching mode. The students, working in groups of four, had to enter recursive design-research workflow. They were asked to design whole digital fabrication process, including manufacturing of a prototype of a given 3D model (fig6). The model was loosely based on the geometry of Cloud Gate by Sir Anish Kapoor. This particular geometry was chosen because it is constructed out of continuous concave, convex and saddle surfaces. That poses an interesting problem from the point of view of modelling, fabrication and assembly. In order to solve the aforementioned issue of learning limited skill-set each group had to go through the described process two times. Each time using different design strategy, fabrication method and materiality to operate with. The six developed solutions/prototypes presented various, sometime unique approaches and will be further discussed in the next section.

Figure 7: Group of students during discussion on possible fabrication strategies. In this example a thin shell casting and a geometry approximation with flat panel tessellation.

Teaching Outcomes

Because the teaching process was based on design-research methods it is justified to treat and examine the teaching outcomes as artefacts of a research-into-teaching. While using different modes of delivery also different types of knowledge were created. This is represented in the scheme where knowledge flow, related to described in-class activities is mapped onto three entities of design-research (Figure 3). During the seminars the explicit knowledge took form of a Moodle database of students' presentations offering in-depth overview of various technologies, materials and fabrication strategies. Students have access to this resource shall they need it. At the same time a tactic knowledge, an understanding of digital fabrication environment was achieved. During the workshop part, this intuitive understanding was verbalised with the creation of the matrix. Again, the matrix was photographed and uploaded to the Moodle site, students have access to it. Moreover, students gained ability to see interconnectivity of various elements in digital fabrication processes and reading these in architecture precedents. Their architectural vocabulary developed, a tacit knowledge. In the final design-laboratory part students put all of explicit and tacit knowledge to work in creative process. Six unique prototypes were built (Figure 8). Topics covered in this recursive exploratory design process include [1] thin shell elements casting, [2] FDM panels robotic extrusion (Figure 7), [3] material behaviour simulation and optimisation, [4] geometry approximation with flat element folding, flat panel tessellation and material properties.

Figure 8: FDM type extrusion controlled with a small robotic arm was used in one of the fabrication strategies.

Figure 9: All six models designed and manufactured during Digital Fabrication course, presented during graduate exhibition.

During *aggregative* activity a large amount of the knowledge is being created ad hoc, through exploration. Often it is being lost in the recursive design cycle or remains a know-how, tacit knowledge of an individual. In order to avoid that each group submitted a final artefact. A booklet offering an in-detail description of whole creative process, a research report. Each design iteration is described through discussed elements of digital fabrication, technical and material exploration, etc. The booklets were uploaded on the Moodle site and are accessible to students, giving them an opportunity to learn from and reuse some of the developed solutions.

Conclusions

The conducted three-stage process of transferring and creating knowledge based on the increasingly advanced design-research methods proved to offer very good teaching results. This has been confirmed with formal and measurable effects, such as those given by students models as well as process booklets, which mostly presented high levels of critical observation. The adaptation of the theoretical framework as the teaching method allowed for innovative outcomes to be achieved in several categories: [1] parametric design and digital workflows, [2] custom CNC methods and fabrication processes [3] knowledge of CAD/CAM in architecture verbalisation.

From the didactic point of view all the above elements allowed to equip students with knowledge and skill-set described in the digital fabrication curriculum. Moreover, operating in design-research context allowed to develop work of an innovative character. Work which in many cases significantly outgrown author’s expectations, especially in the context of MADA’s non-digital curriculum.

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ADR18

Not to Scale: representing and making new design dimensions

Chaired by Dr Paolo Stracchi

Horizon of Being

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Abstract

Considering Ibn al-Arabi's visualization of the world, and Shihab al-Din al-Suhrawadi's science of light, which pronounces that the principle of Being is that of 'light,' this presentation regards architecture as a science of light where light is taken as the interrelationship of things. A reading of light here is both metaphysical and symbolic and provides the connecting ground for a reconfigured science of architecture. This presentation proposes that the act of drawing is considered as an existent (having a reality) of 'light;' and that light is drawn out of the darkness of the medium- a moment of simultaneous existence/construction/vision. Therefore, using a method of indeterminate architectural drawing, there is an attempt to bring into being a view of an Islamic cosmology and ontology. The act of drawing is transcendental in that it melds the imagined and material world. The drawings are regarded as being Heteroglossic in that they examine a realm of space-time of overlapping horizons that consist of a co-existence of past, present, and future. There is an awareness of the uniqueness of verticality having a spiritual significance in mystical experience. The concept of verticality is viewed to be a spatial expression of the Muhammadan Reality in its eternal presence; Horizontality intersects with the layering of the seven heavens. Seeking to uncover, amplify and compose multiple horizons of the peculiar through illustration of spatial reference of Arabi and Suhrawadi, the house becomes the subject for manifestation of the world within the universe, hence being a 'space of reality'/ 'state of reality (*manāzils*).' This suggests its spatial dimension protects and gives value to everything being 'with-in.' Hence architectural and spatial inquiry happens by 'drawing out' an 'aura' or 'spirit', from the sketch through to the developed *Cosmogram* drawing.

Introduction

> Allah [God] is the light (nūr) of the heavens and the earth! The likeness of His light is a niche within which is a lamp in a glass, the glass like a shining
>
> star lit from a blessed tree, an olive neither eastern or western, its oil nearly glowing though fire had touched it not. Light upon light! Allah guides to His light whom He wills.[1]

The twelfth-century philosopher Shihab al-Din al-Suhrawadi, in *The Philosophy of Illuminatio*n, pronounces that the principle of Being is that of an imminent light. In this paper, I explore this by proposing that architecture is a 'science of light' in which light illuminates the interrelationship of things. Suhrawadi stated:

> If you wish to have a rule regarding light, let it be that light is that which is evident in its own reality and by essence makes another evident. It is, thus, more evident in itself than in anything to whose reality being evident is superadded.[2]

Light is part of the logic in classic scientific thought as being concepts that can either be acquired or self-evident and thus as a science it "has to be self-evident expressions of essences of the subjects of that science."[3] Light is both metaphysical and symbolic and provides the connecting ground for a reconfigured science of architecture. It is proposed that the act of drawing is literally working and creating a reality of 'light', hence drawing as light, draws out of the darkness of the medium a moment of simultaneous existence, a construction and the vision of the past, present and future.

Alongside al-Suhrawadi, this work also uses twelfth-century Islamic philosopher Ibn-Arabī' '*three modalities of Being*,' *manāzils* (house/dwelling):[4]

1. *dunya* (present world/visible world), see figure 1.
2. *barzakh* (intermediate world/invisible world of the dead), see figure 2.
3. *akhira* (future of the world/hereafter), see figure 3.

The research uses this metaphysics to spatialise and create an architecture that manifest an Islamic cosmological view of the world as a whole. The act of drawing is a method of illuminating ideas and truth, sketching out these fragmented modalities of being is considered the preparatory studies for the construction of a more laboured cosmogram drawing that Marco Frascari has noted as the "cosmological tracings are the real drawings of architecture. They are not prescriptive but descriptive instructions for constructions within a horizon, resolving the contrast between the immediate intuition of the imaginative world and the mediative materiality of architectural practice."[5] As a spatial and architectural practitioner, the visual and spatial fields are important in articulating the creative aspects of the research. By adopting a methodology of 'spatial exposition' through drawing one "exhibit[s] the contents of the concept of space … an engagement with social space and lived situations, in which concepts, identities and polities are continually produced and consumed."[6] In these drawing the line is one of delineating form, and the effects of light and shadow through various methods of mark marking is the illumination of the surface.

Spatial Exposition

The Black House,
orientation
radiates out from the East,
body
draws in from the West,
From the shadows,
projection,
light emits form,
a path,
the manifestation of dwelling and spirit.[7]

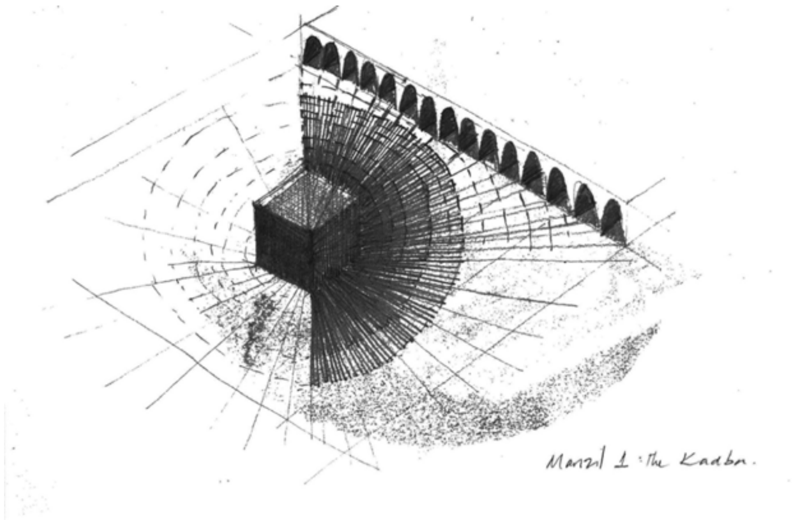

Figure 1: *Manāzil* 1: *dunya* (intermediate world/invisible world of the dead). Pencil on paper, drawing by author, 2017.

The research begins with drawings that sketch the *Ka'ba* or the House of *Allah* located in Mecca which is understood to be the first house in Islam (see Figure 1). Speculative architectural sketching is founded on Giorgio Vasari's assertion that drawing is considered as the concrete invention of idea and form of the intellect. Bernice Rose in *Drawing Now* equates Federico Zuccari's concept of *disegno* has:

> "elevated drawing to a metaphysical activity with its origin in the mind of God… *Disegno* is made up of "*disegno interno* and *disegno externo*. The "inner design" (or "idea") which precedes execution and actually is completely independent of it can be engendered by man in his mind only because of God; man's idea is only the spark of the divine mind. *Disegno externo* is the external, visual shape of the structured concept, the actual artistic representation, be it pictorial, plastic, or architectural."[8]

Therefore, Zuccari's concept of *disegno* connects both design and drawing with the intellect, and thus is heteroglosic by its coexistent nature. It is the revelation and projection of the artist's intelligence, its illuminated reality; auto-biographical in that the marks are a confession of one's intimate interior and exterior. The Renaissance regarded drawing as highly intellectual, that it was both poetic and scientific. The nature of the drawn-line through perspective, for example, was considered a personal "window to reality…its subjectivity was regarded as spiritual."[9]

Similarly, al-Suhrawardi's cosmology and ontology regard *haqiqa* (reality) as 'light' (luminous reality), a realm of metaphysical truths, where access to and vision of this reality is only obtained by assertion to seek knowledge via practices that "in their quest for the apperception of those lights,"[10] hence the intellectual process through drawing is considered in this research as 'Illumination' via *disegno*.

With this in mind, the architecture of this research attempts to embody al-Suhrawardi's metaphysics of four divisions of light/reality[11]:

1. self-subsistent immaterial or pure lights (*al- nūr al-mu-jarrad, al- nūr al mahd*);
2. accidental lights (*al- nūr al-ārid*) inhering either in immaterial lights or in physical bodies;
3. barriers (*al-barzakh*) or dusky substances (*al-hay'a al-ghāsiq*);
4. dark modes (*al-hay'a al-zulmāniya*) – accidents in either immaterial lights or physical bodies.

The following sketches attempt to draw out the attributes of these four divisions through the line, which is the delineating form, and the variation in layering, tone and shadow which is the illumination of the surface, idea and intellect.

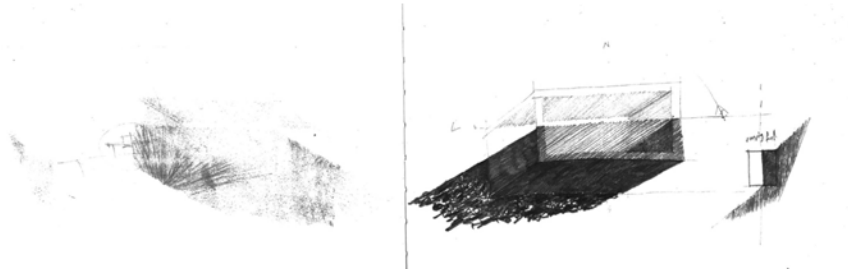

Figure 2: *Manāzil*: 2 *barzakh* (intermediate world/invisible world of the dead). Pencil on paper, drawing by author, 2017.

Hans Blumenberg, a philosopher and historian, suggests in *Light as a Metaphor for Truth* that light in the history of metaphysics has made use of the transcendental characteristics explored above by al-Suhrawardi. In this way, we come to grasp the concept of Being conveyed by light as the overwhelming, with remarkable clarity, of that in which the true "comes forth [and] produces space, distance, orientation, calm contemplation; it is the gift that makes no demands, the illumination capable of conquering without force."[12] This allegory of light articulates a particular truth in the way that the sketches here in this research creates a pathway that constructs space, distance, orientation, knowledge, spirituality, and contemplation for the production of a greater picture of one's world. The drawings are therefore considered 'heteroglossic.' This termed is borrowed from Mikhail Mikhailovich Bakhtin's concept of 'heteroglossia', which in reference to the novel, is the co-existence of, and tension between, two or more forces that seek to keep things apart, as well as striving to keep things cohere.[13] Hence the novel is viewed as a type of bricolage that reflects and examines the coming together of various forms of speech to create a distinct language. Drawing works in this manner. It relies on the transcription of fluid ideas via the line, that results in the production of space, form and language. As well, the ontology of this study is 'heteroglossic' in that it attempts to examine a realm of space-time of overlapping horizons that consists of a co-existence of past, present, and future; and the coexistent of light and darkness. Also, following John Hejduk's[14] assertion that drawing is a complete act of architecture with the use of poetry, sensuality, and language; new worlds capture the atmosphere of stories, characters, sacredness, and rituals – the graphic visualisations 'draw out' an 'aura' or 'spirit.” David Shapiro states "poetry and architecture are not just contingent analogs for Hejduk. They are both building arts. They are ontologically the same art, as he has proposed a drawing strong as a building and vice versa."[15]

By diagramming and tracing the 'spatial sensibility' of an Islamic epistemology and metaphysics, the mark maker is connected to the divine. Seeking to uncover, amplify and compose multiple horizons, the *manāzil* or house/dwelling become the container for one's peculiar condition since, as Bachelard believed, "our home is our corner of the world … it is our first universe, a real cosmos in every sense of the word.”[16] Here the *manāzil* or house is considered a large cradle where the archive of thoughts, memories, and dreams are held ‘with-in.’

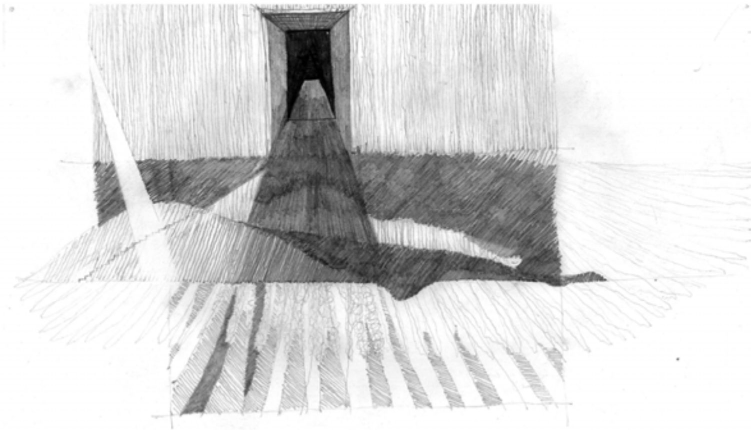

Figure 3: Entrance to Manāzil 3: akhira (future of the world/hereafter). Pencil on paper, drawing by author, 2017.

The Cosmogram

> Allah it is who created seven heavens, and of the earth the like thereof.[17]

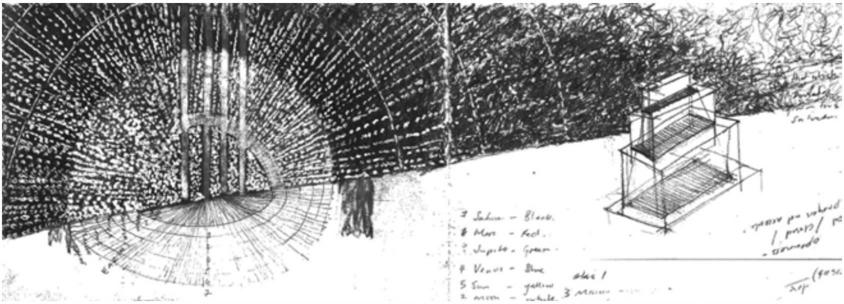

Figure 4: *Domes of the Universe*. Pencil on paper, drawing by author, 2017.

I consider the act of drawing via pencil and paper to be like that of the prophetic tradition of the pen and tablet in which *Allah* revealed his design of the world through the luminous traces the pen inscribed upon the Tablet - the pen is identified as the first Intellect (*al-aql al-awaal*), and the preserved tablet as the ‘universal soul’ (*al-nafs, al-lulliyya*)[18]. Hence with regards to this research, the pencil becomes a fundamental tool for tracing the cosmic manifestation, and "cosmic refraction" of the primordial world that embodies the triplicity of the creative command "Be!"[19] Paper, on the other hand, is the passive site. Theologically, it is believed that *Allah* created a pen with a length that equalled the distance between heaven and the earth, and a tablet, whose length extended between heaven and earth, with its width stretching from East to West.[20] The drawing *Cosmogram* (see figure 5) diagrams the mark maker’s world of Being. External depictions of elements of the cosmos illustrate one’s interpretation of the worldview. It is a cultural map that presents a spatial holism that is open – “determinate but not definitive.”[21]

Drawing,
Darkness is Light,
abundant Darkness, abundant Light,
illumination,
Mystical truth is revealed,
reality, emanating from the light of the intellect,
Depth, and motion,
of being ‘with-in,’
the subconscious and conscious,
Radiating Worlds of reality,
diaspora domiciled within night dwellings of the moon,
floating in, around and above the world of ‘being’.

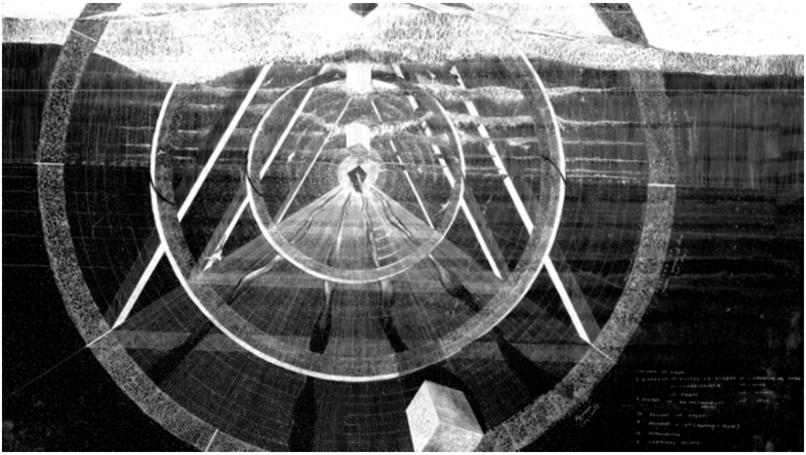

Figure 5: *Cosmogram*. Pencil on permatrace, drawing by author, 2018.

Human spirituality and its inwardness is linked to the vertical axis of the pen that also corresponds to *alif* (first letter of the Arabic alphabet), and to the trunk of the Tree of Being (see figure 6). The tablet, on the other hand, refers to the horizontal plane of human corporeality, which corresponds to *bã* (second letter the Arabic alphabet), and to the branches of the Tree of Being. The essence of the world was transcribed by the flow of ink on the tablet.

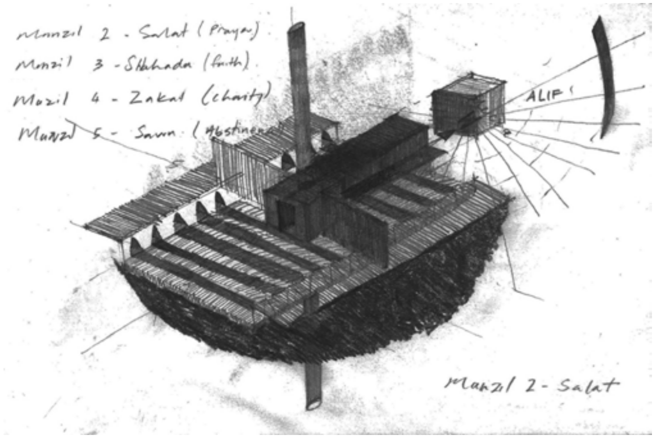

Figure 6: *Vertical and Horizontal Corporality*. Pencil on paper, drawing by author, 2017.

Verticality is depicted in *Cosmogram* to be a spatial expression of the Muhammadan reality. The ninths-century Sufi philosopher Sahl al-Tusturi speaks of this as a 'light of Muhammed' (*nur Muhammed*). He suggests that when *Allah* created Muhammed, he projected from his light a distinct light (*azhara min nurihi nuran*) that when "it reached the veil of the Majesty (*hijab al-'azama*) it bowed in prostration to God [*Allah*]. God created from its prostration (*sajada*) a mighty column (*amund*) like crystal glass (*zujaj*) of light that is outwardly (*zahir*) and inwardly (*batin*) translucent".[22]

According to Samer Akkach,[23] the Ibn Arabī's cosmology originated from the prophetic tradition that espoused the idea that within the sphere of the fixed stars and the ground of the Gardens of Paradise, Allah unfolded the heavens and the earth into the world of space and time. *Cosmogram* attempts to construct Ibn Arabī's diagram of this world perceived with the sphere of the fixed stars with *manāzil al-qamar* (twenty-eight mansions within the circumference of the moon), *al-ardūn* (the seven domes of the heavens resting upon their respective layers of the earth), the four kingdoms, and *al-insan al-kamil/al-kulli* (universal man). At the centre of the diagram a vertical line, identified as *amad* (pillars), is shown, representing the invisible cosmic pillars that hold up the vaults of heaven. Heaven and earth is the last and innermost world in the hierarchy of cosmic manifestation. The Prophet Muhammed reported that, upon the flat expanse of the earth, the skies were constructed as a canopy in the form of a dome (see Figure 4 & 5). Seven skies (*al-samāwāt*), are laid, one above the other, each being smaller than the one above it, creating a layered space that is separated by a distance of five hundred years of travel. Similarly, there are seven earths (*al-ardūn*) laid flat, each being smaller than the one below it. The world of command shows the first stage of the formal articulation with the primordial Cloud. It shows the Cloud in the form of an encompassing circle, the circumference of which is marked by thirty stations of angels ecstatic with love."[24] These encompass the quadrature of the pen, the preserved tablet, nature, and matter, with each assuming a distinct geometrical shape. With each modality of being there are distinct existential conditions, and each has four gardens and twelve constellations. *Cosmogram* uses the perspectival frame, to spatially exposits the depth and motion of both the intellect and soul, therefore if fundamentally is an interior and exterior horizon of Being.

Conclusion

For the mark maker in this research, drawing is a method of melding the cosmic world and ones perceived accurate account of the world- it is one of observation and imagining that opens up broader issues and propositions about the nature and workings of an Islamic cosmology. Through the lens of Ibn-Arabī's cosmological worldview and an interpretive framework of Shihab al-Din al-Suhrawadi's metaphysics of light and illumination, a series of exploratory sketch drawings spatialize textual ideas. The developed drawing *Cosmogram* exposits and Illuminates an Islamic horizon of Being affirming that drawing is a creative mode of expressing the depth of the intellect. Paper is the site for ideas to be constructed on, in and through, hence the act of drawing, therefore, becomes a generative voyage of discovery, invention, statement, and is transcendental. Through drawing, frames the identity of Islamic culture extrapolated through a 'heteroglossic' formation of space and time, and light and darkness, that work actively to animate the past, present, and future. Inherently there are gaps between space and time in such a milieu; however, the unconscious mind of *disegno* does attempt to fill uncertain voids. The will is to collate and connect, not a will to totalise so much as to relate. Moreover, there is the desire to construct a space of spiritual duality where Being is manifested through the will of creating light via drawing and is illuminated by the acceptance and will of the '*light upon light'*.

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On why we can not envision a tesseract: 'unfolding' the interior once more (reflections on three representational techniques for the design of the interior)

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Abstract

Narrowing in on the drawings made by the furniture maker Gillow and Co. (c.1806 - 1831), this text will examine the notion of hybridity as a tenable representational premise for the design of the interior within the digital age.

Stylistically, the link between Gillow and Co.'s work and current practices of interior representations exemplify an amalgamation of sorts. Where both showcases a multitude of drawing techniques harnessed to provide a synoptic impression of the interior in one drawing, as a point of departure, present-day interior projections—in particular, interior collages—emancipate both their mediums and representations in the process of hybridising drawing conventions and images as part of their design language.

This endeavour is a historiography of interior spatial representations that begins with the drawing of lines between interior decorators and upholsterers that occurred around the time of this 'curiosity' of a technique made its appearance (see Figure 2), to the rise of the professional interior designer and its reliance on the interior perspective render (see Figure 3), and of the practice's continued 'unfolding' under the praxis-practice of environmental design and its types of spatial experimentation (see Figure 5). This hybridity of conventions, images and of course, meanings have exposed latent possibilities that have become increasingly useful in the actual design of space in specific levels of scale—cutting across the spatial disciplines through this manner of either representation and lamination.

By rendering this history of interior spatial representation as a metaphor of the interior-as-box, this text ultimately aims at advancing how the interior collage as a means of representing the 'design idea' is reshaping how interior design notions echoes outwards to influence how other spatial designers conceptualise and design space today.

On why we can not envision a tesseract[1]: 'unfolding' the interior once more (reflections on three representational techniques for the design of the interior)

Figure 1: williamCromar, Unfolding a cube creates its net, a graphic, cruciform shape, 2013.[2]

The ways of representing the built environment today are more or less the same as it was when architecture was first conceived as a distinct practice during the

Renaissance[3]. Primarily driven by the audience they wish to engage, they can still be broadly categorised in the same way in the contemporary practice of interior design: conceptual, presentational, and technical.

It can be argued that we are at a period in history where we are no longer concerned with distinctions and that any mode of representing the design idea for the interior is as good as the other. However, in actual practice, this can never be farther still from reality as many interior design practitioners can still be seen generating ideas by way of the sketch (conceptual), clients still rely on interior perspective renders in order to visualise the outcomes (presentational), and builders still depend on orthographically drawn plans, elevations, etc. towards the realisation of interior design projects (technical).

Of course, with the continued advancement of technologies, we are seeing new ways of communicating the design idea for the interior[4].

For this text, we will look into one *presentational*[5] technique that can be said to be fitting of the technologies of today: the interior collage as a hybrid presentation drawing.

Ro Spankie in *Drawing out the Interior* would broadly define hybrid drawings as the “fusing of the different techniques [that] creates new methods of drawing for the interior” — and the interior collage belongs to this representational category in both its traditional (use of scissors and glue) and contemporary (use of image-editing softwares) sense.[6]

Certainly not a unique phenomenon, this will be the first question of two that this endeavour will concern itself with: of identifying whether there were precursors to the interior collage within the drawing traditions specific to the practice of interior design.

Flowing from this, the second question that will concern us here will be similarly framed as the proposition posited by Robin Evans in “The Developed Surface: An Enquiry into the Brief Life of an Eighteenth-Century Drawing Technique” and Laura Jacobus In “On ‘Whether a Man Could See before Him and behind Him Both at Once’: The Role of Drawing in the Design of Interior Space in England c. 1600-1800”: that in as much as the developed surface interior[7] as a hybrid presentational technique can be said to be an example for the exchange between “things visual and things social”[8], could the same be said of the interior collage of the present-day?

This is a big proposition indeed, and on top of this, unlike both authors who benefitted from looking at interior representations made in the past, this endeavour will look into drawings being generated contemporaneously.

With this in mind, in surmising what role interior collages play in the process of designing interiors today, this text takes on a more explorative approach. In the end, more questions may arise than originally thought—which is perhaps best as we still grapple with the speed these technologies are changing and how this, in turn, is challenging long-held drawing traditions in the practice of interior design.

Lastly, in the framing of this text as a chapter in the continuing narrative of the unfolding of the profession under the rubric of environmental design[9], this text intends to forward the relevance (still) of a historiographical approach as a form of design research in its positing of the interrelatedness of historically specific texts—

and drawings—of Evans and Jacobus to current practices of representation in order to arrive at the question of what role does the drawing have in the spatial practices of today.

The drawings made by the furniture maker Gillow and Co. (c. 1806 - 1831) can be argued to be the first presentational hybrid drawings produced by a company *specifically* working on interiors. Meant to illustrate how furniture produced by the company are to be located in a room—and made primarily for the benefit of clients—these drawings are hybrids in the way they combined the developed surface interior with furniture drawn in perspective (see Figure 2).

Although for Robin Evans in “The Developed Surface: An Enquiry into the Brief Life of an Eighteenth-Century Drawing Technique”, these drawings by the company were actually the harbinger of the demise of the developed surface interior technique: that instead of arriving at a clear representation of the design for the interior in one drawing, it ended with a more confounding one[10]. In spite of this, it would be interesting to hypothesise—and we can only speculate why indeed these drawings were produced this way—how:

1) simply, the draughtsperson could have intended the drawing to be capable of economically relaying information to all concerned all at once—economical as this is above all, a business;
2) more intriguingly, given the developed surface interior’s prevalence in the last two centuries of working on the interior[11], by the turn of the century, they’re simply considered *de rigueur,* and the addition of the furniture in perspective is but a stylistic flair added by the company.

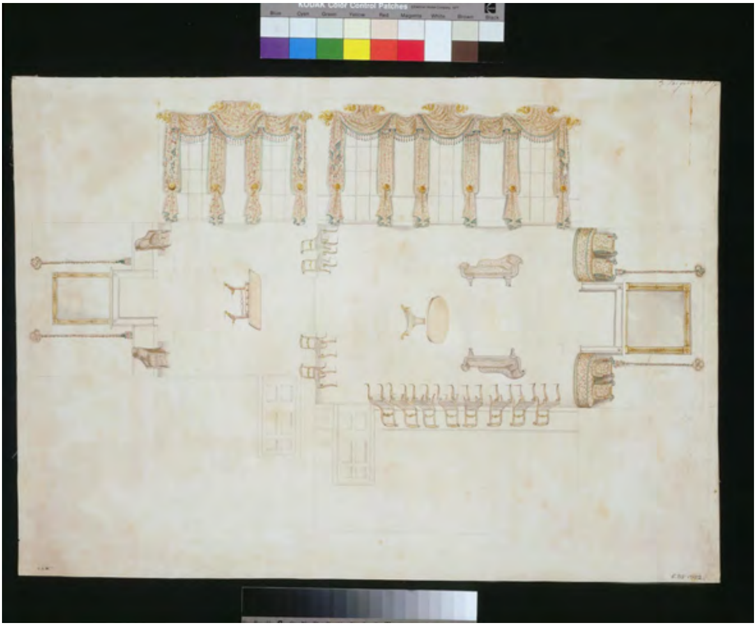

Figure 2: Gillow & Co., Design, from a set of 94, for furniture and interiors, made in the studio of Gillow & Co., London, 1806-1831. Drawing in pen and ink, and watercolour.[12]

The first point is certainly important considering that with one drawing, all 'audiences' are indeed engaged: the client, as noted, to show how a piece of furniture they intend to buy relates to the interior, fellow designers to showcase the interior in its totality and even builders themselves[13] with the developed surface interior's orthographically-correct drawing of the plan and elevations.

In fact, this is consistent with the visual presentation of the developed surface interior that works along the line of thought of opening up the interior as if a box (see Figure 1); where all the elements that make up the interior can be taken in at one go.[14]

Unfortunately, no such economical drawing—one that can simultaneously communicate with everyone involved in the designing of the interior—can truly exist.

The second point—the stylistic addition of furniture in perspective—can be easily dismissed as a reflection of the owner's, designer's, or even the draughtsperson's mere preference.

But Evans' insistence of this being the source of confusion in the whole drawing brings us to question his argument for drawings in general as something more than just a neutral 'conveyor of an idea'[15]. Further, as Evans himself explicated, the developed surface interior drawing made manifest how 'things visual and things social' interacted. Within this frame, this 'curiosity' of a technique can not be reduced to just a simple matter of taste. For Evans, the enveloping space of the interior was better represented using the developed surface interior technique at the time when the interior spatial configuration of the houses in England slowly evolved from the traditional hierarchal, user-centred layout to a layout that emphasised how rooms are used in themselves. When it used to be that uniformity of the way rooms are designed was the rule, the shift of focus to how they function meant that variance between rooms now took precedence. Herein lies the power of the drawing: the hermetic developed surface interior technique made it possible to *think of* rooms by themselves[16] that goes beyond the idea of the drawing as a mere tool for presentation. Evans would continue and point how this change in the layout of houses was also made manifest in how furniture in each room is arranged. From a heliocentric arrangement of chairs—as if the host was the sun and around her was the circle of chairs that reverted back to be positioned against the walls when a room is not in use[17] and hence drawn in the elevations as if they were attached to the interior walls—the 18th century witnessed a similar liberation from such a restrictive social hierarchy within rooms.

And this is what interests us here, this idea of a break from tradition as made visually manifest in the drawings of Gillow and Co.

From this vantage, these ‘confusing’ drawings produced by Gillow and Co. did not only afford the viewer a synoptic drawing of the interior, but with the introduction of pieces of furniture drawn in perspective, it actually introduced a novel way of situating interior objects that unlike other elements of the interior, are now free to move about.

What Evans failed to acknowledge here is the idea that these drawings are not ‘confusing’ because of the interjection of movable furniture in perspective per se. What made them confusing is found in their betrayal of the draughtsperson’s inability to communicate this *new* interior.

These drawings by the company exposed the limitations of such a technique that in turn showed the draughtsperson literally struggling on paper with the drawing.

Such a technique so obsessed with the fixed planes of the interior (i.e., floor and walls) made it simply impossible to account for things that have all of a sudden become mobile (i.e., furniture).

Laura Jacobus in “On ‘Whether a Man Could See before Him and behind Him Both at Once’: The Role of Drawing in the Design of Interior Space in England c. 1600-1800” also made explicit the connection between ‘things visual and things social’ by way of other drawings for the interior that also made use of the developed surface interior technique.

Given the limitations of any drawing technique, Jacobus emphasised the workarounds spatial practitioners made in order to present the design idea. Like Evans, Jacobus understood the drawing to be a determining force in the design process directly influencing how the designer conceives space[18].

From Evans' 'things visual and things social,' Jacobus, however, would transition to 'things visual and things of the mind' and argue for how the drawing is like a map to the designer's way of thinking about space[19]. The author used William Kent's drawing of the Queen's Library at St. James' Palace as a demonstration of this—"thinking aloud on paper"[20]—as the decorator struggled to represent what he had in mind, pulled apart by the opposing forces of the strict geometry of orthography and the physical dimensions of the actual space.

As noted, the draughtsperson responsible for the Gillow and Co.'s drawings struggled similarly, but instead of being pulled apart by the limits of the technique and actual space as in the case of Kent[21], it was the developed surface interior that was being stretched by the possibility of movement within the space.

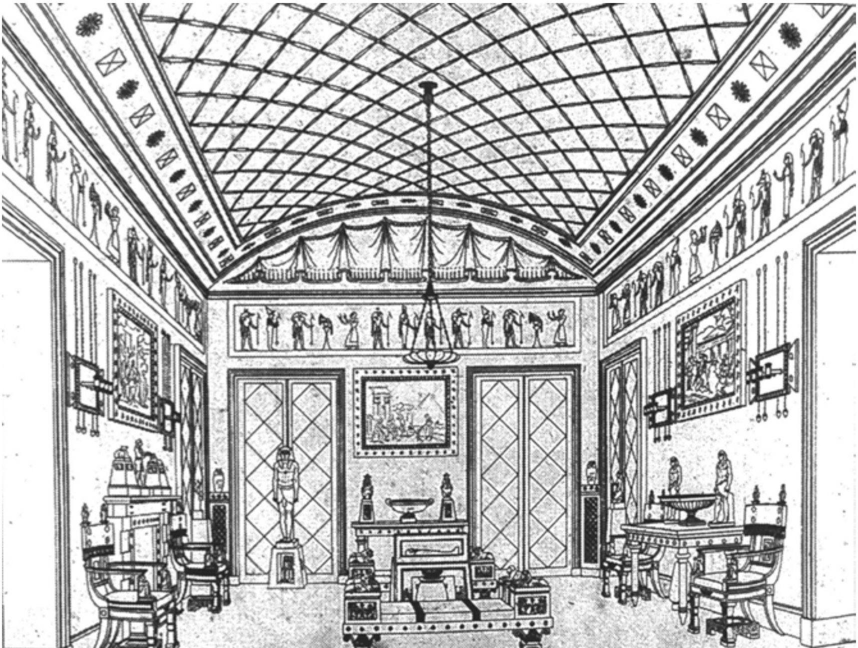

Figure 3: Thomas Hope, The Egyptian Room in the Duchess Street Mansion in Household Furniture and Interior Decoration, 1807.[22]

The rise in the popularity of the use of the interior perspective render in the 19th century in the practice of interior design can be boldly attributed to this idea of the inability of the Gillow and Co.'s drawings to affix the otherwise mobile elements of this interior.

It was around the same time as when these drawing by the company were produced that perspective drawing can be said to be endorsed in the practice of interior decoration by way of its use by one of the practice's most prominent figure: Thomas Hope (see Figure 3).

Not that perspective has not been used prior: it forms part of the architect's repertoire of drawings ever since the Renaissance after all—even if it was relegated to a less important role when compared to orthographically produced drawings[23 24].

Before this revival of sorts, perspective drawing was employed in the production of interior-portraits[25] and as a tool for documenting the details for old buildings[26]. However, in its 19th-century reiteration in the practice of interior decoration, it became the most effective tool in the interior decorator's repertoire of drawings—generative in the sense that it came before the fact of building as a presentation drawing.

The anthropocentric point of view this drawing technique afforded meant that interior representations became more, to an extent, humanised in its presentation of the interior; as

if one is actually standing inside the space thus providing a sense of bearing relative to the other elements of the proposed interior.

Further, and of particular interest for us here, perspective drawing is not bound to the strict geometry of orthography.

The language of perspective necessitates none of the rules that made the drawings of Gillow and Co. 'confusing' because ultimately the definition for such is only bound to that which it relates to—which in this case is the orthographic geometry of the developed surface interior.
In perspective's privileging of the singular 'look' of the interior—that literally is prefigured by the point of view—the interior perspective render is able to secure all the elements of the interior in one drawing.

The fixity it afforded clients as a presentation drawing made it succeed where the room-as-a-flattened-box that is the developed surface interior, in its inability to pin down otherwise ambulant pieces of furniture, failed.

Where the Gillow and Co.'s drawings struggled to reign in the furniture, the interior perspective render in its centring of all interior elements to that vanishing point made sure the necessity for the traditional triumvirate of conceptual, presentational, and technical drawings well into the 21st century.

The tesseract (see Figure 4) represents another dimension beyond the purview of the first two representational techniques discussed so far: time. Ironic indeed since the discussions so far have, in fact, revolved around the idea of temporality: of the fixity of representational techniques vis-à-vis mobility of interior elements in the case of the developed surface interior and the fixity of the point of view—and concomitant 'freezing'[27] of such a view for posterity—in the case of the interior perspective render.

To an extent, herein lies the objective of the interior collage: that precisely in its disregard for the technicality that governs both orthographic and perspective drawings, it is able to introduce the element of time.

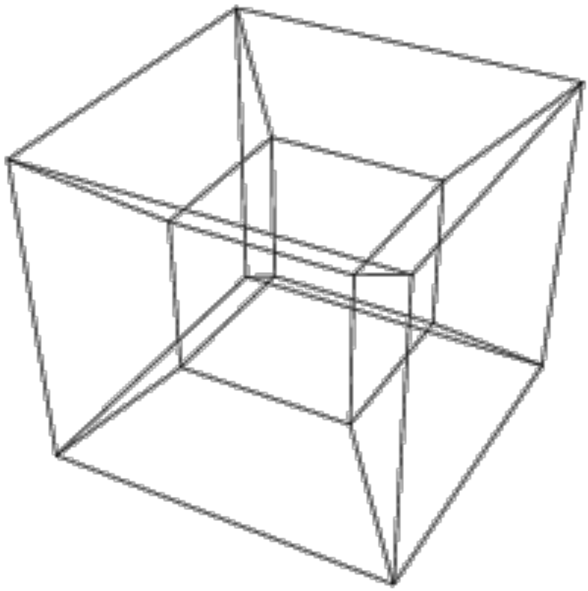

Figure 4: Eric W. Weinstein, Tesseract.[28]

The drawing by Doris Hung Shuk Ying entitled "The Adventurous Room," (see Figure 5) is a particularly interesting example of such an interior collage. Stylistically operating in the same way as the developed surface interior technique in its flattening of the walls of a box outward, their similarity ends there.

At the most basic, this drawing is in fact representations not of interiors but—by way of contraction—of cities in Italo Calvino's 1974 novel *The Invisible City*[29]. Following a process of translating written text into spatial terms, the premise of the project questions how the description of spaces, materialises from text into space as a consequence of hybridising representations and descriptions. The thesis questions the validity of drawing itself. Beyond that, it is through the mechanisation of the developed surface interior, as facilitator of spatial meaning and context, that the actual descriptions are made in their spatial specificity.

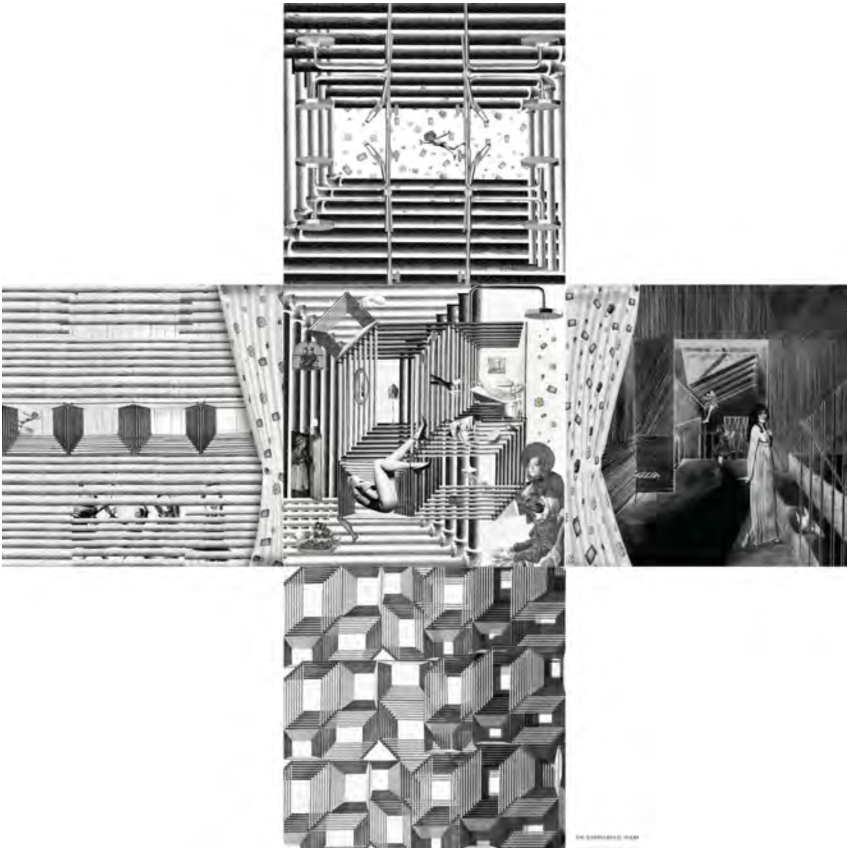

Figure 5: Doris Hung Shuk Ying, The Adventurous Room, 2017.[30]

Harnessing Jacques Derrida's philosophical work Of Grammatology and its inversion of language rules as an example, Hung limits her focus to the novel which was originally penned in Italian and later translated into both English and Chinese.[31] Each line of the four individual spatial descriptions is first visualised, collapsing elements, drawing mediums as well as perspective angles into one whole. Thereafter the various elements are mathematically examined in terms of its layout, graphically linking text with images and eventually space. Interior space in this sense, is reframed through language terminology as 'eloquence,' 'spacing,' 'word choices,' 'oxymoron,' 'parables' and 'analogies.'

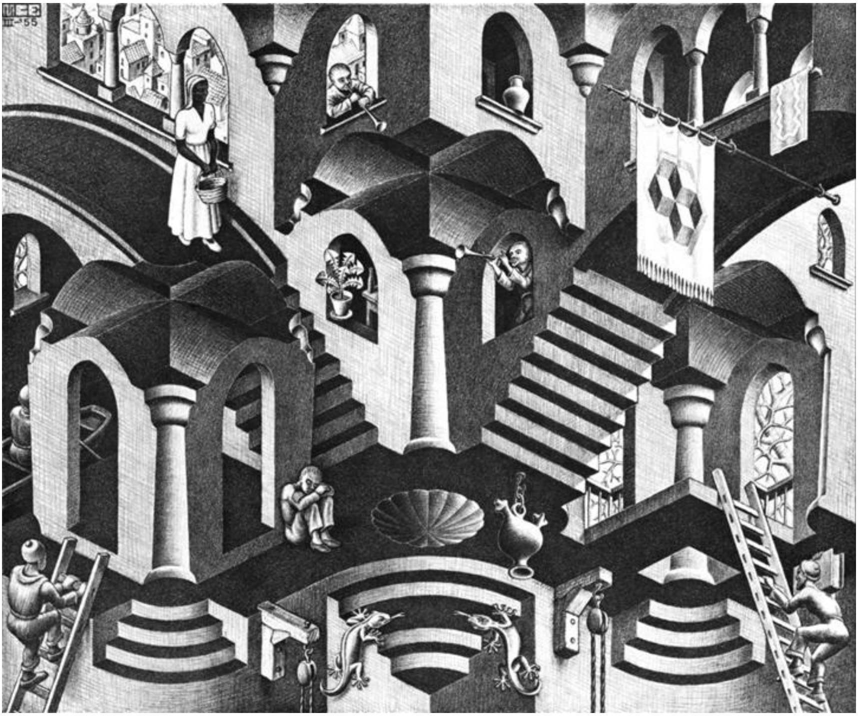

Figure 6: M.C. Escher, Convex and Concave, 1955.[32]

As a consequence, the operative medium is a collage: an assemblage made up of fragments of text and language. For example, where the English text refers to the characteristic of being “thin,” describing pipes as the predominant structure of the city, the Chinese version harnesses the idea of thin nets suspended over the city to explain the delicate landscape. The final hybrid translation occurs when images of elements are substituted back into the original text for words. Each newly formed text-image tests the material qualities of text to space. Nowhere near *presentational* with its complex, Escherian logic (see Figure 6), objects or ideas that are supposed to be drawn to access their meaning are offset against their textual descriptions, which by default employ the linguistic characteristics of alphabetic or phonetic characters to convey meaning through an unfolding of images in both space in time and spatial experience.

In spite of this, in the same manner that the Gillow and Co.’s drawings can be argued as examples of a decorator thinking aloud on paper, this example of an interior collage by Doris Hung Shuk Ying is similarly of this genre with its attempts at putting on paper ideas that are similarly convoluted.

In this mode of representing spatial ideas—in the stretching of the representations of space and time—we see a break from tradition.

Although the developed surface interior and the interior perspective render have helped in the circumscription of the interior design profession—at the turn of the 19th and 20th century by way of the professionalisation of the interior decorator and the interior designer respectively— the interior collage as a mode of representation is now at the forefront of *presentational* practices that go beyond customary ways of representing the design idea.

In as much as the drawings of Gillow and co. can be considered an attempt at breaking with representational traditions—intentionally or otherwise—the interior collage of today can be argued to signal the desire to do away with the restrictive rules of perspective drawing and its privileging of the centralising vanishing point directed by the human eye. In effect, this also entails the desire to do away with the reality that has been conditioned by this Renaissance point of view.

As axonometry was championed at the beginning of the 20th century as an alternative to perspective drawing[33], we are now once again at a similar juncture in the history of representing spaces. However, unlike these Modernists that were limited to the bounds of the paper, the virtual surfaces afforded by tablets, mobile devices, computers is a leverage that today's practitioners are enjoined to exploit.

( or postscript)

Let us briefly return to the inspiration behind the title of this text[34]—or rather to an answer offered by rschwieb on why indeed we can not envision a tesseract:

> Big surprise: our brains evolved in a three-dimensional environment, and so that is what they are best suited for thinking about. It's easy to visualize because *we literally see it all the time*.
>
> Thinking in higher dimensions is harder because we have no (little?) direct experience with them, so there is not a clear prototype for most people to use as a springboard for visualizing it.[35]

So if ever the interior collage—similar to that of Doris Hung Shuk Ying's—as a *presentational* drawing may be hard to visualise to serve any purpose in the practice of interior design, let us take comfort in that 'curiosity' of a story by Edwin Abbot that came out in 1884: *Flatland: A Romance of Many Dimensions* (see Figure 7).[36]

In the same way that the two-dimensional characters of this story had difficulty understanding the notion of three-dimensionality—so used were they to things in two dimensions of the world they inhabit—we are perhaps just similarly unable to comprehend representations that attempt to go beyond three-dimensionality. Simply, our inability in visualising the interior collage can be said to be beyond our purview.

And as the future will undoubtedly be dominated still by perspectival modes of looking at things—in the way augmented and virtual reality technologies are harnessing this dependence in the practice of interior design—the time will come that the interior collage will be reduced to being just like the developed surface interior: as a curiosity of the technique that was the harbinger of the demise of itself, as artefacts that show yet another designer thinking aloud on paper.

Nonetheless, let the interior collage be this struggle representing the inability to illustrate not the freely moving furniture in the way the Gillow and co. did 200 years ago, but the intangibility of space itself that is slowly being dissolved not just in the figurative sense, but also in the literal sense as well.

This can be considered but fitting as the profession of interior design is at the centre of the continued dissolution of traditional spatial *specialisations* under the spatially-encompassing practice of environmental design—given that this phenomenon of an ‘unfolding’ still holds true in countries where the practice is still traditionally contained within the notion of the interior-as-box[37] despite the fact that this shift was initiated around half a century ago.[38]

From this perspective, the interior collage is not only but a mere tool of presentation but is actually the crux—in its kinetic unfolding as afforded by the technologies of this Fourth Industrial Revolution—from which we will conceive the future of spatial practices.

Figure 7: Cover illustration for Edwin Abbot’s Flatland: A Romance of Many Dimensions, 1884.[39]

References

[1] The title for this work was inspired by a question posted on an online site dedicated to math (Math Stack Exchange) by Robottinosino in 2012 who wondered: “Why is it that I cannot imagine a tesseract?… Specifically: what is *missing* for me to be able to imagine a tesseract? Understanding? A different kind of brain, that processes information in a different way?”

Robottinosino. “Why is it that I cannot imagine a tesseract?” *Mathematics Stack Exchange*, (October 19, 2012). https://math.stackexchange.com/questions/216847/why-is-it-that-i-cannot-imagine-a-tesseract

Further, this text can be considered a response to Bruno Latour’s challenge in a 2008 keynote lecture delivered for the Design History Society entitled “A cautious Prometheus? A few steps toward a philosophy of design” to, in this sense, a *literal* ‘return to the drawing board’:

> Now here is the challenge: In its long history, design practice has done a marvellous job of inventing the practical skills for drawing objects, from architectural drawing, mechanic blueprints, scale models, prototyping etc. But what has always been missing from those marvellous drawings (designs in the literal sense) are an impression of the controversies and the many contradicting stake holders that are born within with these. In other words, *you* in design as well as *we* in science and technology studies may insist that objects are always assemblies, “gatherings” in Heidegger’s meaning of the word, or things and *Dinge*, and yet, four hundred years after the invention of perspective drawing, three hundred years after projective geometry, fifty years after the development of CAD computer screens, we are still utterly unable to draw together, to simulate, to materialize, to approximate, to fully model to scale, what a thing in all of its complexity, is…. So here is a question I wish to raise to designers: where are the visualization tools that allow the contradictory and controversial nature of matters of concern to be represented?… Why can the powerful visual vocabulary that has been devised in the past by generations of artists, engineers, designers, philosophers, artisans and activists for matters of fact, not be devised (I hesitate to say restyled) for matters of concern? pp.12-13.

Bruno Latour,"A Cautious Prometheus? A Few Steps Toward a Philosophy of Design." Keynote Lecture for *Networks of Design*, meeting of the Design History Society, Falmouth, Cornwall, 3rd September 2008.

[2] Image from CHAPTER 4 — Dimensional Visual Elements I by williamCromar, accessed May 14, 2018 http://newmediaabington.pbworks.com/w/page/67293527/CHAPTER%204%20—%20Visual%20Elements%20I%3A%20Point%2C%20Line%2C%20Plane.

[3] Cammy Brothers, “What Drawings Did In Renaissance Italy,” in *Companion to the History of Architecture vol.1*, edited by Harry Francis Mallgrave 104-135 (Hoboken, NJ: Wiley, 2017); Wolfgang Lotz, “The Rendering of the Interior in Architectural Drawings of the Renaissance,” in *Studies in Italian Renaissance Architecture* 1-65 (Cambridge, MA: MIT Press, 1977); Michael Snodin, “Representing Rooms: Plans and Other Drawings,” in *Imagined Interiors: Representing the Domestic Space since the Renaissance*, edited by Jeremy Aynsley and Charlotte Grant, 128-129 (London: V&A Publishing, 2006); Peter Thornton, *Authentic Décor: The Domestic Interior, 1620-1920.* (New York, NY: Viking, 1984).

[4] Although not specific to interiors:

Olivier Meystre, *Pictures of the Floating Microcosm: New Representations of Japanese Architecture,* translated by Deke Dusinberre (Zürich: Park Books AG, 2017)

is a good survey of professional works made in the last two decades by Japanese spatial practitioners that reinforces the diversity of ways of representing the design idea.

[5] By presentational we share the definition of:

Sonit Bafna “How Architectural Drawings Work — and What that Implies for the Role of Representation in Architecture” *The Journal of Architecture* 13 (5) (2008): 535-564 of what constitutes presentation drawings:

> drawings that are used by designers, clients or critics to discuss qualities of architectural projects… drawings of this kind function less as transparent descriptions of buildings to which the actual critical attention is directed, but rather call for a specific mode of attention to themselves as artefacts. p.535

This is Bafna's take on Robin Evans' problematique in:

Robin Evans, "Translations from Drawing to Building" in *Translations From Drawing to Building and Other Essays*, 153-193. (London: Architectural Association Publications, 1997)

wherein the latter began with the idea that unlike artists (painters, sculptors, etc.) that work on their objects directly, architects work with an intermediary that is the drawing.

[6] Ro Spankie, *Drawing out the Interior* (AVA Academia, 2009), 150.

[7] Although Jacobus would refer to such a presentation as the "laid-out interior":

> to describe drawings having certain basic features in common, namely, that they use an orthographic (i.e., non-perspectival) system of rendering to show all upright sides of an interior arranged radially on a single sheet of paper. p.148

it ties up with Evans' definition for such a technique:

> In descriptive geometry, folding out the adjacent surfaces of a three-dimensional body so that all its faces can be shown on a sheet of paper is called developing a surface… It became a way of turning architecture inside-out, so that internal rather than external elevations were shown. p.202

Michael Snodin in "Representing Rooms: Plans and Other Drawings" will, like Jacobus, refer to this drawing technique as the laid-out interior.

However, we will use the term developed surface interior here in order to be consistent with the use of the visual metaphor of the interior-as-box that drives the narrative of this text (see Figure 1).

Laura Jacobus, "On 'Whether a Man Could See before Him and behind Him Both at Once': The Role of Drawing in the Design of Interior Space in England c. 1600-1800." *Architectural History* 31 (1988): 148-165.

Robin Evans, "The Developed Surface: An Inquiry into the Brief Life of an Eighteenth-Century Drawing Technique," in *Translations From Drawing to Building and Other Essays*, 195-231. (London: Architectural Association Publications, 1997)

[8] Evans, "The Developed Surface", 196.

[9] Merwood-Salisbury in "Interior Design as Environmental Design" ascribed the beginnings of this shift to one of the more celebrated and influential school of interior design: "based on modernist ideas about the improvement of physical well-being for all and the betterment of social relations.", p.119.

Joanna Merwood-Salisbury, "Interior Design as Environmental Design: The Parsons Program in the 1960s," in *After Taste: Expanded Practice in Interior Design*, edited by Kent Kleinman, Joanna Merwood-Salisbury, and Lois Weinthal, 110-129. (New York, NY: Princeton Architectural Press, 2012).

[10] Evans, "The Developed Surface":

> they ended up conflating three distinct types of drawing in a vain attempt to illustrate the topography of the floor and the flatness of the walls in one summary representation. The old technique of folding the walls outward is trundled out unflinchingly to satisfy one part of the requirement. At the same time small-scaled perspectives of the disengaged chairs, couches, footstools, card- and dining-tables float in the maelstrom of conflicting imagined spaces, each piece contributing its own idiocentric and cock-eyed

> cone of vision. Orientation of the drawing is utterly impossible, directly adjacent objects being frequently upside-down or sideways in relation to each other. Add to this the constant flicker between the two-dimensional representation of the wall surface and floor plan, and the splayed three-dimensionality of the autistic perspective constructions, and the confusion is complete. pp.221-222

[11] Evans, "The Developed Surface"; Jacobus, "On 'Whether a Man Could See before Him".

[12] Image from Victoria and Albert Museum, United Kingdom, accessed May 14, 2018, http://collections.vam.ac.uk/item/O78203/design-for-furniture-gillow-co/

[13] This would constitute third-party suppliers that interior designers rely on such as curtain-makers, carpenters, wallpaper suppliers, etc.

[14] As Evans, in "The Developed Surface", would theorise of the process of drawing the developed surface interior: "Drapes, furnishings, fittings, wall coverings, plasterwork, floor and carpet all beg to be drawn." p.209.

[15] To use Evans' description of the metaphor for the drawing as a vehicle in his introduction to *Translations from Drawing to Building*.

[16] Further, Wienthal in her foreword to *Interiors Beyond Architecture* would consider this drawing technique to be part of a 'distancing' of the practice from that of the practice of architecture in its literal depiction of interiors that does away with the "architectural framework" (ix) altogether.

Lois Weinthal, "Foreword" in *Interiors Beyond Architecture*, edited by Deborah Schneiderman and Amy Campos, vii-xii (London: Routledge, 2018).

[17] "When the room is empty the furniture reverts to the wall.": Evans, "The Developed Surface," 214.

[18] Evans would argue in the postscript to his essay that appeared in the book *Translations From Drawing to Building and Other Essays* that he meant the same with his statement: "(the drawing) makes it possible to see some things more clearly by suppressing other things: something gained, something lost" p.199. As noted, given the similarity of not only the subject matter, but even take on the matter, this postscript was meant to address the fact that his essay came out a year after Jacobus' text.

[19] "the sketch can be accepted as a record of the workings of the architect's mind": Jacobus, "On 'Whether a Man Could See before Him," 157.

[20] Jacobus, "On 'Whether a Man Could See before Him," 156.

[21] For Jacobus, the ultimate demise of the developed surface interior technique was brought about by the fact that once a room is no longer anything other than a rectangular or square box, then it simply would be near impossible to represent it using this technique.

[22] Image from Gere, *Nineteenth Century Interiors: An Album of Watercolors*.

[23] Brothers, "What Drawings Did In Renaissance Italy"; Lotz, "The Rendering of the Interior in Architectural Drawings of the Renaissance."

[24] That is if indeed, 'to sell' is less important in the building trade.

[25] See definitive scholarships on the matter:

Charlotte Gere, *Nineteenth Century Interiors: An Album of Watercolors*. (London: Thames and Hudson Ltd, 1992); Thornton, *Authentic Décor*; Mario Praz, *An Illustrated History of Interior Decoration: from Pompeii to Art Nouveau* (London: Thames and Hudson, 1981).

It should be noted though that these publications were subjected to criticism from scholars operating within the domain of interior design: editors Mark Taylor and Julieanna Preston in their introduction to *Intimus* would cast doubts on these publications as they "perpetuate the style-manual documentation of furnishings and accessories… [that] contributed to the suppression and relegation of the decorative to a lesser understood architectural activity" (p. 11). Also, in Penny Sparke's "The Modern Interior", the author noted how in relation to modernism, both Praz and Thornton have "adopted a highly elitist view. They showed little interest in the ideological impact on the interior of architectural and design modernism in the early twentieth century" p.10.

Penny Sparke, "The Modern Interior: A Space, a Place or a Matter of Taste?" *Interiors* 1 (1): 7-17; Mark Taylor and Julieanna Preston (editors), *Intimus: Interior Design Theory Reader* (Hoboken, NJ: Wiley, 2006)

Diametrically opposed to this, these works can be considered important as they afforded readers a glimpse of the lives of the people who occupied these spaces. That ultimately, the intimacy afforded by these portraits are more evocative of the times in which they were made as the three authors have asserted in their own way.

[26] Jacobus, "On 'Whether a Man Could See before Him."

[27] For Yve-Alain Bois in "Metamorphosis of Axonometry" this drawing technique represented Medusa's death-stare.

Yve-Alain Bois, "Metamorphosis of Axonometry." *Daidalos* 1 (1981): 41-58. http://arch.ttu.edu/w/images/e/e9/Bois,_Y.-A._Metamorphosis_of_Axonometry.pdf

[28] Image: Eric W. Weisstein, "Tesseract." *MathWorld - A Wolfram Web Resource*. http://mathworld.wolfram.com/Tesseract.html

[29] Gerhard Bruyns, "Interior Materialism[s]," *Artomity.* November 23, 2017. https://artomity.art/2017/11/23/interior-materialisms/

[30] Image from "Interior Materialism[s]" by Gerhard Bruyns in Artomity, accessed May 14, 2018, https://artomity.art/2017/11/23/interior-materialisms/

[31] Jacques Derrida, *Of Grammatology* (Baltimore, MD: John Hopkins University Press, 1976)

[32] Image from wikiart, accessed May 14, 2018, https://www.wikiart.org/en/m-c-escher/convex-and-concave

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Floppy Logic

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*A*bstract

This paper discusses a body of work that investigates the 'architecture' of fashion and textiles, and how the concepts, aesthetics, techniques and construction of this architecture might be understood and used to design and fabricate objects and space differently. I discuss how these seemingly diverse disciplines can be used to traverse from the scale of material and garment to that of rooms and buildings. Working to develop an approach to the geometry of architecture where the material logic assist in seeking the appropriate geometry, rather than geometry first and materials second.

By working with fashion and textile techniques, form and material are developed simultaneously to produce architecture. Digital advances in architectural modelling and fabrication allows us to work directly with disciplines that up until now, have only functioned as inspiration where the distance between them has been too great to bridge. A key concept I discuss is the Floppy, defined as the quality in material that requires extraneous support to produce architecture. Floppy generally refers to fabric but can also refer to any material that fails when there is not enough support.

Through a set of architecture projects, the aesthetic, tactile nature of fabrics are brought into architecture. These projects demonstrate novel ways to judge material behaviours, and techniques to create form, working to draw out the inherent qualities or characters of the materials rather than subjugating them to only support, or only skin, or only surface. This paper discusses the potential of material, and understands material as having intrinsic qualities that can be exploited, where a condition is not applied but rather revealed.

Floppy Logic

This paper discusses approaches that look beyond architecture to understand how other disciplines, namely fashion and textile design, deal with materials and form. The approaches explored come from research conducted through practice, and has successfully seen the completion of interior projects, as well as ideas for larger architectural projects. These approaches are primarily concerned with developing ways to express a material logic, that is, a logic that comes from understanding the way materials behave. The projects and the figures discussed explore a range of thinking that has developed around the fabrication of space and how fashion and textile techniques can be used to investigate possibilities and opportunities for architecture.

Architecture has become skilled at modelling and visualising the geometry of anything and everything. Geometry, the branch of mathematics concerned with the properties and relations of points, lines, surfaces, solids, and higher dimensional analogues[1], is used in architecture to explain buildings in a clear and efficient way, allowing for the relationships described in the geometry to be repeated and transcribed into drawings. Historically architecture has produced forms that have an efficacious format, being led through geometry. However at some point in the recent past we have been able to look at ideas freely without the need to filter through geometry. In Architecture Before Geometry or the Primacy of Imagination by Jose Oubrerie[2], Oubrerie talks about "One of the most dramatic shifts happening in architecture today results from the intrusion of digitalization in the elaboration of still unknown objects." Oubrerie discusses this shift as "the concept of a "thing" can be generated by discoveries made through images that titillate the imagination of their creator. An extreme example would be Jeffrey Kipnis's grafting procedure in which a project is directly generated by the transplantation and successive adaptations and legitimations of images chosen from any non-architecturally related field". This means that we as architects have the freedom to now focus on the development of structure and form of properties, knowing that we can reduce anything to geometry if needed. With this freedom comes the ability to look into a vast array of other disciplines who's processes, scale and materiality was simply not able to be translated meaningfully into architecture.

K. Michael Hays says "architecture is not a language. Rather architecture summons into appearance ways of thinking about the world that are otherwise unavailable; it is a particular mode of thought, one irreducible to other ways of thinking"[3]. He suggests there is more to architecture than representation. If we think of how much of architecture assumes a constant stable geometric shape of fixed planes, due to the convenience of its geometry then we can see how constrained architecture has been. Presently, it is the absence of an ideology of geometry that is allowing the freedom of ideas generation, where these ideas are not tethered to a geometry. Our capacity to describe through neural and digital means, allows for more of the architectural project to be investigated[4]. From neural networks of cities to fashion and textile design.

Through this 'freedom' and its reinvigorated approach to architecture, I have been able to look at techniques from the disciplines such as fashion and textile design and their understanding of material conditions, specifically the Floppy, a term I have coined for the purpose of explaining this material based approach. Floppiness has long been a condition that I as a practicing architect/academic repel from, not only because of its lack of firmness, but because this condition is difficult to describe geometrically, that is, the floppy quality once drawn remains static within the constraints of the drawing. This difficulty has been relieved somewhat through digital means, where we can simulate the behaviours of the floppy through scripts which accurately mimic its behaviour. This ability to predict and model behaviours allows for the focus on materials prior to their absorption into a kit of parts that is typical with proprietary materials used for architectural use.

By pursuing the idiosyncratic qualities of materials we can look at a range of techniques developed by fashion and textile design who deal with non-structural fabrics as the basis of their garments. The key fashion designers that have clear overlaps with architecture are Iris van Herpen, and Rei Kawakubo as they pursue structure and form within garments and explore spatial relationships between garment and the body. In the case of van Herpen they also pursue advanced fabrication techniques, common to architecture to develop intricacy. By studying these practitioners I have tested techniques that can develop ideas for non-structural materials to behave in a structural manner.

Firstly, Iris Van Herpen who works with parametric modelling and advanced manufacturing techniques that includes 3d printing highly intricate garments that relate pattern to form. The form of the garments is driven by the pursuit of intricacy rather than applied to a garment post completion. Van Herpen's collaboration with architects such as Daniel Widrig, for example, work with the technique of the pleat with the form of the body to develop a garment that is a able to express the form of the body via the pattern of the pleat. These garments[5] are modelled digitally rather than developed through the toile[6] process that allows for the merging of pattern, structure and form as an exaggerated pleat furling around the curves of the body. While this has benefits to the development of architecture it is somewhat limited for fashion as the 3d printed garment does not move with the body and behaves like armour rather than garment.

Rei Kawakubo[7] is a second figure that has been useful in the development of this approach to architecture. Her work as part of her label Comme des Garcons has been exploring the idea of the creation of space between the garment and the body, often wrapping fabric around padded additions to the body to morph the shape of the body. This work has been useful for investigation into form and material in that is shows a way of developing a material response to the creation of space. One can think of these garments as mini architectures that express material, form and space simultaneously.

The Floppy

The Floppy, a term I have used to describe a material condition that is soft and flexible and requires extraneous support to produce enclosure, generally refers to fabric but can also refer to any material that fails when there is not enough support, as is the case with sheet materials when the span between supports exceeds a certain length. I have used the term Floppy because it does not connect to any architectural terms or systems and allows for the exploration to define the ideas, rather than having the definitions limit the exploration. The initial driver of this exploration is to make the Floppy architectural, i.e.: stand up and form an enclosure. By understanding the Floppy as a condition, we can revisit our ability as architects to express material and its properties, using these qualities of material to find support and enclosure, rather than applying a separate geometry or structural system that works to override the material condition.

Designing a way that prioritises material first, gives us the opportunity to look at fashion and textile design. These disciplines have the experience of dealing with a material condition first and then directly applying fabric to the body to test and develop ideas. Through my practice I have worked directly with fashion and textile design and have witnessed this process of fashion using calicos directly on the form of a body to develop ideas. Here design ideas are not generated from set geometry but rather techniques that allow a material to adapt to complex forms or the body.

A second process that textile design use to sample ideas, is through the process of Croquis[8] and is a way that fashion and textile designers work to translate ideas into finished garments. Croquis is a term derived from the word ‘sketch’, where the ‘sketching’ is done through the act of making samples that are trialled on the body or as small samples that test pattern, shape and construction[9]. This is not dis-similar to the way architects develop ideas around form, structure and materials, in that we test through smaller scale simulations of form.

By using the Croquis and Calico method of working, knowledge around material behaviours was gained and able to be scripted digitally to produce larger architectural proposals. This way of working not only tests physical limitations but trains us to apply visual judgement to the digital models allowing for a rapid development of croquis to prototype.

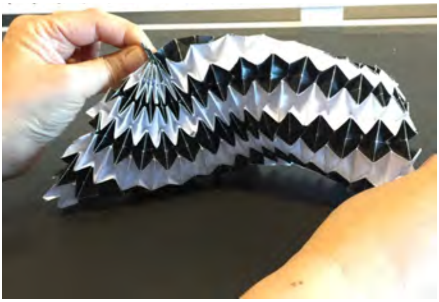

Figure 1: An example of a croquis, smaller samples being tested for form generation.

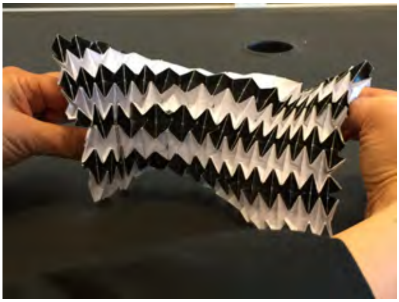

Figure 2: An example of a croquis, smaller samples being tested for form generation

Figure 3: Pleat. Fabric behaves differently to paper, where the paper has embedded strength. The fabric samples show how the pleat needs to be held in place at moments and when these moments are too far apart the pleat loses its definition. Understanding these behaviours are important when looking to code a digital model such that it represents the material behaviour.

Figure 4: Pleat. Fabric behaves differently to paper, where the paper has embedded strength.

Pleat

The pleat is a fashion technique that I have used to develop architectural space. It is defined as a type of fold formed by doubling fabric back upon itself and securing it in place. It is commonly used in clothing and upholstery to gather a wide piece of fabric around a circumference. Pleats are categorized as pressed, that is, ironed or otherwise heat-set into a sharp crease, or un-pressed, falling in soft rounded folds[10], where the varieties have been developed to alter the formal relationship between body and fabric. By contrasting the pleat with the fold, architectures parallel term to the pleat, we can see that the pleat expresses form where the fold does not. The fold can appear anywhere from a surface treatment to a way of treating a corner but is somewhat disconnected from form. The fold is not tethered to a support or structural system, it can be decorative or structural. It is used regardless of the material sizes as these are just absorbed into the pattern. The pleat on the other hand is the result of many folds, fixed in parts so that the material can respond to form and movement. The discussion between the pleat and the fold is important as we can see the opportunities the pleat can give to architecture. That is a way to simultaneously considering form, structure and skin.

The PleatPod was an interior project that used the idea of the pleat together with the way fashion and textile designers work to develop an interior enclosure that is able to combine material, structure and form, without the need for a separate structural frame.

Figure 5: PleatPod. Meeting space designed using the fashion and textile technique of pleating to develop material/form/structure simultaneously.

The process of developing the PleatPod used the small croquis scale tests to initially understand how to simply pleat paper around a form. These tests then increased in size to test structure and form and then construction, where the incremental shifts ensured there was a balance between space, material and form. The following annotated images show the process from small physical croquis to larger scale prototypes, in order to evidence the practice based approach required to flesh out the contribution such an approach can make.

Figure 6: Structural Pleat. Initial tests through the folding of paper to create a form. This pattern was decided upon after many trials to ensure the pattern could cope with a structural load.

Figure 7: Structural Pleat. Initial tests through the folding of paper to create a form. This figure shows the opportunity the pleat pattern gives to transfer the load from the top of the form to the bottom.

Figure 8: Form. Once the pleat pattern was decided upon, form tests took place, simulating the opening and closing of the room and the limitation of material sizes.

Figure 9: Form. Once the pleat pattern was decided upon, form tests took place, simulating the opening and closing of the room and the limitation of material sizes.

Figure 10: Digital Pleat. Digital model looking to mimic the fabric investigations. The compression and expansion of the material when pleated.

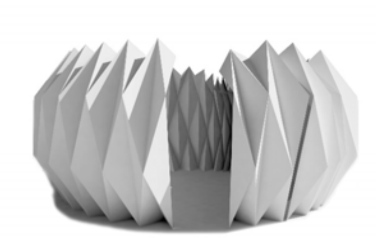

Figure 11: Digital Pleat. Digital model looking to mimic the fabric investigations. The compression and expansion of the material when pleated.

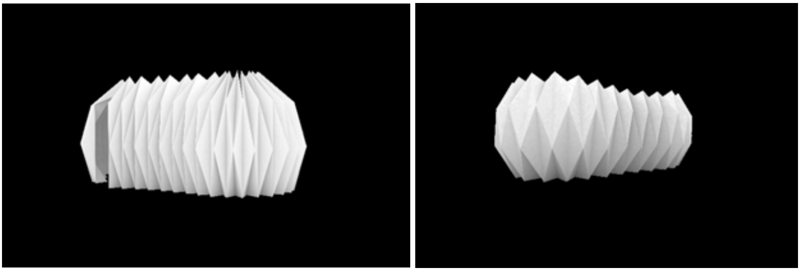

Figure 12: Pleat Form. Digital testing of form, based on principals generated from the croquis process.

Figure 13: PleatPod Prototypes. full scale prototype based on the previous smaller tests or croquis.

Figure 14: PleatPod Prototypes. full scale prototype based on the previous smaller tests or croquis.

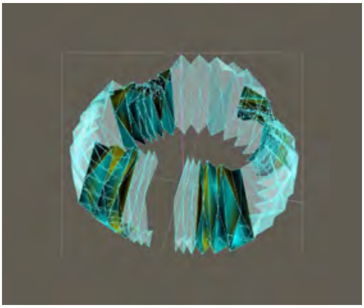

Figure 15: Structural Analysis. Showing the different stability patterns of the enclosure. The darker sections provide the support to the lighter sections.

From the experimentation done with the pleat technique the principles understood from the digital and physical modelling gave a method of working for other architectural propositions. These propositions focused on the manipulation of fabric only and exaggerated the pleated pattern or incorporated an idea around the space between the structure and space. The following annotated images show these propositions.

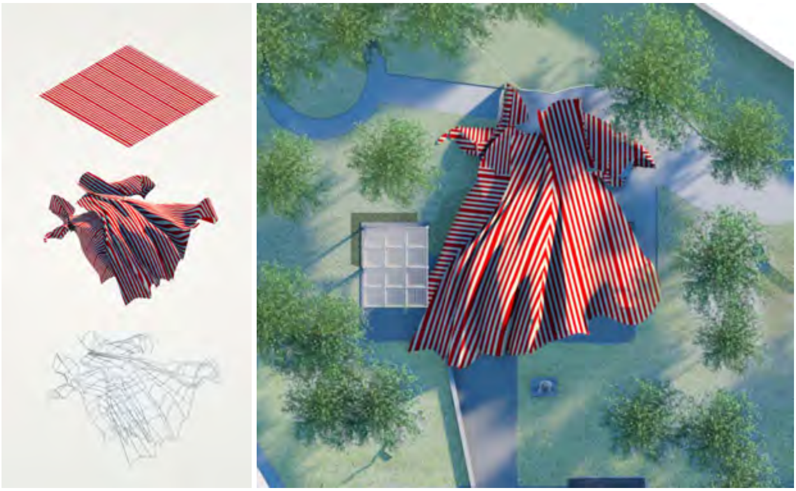

Figure 16: Dressing Room. Competition entry testing Rei Kawakubos ideas around the space between skin and frame. This oversized dress with corset support, provides a canopy to the space under, in the same way that Kawakubo develops space between garment and body.

Figure 17: Pleat Pavilion. This competition entry extends the intricacy possible by using the pleat to drive the form. Here the furling of the fabric structures are dictated by the expansion and compression of the pleat.

Conclusion

By investigating fashion and textile techniques and understanding how to apply these to architecture such that there is an alternative offering to the default position of working with a ‘kit of parts’, architecture can work towards developing ideas that simultaneously deal with material, structure, form and space. This is now possible as we have the digital tools to model any phenomena, whether it is self-generating cellular structures or the vast array of material behaviours. We are no longer beholden to geometry and can now use architectural thought to develop ideas around the fabrication of space. The potential of this life after geometry brings architecture closer to its own identity which is a discipline or a way of thinking that is unique and not tethered to other realities for its justification.

The explorations of the pleat through the built and imagined work acts to show the freedom the digital model gives but equally shows the limitation of translating these ideas into physical reality. Translating the ideas into the space of habitable object or space is again where the difficulty lies. The examples shown try to work through possibilities without the need to develop new materials and new techniques to assemble these materials (as seen with the robotic fabrication), rather I use standard materials, and machinery revealing the possibilities for structures that use a single concept to develop form, structure and skin simultaneously.

The contribution of the approaches discussed in this paper lies in showing a model of working that relooks at the qualities of material prior to deploying them. This has required the development of a methodology that tests ideas through the exploration of set of projects that demonstrate the benefit of treating architectural experimentation as the best way to test ideas and develop a shift, if not small, to the way we currently approach design and the fabrication of space. The freedom to explore these other territories de-materialises established norms of practice and throws up opportunities that do not need to be tethered to geometry.

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[3] K. Michael Hays, “Architecture’s Appearance and the Practices of Imagination”. *Log* 37 (2016): 205

[4] Oubreire, “Architecture before Geometry”, 95

[5] Iris Van Herpen and Daniel Widrig, *Capriole (*Paris Haute Couture week, 2011).

[6] Toile - An early version of a finished garment made up in cheap material so that the design can be tested and perfected. (Oxford Dictionary definition)

[7] Bonnie English, “Rei Kawakubo and Commes Des Garcons”, in *Japanese Fashion Designers: The Work and Influence of Issey Miyake, Yohji Yamamoto and Rei Kawakubo* (Oxford: Berg Publishers, 2011).

[8] Croquis – derives from the word ‘sketch’, in fashion and textiles this sketching is done through the act of making samples that are trialed on the body in the case of fashion or as small samples that test pattern, shape and construction in the case of textiles. (Definition from Picken, The Fashion Dictionary)

[9] Mary Brooks Picken, *The Fashion Dictionary: Fabric, Sewing, and Apparel as Expressed in the Language of Fashion* (New York: Funk & Wagnalls, 1973), 256-257

[10] Picken, *The Fashion Dictionary*.

Growing and Bio-fabricating SCOBY: A Project Developed in an Extended Cross-Disciplinary Research Team

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Abstract

This paper will explore recent collaborative design research into Symbiotic Colony of Bacteria and Yeast (SCOBY), also known as Kombucha. This material is being utilised by both product and fashion designers working within the field of bio-design. Suzanne Lee's BioCouture SCOBY garments are well known examples of SCOBY used in an experimental fashion context. However, up until now upscaling of SCOBY and the challenges of working with it as an architectural medium, both structural and expressive, have not been investigated.

In this research, the architectural possibilities of this biodegradable leather-like material have been investigated – supported by three separate, yet related, projects: a team-teaching development grant that brought together chemistry and architecture/design, research undertaken by a student in a Deans Summer Research Scholarship programme, and other students in an Advanced Design Research unit. In this paper, the collaborative cross-disciplinary process will be outlined, including the challenges encountered and the SCOBY outcomes produced. The process of up-scaling the growing process will also be described. To facilitate this up-scaling of the growing process, large 'farms' were constructed – the largest 2.4m x 1.2m. This process extended the dialogue beyond the initial team to include the knowledge and expertise of a SCOBY artist.

The next stage of the research and investigation involved students exploring the bio-fabrication possibilities of the material. SCOBY presents unique challenges for fabrication. It has variable moisture content, lacks self-supporting structural integrity and is a living material. The 3D-printability of SCOBY was piloted; and subsequently, through further student research development, techniques of folding and creasing tested. This multi-dimensional project, with its various outputs and investigations, represents a collaborative, cross-disciplinary material investigation that seeks to operate at the porous edges of disciplines, technologies and design paradigms.

Introduction

Researchers at the University of Tasmania have developed a collaborative partnership across disciplinary boundaries to build capacity in the field of bio-design. Bringing together architecture, design and chemistry, the team worked to develop processes for growing and processing a Symbiotic Colony of Bacteria and Yeast (SCOBY) which could be used as a pilot project for future integration into classes. The collaboration expanded to include a 'SCOBY artist' (author Sonja Hindrum), who provided support and advice for upscaling the growing of the material to architectural proportions, with the intention of eventually using these large sheets of biofilm with digital fabrication technologies such as CNC routing. The research was further developed in the context of a student-led undergraduate summer research scholarship project investigating the 3D-printing potential of SCOBY, and currently ongoing research in the Master of Architecture (MArch) programme.

This paper will introduce SCOBY from a design perspective and then situate the material in relation to the field of bio-design and its critical practices. The cross-disciplinary collaboration and project parameters will then be defined, before outlining the process through both a chemistry and design lens. The extension of this initial testing and learning into a student-led summer research project will then be discussed, while noting further research currently underway in MArch. Due to the disciplinary collaboration undertaken for this research and paper, the narration and analysis of the process employs both design and chemistry terminology and presents a detailed outline of the procedures implemented.

What is SCOBY?

SCOBY, better known in its capacity for brewing Kombucha tea, is a culture of yeasts and bacteria that can be used to grow a vegetable-like cellulose material. The readily available ingredients of black tea and sugar, provide a nutrient-rich solution on which the SCOBY feeds and grows.[1] Growing rather than manufacturing materials is being explored in the field of bio-design. Expert in the field, curator William Myers, defines the emergent field of bio-design as, "(referring) specifically to the incorporation of living organisms as essential components, enhancing the function of the finished work."[2] Myers further explains that, "the label is also used to highlight experiments that replace industrial or mechanical systems with biological processes." SCOBY provides one such example of a biological process and output that is being explored by designers.

To work with SCOBY requires patience as you must feed and nurture your batch of Kombucha. The SCOBY will continue to grow even if affected by penicillin (although it is not fit for human consumption). The penicillin also changes the colour of the SCOBY and can leave a patterning on the surface. SCOBY will often respond positively to other living organisms, opening up further design possibilities. From an architecture and design perspective, the material presents challenges in relation to its built environment application, both because of its hydrophilic quality and lack of compressive strength. Most current design work with SCOBY is around ideas for a leather alternative, while its treatment using beeswax or coconut oil to make the material more hydrophobic, opens up additional design possibilities.

The SCOBY feeds on simple sugars and this also opens up new design possibilities in regards to 'training' the SCOBY to grow in a particular direction or 3D form; rather than the current technique of letting the SCOBY grow to the size/shape of the vessel it is growing in – as is the case when used to brew Kombucha tea. The SCOBY will also grow successfully through natural fibres such as wool rovings, felt, silk, and cotton, as long as the weave/knit of the fabric is porous enough for the SCOBY to bond and grow through. Otherwise the SCOBY creates a laminate that will peel when dried. Experimentation has also demonstrated that although SCOBY will erode electronics over time, it will tolerate coated electronics and items such as fibre optics.[3]

There are several aspects of the material that appealed to the authors from a design perspective. One quality is the skin-like tactility of the grown sheet. The other is its domesticity. There is something both quotidian yet, at the same time, unorthodox about SCOBY. Artist and paper author Sonja Hindrum produced a series of design research outputs that interrogated a speculative re-imagining of the body, questioning concepts of connectivity and communication.[4] The SCOBY pellicle is also known as a 'mother', and the intention was to locate a suitable metaphorical vehicle with appropriate visual signifiers in order to express the complexity of the project.[5] The SCOBY has a skin-like quality and for the purposes of these works it represents a flesh analogue. Skin is a barrier between the inner and outer world and also a barrier between private and public; it is a container of human spirit, a visual reminder of our morality and mortality; it is our first physical point of contact with an outer world via tactile experience. It is also the only human organ that simultaneously registers incoming stimuli while communicating our physical state and it provides the border that allows individuals to experience each other. Skin carries social codes and is a social context communicator. What this project illustrates is that SCOBY presents opportunities in its role as an interface, both as the skin analogy highlights, and as a conceptual bridge to connect disciplines. The skin continues to offer metaphorical and architectural figures for ongoing student work in the Advanced Design Research MArch unit.

SCOBY and Bio-design

SCOBY is one material type that belongs within the larger and emergent bio-design paradigm. Bio-design takes biomimicry to a new level. Rather than only deriving inspiration from nature, bio-design incorporates living materials into the design process and/or output. Bio-design becomes a complex design process, as the designs are created from actual living materials, ranging from trees to bacteria. Myers suggests that bio-design seeks to "bring the material existence of artificial environments and objects into a sustainable harmony with nature, a state upon which everything ultimately depends."[6]

Current design trends in bio-design practice are driven by creativity, innovation and environmental and sustainable responsibility. These trends often set out to achieve better ecological performance including improving environmental footprints.[7] Bio-design offers a process to harness biological organisms such as yeast, bacteria, fungi and algae. In the field of bio-design, "Life is increasingly seen as the new frontier for exploitation; from industrial framing through in-vitro meat and bio-prospecting to synthetic biology, life is extracted from its natural context into the realm of the manufactured."[8] This approach to design manipulates organisms to interact with the ecosystem around them.[9] Bio-design also paves the way for cross-disciplinary activity, as designers, artists and life scientists (such as biologists) work together to extend the possibilities of the process and material.

There are a number of design practitioners and researchers, locally and internationally, experimenting and exploring the potential of SCOBY as a design material. Research and prototypes illustrate the possibility of the material to reinvent archetypal forms and processes, informed by its inherent qualities and sustainable possibilities. For example, in the fashion sphere, Suzanne Lee's New York-based practice *BioCouture*, grows SCOBY textiles for clothing. Although the "product feels similar to artificial leather…just like vegetable waste, it is safe to compost at the end of its useful life", presenting a new sustainable fashion alternative.[10] In a similar vein in Australia, the Queensland University of Technology are collaborating with the State Library of Queensland to develop SCOBY as a leather replacement material.[11] Other researchers are exploring how the material intersects with existing and emerging technologies. To this end, researchers in Japan are exploring SCOBY in relation to fashion, particularly focused on pattern prototyping using a combination of 2D and 3D techniques.[12] Pre-harvest techniques are also being explored by researchers. The *Edible Materials Lab* by The University of Texas at Austin has exhibited a cellulose mat exploring, "SCOBY's resilient, flexible, fuseable nature", generating forms by intervening with the material pre-harvest.[13] At an architectural scale, Pratt Architecture have conceptualised an architectural wall grown by establishing a relationship between Bacillus subtilis and Kombucha culture. Their prototype project has the potential to be integrated into spaces to change energy profiles, materials, and the resilience of architectural structures.[14] These precedent examples are drawn from across the design disciplines and demonstrate the growing level of interest in SCOBY for design applications.

A Multidisciplinary Process: learning and teaching development

In 2017, a number of the authors of this paper were awarded an institutional teaching development grant. The project was proposed as a pilot for design students and engineering students (enrolled in an introductory chemistry unit) to work together across their disciplinary boundaries and respond to the challenge of growing and processing SCOBY material using an 'inquiry-guided process'. This project also encompassed the objective of rethinking the "silo" separation and relationship between the science laboratory and the design workshop, in order to operate at the intersection of our disciplines. Additionally, we were seeking to proactively respond to the need for curricula revitalization in laboratory teaching environments, and ultimately improve student engagement through novel learning exercises. The adoption of the inquiry-guided process was intended to support transformative learning in both the workshop and the laboratory, embracing "mistakes and the subsequent redefining of a problem or solution [which] may be an intrinsic part of irreversible learning."[15] Our collaborative approach also sought to align with the institution's white paper on curriculum renewal, which recognises that "emergent issues…cannot be understood through a single disciplinary lens", but require collaborative and multidisciplinary approaches.[16]

The learning and teaching context gives a different emphasis in terms of the aims and objectives of the design project, and indeed multiplies and defers development goals across longer timeframes, towards future research. As discussed, the sensitivity and variable requirements of SCOBY as a material, means the translation and upscaling of biological processes for design outputs is no easy task. However, the very nature of experimental trial and error has also called for frequent communication between the two disciplinary sides of the collaboration, with student researchers driving the testing process, allowing for iterative reflection around the learning process. This paper focusses on research undertaken by Aaron Yong (a student co-author) through a Deans Summer Research Scholarship; while the current phase of learning development is now being explored (at the time of writing) with a small team of 5th year students in Advanced Design Research (MArch program). This has allowed for further trialling of learning activities with a larger team, while initiating alternate methods around fabrication techniques towards design outcomes. Although these additional learning and teaching iterations were not initially conceived as part of the original grant, this gaining of momentum demonstrates the ongoing value of the original project.

A Cross-disciplinary Team

This project brought together a cross-disciplinary group who were interested in exploring opportunities aimed at developing new learning activities to enhance student experience. In addition, the team members were eager to explore something different while endeavouring to integrate two ostensibly disparate areas of research. The partnership brought together teams from two seemingly disparate areas, specifically Chemistry and Architecture and Design. The collaboration presented the opportunity to delve into a cross-disciplinary research context and challenge the orthodox conceptions of materials for design and engineering. The authors understand cross-disciplinary practice to involve "one discipline using the knowledge set of another, i.e., importation across discipline boundaries."[17] As such, we titled our research project '*Rethinking the relationship between the science laboratory and design workshop using inquiry-guided learning.'* The cross-disciplinary approach to the research allowed us to understand our respective disciplines and their unexpected intersections.

However, we were also conscious that as Kit Wise notes, referring to Davies and Devlin's disciplinary framework, cross-disciplinary collaboration can also be seen as an occasion where investigation from outside a given field does not sufficiently engage with relevant expertise, limiting the transfer of methodologies.[18] In our case, the cross-disciplinary cooperation is exacerbated by distance, working cross-campus (Chemistry in Hobart, Architecture and Design in Launceston, a 2.5 to 3-hour journey by car). The nature of the project dictated the involvement of professionals with complementary skills, expertise and experience, with the key to its success hinging on constant communication between teams, led by the respective group leader in each location. Importantly, existing professional relationships that bridged the two research areas assisted in facilitating this communication. The frequent contact and rapid exchange of ideas between the two clusters, primarily via email, telephone and video-conference, ensured that each group and the overall team worked efficiently, allowing key project milestones to be met. In this sense, while the team may be *cross-disciplinary* in formation, the process itself will be argued to move across other modes of collaboration – *multidisciplinary* and *interdisciplinary* – towards future *transdisciplinary* research and development.

According to Davies and Devlin's framework, disciplinary boundaries often shift in a multidisciplinary manner; when disciplines first come together to contribute their own perspectives, albeit with limited awareness of the others' methods. Multidisciplinary processes become more integrated by renegotiating the limits of cross-disciplinary expertise, even when it may only be the topic that is particularly new. Interdisciplinary insight marks the next stage, towards; "(The) emergence of insight and understanding of a problem domain through the integration or derivation of different concepts, methods and epistemologies from different disciplines in a novel way."[19] It is the emergence of integration and novelty that is of critical importance here, versus the ostensible newness of a cross-disciplinary topic as such. For Wise, and indeed for our own emphasis on inquiry-guided learning, an interdisciplinary "model of research through 'integration' can be related to the inquiry-based learning processes that characterise creative practice, where real-world problems are engaged in a far-reaching practice-led context."[20]

The subsequent Advanced Design Research (ADR) process, extending the initial project, is also underscored by a principle of integration, following the conceptual framework developed by Frayling; that is, of various non-linear processes working 'into', 'for', and 'through' design.[21] Discussing work in the ADR unit as an example of the 'teaching-research nexus', Norrie and Owen offer a diagrammatic model for the way 'into–for–through' modes of design research move across traditional and non-traditional methods.[22] This includes literature review and precedent case study, to prototyping and materials research, both within and outside the discipline, across multiple fields of inquiry; and indeed, *through* iterative design process itself. Building on Wise, alongside Davies and Devlin, the SCOBY project may be seen as one that negotiates modes of 'into–for–through', as an integration that might also resolve the development of 'multi–cross–inter' disciplinary learning (albeit nonlinear and inexact in corresponding frameworks). For the DSRS process, a viable method was developed for the growth of SCOBY sheets that enabled pilot studies investigating a range of creative applications for bio-design to be successfully undertaken. In ADR, current teaching-research and learning development is now seeing a number of proposed solutions to up-scaling (Figure 1), specific to the requirements of architectural fabrication (including methods of creasing and folding; and prospectively, armature support and distributed modular compression).

Figure 1: SCOBY origami structures, design and photographs by Diyannah Syafiqah Binte Mohd Sham. SCOBY grown and coloured by Alex Bissember, Nathan Kilah, Stuart Thickett.

Chemistry and Design

While it may not be readily apparent, chemistry shares many similarities with architecture and design.[23] The chemist often utilises atoms as building blocks and exploits their properties to design and engineer original molecular architectures for a specific purpose. Form, function and aesthetic considerations (including molecular symmetry and asymmetry) are inextricably linked in this science and significant attention is directed to all aspects of design.

In the chemical processes used in this work, chemical building blocks made of carbon, oxygen and hydrogen (monosaccharides or simple sugars) are assembled as repeating units into larger threads and networks (polysaccharides or carbohydrates), with the purpose of supporting the growth of SCOBY.[24] These organisms require this scaffold for their survival and proliferation, and the conditions in which they are cultured influences the structure and thickness of the resulting material. In this project, considerable effort was directed to developing an optimal, reproducible and scalable method to enable the preparation of useful quantities of SCOBY; which would then allow the team to investigate the potential for this material to be effectively explored in the design workshop. By design, this approach focused on developing viable strategies that would be sufficiently robust to also enable chemical colouring agents (such as coloured and fluorescent dyes) to be incorporated into the material during its growth. Ultimately, a highly reliable method to prepare scalable quantities of biofilm (Figure 2) was developed using standard optimisation practices and problem-solving approaches generally consistent with standard approaches used in the chemical sciences. As a result of this study, SCOBY sheets could be prepared in sizes of up to ~2.88 m^2.

Figure 2: SCOBY growth in the laboratory. Photograph by Nathan Kilah.

Initial experimental testing of the SCOBY sheets was then carried out in the design workshop. Experimentation focused on the digital fabrication process, which was identified as a potential point of differentiation based on precedent research in the design application of SCOBY. This research had shown that SCOBY is largely processed using fashion or craft-based joining and forming techniques. The decision was made to test the laser-cutting and engraving potential of the material. An undergraduate student researcher developed laser cutting and engraving parameters. Power and speed options were tested on a 100-watt laser. It was determined that the following settings produced a desirable outcome on one particular sheet (Figure 3): engrave power 40, speed 2; laser-cut power 65, speed 2.

Further testing highlighted that the variation that occurs in the growth of the material (consistency of thickness and moisture content) impacts on the ability to laser cut and engrave with consistent settings. The growing and drying process itself needs further standardisation to utilise these same settings consistently in future applications.

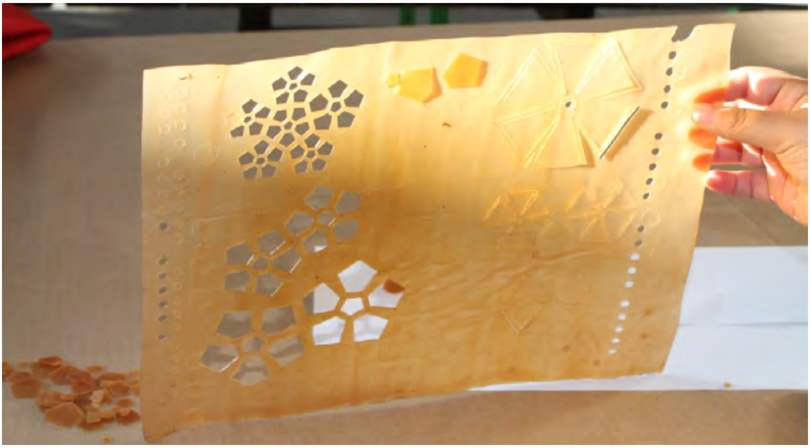

Figure 3: SCOBY laser-cut and engraved sheet, prototyping by undergraduate student, Hanis Sanusi. SCOBY grown by Alex Bissember, Nathan Kilah, Stuart Thickett. Photograph by Jacqueline Power.

Optimisation of SCOBY Growing Procedure

Key variables that were investigated from a chemistry perspective included the type of vinegar and tea used, the growth period, and the washing and drying of the films. The optimum procedure used apple cider vinegar and black tea (Essentials), with 3–4 weeks for incubation and 1 week for drying. White vinegar provided noticeably poor growth compared to the more expensive apple cider vinegar, while green tea (Tetley) typically provided a thinner material. It was determined that it was necessary to thoroughly wash the harvested sheet with water, followed by a week of air-drying at ambient temperature. This ensured that residues were removed from the surface biofilm in case their adhesive properties complicated further processing in the design workshop. The washing also lowered the residual smell of vinegar.

The typical colour of the dried biofilm was that of a pale beige leather, and the texture was similar to that of a fruit leather. To explore the opportunities to augment the aesthetic elements of the biofilms, a range of coloured dyes was added to the optimised growing conditions. In this way, synthetic dyes of various colours were successfully incorporated into the biofilms. Notably, natural dyes were incompatible with the mildly acidic growth medium, while synthetic dyes were more robust and provided excellent results (Figure 4). An additional experiment with the fluorescent dye, fluorescein, was also successful, giving a biofilm that glowed upon UV irradiation. Fluorescein was selected as it is well known as a biocompatible dye.[25]

Physical modifications to the biofilms were also briefly explored. Polymer netting and Kevlar fabric were introduced to the growing medium to explore whether the scaffold material could be integrated into the biofilm. However preliminary attempts were unsuccessful due to difficulties in suspending the scaffold materials at the air/water growth interface.

Figure 4: Coloured SCOBY biofilm placed over scaled model to simulate cladding possibilities. Prototyping and photograph by Aaron Yong. SCOBY grown and coloured by Alex Bissember, Nathan Kilah, Stuart Thickett.

General Procedure for SCOBY Preparation

Sugar (600 g) was dissolved in boiling water (3 L) and teabags (7) were added to a plastic container (38 x 25 x 10 cm). Cold water (3 L) was then added to the hot mixture and the ensuing mixture was cooled to room temperature. The teabags were removed and apple cider vinegar (600 mL) was added.[26] The ensuing solution was stirred and then the seed SCOBY (3–4 pieces) was added and the container was covered. The container was placed in a well-ventilated area for 3–4 weeks.[27] The SCOBY sheet was then harvested, washed with water, and allowed to dry (~1 week). This provided one SCOBY sheet (~38 x ~25 x 0.5–1 cm). The seed SCOBY was transferred to a separate container containing water and then used to prepare subsequent batches as required.

The Dean Summer Research Scholarship (DSRS) process

The main aim of the DSRS phase was to generate ideas and working prototypes for the use of SCOBY as an architectural material. The intended outcome involved developing physical prototypes of 3D printed SCOBY that would be self-supporting and capable of carrying additional load.

Figure 5: Analogue process of developing a form made of SCOBY. Prototyping and photograph by Aaron Yong.

An initial set of experiments was conducted in analogue format (prior to digital processes), using strips of dried SCOBY sheets layered on top of one another to create a dome (Figure 5). This mimicked the 3D printing process as a way of testing the material's ability to self-support and maintain its form. The dome maintained its form but remained malleable, a weakness that was further exacerbated when exposed to moisture. The dome was then placed inside a kiln at 103°C for 72 hours to harden the SCOBY (Figure 6). The drying process hardened the material significantly and it was able to withstand additional loads but remained vulnerable to moisture. Extensive exposure to humidity and moisture resulted in the material eventually returning to a weaker state of malleability.

Figure 6: SCOBY dome after kiln drying. Prototyping and photograph by Aaron Yong.

Another analogue test was conducted to mimic Rapid Liquid Printing, replicating a process performed by MIT.[28] This method allows 3D printing to be done without scaffolding and is therefore quicker than conventional 3D printing methods. The process involves extruding SCOBY puree into a gelatine made from sweetened black tea (Figure 7). The experiment yielded results that were satisfactory in that it was able to hold the shape of the extruded SCOBY. However, as SCOBY does not harden, once it was removed from the gelatine, the material broke apart.

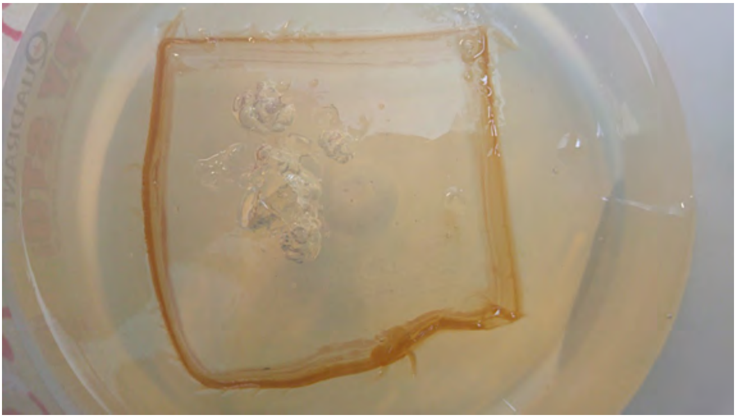

Figure 7: SCOBY puree extrusion process. Prototyping and photograph by Aaron Yong.

With regards to the integrity of SCOBY, an excerpt from Yong's portfolio states:

> "Knowing that SCOBY is unable to properly dry up or remain dry without prior additives is concerning, as a drying agent would be required as well as a solidifying agent to give the SCOBY structural integrity."[29]

Several solidifying agents were tested, first flour, then rice flour, corn starch and paper mulch. These were chosen over industrial drying agents to align with the university's ethos of sustainability. The tests revealed that corn starch is quite promising in delivering a printable SCOBY as it allows for smooth extrusion through the 3D printer. Research in the final stages involved creating basic shapes to be 3D printed using a mixture of blended SCOBY and corn starch. A ceramics 3D printer was used, one that has a cool extruder rather than a heated extruder, so as not to kill the SCOBY during printing. The first few minutes of the printing process ran smoothly as the SCOBY was extruded, but this didn't harden enough before the next layer was applied, with the material giving way and flattening on the printing board (Figure 8).

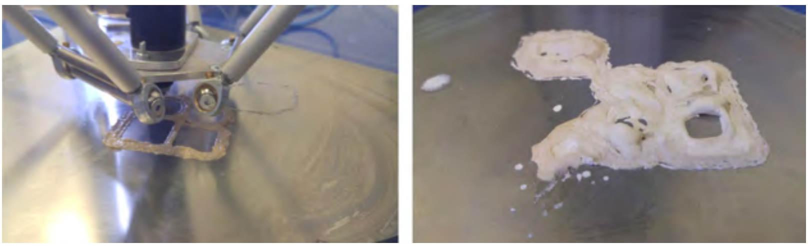

Figure 8: SCOBY and corn starch 3D printing. Prototyping and photograph by Aaron Yong.

The intended outcome was not achieved but provided useful insight into the bio-fabrication of SCOBY. More research and experimentation needs to be carried out with SCOBY and additives to create a solid composite capable of being used as an architectural material via 3D printing.

Figure 9: SCOBY farm being 'fed'. Photograph by Jacqueline Power.

Concurrent with the 3D printing process, large growing farms were established in the design workshop with the intention of growing architectural-sized SCOBY sheets (Figure 9). Three farms, the largest 2.4m x 1.2m in size, were constructed using common building materials lined with pond-liner to create a water-proof structure. The pond-liners were left to leach for approximately two weeks before the ingredients were prepared. This growing process remains ongoing. Key challenges faced have included the outbreak of penicillin, elements that halted growth, such as the under-water lights used to assist the filming process, and temperature fluctuation caused by the lack of insulation.[30] This ambitious process was supported by artist Sonja Hindrum who shared her experience and tacit knowledge in working with SCOBY. At the time of writing this paper, the SCOBY farms continue to be nurtured and fed, through new iterations of research and development, including the ADR learning and teaching process.[31]

Conclusion

This collaborative cross-disciplinary research has investigated the properties and growing possibilities of SCOBY and its potential for design fabrication. The research methodology adopted standard principles of scientific method and hypothesis-driven research for the iterative development of reproducible SCOBY biofilms, and their subsequent chemical and physical modifications for specific design applications. By situating our practice in relation to the existing bio-design field, and in particular the current utilisation of SCOBY as a material with fashion applications, we identified two potential points of differentiation: intervening in the growing process to reduce post-fabrication requirements, and investigating the digital fabrication possibilities of the material. The initial digital fabrication pilots, exploring laser cutting and engraving and 3D printing, quickly revealed the complexities of working with SCOBY as a design material. The main findings of the project are that: a detailed and iterative method can be developed for the production of SCOBY that can provide a consistent product for further design applications; that chemical modification during the growing process through the incorporation of dyes is both practical and effective. Further development and testing is needed to produce consistent proofs of concept. This bio-fabrication research remains ongoing, with further student-led research being undertaken as part of the Advanced Design Research unit in the Master of Architecture program.

This ADR process is still in its early stage of development but continues to build on previous work, including supporting the growth of the farms and finding new avenues for experimentation. As discussed, current propositions for architectural upscaling include methods of creasing, folding, armature support, and distributed compression, whereby single SCOBY modules might find their own structural integrity, with the limits of the material being deployed across an interconnected series of responsive envelopes. In this way, interdisciplinary integration is beginning to occur, as a recursive development of cross-disciplinary expertise and multidisciplinary processes. Future outcomes may then arrive at what Davies and Devlin describe as the contribution to a *transdisciplinary* field; constituting a unified synthesis of disparate frameworks, even the creation of a new field (or sub-field) altogether. In our case, this involves the insertion into a field that is still at a nascent stage – bio-design. The material specificity of SCOBY is entirely new for its proposed architectural application, supported by the niche through which inquiry-led practice-based research intersects with learning and teaching.

The richness of this research has been the result of its collaborative nature and the ability to bring together the seemingly disparate disciplines of Chemistry and Architecture and Design. These conversations have allowed us to better understand each other, and likewise to turn the lens on our own disciplinary practices and assumptions. Collaborating initially on an internal grant, then sharing our process across campuses, has allowed us to find a common language, making small steps towards rethinking the relationship between the science laboratory and the design workshop.

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[31] A limitation of working with SCOBY is the need to continually feed it. It is living and needs to be treated as such.

ADR18

Design Research and Pedagogy

Chaired by Dr Ross Anderson

Design/Build Technological Architectural Education In Chile: Participative Bottom-Up Design Approach In The Course "Introducción A La Construcción"

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Abstract

The Design/Build Methodology in the Education field of Architecture is an alternative to traditional and theoretical training. This paper gives an overview of the undergraduate unit of study "Introducción a la Construcción" in technological architectural education in Chile. The course's main feature is to encourage the learning process through a direct hands-on experience and the development of prefabricated built projects. Recently the course has realigned its focus to community-oriented projects outside the university. This study analyses two prototypes built between 2017 and 2018 under similar development processes but different context and constraint conditions. The analysis focuses on the stages of management, development, onsite installation and results of these projects. In addition, the study defines relevant features to be considered in the future development of off-campus projects.

The course has three distinctive features applied to the design research:

a) A participative and iterative process through design and testing of different structural components developed by groups of students. Coordination of components is done by professors, while the authorship of the project belongs to all students.

b) The course combines the bottom-up design methodology with modular coordination strategies to develop on-campus temporary structures managed and financed by the course's own resources. However, recent projects that respond to the needs of a community and code requirements entail complex logistics and higher financial costs.

c) Timber has been used as the predominant building material since it allows to explore concepts of prefabrication, modular coordination and structural performance. This intuitive design approach is complemented by a low-tech solution and low-cost solution according to the local context.

Conclusions drawn from final projects show a successful experience in the exploration of this methodology. Built results have exceeded original expectations while these initiatives open new exciting possibilities for the course.

Introduction

The Design/Build Methodology has been implemented in the Education field of Architecture, Design, and Construction as an alternative to the traditional training by aiming to learn from direct hands-on experience.

This paper reviews the experience of the course "Introducción a la Construcción"' in Chile and its relationship with various structural typologies and the local context to deliver a Design/Build course. This course is intended for first and second-year undergraduate architecture students, based on material experimentation and prefabricated building components. Traditionally, the course has been defined as a laboratory of highly experimental structures applied to temporary prototypes; however, recently has realigned its focus to community-oriented projects outside the university.

This study analyses two of these later prototypes built between 2017 and 2018 under similar development processes but different context and constraint conditions. The analysis focuses on the stages of management, development, onsite installation and results of these projects. In addition, the study defines relevant features to be considered in the future development of off-campus projects.

Background

The conventional method used in architectural education is based on representation through drawings, models and digital media. The Design/Build alternative deals simultaneously with design, economic and technological issues by building a small-scale structure[1]. The main common feature to all Learning by Building programs is the hands-on experience approach, with a high agreement on referred authors to embrace John Dewey philosophy of education based on “learning by doing”[2]. Most of them are addressed to post-graduate students as studios, while undergraduate units are mostly dedicated to materials and methods [3]. The schedule of Design/Build courses can last up to a full academic year in combined studio/building experiences, and, infrequently, short period courses can last down to 10 - 12 days[4].

Since its origins, Design/Build courses have encouraged students to explore with building materials and include a social agenda in its precepts. In early 20th century, the Bauhaus school conceived design education in a close relationship with industrial production. However, it wasn’t until the 60’s -with the Yale Building project headed by architect Charles Moore- Design/ Build courses started to be developed and incrementally embraced by many other universities within the US and also abroad[5]. Most recently, postgraduate programs from the University of Stuttgart, the ETH Zürich and the Design and Make Masters Studies at the AA, are applying this methodology to study advanced methods of digital design and fabrication. Currently, Design/ Build courses are considered one of the latest trends in architectural education. In 1997 Carpenter[6] stated no more than ten schools in the US included this type of programs, more recently Hailey[7] states more than a hundred schools have embraced Design/ Build methodologies. Arguably the experience of Rural Studio at Auburn University and Steve Badanes at University of Washington has influenced many other schools to incorporate Design/Build courses in their curriculums.[8]

Initiatives and strategies to deliver the courses differ within schools of architecture. Canizaro[3] identifies intentionalities in at least three different groups: technical oriented, social oriented and as a critique to academia. Community service projects demands a more complex management than technical oriented ones. A location, a client, a non-profit organisation, funding and an extended period of time are needed to successfully deliver a project to benefit a community[9]. The design strategies applied in these projects can be either a "top-down" traditional approach where the entire building is designed in an early stage and then is dissected into smaller components; or a "bottom-up" methodology that consists in a design of basic components that are then assembled to conform the total design. The “bottom-up” methodology has been studied in various fields while its application in architecture has not been fully developed and mostly focused on parametric design[10].

Building materials are a fundamental topic in Design/Build courses, learning about their properties and construction techniques are basic contents in all educational programs. Projects are materialized either by low cost, discarded and/or donated materials[11]. Timber is appraised as a fundamental material for student built projects as been proven an excellent material for structural applications, even considering low-tech tools and on-site construction. Furthermore and compared to other available building materials, it would be hard to find a material with a better weight/resistance correlation to work with in short periods of time[12]. Education on wood manufacturing techniques and timber construction systems in architecture projects is significantly relevant in Chile as forestry is the second most important economic activity in the country. Timber construction techniques are part of the heritage brought to the country by immigrants in the 19th century and has been widely used in many historical buildings. Currently, timber building has been much affected by developments in manufacturing technologies and building components. Today, the merging of building traditions with the application of new technologies has produced new knowledge on the use of wood in construction[13].

However, Design Build courses have higher costs than other units of study. Funds available comes from non-profit organizations; tax deductible and materials donations; local businesses and authorities; and academic institutions. Nowadays, these courses are funded with resources managed by scholars while local volunteers also participate on these initiatives[14]. The work is organized considering students as labour, while the teaching staff acts as project managers. Groups of people ranging from 6 to 15 are considered the ideal to achieve an efficient onsite work[15]. Funds raising, consultants coordination, legal/codes considerations, subcontracts and relationship with clients are generally tasks carried out by tutors and professors[16].

Other common issues to deliver Learning by Building courses come either from academic institutions, teaching staff and students. In general, Universities are concerned with liability and student safety issues. Within architecture schools there is criticism for the not challenging enough of either designs or construction methods. Low earned credits in relationship to the amount of work required to actually build something, and exploitation of students as low-cost labour. Lastly, student resistance comes from no concern in social agenda, lack of interest in building technologies, project ownership and availability of time to enrol in these specific courses[17].

The “Introducción a la Construcción” Course

The “Introducción a la Construcción” unit of study is based on material experimentation through prototyping prefabricated components. The course is organised in small groups and a bottom-up design approach to develop individual components, which assembles a single temporary structure on campus, by the end of each semester (figures 1 & 2).

Figure 1: Example of prototyped structure on-campus, 2014.

Figure 2: Example of prototyped structure on-campus, 2015.

Typically, the bottom-up design methodology is applied in two stages: first, students independently work in prototypes without any information about the final project, while in the latter stage, a comprehensive design is conceived as a product of component coordination (Figures 3,4,5). Consequently, drawings are used only as reference for modular coordination within a pluralist and participatory design.

The prototypes have a series of established constraints, mostly related to time frame; budget and materials; and weight:

1) Time-frame: exercises are developed within 3-4 hours on a weekly basis. The final assembly is carried out in between 3 to 5 days in a activity where students are encouraged to solve real issues according to available resources.
2) Budget and materials: The course is self-financed entirely by the students. Each student's total contribution is US$50 per semester. The course's goal is to generate awareness of the investment cost related to an architectural project; to encourage the responsibility of students with their project; and to develop management skills through the purchase and storage of building materials. The total budget of U.S. $ 2,400 for these projects is extremely limited using conventional

construction systems and the reusing/recycling of materials is highly encouraged.

3) Weight: No crane nor mechanical devices are available to move parts, therefore components must be able to be carried by a group of people.

Figure 3: Bottom-up prefabricated components during assembly, Dec. 2008.

Figure 4: Bottom-up prefabricated components during assembly, Dec. 2008.

Figure 5: Bottom-up prefabricated components during assembly, Dec. 2008.

Research Methodology

This study analyses two projects originally developed by the "Introduction to Construction" course and built between 2017 and 2018. Both buildings are located off-campus, as permanent structures, and as community-based projects: Patagonia Scientific Station and Pumanque Community Center.

As a research methodology, a comparative analysis was applied to evaluate the results of the entire process. The scope of work considers the stages of design, prototyping, prefabrication and onsite construction for both case studies from the reported experience from tutors and students. A description sheet of the projects is included to contextualize each case and to analyse the process under three main focuses: the design process, building processes and management.

The analysis considers the following parameters. Design process: description and analysis of the design strategies and development process from the work with students; client, building use and built area; location, site conditions and pre-existing buildings. Building processes: structural and fabrication considerations based on construction and structural systems, building materials specs and prefabrication considerations. Management: efficiency in the project development through the analysis of permits management, time frames, budget, teams, level of completion and assistance from third parties.

The comparative analysis considers quantitative aspects (e.g. costs, time frames, physical resources, etc.) and qualitative aspects (description of the processes, management, etc.) in the development of the projects to frame the discussion on each area. The identification of critical issues allows defining improvement proposals for upcoming projects.

Case Studies

The Patagonia Scientific Station

The Patagonia Scientific Station consists in an open pavilion on a remote province located in the South of Chile. This station is owned by the Catholic University and specifically managed by the Department of Geography. The roof structure was installed on the existing deck as part of the station project to provide shelter to the constant heavy rains on this location. The Department of Geography allocated funding to acquire building materials and all building components were prefabricated on campus during the academic term by students (Figures 6 to 10) (table 1).

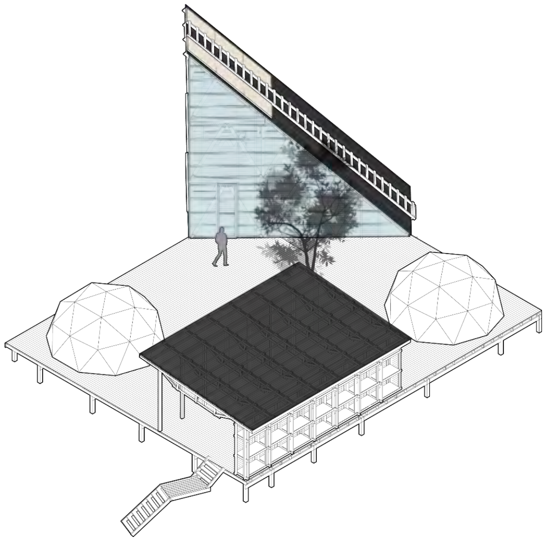

Figure 6: Axonometric view of Scientific Station.

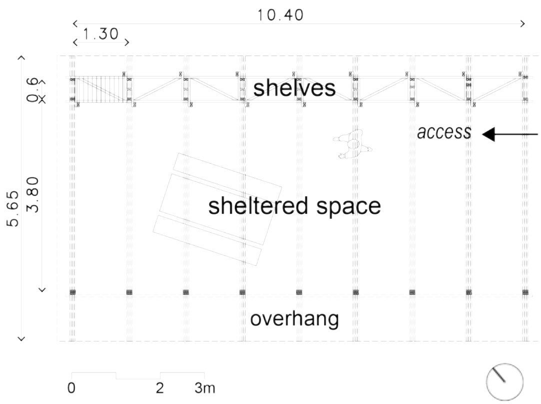

Figure 7: Roof structure plan.

	Project	Patagonia Scientific Station		
general information	*Location*	46°17'10.3"S 73°31'58.7"W		
	Sector	Rural		
	Access	Flight/ road route Santiago - Coyhaique	1690km	26 hours/ 2 hours flight
		Asphalt road route Coyhaique - Puerto Tranquilo	216km	4-5 hours
		Ship/ boat Puerto Tranquilo - Bahía Exploradores		2 hours
		Walking Trail (deck) to Scientific Station	500m	
	Existing Structures	Wooden deck; utility tower with sanitary service and electrical power from PV cells; two geodesic domes as dormitories.		
	Height	1 - storey/ 4.00m		
	GFA	68m2		
	Client/ commissioner	Department of Geography, Faculty of History, Geography and Political Science, Pontificia Universidad Católica de Chile		
	Budget (USD$)	USD$3,400 final structure + USD$3,000 during prototyping		
	Funding	Department of Geography, Faculty of History, Geography and Political Science, Pontificia Universidad Católica de Chile		
construction	*Components Prefabrication*	Prototyping: through semester by 60 students + 4 professors + 6 tutors.		
		Fabrication: 4 days by 60 students + 4 professors + 6 tutors.		
		Onsite assembly: 4 days (see schedule below)		
	Assembly Schedule	Day 1 - footings, connection to existing deck		
		Day 2 - posts, bracings and shelves type support		
		Day 3 - trusses		
		Day 4 - roof sheets		
	Assembly Team (onsite)	Academic stuff - 2 professors		
		Students (volunteers) - 6 2nd year students		
		Volunteers - 2 senior students		
	Level of Completion	100%		
mate rials	*Primary Structure*	CCA treated sawn timber post and beam		
	Footings	Existing native timber deck		
	Roof	Coated Zincalum sheets		

Table 1: Summary of Patagonia Scientific Station Case of Study

Figure 8: Image of sheltered space at the Patagonia Scientific Station.

Figure 9: Image of assembly crew under roof structure at the Patagonia Scientific Station

Figure 10: Panoramic view of Patagonia Scientific Station.

The Station was developed within the constraints and scope of work of “Introducción a la Construcción” course with the following considerations: an existing previous project; feedback of the client through the prototyping process; additional funding; and a volunteer summer workshop to install the structure. The extremely remote location of the project defined additional constraints regarding the onsite operation. The transportation of components must consider a boat itinerary; all the assembly to be carried by a small group of workers with no access to heavy machinery; and onsite modifications are not allowed due to the lack of hardware stores in the area.

The Pumanque Community Center

The Pumanque Community Center (Figures 11 to 19) (table 2) is part of the initiatives from the Catholic University of Chile to benefit the communities affected by bush fires in summer 2017. The prefabrication of the whole structure was performed on campus facilities where a recently graduated student performed as project manager in charge of the components’ manufacture.

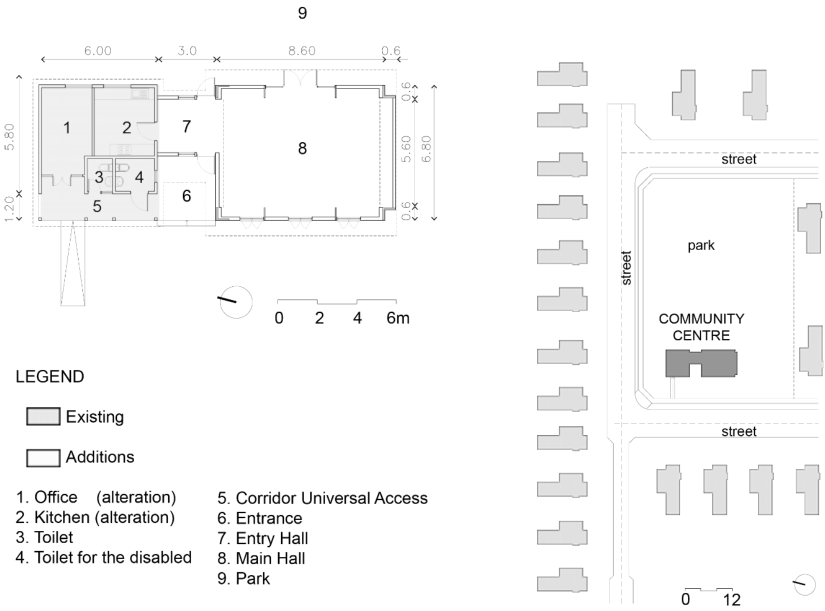

Figure 11: Architecture Plan and Site Plan of Community Center.

	Project	**Pumanque Community Center**
general information	*Location*	34°33'23.0"S 71°36'55.2"W
	Sector	Rural
	Access	Asphalt road route Santiago - Pumanque 250km 3 hours' drive
	Existing Structures	Masonry structure housing a small multi-purpose room and two toilets, one for the disabled. Universal accessibility. 30m2
	Height	1 - storey/ 4.00m
	GFA	75m2
	Client/ commissioner	Nuevo Amanecer community & Pumanque Municipality/ Políticas Públicas UC and FADEU UC.
	Budget (USD$)	USD$30,000
	Host	Accommodation: Municipality of Pumanque / Catering: Community + Municipality of Pumanque
	Funding	Departamento de Políticas Públicas + Facultad de Arquitectura, Diseño y Estudios Urbanos Pontificia Universidad Católica de Chile + Municipalidad de Pumanque
construction	*Components Prefabrication*	1 semester prototyping by Intro to Construction: 60 students + 4 professors + 6 tutors Components prefabrication: 1 graduate architect + 2 students (casual)
	Assembly Schedule	Week 1 - footings subcontract + CLT primary structure Week 2 - i-joist beams + trusses + purlins + plywood ceiling Week 3 - Timber frame envelope + home wrap + access structure Week 4 - Roof + Fibre cement boards Additional 3-4 weeks: plasterboard + paintings + windows subcontracts
	Assembly Team (onsite)	Academic stuff - 3 professors in shifts Students (volunteers) - 13 students in shifts (7 permanently) Tutors - 1 senior student + 1 graduate student
	Level of Completion	80% by students summer course/ 100% after finishing subcontracts
materials	*Donations*	Volcan industries: plasterboards, insulation, humidity barriers, fibrecement boards + onsite installation training Simpson strong tie: timber structure hardware Glasstech S.A.: window units FADEU Dean: Radita Pine Timber 2"x6"
	Primary Structure	Timber post and beam: CLT posts, compound LP i-joist, plywood and sawn timber trusses.
	Footings	H-25 concrete footings (slab on ground)
	Envelope	Structure: timber studs 2"x6", Interior: plasterboards, Insulation: glass wool, Membrane: Typar Membrane, Exterior: Cement fibre rainscreen
	Roof	Faceted Zincalum sheets
	Subcontracts	Footings premixed concrete, electrical certified installation, roof, windows
	Permits	Alterations and Additions permit (CC) and Occupation Certificate

Table 2: Summary of Pumanque Community Center Station Case of Study

However, the scope of work exceeded the capability of the course and counted with financial support from the University, private companies and the local Municipality. The University through the Public Policies Department and the Faculty of Architecture, Design and Urban Planning financed three subcontracts supplementary with the work of students: premixed concrete footings, certified electrical installations and roofing. Private companies donated building materials such as sawn lumber, plasterboards, cement fibre boards, timber connectors, thermal insulation, weather membranes and windows. The community provided accommodation for the students and skilled labour to support the work. This substantial support allowed to focus the student work on the primary structure and the envelope of the building.

The work onsite including the assembly of the structure was managed by the course's professors through a summer workshop in January 2018. By then, the building had reached 85% of completion and the finishes were executed by a local contractor.

Figure 12: Views of Community centre in its relationship with the existing structure.

Figure 13: Views of Community centre in its relationship with the existing structure.

Figure 14: Exterior views of community centre.

Figure 15: Exterior views of community centre.

Figure 16: Interior views of community centre.

Figure 17: Interior views of community centre

Figure 18: Exterior views after subcontracts on finishing.

Figure 19: Exterior views after subcontracts on finishing.

Discussion

The analysis will compare both experiences and focus on three main aspects of the course: the participative/iterative methodology; the use of timber applied to the bottom-up method; and a discussion on main issues faced in the process.

Participative/Iterative Design Methodology

The course is organized by teams of students to ensure a participative design process. Each team is assigned to build a full-scale structural prototype as a design in itself and, at the same time, as part of the design for the whole project. Within this context, the development of social skills (i.e. leadership, agreements and compromises) are encouraged and established spontaneously. The successful application of this design methodology depends on the constant guidance and coordination by professors through the stages of development.

Traditionally, assignments refer to long-span structures as a starting point for prototyping despite the students' lack of knowledge in traditional structures. Early exercises aim to deal simultaneously with issues arising from: the studied structural phenomenon, the building material, its available format and the components' shape. The students' unprejudiced approach to structural design has resulted in unconventional and highly experimental prototypes with convoluted geometries and complex structural performances. Thus, a performance analysis is very difficult to achieve using traditional calculation methods but an excellent case for the "trial and error" iterative methodology to understand basic mechanical concepts such as; stress, strain, elasticity, plasticity, resistance and isotropy. Knowledge regarding structural features and building material properties are reinforced with conventional lectures and readings on the topic. Additionally, students are required to review their designs and fabrication and elaborate a report on the material's properties that triggered that specific solution. No schematics are used and only once students define their first prototype design, they develop a set of as-built drawings. This reverse engineering process allows students to identify and fully understand structural and materials' behaviour; then to amend and innovate on constructive issues (figures 20 and 21).

Figure 20: Post stressed connections for laminated components using PVC pipes.

Figure 21: Post stressed connections for laminated components using PVC pipes.

The bottom-up approach has been perfected applying a Modular Coordination strategy. The course has defined two modular coordination strategies: "Common Dimension", when the design is based on a unique dimension applied to the entire project, components and final project are defined by multiples of these modules. On the other hand, "Object Coordination" is based on different dimensions and connections between each component. Each component has its own layout logic and the coordination defines only overall dimensions (figure 22 and 23). Both of these coordination protocols have efficiently applied to the course's methodology and diverse structural systems.[18]

Both case studies consider an object coordination strategy as the prevailing modular coordination. Connections between components were devised and tested throughout the prototyping stage.

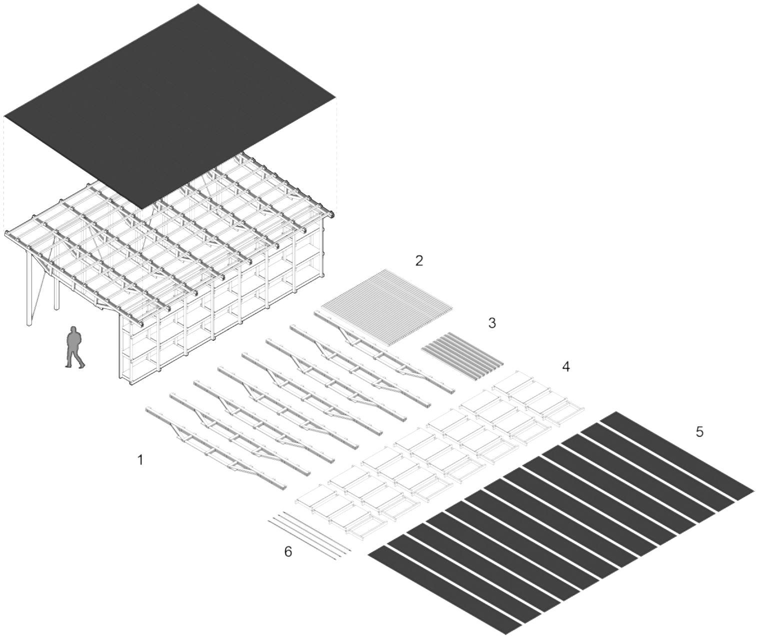

Figure 22: Exploded isometric of Scientific Station 1. Trusses, 1”x4” CCA treated pine 2. Roof battens 1”x4” CCA treated pine, 3. Posts 1”x4” NLT CCA treated pine, 4. Shelves 2”x4” CCA treated pine, 5. Roofing coated Zincalum, 6. Steel Bracings

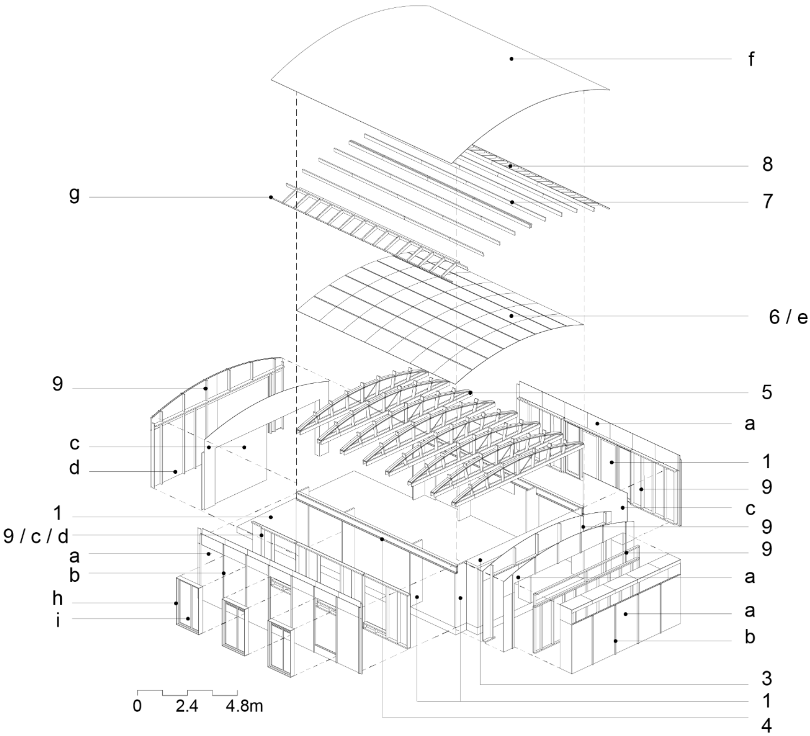

Figure 23: Exploded isometric of Community Center.

PRIMARY STRUCTURE COMPONENTS

1. H-25 reinforced concrete footings (*)
2. 3-layer CLT vertical structural panel th:60mm.
3. 5-layer CLT horizontal structural panel th:100mm.
4. double "LP i-joist" beam h:300mm.
5. Trusses: 2"x6" sawn timber + double layered 15mm. plywood on top chord
6. 15mm. structural plywood ceiling
7. 2"x6" sawn timber purlins
8. 2"x6" sawn timber eaves support
9. Envelope support: 2"x6" sawn timber frame + 15mm. plywood board

ENVELOPE SPECIFICATIONS

a. Rain Screen Facade: Fiber cement boards th:8mm + TYPAR wrap barrier + acrylic paint sealer + latex coating.

b. 2"x2" finishing vertical timber battens

c. Linings: 15mm. plasterboard + latex paintings (*)

d. Wall Insulation: 100mm. glass wool insulation in cavity

e.10mm. plasterboard fire protection over ceiling + 120mm. glass wool insulation.

f. Roof: 11mm. OSB boards + TYPAR humidity barrier +

0.5mm faceted zincalum roof sheets (*)

g. 40x40x2mm. fascia steel angle enamel coated

h. 18mm. plywood jamb + zinc flashing

i. window unit (*)

A previous survey of the site of the Scientific Station was required to define anchoring points to the existing deck and the final layout of the proposed structure. With the general layout, students developed a full-scale mock-up and a construction manual in order to provide assembly guidelines. Construction time, resources and labour allocated were extremely short, because of the location constraints. The structure was assembled in 4 days by a team of 8 people (figure 24).

Figure 24: Scientific Station during assembly.

The Community Centre was devised in the exact same way as the Scientific Station. However, professors were responsible for the required council approvals and building permits management. Code compliance added complexity as prefabricated components needed to be sturdier which in turn resulted in heavier components (figure 25 and 26). However, still manageable by a reduced group of students.

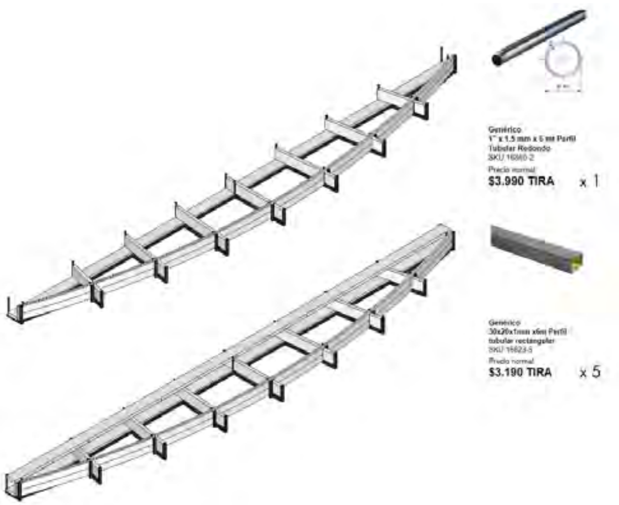

Figure 25: Studies for truss prefabrication matrix.

Figure 26: Primary structure upon finishing, Pumanque Community Center.

Layout of the structure was determined in a 1.20m module allowing for any board-format material be used for the envelope. Its materiality was defined in a later stage and prior to onsite construction, conceived as infills of the primary structure; and in the form of timber framing, therefore easily to be built and adjusted onsite. Leaving a part of the process to be defined and built onsite was critical in order to complete the works on the allocated time.

The workshop considered twenty-five days of onsite work and only few students were present during the whole process. Delays may be associated with shift changes and tasks that require customized sized elements (e.g. envelope infillment and adjustments to link the new pavilion to the existing building). Finally, the completion of works was carried out by subcontract on finishing (plasterboards, paintings and windows).

Timber as a Pedagogical Tool

One of the features of timber is that from a single element, such as studs and boards, it is possible to develop a wide variety of basic structural solutions. Timber has provided an exceptional opportunity for innovation through the prefabrication of various building components that are fundamental for a quick assemble of the final project. However, the application of timber construction systems requires to adapt to the course and local context limitations such as: budgets, available on-campus manufacturing technology and unskilled labour. Thus, the course's methodology has converged in a tendency towards a "low tech" design to apply local building tradition in contemporary designs. Students are encouraged to re-evaluate traditional carpentry techniques as a strategy for deepening the relationship with materials, expand its design possibilities and improvise. Thusly, timber has become the preferred material for use in this course.

In regards of the pedagogic process, due to timber elasticity and defects, structural issues derived both from design and execution errors are visible with ease, therefore an excellent material to learn from practical experiences. Manufacturing processes developed by students deal with these defects by using mechanical connectors, chemical binders and also combining sawn with other timber-based products. Dry-construction techniques provides immediate results, which in turn, allows for drawing immediate conclusions regarding assignment results. Iterative trial-and-error processes allows to enhance efficiency in prefabrication, weight of components, waste production and recycling.

Management and Pedagogical Issues

The “Introducción a la Construcción” unit of study has been delivered uninterrupted for fifteen years. Since its origins it has relied on students own funding to achieve numerous temporary structures; however, both cases of study where conceived with funds allocated since the beginning. The scope of works was determined considering the resources available and additional funding and donations were managed as the project was further developed. Funds, along with the client, are considered fundamental aspects to achieve an off-campus built project.

Consequently, the planning process in Pumanque project requires further review in order to have fully completed the works on time with students. A fully prefabricated construction seems to be an option, as the scientific station experience suggests. Nevertheless, a fully enclosed building is a more complex one. A second solution would be to either have more people onsite or longer period for construction, issues with this option would have translated into insufficient enrolment of students. A Third option -and used by other schools- is to plan summer additional courses specifically for unfinished works[4].

The local context constraints have orientated solutions to be developed within the field of non-conventional structures, while encourages recycling of materials to reduce costs. Paradoxically, the economic restrictions have not meant a reduction in the scale of the built works, but in a condition for the students to search alternatives to conventional solutions.

Adjustments to local conditions have changed the perspective of the course towards an optimized use of basic resources: economic, technological and technical. The scarcity of resources combined with non-traditional learning methods has produced built works that exceeded the expectations for first-year students. The contents of the designs and thinking processes are generated by the students themselves, the pedagogical process works as a guideline and exceeds the pedagogical objectives initially proposed.

Conclusions

This study analyses two projects as part of the course’s new focus on community-oriented projects outside the university. This challenge considers development processes similar to on-campus projects but different context and constraint conditions. Key findings in off-campus projects have been identified in the stages of management, participative design development and the use of timber as main building system.

Through the years, the course management has progressively been perfected. The proper combination of the bottom-up design methodology with modular coordination strategies has been effective to promote a participative design. On-campus temporary structures are fully managed and financed by the course's own resources. Off-campus projects respond to the client needs, code requirements and entail complex logistics and higher financial costs. These experiences represent a unique opportunity to combine service and learning but management should not be considered as a conventional construction project. This area still needs to be revised to fit the profile of the course through additional funding or extended time frames.

The application of participative design to the "Design-Build" methodology has proved to have a strong potential to communicate concepts related to structural design and building construction. The students have been able to develop practical skills and apply theoretical concepts in the design and construction of full-scale prototypes. In the case of off-campus projects, students have been able to positively apply the same skills and adapt to the new challenges while their feedback about the experience has been positive.

The course has fostered the exploration of form and matter simultaneously and timber has proven to be a suitable building material thanks to its physical properties and versatility. Timber construction systems have encouraged the study of prefabrication, modular coordination and structural performance. This intuitive design approach is complemented by a low-tech solution and low-cost solution according to the local context. The design process is oriented to generate alternatives that can be used as pedagogical tools to understand structural and constructive phenomena applied to a community-based project. In the case of off-campus projects, building processes increase complexity since it is not possible to conceive an entire building using only timber. In this way, new considerations related to items that exceed the capacities of the course and where assistance from subcontractors have been required (i.e. roofing flashing, finishes, foundations). This situation involves additional coordination and merging between the course's experimental design and traditional construction techniques.

Non-traditional teaching methods applied to development of off-campus projects have represented a new challenge for both students and tutors resulting in buildings that widely exceed the expectations for second year architecture course.

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Space Making in Nepal: Exploring Design Pedagogical Strategies for a Newari Cultural Centre

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Abstract

Historically, the inhabitants of the Kathmandu Valley in Nepal, the Newars, have for more than a thousand years contributed to a large part of the country's cultural heritage, traditions, and built environment. The Newars are culturally very rich, and have a long history, immersed with socio-cultural-religious traditions, festivals, craftsmanship, as well as a deep understanding of architecture and urbanism, particularly seen in their design of public spaces.

In architectural design, we generally design the walls, floors, windows, and other building elements. But how aware are we of the *space* that these elements actually enclose? In other words, how much are we concerned with the shape and quality of *space* itself? In the first semester of 2017, at Nepal Engineering College, a design studio was conducted to explore the theme of semi-public open spaces as well as internal environments for a Newari Cultural Center to be designed at the UNESCO world heritage site of Bhaktapur. For this project, the idea and functions of a cultural centre were open to interpretation. However, it was not to be of one singular building, but rather multiple building blocks and projects had to address how to arrange these building blocks according to ideas of a cultural theme. The central question all projects had to investigate was: how to design, not just the buildings, but the *spaces between* the buildings?

The theme of space as primary is central to the research proposed in this paper and through the case study of this particular design studio, this paper highlights how design education shows the mutual relationship between culture and design. Particular emphasis will be placed on the method and process of design with regards to the pedagogical strategies employed to enhance students' appreciation and understanding of their own cultural values in relation to space and architecture.

Introduction

The Newari people of the Kathmandu Valley have for more than a thousand years contributed to a large part of Nepal's cultural heritage, traditions, and built environment. The culturally rich Newars possess many deep-rooted socio-religious traditions and a holistic understanding of architecture and urbanism. In the first semester of 2017 for the Bachelor of Architecture degree at Nepal Engineering College (affiliated to Pokhara University), a fourth year design studio was developed to produce a hypothetical centre for Newari culture. This was situated in Bhaktapur, as the subject of promoting culture fitted well with Bhaktapur being known as the 'cultural capital' of Nepal, abundant in local Newari tangible and intangible cultural value.

Figure 1: Bhaktapur Tamaudhi Square with the tall Nyatapola Temple.

The studio placed particular importance on the conceptualisation and development *of semi-public open space* in terms of the masterplanning of the cultural centre as well as the development of *interior space* in terms of a museum design. In architectural design, we generally design the walls, floors, and other solid building elements. But how aware are we of the *space* that these elements actually enclose and contain? How much are we concerned with the nature and quality of *space* itself? We do not inhabit the walls, floors, and ceilings that we spend much of our time designing, but rather the *space* that they demarcate. This notion of in-between space has been central to architects and theorists such as Stan Allen, who in his seminal article “From Object to Field”, states, “Form matters, but not so much the forms of things as the forms between things.”[1] How space is conceived is a central theme of this studio, which draws upon the research of Kathmandu Valley’s urban forms and their fundamental concepts, and attempts to give an interpretation of these into a modern design context through different pedagogical strategies.

Generally, a cultural centre is a building or complex which promotes culture and the arts. It is designed for interested persons to learn about a particular culture or place, as well as to preserve particular cultural artefacts and knowledge. Rather than one singular building, the proposed cultural centre will consist of multiple building blocks, namely, permanent and temporary museums, café and bookstore, multipurpose and learning centre blocks. Projects had to ask: how to arrange these blocks according to ideas of the cultural theme, and how to design, not just the buildings, but the *spaces between* the buildings. Thus, the masterplanning will focus on the shape and quality of semi-public open space. Additionally, this project will place particular emphasis on the museum component, whereby designs have to consider the shape and quality of *interior space* in terms of the relationships between form, light, and materiality.

The learning objectives of this studio are as follows:

1) To develop a masterplan concept in three-dimensions at an early stage to appreciate semi-public exterior spaces.
2) To enhance students' appreciation and understanding of natural light, material, and experience for exhibition type interior spaces.
3) To establish students' understanding and critical appraisal of the traditional-socio-cultural dimensions influencing architecture and urbanism.
4) To build a holistic understanding of the design process and the communication of ideas.

The studio's pedagogical approach addresses the education of today's millennial students of architecture.[2] What is most apparent about the current generation entering universities, is that technology is intimately embedded into their everyday lives, literally as extensions of their bodies, hence why millennials are also known as 'digital natives'. The need to 'engage' is generally what research suggests to produce millennial-centred learning environments, as well as the need for collaboration working with various media.[3] Although architecture studios are by necessity a key instance of active learning, this studio attempts to explore pedagogical strategies in the prospect of providing a more experiential and engaging learning environment which allow students to appreciate and understand their own cultural values in relation to space and architecture.

The study methodology emphasised the interrelations between the different stages of a design process, including research, analyses, conceptualisation, and integrative design development. The studio consisted of lectures, tutorials, and presentations. To reinforce these, a site visit to Bhaktapur and a fieldtrip to Carl Pruscha's Taragaon Museum were held to facilitate students with a better understanding of the project's contextual, conceptual, programmatic, and three-dimensional aspects.

This studio criticises what has been referred to as a 'mechanistic' pedagogy of students likened to recording devices learning a wide spectrum of unrelated fragments of knowledge, and instead leans towards a more 'systemic' approach focusing on active learning experiences underscoring the holistic understanding of different bodies of knowledge in relationship to the wider design process which can be applied to current or future design projects.[4] Moreover, this design studio emphasises heuristic empirically-based pedagogical approaches to learning about space, employing active and experiential learning, through physical and digital models.[5]

This article will proceed to discuss this studio with the first section providing a summative literature review to establish some key architectural and urban ideas found in Kathmandu's historic cities; the second section elaborates the research stage; the third section discusses the lighting studies; and the fourth section articulates how these various aspects were applied into the students' masterplans and developed designs.

Kathmandu Urban Conditions

In Nepal's capital, Kathmandu, and specifically within its historic Newari townships, one can experience an integration of architectural and urban elements, such that the design of a house is intricately woven to the urban experience of the city. Kathmandu's built heritage is very rich with some monuments dating back to 5th Century AD. Historic buildings and urban-scapes are part of everyday life in Kathmandu, which consists of three historic city cores (part of the seven UNESCO World Heritage Sites), namely, Hanuman Dhoka (Kathmandu), Bhaktapur, and Patan. What follows is a brief explanation of some of the architectural and urban phenomena found within these historic cities, particularly Bhaktapur.

Figure 2: Patan Durbar Square.

What if a city and a building, and that's every building in a city, is actually one integrated whole. A typical traditional house in Bhaktapur has a deep connection to the urban-scape. A house is not only a building by the street, but part of a greater entity. An entrance to a house is not simply a door; but more like a portal, which mediates between the public space of the street and the private space of the house. This portal is an articulated zone between the street and the house-front. This portal, known by locals as an 'alley' or in Newari, a '*galli*', is not an alley in the conventional sense as a recess between two buildings, but rather a passageway open at both ends, usually dark, around two-metres deep, which separates the public zone of the street and a semi-private courtyard.[6] This courtyard or '*chowk'* is shared between multiple semi-detached houses, acting as both a private-public buffer zone and a communal-social gathering space for the residents.[7] The *galli* passageway acts to screen off the courtyard from the street, yet invites, brings in, and physically connects the public open space of the street with the open space of the semi-private (and therefore also semi-public) courtyard. The open space of the city literally enters into the space of the dwellings by means of this passageway.

Figure 3: *Gallis* leading to *chowks* (courtyards).

In Kathmandu's historic cities, indeed buildings matter, but not as much as the *spaces between* them. Wolfgang Korn describes the way how individual building elements are grouped and arranged, though appearing irregular and unplanned, is more impressive than the buildings themselves.[8] It is in the interrelationship between the buildings and elements at a human scale which makes the traditional city so articulate in urban experiences. The historic cities are structured around two main elements: firstly, meandering 'streets', many of which are rather narrow, and secondly, larger open spaces, which act as communal 'public squares'. These streets, composed in a chain of linear segments, widen out into courtyards and squares. The need to stop, congregate and continue further along a street was the conceptual basis for the squares' sudden burst of open spaces, which not only marks the points of intersection, but also brings more sky and light into visual play.[9]

The squares which the streets open onto are part of a wider urban entity, and according to Tiwari, there are four categories of squares, namely: the Durbar (palace) square, the market square, the neighbourhood square, and the semi-private residential square (the aforementioned *chowk*). Each of these squares varies with size and importance in a Newari township, according to their hierarchy of socio-cultural activities.[10] In a typical western city, architectural monuments are anchors which guide people, drawing people towards them, however, in Nepal, many monuments, normally located in the public squares are, from a pedestrian viewpoint along a street, generally concealed. This is clearly evident while walking towards Bhaktapur's Tamaudhi Square, where one does not fully see the square and its monuments until physically entering the square. Here, the streets physically, rather than visually, lead towards monuments, as the visitor sees the important features of a particular public square only upon entering the space.[11]

Figure 4: Bhaktapur: element of surprise.

This contributes to what is referred to as ‘an element of surprise’[12] or a sense of discovery, which is central to the experience of the historic city. Major monuments and reference points are hidden from view due to narrow curving or sharply turning streets, creating ‘blocked vistas’. Large open squares are entered from the corner, so that any central element, such as a tall temple or other monument is not seen until actually entering the square.[13] In the sequence of ‘positive and negative volumes’ articulated by the streets and buildings, spaces suddenly burst open, and major elements of the square, such as the Nyatapola Temple in Taumadhi Square, is suddenly revealed to the pedestrian visitor, which can be a particularly overwhelming and dramatic spatial experience.[14]

Figure 5: Tamaudhi Square.

Research Stage

Following the introductory session to the studio, whereby students were introduced to the idea of a cultural centre with museum, the class was divided into five-person groups for research of 1) literature review: cultural centres and museums, 2) Newari culture: traditions, festivals, crafts, architecture, and urban forms, 3) cultural centre case study, 4) museum case studies, 5) space requirements (areas) for the five blocks, and 6) site analysis. For the case studies, each group was to present and compare and contrast their findings. This exercise was not only to identify the main features of cultural centres and museums so as to establish the functional requirements, but more importantly to understand the conceptual themes employed in the case studies which could be of relevance to the students' own design thinking.

For the cultural centre case studies, students had to analyse the concept behind the form of their selected building, its functions, its articulation of semi-public open space (its mass-space relationship shown through a Nolli plan), and the means of connection between the blocks (physically and/or visually). Cultural centres which were studied included: Peter Eisenman's City of Culture of Galicia (Spain) and Carl Pruscha's Taragaon Museum (Nepal). A similar approach was taken to analyse the museum case studies, particularly, understanding the concept behind the form, the idea behind its circulation, as well as its articulation of natural light.

Figure 6: Eisenman's City of Culture of Galicia.

Figure 7: Pruscha's Taragaon Museum.

This predesign phase exercise should not be understood as isolated, as it draws upon knowledge, experience, and various other skills acquired in courses prior to this particular studio.[15] As a fourth year project (Architectural Design V), it draws upon the lessons from the previous studios, from where this mode of case study research has been developed, but adding further cultural and conceptual dimensions to the scope of analyses. This studio also sought to integrate and apply historical and theoretical knowledge gained from the history courses, lighting design principles from the building science courses, as well as skills from other practical courses (figure 8).

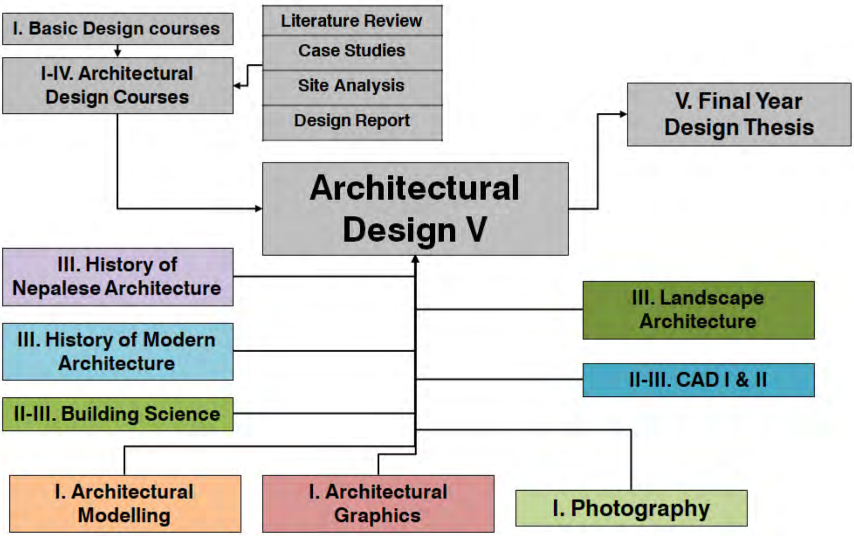

Figure 8: Integrated teaching approach.

Conceptual Lighting Studies

In anticipation of the developed design of the museum component of the cultural centre, the students were given a simple yet stimulating task of making conceptual study models to explore light, shadow, and material. Each model had a bounding volume of 10cm x 10cm x 10cm, and the scale was open to interpretation. As the external box volume was fixed, the task emphasised more on interior space rather than exterior, and students had to design the shape of this *interior* space in relationship to the *human body*. Students were to produce three models and one interior photograph of each.

They had to explore what kind of interior space is interesting and appropriate for an exhibition or circulation space within a museum. Students had to consider openings in terms of how natural light enters (directly, or more importantly, diffusely or indirectly), shadow effects, and how light and/or shadow interacts with material (as models had to use brick, stone, or wood). This ‘hands-on’ mode of *working conceptually was* not only new to the students in this context, but allowed them to explore their own creative potentials in relation to the later design stages. Considering the importance of the museum’s interior, this exercise permitted more holistic thinking about gallery spaces beyond mere floor plans done using CAD software, which was the trend.

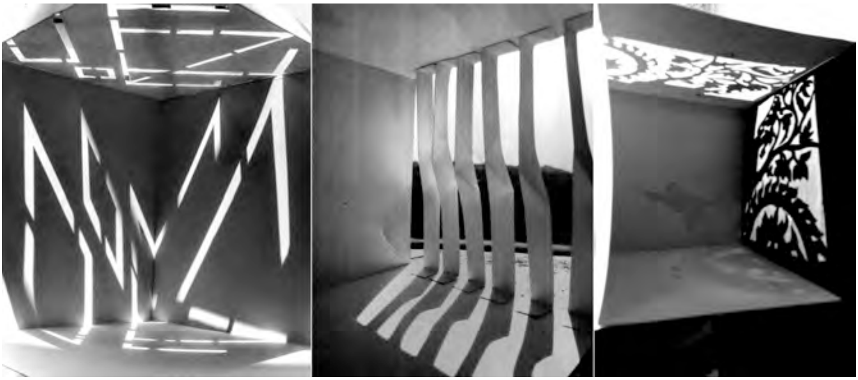

Figure 9: Lighting studies by Dakshata Shahi, Subina Tuladhar, and Manjil Bista.

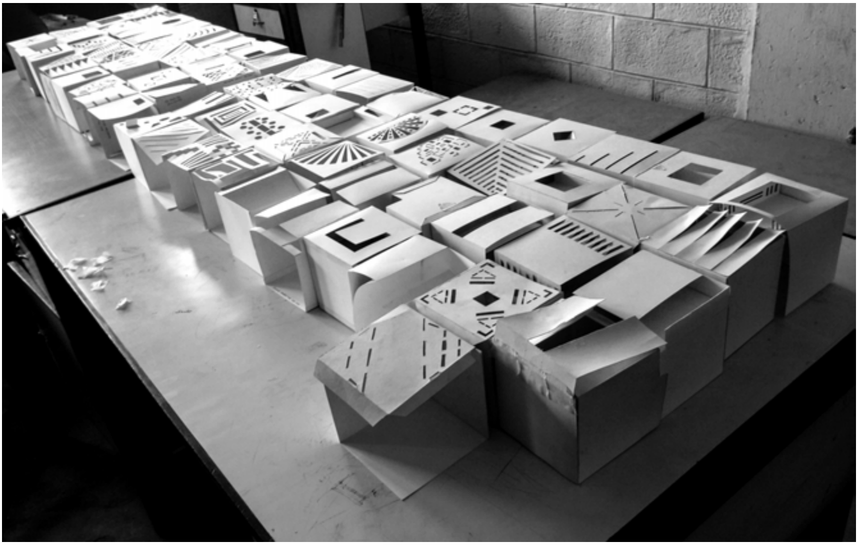

Figure 10: Lighting study models.

Figure 11: Students making and presenting their explorations.

Masterplan and Design Development

Following from the previous stages, the task was then to develop a masterplan, applying the knowledge gained from the research, case studies, and cultural precedents. Projects had to consider the following: 1) site response, in terms of contours, orientation, views, entrance/exit, landscaping, set-backs, maximum building area, and other relevant by-laws; 2) the arrangement of the five blocks and their integration/separation; 3) *shape and quality of the open space/s* between building blocks. Students were to learn from tradition and case studies in terms of the masterplanning, employing open space concepts like c*howks* (communal courtyards) and considering streets and public square relationship (like the element of surprise).

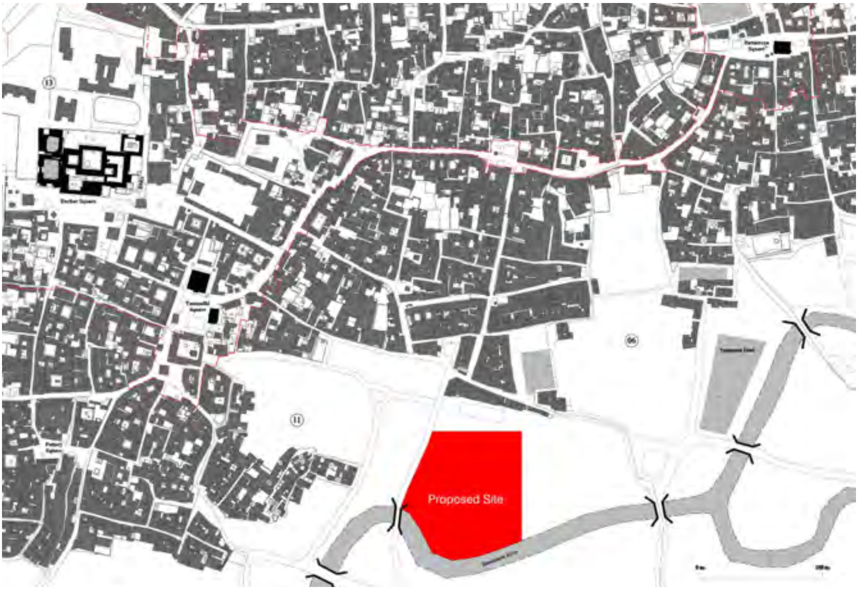

Figure 12: Nolli map of Bhaktapur highlighting site.

To facilitate in the interrelated conceptualisation and representation of their masterplan proposals, students had to prepare a three-dimensional concept massing model on a printed scaled site plan. The students' three-dimensional thinking was best achieved by means of actually experimenting with the blocks' shape and size, and more importantly their placement on site, both physically and then digitally using SketchUp. The most valuable pedagogical moment was when students were able to see the open spaces made between the blocks and were designing according to the human scale and experiences at eye level, that is, how to achieve an element of surprise at pedestrian level through specific compositions of blocks, and how blocks could be aligned or misaligned to conceal views.

Both the conceptual lighting studies and the masterplan massing models are what can be considered as 'heuristic empirically-based learning approaches', where the order of conventional operations (standard practice or phases of design, whereby plans are drawn first, followed by three-dimensional, sectional, and elevational explorations) are reversed in order to make tacit and physical the ideas about the qualities of space.[16] The SketchUp model was for 3D and 2D conceptual exploration and representation, which was supplemented by image-editing graphical courses to help with communicating ideas. Students were to produce solid-void diagrams in both plan and section, supplemented by conceptual perspectives taken directly from the digital model, without rendering, to show the sequence of open spaces, reinforcing the notion of designing according to eye level experiences.

The hands-on learning approach through model making as an 'interactive learning mechanism' fosters spatial thinking and knowledge production skills. The exercise gives impetus to early design development in physical and digital 3D to help students visualise volumetric explorations and options, whilst establishing potential relationships that otherwise would have been concealed in more conventional processes focusing solely on top-down planning drawings.[17]

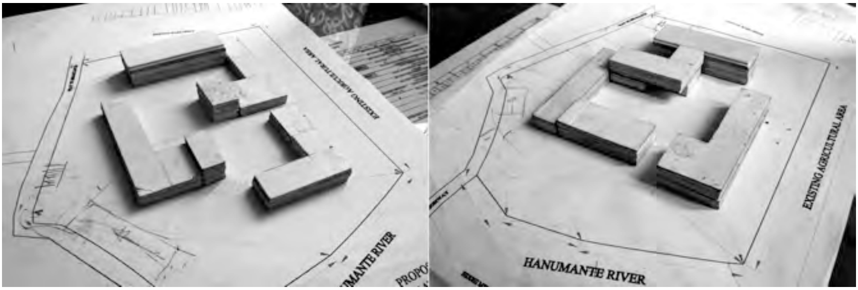

Figure 13: Massing models to study open spaces.

Figure 14: Students engaged in massing studies.

Once the masterplan was proposed, design development followed to make the scheme workable and presentable. A final set of presentation drawings and images followed which included the site plan, floor plans, sections and elevations, but more importantly, the perspectives, both exterior (showing masterplan open space concepts) and interior (showing how the lighting concepts explored previously were modified and contextualised into the museum). What follows are project descriptions detailing the ideas and their application of three exemplar projects from this studio.

Eliza Shrestha's project typifies the schemes of this studio with an idea of a courtyard surrounded by blocks, however, in this scheme certain blocks are interconnected forming a *galli* (open but covered passageway), learning from traditional Newari architecture, effectively separating the public space of the street and the semi-public space of the courtyard. A visitor walks through the *galli* to encounter a sudden expansion of space, providing an element of surprise as he/she enters the courtyard (figures 15-18).

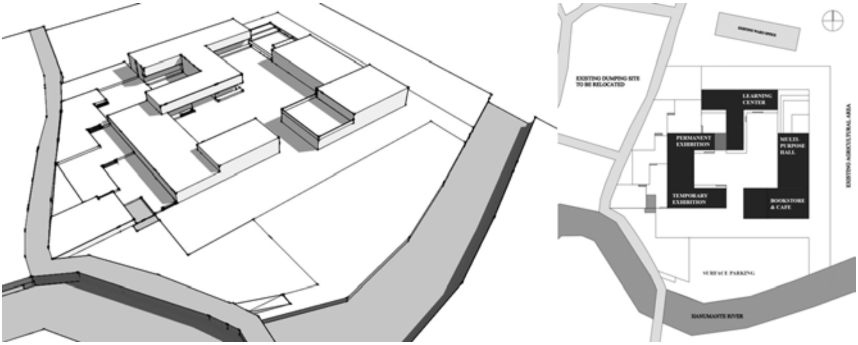

Figure 15: Aerial view and Nolli plan of Eliza's scheme.

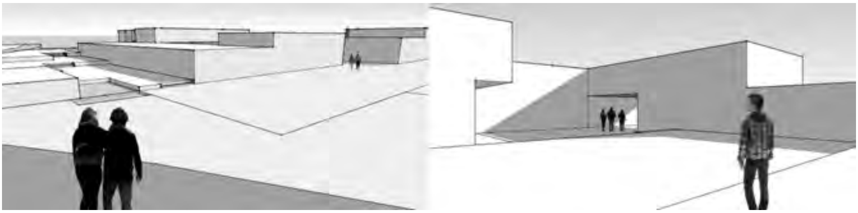

Figure 16: Conceptual exterior views and *galli* entrance.

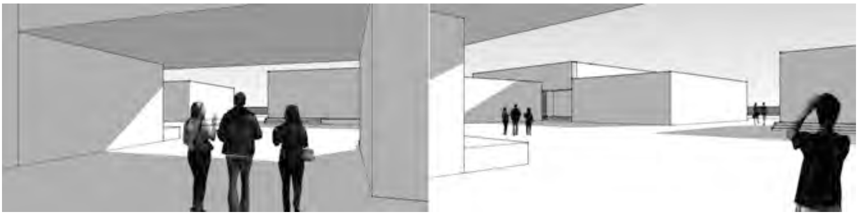

Figure 17: Walking through *galli* and the sudden widening of space.

Figure 18: Aerial perspective.

Subina Tuladhar explores the element of surprise with corner entrances and sudden turns into bursts of open spaces. The café opens out to the *dabali* (traditional raised platform) in the central square. This square connects all four blocks of the scheme. The lighting concept of twisted louvers is here developed into a timber façade, as seen in the permanent museum, which has a dynamic surface due to the shifting location of the twist in each louver. This scheme is an interesting reinterpretation of traditional Newari architecture, as the arrangement of the buildings and spaces are designed according to traditional urban forms, but the architectural expression is modern, yet using traditional building materials such as brick, stone, and wood (figures 19-22).

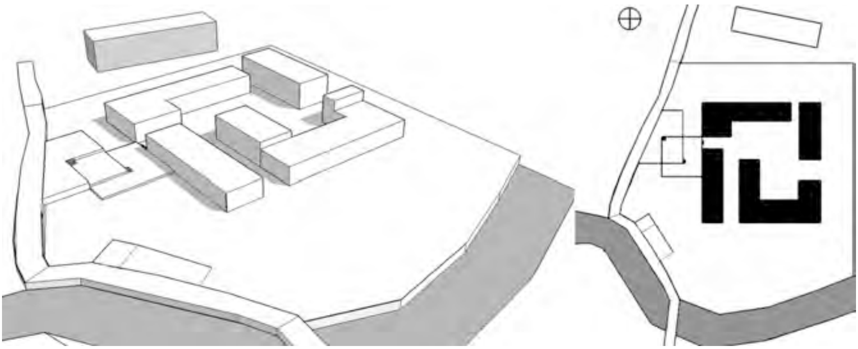

Figure 19: Aerial view and Nolli plan of Subina’s scheme.

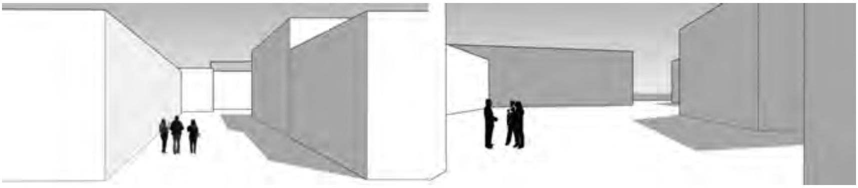

Figure 20: Walking through internal street – expansion and contraction of spaces.

Figure 21: Aerial perspective.

Figure 22: Renders, louvered façade developed from lighting studies, as per figure 9.

Manjil Bista's scheme sought to reinterpret the notion of nested *chowks* (courtyards) found in the palaces of the Durbar squares. Learning from traditional urban forms, there is an element of surprise from both the western and northern sides. People walk between the blocks only to discover a sudden burst of space as they approach a large courtyard. There is a circular amphitheatre in this main courtyard, referring to the Taragaon Museum case study which also has an amphitheatre. The project employs traditional building materials, fusing traditional and modern expressions. The lighting concept of using a wooden carving pattern from traditional Newari pillars to form a skylight pattern is extended into the final scheme by topping all the internal *chowks* with a different pattern to frame the glass and more importantly to cast a shadow into the spaces. Wooden carvings are given new meaning, solid patterns are turned into a dynamic interplay of light and shadow; traditional forms of presence are reinterpreted as absence (figures 23-27).

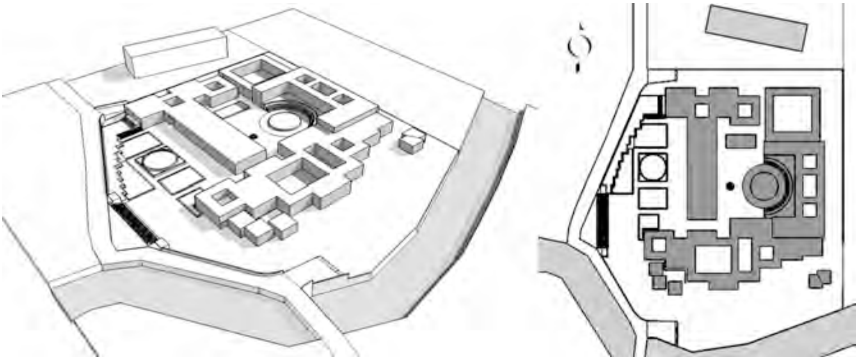

Figure 23: Aerial view and Nolli plan of Manjil's scheme.

Figure 24: Floorplan: positive and negative volumes of blocks and courtyards.

Figure 25: Aerial perspective.

Figure 26: *Galli* entrance and the sudden widening of space into courtyard.

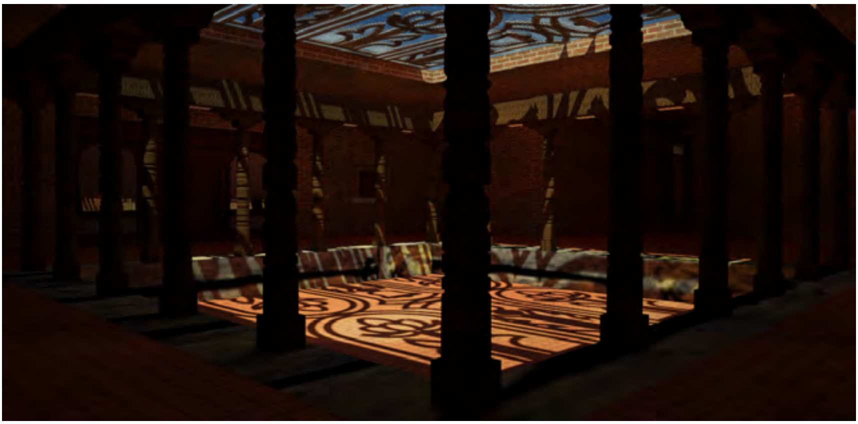

Figure 27: Interior courtyard with shadow pattern, developed as per figure 9.

Conclusion

In summary, this project, in its different stages and pedagogical steps, aided the students to fulfil the four key learning objectives, namely: 1) masterplanning considering the shape and quality of semi-public exterior space; 2) museum design considering the shape and quality of interior space for exhibition galleries; 3) appreciation and interpretation of cultural ideas into a design project; and 4) integration of all aspects of a design process. In an age of education for millennials or even neomillennials, there may not necessarily be a need for more physical 'hands-on' experiential learning, but rather such hands-on exercises could be supplemented with digital explorations, particularly in architecture and urban design studios, to help students better visualise the subject of their creations, namely, space.

This studio not only contributes to the research on traditional architecture and urbanism in relation to designing in a modern context in Nepal, but also broaches innovative ways of introducing knowledge producing strategies in architectural design teaching and research. In using an explorative 'systemic' experiential approach to learning about and designing spaces based on cultural themes and urban phenomena, this studio has particular relevance to design pedagogy not only in Nepal, but in a variety of educational studio contexts around the world.

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Note: All images credited to the author and respective students, used by permission of the author.

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The City as our School

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Abstract

This paper describes three approaches to an ‘urban pedagogy’; a post-graduate *lab*, an under-graduate *event studio*, and a primary school *performance walk*. To think through what is going on in such an urban pedagogy, where the city is our school, the idea of ‘technical democracy’, a move towards democratising expertise by fostering collaboration among experts and lay-people, is borrowed from science and technology studies. In the urban realm technical democracy is sought through ‘hybrid research forums’ that coalesce under dimensions of ‘shared uncertainty’ and ‘material politics’, to engage in ‘collective experimentation’ with an impetus towards the ‘fragile democratisation’ of knowledge and expertise. These dimensions are explored as the conceptual field in which this urban pedagogy takes place. Considering design research teaching and learning as *social labour* set within these dimensions, re-frames the subjectivity of teachers, students and communities as collaborators in the work, and, it is argued, prepares students for contemporary forms of expanded architectural practice.

Introduction

This paper introduces *urban pedagogy* as a form of design research that mixes the studio and the city in different ways. This is an approach to design teaching underpinned by the idea that the field of architecture is shifting, no longer “done by an ‘architect’”, architectural work is increasingly “distributed and dispersed, collaborative and entrepreneurial, knowledge-based and open-sourced, specialized and flexible”.[1] As a result, as Peggy Deamer notes in *The Architect as Worker*, designs are developed by “a socially diverse panoply of contributors”[2] engaged in a collective learning process. Both learning (following Friere[3]) and increasingly then design, can be understood as social practices, *design research* (an assemblage of knowledge and understanding through design making, and the subject of this conference), is therefore usefully construed as a form of dialectical *social labour*.

In what follows, I will first briefly describe three approaches to this urban pedagogy; carried out through a post-graduate *lab*, an under-graduate *event studio*, and a primary school *performance walk*. Then I will introduce ideas of ‘technical democracy’ originating from Science and Technology Studies (STS), which provide a useful language in thinking through what is going on when we construe the city as our school. STS ideas of ‘hybrid research forums’ that coalesce under dimensions of ‘shared uncertainty’ and ‘material politics’, to engage in ‘collective experimentation’ with an impetus towards the ‘fragile democratisation’ of knowledge and expertise, are explored as the conditions in which this urban pedagogy takes place. Considering design research teaching and learning as a kind of *social labour* set within these dimensions, re-contours the positions of teachers, students and communities as collaborators in design research projects and prepares students for the contemporary forms of expanded architectural practice that Deamer and other describe.

Three pedagogical approaches to the City as our School

Approach 1. 'Muddy Urbanism' Post-graduate Research Lab.[4]

The *Muddy Urbanism Lab* proposed that urban estuarine spaces in Tāmaki Makaurau Auckland are poorly utilized. The research focused on the Whau River, a tidal waterway bisecting the city's inner west. Once an important food source and transport route, it's now a site of neglect, conflict and ecological degradation. Through critically mapping the river's neighbourhoods such issues were bought to light and new interfaces between urban policy, ecological systems and community participation for the regeneration of the catchment were proposed. Working backwards from each proposal, students identified a series of research questions, and used these to distinguish the complex assemblages of property and cultural rights, legislation, infrastructure and spatial planning, environmental policy and the array of sanctioned and unsanctioned activities in which their speculative design proposals were situated.

Initiated for 'The LAB' at the 5th Auckland Triennial in collaboration with architect activist Teddy Cruz, the *Muddy Urbanism Lab* has involved the work of post-graduate students, university staff, independent researchers, municipal agencies and community stakeholders. (Fig. 1) This speculative research has transitioned from the space of the academy as the studio adopted an advocacy position, distributing the research through exhibitions, publications, presentations and websites. (Fig. 2) Advocacy from this design research lab has led to the establishment of a partnership between a community trust and Auckland Council, for the realisation of Te Whau Pathway, a thirteen kilometre shared path currently under construction. This pathway will re-establish an important pre-colonial route between two harbours, link river-side neighbourhoods, promote moves towards ecological restoration and generate a safe and accessible pedestrian and biking network.

Figure 1: Discussing the Muddy Urbanism design research at The Lab, as part of the 2013 Auckland Triennial, Auckland Art Gallery.[5]

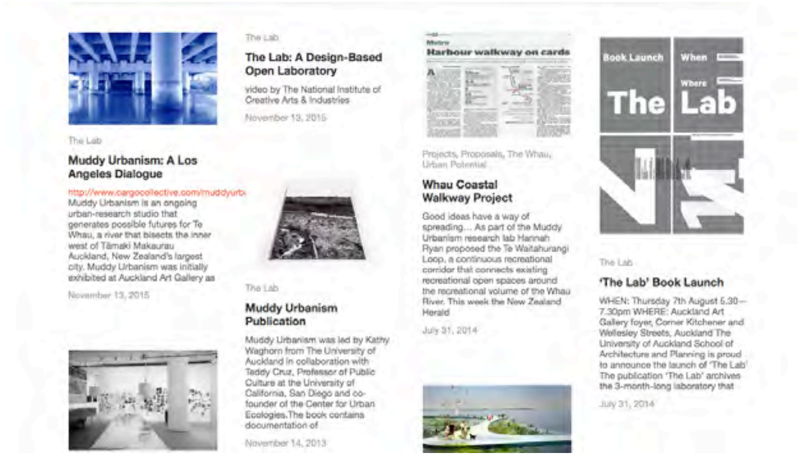

Figure 2: The Muddy Urbanism website, muddyurbanismlab.wordpress.com[6]

Figure 3: An event studio as part of the Festival of Transitional Architecture (FESTA), Christchurch. This design research project was led by architect Craig Moller working with a group of second year students.[7]

Approach 2. Under-graduate Event Studios.[8]

Event Studios are live projects where second year architecture students, working in groups, produce large-scale installations for civic public events. (Fig. 3) These studios focus on architecture as both material culture and collaborative enterprise, where the work is made and tested in a live situation with publics. Here design research is not concealed as a private project, bounded within screen or notebook, but is instead given a collective, physical presence. In event studios students source all their own materials and fabrication services, they locate and negotiate access to spaces for fabrication and assembly and they handle transport logistics. In so doing they take on roles and develop expertise beyond those normally attached to the architecture design studio – the promoter, the materials technician, the facilitator, the logistics expert, the project manager – and to extend this into the social realm – the host, the caterer, the confidant, the colleague. In event studios, students work collaboratively in trying circumstances, within the shifting constraints of large public festivals, meeting non-existent budgets and tight non-negotiable deadlines. Although temporary, the work made in these studios collectively makes places – and students, who have often never so much as lifted a hammer, realise something actual in the world, registering its civic presence and reception.

Figure 4: Using photographs to piece together choreographic components for the Come Join the Circus performance walk.[9]

Approach 3. "Come Join the Circus" Performance Walk.[10]

In this approach to urban pedagogy the students are much younger. *Come Join the Circus* was a choreographic workshop devised and performed by ten year 6 students in their suburban town centre. The work took the form of a 'performance walk', a form of site-specific choreography in which pieces of performance occur in public space, with the audience joining the performers in walking between sites, and where the line between performer, audience and passer-by is intentionally blurred. *Come Join the Circus* provided an opportunity to engage students in an intersection of urban ecology and local history through site-specific-devised performance. Students were encouraged to approach the public realm as a place in which improvised performance is allowed as such we likened the activities to other emergent forms of urban performance such as flash mobs. The students responded to the spatial qualities of the town centre with their own physicality—posing on jutting concrete curbs, vaulting benches, hanging off glass walls by their fingertips, placing wet hand-prints to mark sun-warmed brick columns—generating a kinaesthetic dialogue with the material and spatial attributes of this urban field. At times the group worked as ‘place detectives’, piecing together a social history, responding to clues such as architectural remnants, street names, plaques and memorials. (Fig. 4)

The figure of a travelling circus, which had in the past periodically occupied the town centre, was adopted as an appropriately performative structure to traverse the walk between the sequence of sites. This overlay of the circus brought the ‘magic of performance’ to the fore as a strategy through which to see place as mutable, not a fixed realm in which we are positioned as consumers, but as a civic realm open to occupation and transformation in imaginative ways.

An Urban Pedagogy

What we are developing here is an *urban pedagogy* where design research is carried out through being in and with the city. Each of these three approaches hinges on the sociality of knowledge. For education philosopher Paulo Freire “knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world and with each other.”[11] Learning is understood as a social practice, through which the iterative actions of inquiry and dialogue cultivate knowledge. Similarly, David Turnbull considers the production of knowledge as an assemblage process, coalesced through social labour. For Turnbull, who studies knowledge making through the lens of cultural anthropology, the process of formulating knowledge is a dialectical one, produced through “the work of negotiation and judgement” that each participant has to contribute to produce order and meaning.[12]

The *urban research lab* situates the university’s design studio in the civic art gallery. In concert with exploring topics in such a highly visible space, adopting the label ‘lab’ frames the city as an experimental terrain, open for investigation and inquiry. In the gallery[13] this experimental work is not concealed from publics or stakeholders, students and teachers are together answerable to, or are in conversation with, a much wider group. In this the students are, we could say, ‘socialised’ into the role of the architect as public intellectual, a knowledge making ‘design researcher’.

The *event studios* generate an experience of city-making as a material effort, and of design as a social collaborative enterprise, both within the student groups and with a wider body of constituents convened in the making and testing of work in the public realm. Students register this in their commentary, when asked what they have liked best in this studio they have recorded their

> “realisation that an idea or proposal doesn't have to be 'complete' or 'perfect' before you expose it to a community/place - that makeshift or incomplete tests can facilitate more productive engagement due to their openness to change and discussion”.[14]

And that the event studio developed,

> “my understanding of 'the architect' [that] was the value of making yourself vulnerable as a designer - to clients, communities, collaborators.”[15]

Evidently, through event studios the students register space in the sense of Lefebvre, as inherently social, constituted through encounter, assembly and simultaneity.[16]

In the *performance walk* the city is the site of both research and performance. The everyday spaces of the town centre take on new meanings as the kids re-construe the streets, squares and reserves and other places we inhabited as spaces in which such performance is allowed, and therefore a realm in which they might perform their civic agency. In order to break through disciplinary habits and biases, the feminist economists J.K. Gibson-Graham propose following an "experimental orientation" geared towards "thinking connection, convening wider publics and enrolling lively matter."[17] In *Come Join the Circus,* making the performance-walk opened an opportunity in which connections between things — benches, road embankments, low rock walls, war memorials, anti-graffiti glass, networks of drainage and transport, lost gardens, bike racks, archaeological sites, water courses and migration routes, rusty industrial machinery and photographs of forgotten circuses — were invoked as such 'lively matter', congregating a 'wider publics'' connection with and in this particular urban realm.

A Pedagogy of Uncertainty

To think through this urban pedagogy I've found it productive to position this alongside the aims and actions of 'technical democracy'. A concept advanced through the sociological approach of Science and Technology Studies (STS), the movement towards technical democracy arises from the contemporary situation in which science and technology cannot provide certainty to policy makers; where in effect, science and technology now contribute to the generation of *greater uncertainty*.[18] Technical democracy pursues increased democratization in the policy development process, involving attempts to democratize expertise by fostering "dialogue and collaboration among experts and lay-people in processes of technology design, knowledge production and attendant world-making."[19]

Bringing ideas of technical democracy to the realm of urban studies, Farías and Blok identify the creative collaboration of experts and lay people, who in groups and communities collectively experiment with, and prototype fragments of urban life. Such 'hybrid research forums'[20] support collective experimentation and learning in the face of complexity and uncertainty as they "facilitate a process in which what counts as expertise, and who counts as an expert, becomes open to discussion and contestation."[21] In urban-realm hybrid forums, the knowledge of a local is as valid and as useful as that of an technical expert, and expertise emerges as a collective achievement.[22]

Compelled by this means of engaging the city, I see the urban pedagogy we are developing as a kind of 'training' for the practice of such an approach, in which 'hybrid forums' are coalesced around design research projects wherein an experimental attitude is fostered. In the approaches to the City as our School I've described here, the 'teacher' sets up a subject of design research and a method of enquiry - lab, public event or performance walk. However the teacher is not cast as the 'expert' on the subject, instead the roles of teacher and student are hybridised, as together with an amalgam of others, we embark on the project through social labour, together co-inquiring, making knowledge and invoking meaning.

For Farías and Blok, power in the contemporary city resides not in institutions or government, but in the ability to forge such new ways of working in the city. Such work is framed by the conceptual dimensions of ‘shared uncertainty’ and ‘material politics’, working in the modes of ‘collective experimentation’ towards the ‘fragile democratization’ of expertise and attendant civic agency. I’m interested in these dimensions and modes as they describe the methodological terrain in which the City as our School operates.

Shared Uncertainty

Farías and Blok note that occupying a contemporary state of shared uncertainty (especially with regard to developments in techno-science) is at the core of the politics of technical democracy and the *raison d’être* of hybrid research forums.[23] Experiences of shared uncertainty in the urban realm often coalesce around matters of concern[24] where hybrid forums undertake the hard work of un- and re-framing techno political issues in the city “according to their emerging sense of how experts fail to deal in satisfactory ways with the shared uncertainties of the urban.”[25] Generation Zero is an example of a hybrid forum where youth, not normatively considered ‘experts’, have convened around climate change issues and the need to transition society away from a dependence on fossil fuels. This forum, that carefully does not align itself with any political party and invites solutions not from experts but from “real New Zealanders”, has gained considerable traction and political agency in re-framing and communicating transport issues in Aotearoa New Zealand.[26]

In our urban pedagogy, an example of the fertile capacity of shared uncertainty is when the *Muddy Urbanism Lab* worked with the ecological restoration NGO *Friends of the Whau*. Together we convened a forum coalesced around our shared uncertainty in relation to ‘top down’ government’s capacity to imaginatively embark on caring for the river’s future in the face of complex and intertwined urban impacts on the catchment. While we didn’t always agree on the best way forward, in the *Muddy Urbanism Lab* the sophisticated expertise of the students in imagining and imaging speculative propositions was valued for openly communicating future oriented dialogues about the river.

Material Politics

Rather than operating in a purely philosophical, theoretical or policy domain, the dimension of material politics registers the materiality of objects of concern in the urban realm. Contemporaneous with the considerations of ‘vital materialism’ and ‘thing power’,[27] this aspect attempts to “bring things back into the picture of urban politics.”[28] Farías and Blok note here the need to “recognize the recalcitrance, contingency and indeterminacy of urban materialities, and the way this shapes and conditions urban-political conflict.”[29]

The performance walk *Come Join the Circus* clearly bought urban materialities to the fore as the performance making was shaped to a large part by the contemporary and historic ‘material things’ of the town centre. *Come Join the Circus* was part of a much larger project titled *Make Believe; Imagining a new park for New Lynn*, a project with Auckland Council where a material and performative approach was employed to ‘consult’ in the development of a new civic park. A series of installations and episodic live events were carried out in the town centre, with each event coalescing a different group of constituents and allowing for a fleeting and propositional manifestation of this future park to emerge. In so doing *Make Believe* convened hybrid forums as the means to perform exchanges of knowledge in regard to public urban space, using 'things' to imagine how it might be materialised, shaped and used, and to discover what importance and meaning it might hold for specific communities. As part of this larger project, by attending closely to urban materialities through their social labour, the children who made *Come Join the Circus* were cast as 'experts', thereby radically questioning the expert-based terms on which urban places and spaces are normatively produced.

Collective experimentation

Callon, Lascoumes, and Barthe's depiction of technical democracy refers to processes of research 'in the wild', amidst real-world uncertainties and through collaboration between affected parties.[30] Through the shifting constituencies of urban 'hybrid forums', technical democracy is an inherently experimental process, where urban collectives are convened and recomposed in partial and open-ended ways. Anyone who has belonged to a community advocacy group will know that aims and goals shift as knowledge is generated and group expertise is formed. There is often reluctance to arrive at final decisions as the emergent expertise necessitates an ongoing process of "new knowledge, voices, events and visions."[31] Farías and Blok observe the performativity of such urban knowledge whereby "knowledge production is never a purely descriptive or analytical practice, but has performative effects, that is, the capacity to (trans-)form the objects and subjects it refers to."[32]

Such performative effects are at work in our urban pedagogy, as was indicated by the student quoted earlier, who acknowledged her own transformative subjectivity in 'making oneself vulnerable as a designer'. This performative effect is articulated by Elizabeth Grierson who, in considering creative practices as conditions of knowing *and* being says, "implicit in the process or events of knowing are inevitable reflections on processes of self-making through creative actions and activities as one is mediated by, and opens up to one's research process to the point that one 'becomes' a subject."[33] For Grierson, in the creative arts (and here I include designing and architect-ing) we work with materials, technologies and bodies to reveal something about the world *and ourselves* in the process.[34] This is what I see happening through our urban pedagogy – through acting as an advocate in the *Muddy Urbanism Lab*, inhabiting one's installation with the public in an *event studio*, or making a *performance walk* for one's school peers, teachers, parents and council staff to join, such processes of self-making occur. The contours of the positions teacher, student, expert and colleague, and the situated places in power structures these imply, are unsettled in carrying out such urban pedagogies.

Importantly then, this urban pedagogy is preparing students not for the realm of the architect as the transcendent expert, dropped into a situation with their complete and intact 'property'[35] of disciplinary knowledge, but rather for the more messy and open ended 'design researcher' roles many in the field of architecture are now occupying and describing. In concert with Deamer's distributed and dispersed, collaborative and entrepreneurial, knowledge-based and open-sourced, specialized and flexible architectural worker, Awan, Schneider and Till advocate for an 'expanded architectural intelligence' with the intent to "posit a much richer set of activities that give new scope, and hope, for architectural activity".[36] It is this richer set of activities that our urban pedagogy fosters. Such expanded bodies of knowledge might be cultivated and convened through opening pedagogy (and practice) to the hybrid forums Farías and Blok describe and through understanding design research pedagogy as a transformative process, even a 'wild' process, not easily captured in pre-determined learning outcomes and course metrics.

Conclusion

An urban pedagogy, such as I have described here, is a counter hegemonic pedagogy in the corporate university that seeks a one-size-fits-all approach, in which learning is broken into discreet moments of individual assessment, tested against pre-determined criteria, quantified and managed via universalist learning management software. This model of 'corporate pedagogy' neglects current understandings of the bond between learning, emotion and affect. Those who champion the development of a more locally inflected 'situational intelligence' (as is reportedly emerging through this urban pedagogy) tell us that "students and teachers think more effectively in the context of a community - as opposed to a collection of separate individuals",[37] and that "what motivates students to persist with difficulties are the positive emotions arising from 'affiliation' or belonging."[38] Freire proposes that the work of learning is one of *praxis*, where critical thinking "does not separate itself from action, but constantly immerses itself in temporality without fear of the risks involved."[39] Despite the risks and difficulties that crop up in disrupting the normative contours and temporalities of the corporate education model, the approaches to urban pedagogy we are developing coalesce such communities of praxis; students and teachers become affiliated with each other in pursuit of the project at hand and in company with the many other associated groups, publics and individuals engaging with our work.

If we subscribe to a view of the contemporary urban realm as one of complexity and emergent technical democracy (as sketched by Farías and Blok) then as architectural educators we are obligated to develop design research pedagogies that attend to the dimensions of shared uncertainty, material politics and collective experimentation. We must also recognise and tap into the performativity of urban knowledge and the fluid subjectivity and forms of collective expertise found in 'hybrid research forums'. Developing this urban pedagogy, with the city as our school, is a move towards this.

References

[1] Peggy Deamer, The architect as worker: immaterial labor, the creative class, and the politics of design. London and New Delhi: Bloomsbury, 2015, 72.

[2] Deamer, "The architect as worker", 72.

[3] Paulo Freire, *Pedagogy of the Oppressed*. New York: Continuum, 2000.

[4] *Muddy* Urbanism was instigated as part of *'If you were to live here* . . .' the 5th Auckland Triennial (Auckland Art Gallery 10 May – 11 August 2013) with architect/activist Teddy Cruz (Professor of Public Culture and Urbanization in the Department of Visual Arts at the University of California, San Diego), and from the University of Auckland Kathy Waghorn, graduate teaching assistant Esther Mecredy, independent researcher Nina Patel and post-graduate students Herman Haringa, Raimana Jones, Chia Venn Khoo, Sophia Whoi Seung Kim, Antonia Lapwood, Zee Shake Lee, Steven Lin, Vinni Paget, Hannah Ryan and Angela Yoo. It included discussions with guests Robyn Mason (historian), Marcus Williams (curator of the Rosebank Project), staff from Auckland Council and from the following NGOs: the Whau River Catchment Trust, Friends of the Whau, Sustaining Our Streams, Ecomatters and the Keep Waitakere Beautiful Trust.

[5] Figure 1, *Muddy Urbanism* Lab, 2013. Photo by author.

[6] Figure 2, The *Muddy Urbanism* website. Screen shot.

[7] Figure 3, Student project for FESTA. Photo by author.

[8] Event studios have been led by Uwe Rieger (2011, 2013, 2014) and Kathy Waghorn (2009, 2010, 2012). University of Auckland staff have included: Mike Davis, Chris Holmes, Anna Tong, Rob Aerts, Jennie Aerts, Nina Patel, Judy Cockeram, Cameron Rowe, Kate Rogan, John Hayden, Sou Muy Ly, Jessica Knight, Harriet Richards, Andrew Johntson, Jessica Barter, Michael O'Sullivan, Sue Hillery, Graham Burgess and Craig Moller. The studios have contributed to public events such as FESTA (Christchurch), Auckland Architecture Week and the 2014 Rugby World Cup (Auckland).

[9] Figure 4, Using photography in *Come Join the Circus.* Photo by author.

[10] *Come Join the Circus* (24–28 March 2014), part of *Make Believe: Imagining a new park for New Lynn*, was a week-long workshop with ten year-six students from New Lynn Primary School. It was initiated and facilitated by Kathy Waghorn in collaboration with choreographer/artist Christina Houghton. The project was commissioned by Auckland Council.

[11] Paulo Freire, "Pedagogy of the Oppressed", 72.

[12] David Turnbull, Masons, Tricksters and Cartographers: Comparative Studies in the Sociology of Scientific and Indigenous Knowledge. Amsterdam, Abingdon Harwood Academic, Marston, 2000, 13.

[13] Noting some qualifications as to who accesses such high culture spaces.

[14] Anonymous student reflection gathered as part of course evaluations.

[15] Anonymous student reflection gathered as part of course evaluations.

[16] Henri Lefebvre, *The* Production *of Space*. Translated by Donald Nicholson-Smith. Oxford: Blackwell, 1974, 101.

[17] J. K. Gibson-Graham, "A Feminist Project of Belonging for the Anthropocene." *Gender, Place and Culture: A Journal of Feminist Geography* 18, no. 1 (2011): 8.

[18] Michel Callon, Pierre Lascoumes and Yannick Barthe, *Acting in An Uncertain World: An Essay on Technical Democracy*. Cambridge, MA: MIT Press, 2009, 18-19.

[19] Farías, Ignacio, and Anders Blok. "Technical Democracy as a Challenge to Urban Studies." *City* 20, no. 4 (2016): 546. In this article Farias and Blok bring to urban studies the work of Michel Callon, Pierre Lascoumes and Yannick Barthe, *Acting in An Uncertain World: An Essay on Technical Democracy*. Cambridge, MA: MIT Press, 2009.

[20] 'Hybrid forums', described in STS studies by Callon, Lascoumes and Barthe, (2009), facilitate dialogue and "cooperation between specialists and laypersons", providing "visibility and audibility to emergent groups that lack a spokesperson" (p. 36).

[21] Farías and Blok, "Technical Democracy", 542.

[22] Farías and Blok, "Technical Democracy", 542.

[23] Farías and Blok, "Technical Democracy", 544.

[24] Noting Latour's use of this term in Bruno Latour, "Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern." *Critical Enquiry* 30, no. 2 (2004): 225-48.

[25] Farías and Blok, "Technical Democracy", 544.

[26] See http://www.generationzero.org

[27] As discussed by Jane Bennett in *Vibrant Matter: A Political Ecology of Things*. Durham and London: Duke University Press, 2010.

[28] Farías and Blok, "Technical Democracy", 545.

[29] Farías and Blok, "Technical Democracy", 545.

[30] Callon, Lascoumes and Barthe, *Acting in An Uncertain World:* 2009.

[31] Farías and Blok, "Technical Democracy", 546.

[32] Farías and Blok, "Technical Democracy", 546.

[33] Elizabeth Grierson, "Ways of Knowing and Being; Navigating the Conditions of Knowledge and Becoming a Creative Subject." In *Creative Arts Research: Narratives of Methodologies and*

Practices, edited by Elizabeth Grierson and Laura Brearley, 17-32. Rotterdam: Sense Publishers, 2009, 17.

[34] Grierson, "Ways of Knowing and Being", 18.

[35] Lefebevre describes architects, among others, as specialists with "carefully drawn property lines" who "view social space through the optic of their methodology and their reductionist schema". (1991, p.108)

[36] Awan, Nishat, Tatjana Schneider, and Jeremy Till. *Spatial Agency: Other Ways of Doing Architecture*. Abingdon, Oxon England; New York, NY: Routledge, 2011, 30.

[37] Maggie Berg and Barbara K. Seeber, *The Slow Professor: Challenging the Culture of Speed in the Academy*. Toronto; Buffalo; London: University of Toronto Press, 2016, 39.

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Design Studio as Research Catalysts: Unpacking a Research Trajectory

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Abstract

The design studio is a fertile testing ground for new research and, at all levels, have the capacity to initiate, catalyse and catapult students' potential research trajectories. How might design studios be a catalyst for the discovery of research interests that have the potential to launch long-standing research trajectories? Based on my experience, being exposed to a fragment of typological and procedural possibilities as a student in a past design studio was the seed that catapulted a research arc that has impacted my way of working as student; as academic and as practitioner. This paper will unpack a research trajectory drawing on from my personal accounts as a student at RMIT University; two case studies as an academic leading design studios at RMIT Architecture; the application of design research as a practitioner through a design-build project; and a reflective conclusion projecting future tools for the design studio.

Design Studio as Research Catalysts: Unpacking a Research Trajectory

How might design studios be a catalyst for the discovery of research interests that have the potential to launch long-standing research trajectories? This paper will unpack a research trajectory drawing on from my personal accounts as a student at RMIT University; two case studies as an academic leading design studios at RMIT Architecture; and the application of design research as a practitioner.

The Catalyst: Design Research as Student

Design studios, at all levels, have the capacity to initiate, catalyse and catapult students' potential research trajectories. As a past student of RMIT Architecture, I became captivated in a procedural design methodology whilst undertaking a design studio led by Professor Vivian Mitsogianni titled, 'Formfield: The Speculative Campus Project 2.0'.[1] It was a formative studio. It introduced me to new ways of thinking about architecture and design processes but particularly that it exposed me to the potentials of transformations of typological behaviours through the lens of a procedural approach. My student proposal re-imagined the circulatory, programmatic and spatial behaviours of the airport typology to explore speculative propositions for learning environments. It generated a proposition for a 'No Sleep Campus'; a campus that could be programmed for 24 hours with exaggerated circulatory networks for learning – akin to the multi-programmed and over-scaled circulatory spatial behaviour of airports.

The typological experiment was a fragment within the larger agenda of the studio but it sparked an interest. It was the seed. I progressively became interested in a process-based design approach. Broadly speaking, 'Process-based' design refers to a design approach that involves a series of choreographed operations dictated by a sequence of rules and procedures in order to generate architectural designs. The rules mimic and capture the behaviours of systems that exist external to the discipline of architecture. This methodology can come in many names such as rule-based process, a procedural method or a generative design process.

I became interested in this way of working as it had the ability to act as a catalyst for discovering new possibilities that could never be produced through traditional means. I continued these explorations in my subsequent design studio and my graduating Major Project.

You're My Type

My Major Project at RMIT Architecture titled, 'You're My Type', considered and explored how contaminations of 'other' typologies could assist in re-inventing programmatic organization and spatial arrangements.[2] The project investigated how particular strategies of making, influenced by type, can generate new propositions for learning environments and the library. As a testing ground, it generated a "what-if" scenario and proposed RMIT's first civic-academic library.

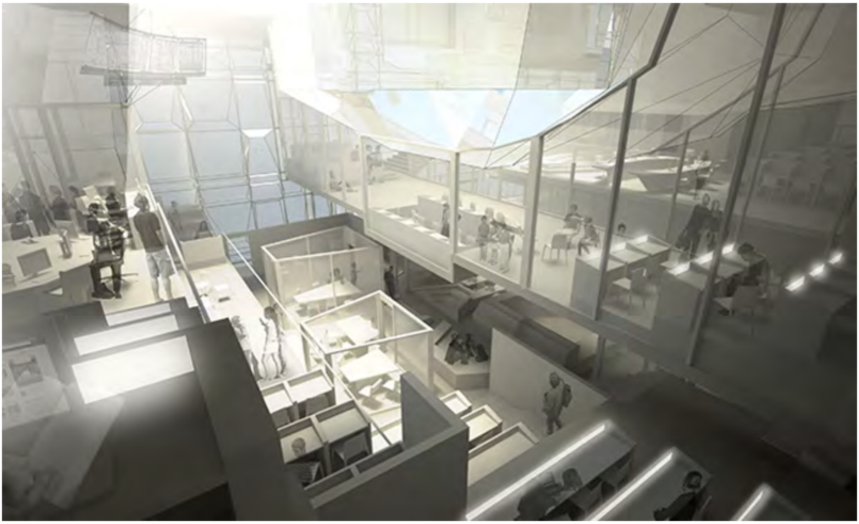

Figure 1: View of the collaborative and highly informal space for learning. 'You're My Type', 2011. Image: Patrick Macasaet.

The project attempted to emphasise the informal side of academic life, not as residual but as a central feature of universities. It embraced the collaborative and the informal as the heroic spaces for learning – viewing learning as a social experience and envisioning a speculative library as a highly charged collaborative and informal learning environment, intensifying its communal and social dimension.

This proposition tested ideas and carried out a series of investigations through both generative and manual processes concentrating on two building types: the stock exchange and the atrium office building. Experiments were choreographed and re-choreographed with minor or major variations in order to open up new possibilities for formal, organisational and spatial strategies for a highly collaborative learning environment.

As a student, I focused on the issues and potentials of working in this way through the investigation of learning environments and questioned; whether this approach and research could be expanded to other typological concerns. I also became interested in a design process that started by identifying multiple existing typologies and understanding their behaviours and qualities. What would emerge if these typological behaviours were amplified and exaggerated for a design project? Or, still, what would emerge from the superimposition, collision and multi-layering of multiple typological behaviours and qualities? The theories and works of Christopher CM Lee and Sam Jacoby highlight the position of viewing type as ‘abstract and conceptual rather than concrete and literal’ and what might occur when ‘type becomes a means of testing possibilities’ was a point of fascination.[3]

The Superwork Series and Experimental Work Futures

The SUPERWORK Series were a sequence of three Bachelor level design studios I led at RMIT Architecture from 2016 - 2017.[4] It continued the explorations on typological experiments through a procedural lens and this time, speculated on experimental models for contemporary work environments. The stimulus from the research interest stems from our own practice’s exploration on ‘Experimental Work Futures’ that speculated on alternative models for spatial and formal types in the arena of work. There was a special interest in new patterns and speculative models of work environments revolving around the “sharing economy” of work or shared workplaces; their internal culture and contribution to cities.

As Bachelor level design studios, I questioned; how might a Bachelor level design studio contribute to a larger research agenda? How do you curate a studio strategy to simultaneously; upskill lower year-level students and ensure they are learning the necessary tools to ‘produce’ architecture? How can students contribute to the research and planting seeds of interest that they might individually pursue beyond the studio?

Case Study 1: Superwork 3 CO: The Docklands Cotton Mills Project

Located at the Docklands Cotton Mills (DCM) complex in Footscray, the third iteration of the SUPERWORK design studios was an industry partnered studio with the DCM Body Corporate who were interested in understanding alternative creative solutions to aid future owners in the development of various warehouses in the area as DCM transitions into largely a hub for creatives, small businesses and startups.[5] The studio also ran in parallel to a real world project by our practice, Superscale.[6]

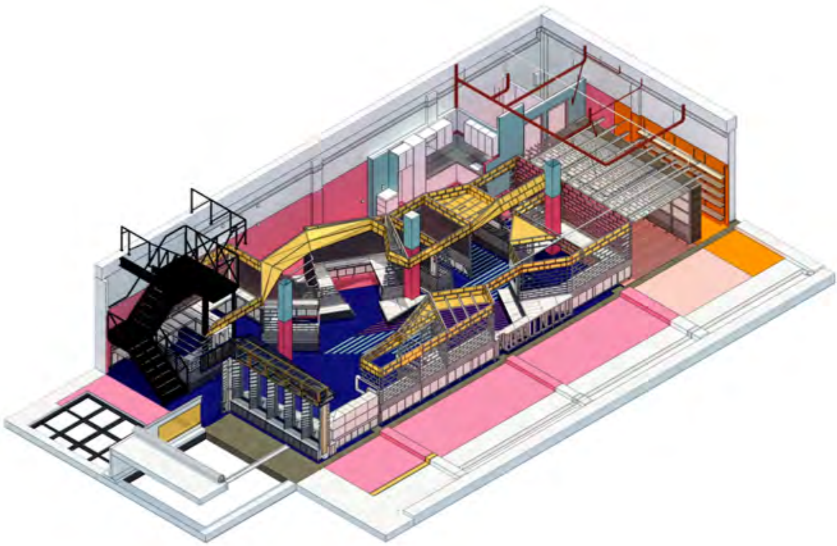

Figure 2: Axonometric of Superscale's self-initiated experimental self-build co-working project at the Docklands Cotton Mills. Image: Superscale.

Although there is a vast amount of research on the subject of co-working spaces and shared workplaces – very minimal have been design-led and the studio aspired to conduct a research project through design. The studio aimed to create a repository of spatial prototypes for the development of future co-working spaces (and work environments in general) and in turn, generate new discussions about the contemporary work environment. The studio also tackled the social and communal aspirations of the DCM Body Corporate investigating ways on how the warehouses' 'public interface' and façade can contribute more to the complex rather than isolated individual hubs.

The studio questioned what might a procedural typological methodology contribute in re-thinking work environments? What new spatial and formal models might emerge? How might 'collaborative' work environments be defined and what would they look like?

The first five weeks of the studio focused around developing a sound knowledge base for students; investigating current questions and exploring best practice models of work environments but also a foundation on procedural methods. Each week focused on a particular thematic that not only dealt with the specificities of site and brief, but also a speculative grounding with the aspiration that students will expand the question through self-directed investigations. Each week included a presentation that explored the week's focus with readings and precedents as support. The themes are simultaneously both broad and specific encouraging the student to expand and re-form their propositions based on their interest and project.

As an example, a focus might be on spatial and programmatic strategies with a concentration on augmenting social and communal qualities through an investigation of an ‘Artificial Terrain’, or a spatial strategy that focuses on the sectional juxtaposition of programs and its qualities through ‘Strategies of the Void’.[7] Each experiment is grounded on a typological inquiry on what existing typologies exhibit qualities that could be magnified for the week’s focus. Students are also urged to continue beyond the diagrammatic outcomes of the experiments by re-drawing the project as a series of architectural propositions and drawings. This way, students are continually exposed to the transition of architectural ideas to drawings and upskilling their skillset to proper architectural graphic conventions.

By creating a layered weekly focus of the following ingredients; 1. Conceptual Agenda (examples from the studio may include ‘Artificial Terrain, or ‘Strategies of the Void’); 2. Architectural Element (questions of form, programme, circulation, etc.); 3. Propositions on Work Environments; and 4. Typology and Procedural systems; it creates opportunities in allowing the student multiple trajectories to hone in on what they may be particularly interested in.

As an example; a student may be interested in a multi-layered and fragmented network of vertical slabs to allow for a more vertically integrated environment brought out by the experiments through the ‘Artificial Terrain’ focus, but the student may not necessarily find it useful in its application for work environments (or the studio project) and may spark an interest for other typologies and application for future studios. Weekly outcomes generate propositions that focus on one aspect of the project as well as tackling specific sets of questions. For example; a programmatic focused experiment probably won’t contribute much for formal strategies and students are encouraged to judge the ‘usefulness’ of their outcomes. Students are also encouraged to ‘remix’ procedural outcomes by superimposing and layering different conditions which in itself, allows an interrogation of a possible ‘third condition’.

Students also participated in a site tour and meeting with the DCM Body Corporate allowing a more pragmatic view of the project in comparison to the conceptual agendas of the studio. This encourages students to see the real-world impact and potential application of the studio outcomes. It reinforces the position that the outcomes of studio have real-world implications and have a real part to play in the progression of a real place. External collaborators were also invited to give talks to supplement the studio discussions.[8]

The studio not only produced individual proposals but also considered an alternative vision for the DCM by amalgamating their propositions into one cohesive proposal; re-imagining the DCM Complex. Students were tasked to negotiate and collaborate with their studio peers exposing them to further questions about the role of contemporary work environments to the larger immediate context. Large composite drawings and models were produced encouraging students to simultaneously develop their project both in micro scale (to the level of their building) to the macro scale (to the level of the complex as a whole). It was an engaging model where students worked in a ‘group project’ but concurrently developing their own individual projects.

Figure 3: Students developing an overall alternative vision for the Docklands Cotton Mills complex as a studio cohort. Individual proposals are merged together through negotiations and discussions.

The studio culminated in an exhibition and presentation at the DCM complex of their own design in one of the warehouses and open to the public. Students were also able to have a discussion with the DCM Body Corporate Chairman who provided feedback to the students as well as being presented with alternative ideas for the Complex.[9] This opportunity to present to public and stakeholders reinforced to students the value of the research and their contribution to a 'place'. The value that their studio outcomes were not just to pass another studio but to contribute to the development of the complex by research through design.

Figure 4: Superwork3:CO – The Dockland Cottons Mills Project final presentations and public exhibition.

Figure 5: Docklands Cotton Mills Body Corporate Chairman Mark Bourjau in discussions with the Superwork 3 students.

The Frontiers Series

The FRONTIERS Series is an emerging research and design-led exploration of and speculations on alternative models for work/live/learn typologies through specific site conditions and procedural typological experiments.[10] The series follows on from the SUPER Series studios and expanding the design methodology to questions of living environments and creating a research umbrella for the three environments being investigated.[11]

Case Study 2: Living Frontiers: Superslim

Housing is one the most complex challenges cities face today. With Melbourne's population growing rapidly; housing affordability, density and liveability are continually questioned. How can we learn from and generate new housing typologies out of existing housing types? How can we refashion them into a vertical condition? How can we embrace past ideas in order to approach the future? What might emerge from hybridised housing types? What might all this look like through the lens of narrow urban infill sites?

The studio explored strategies for alternative housing models from macro to micro scales with a specific interest in narrow urban infill sites. Normally associated with luxury living, the studio re-imagined 'skinny skyscrapers' as viable alternatives for affordable housing models and mix. At an urban scale – the studio questioned civic presence and amenity; social – explored engagement and interaction between units as well as public and private spatial connectivity and arrangements; and the living units – examined its internal specificity promoting variations of housing mix, access and ownership.

Similarly, this studio was ran at Bachelor level and ran a similar framework to the previous studio. The main difference though is that, as part of the studio outcomes, students were tasked on creating a 'Catalogue of HAM' (Housing Alternative Models) and a 'Book of HAM' as a studio collective. It follows from a similar approach to the Superwork3 studio task of generating a unified alternative vision for the DCM complex, in that, it operates as both group work and as an individual task. Students have to support each other in order to complete the studio but simultaneously developing their own propositions in contribution to the whole.

The 'Catalogue of HAMs' was a collection of prototypical spatial models for housing alternative models within the context of 'superslim' towers. Students individually catalogued all possible living environments and models within their own individual projects. Students were also tasked in developing two living models in detail. The 'Book of HAMs' collated each individual student's curated collection of procedural experiments and outcomes as well as the final proposition with descriptors by the students.

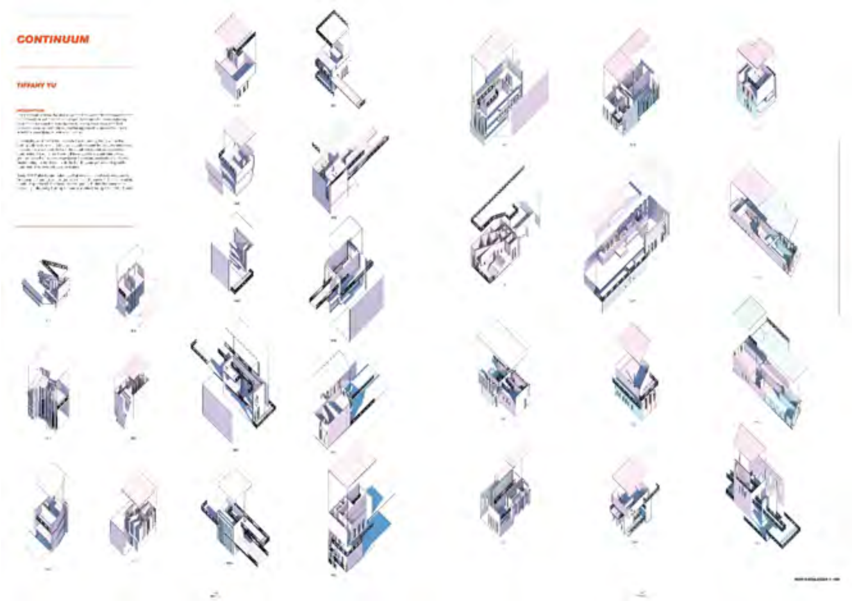

Figure 6: A catalogue of housing alternative models. Student Project by Tiffany Yu.

The books were used as a presentation device during the studio's final examination crits as well as part of the final exhibition at RMIT Architecture. The production of the studio books was a method in attempting to collate a design studio 'research output' that both students and studio leader could access but as well as an artefact that shows the value of the design studio as a research medium. What lacked in the Superwork3:CO studio was a summation of the studio in a physical format. Although the exhibition and final presentation events were a success, once the exhibition was finished, all that is left are fragments of knowledge and folios that need to be re-deciphered without the participating students on hand. I would argue that the books gave the students a rallying call that the design studio is part of a larger research agenda that they are contributing to. From experience, students were also excited by the outcomes and wanted to collect a physical copy – a memento of their contribution to knowledge but also a reference for future creative endeavours.

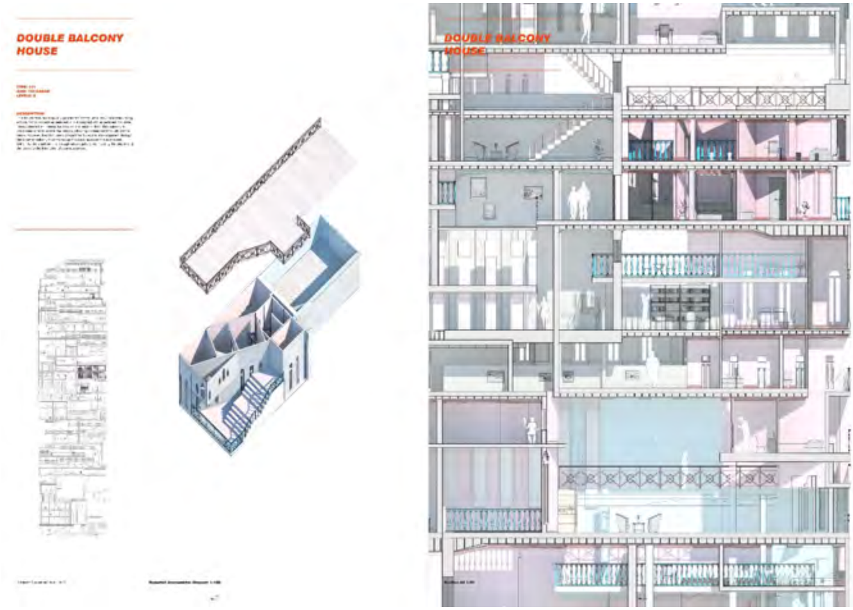

Figure 7: The Double Balcony House living type. Student Project by Tiffany Yu.

Practice and Application of Research: The 20th Biennale of Sydney

In 2016 our practice, Superscale, won the commission for the ‘Public Program and Education Hub for the 20th Biennale of Sydney’ through the ‘Open Agenda Competition’ organised by UTS in partnership with the Biennale of Sydney.[12] The competition brief asked for the creation of a customised, multi-purpose program hub on Cockatoo Island. The proposal was for a spatial design for one of the heritage, industrial era buildings on the island, which would provide the stage for a range of programming and education activities. Proposals were asked to consider the conceptual agenda of the Biennale titled ‘The future is here – it’s just not evenly distributed’; the specific conceptual underpinning the Cockatoo Island titled ‘The Embassy of the Real’ and also establish an interplay between the historical context of the island and graphic identity of the 20th Biennale.

We applied our design research on procedural typological experiments. We tested its application through design methodology and critiqued if it could have real world value. We used this opportunity to not only test some of the ideas on the procedural and typology but also consider how a temporary spatial installation could act as a container of ideas.

The proposal dwells into Cockatoo Island’s naval history and taps into the Dry Dock typology – reimagining it as a stratified and folded topography for educational, civic and public programmes. An artificial terrain containing a legacy of ideas. We also investigated the historical expansion and contraction of Cockatoo Island’s figure-ground relationship over time through a series of maps we uncovered. We calculated its growth over the years and we used these values as a way of capturing the behaviour of growth and choreographed a series of experiments to generate proposals and tests.

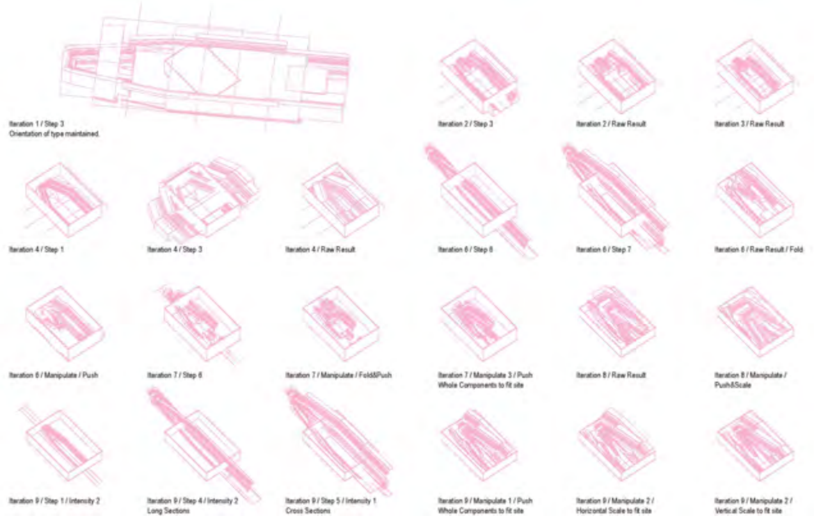

Figure 8: Procedural and iterative process. Image by: Superscale.

It created a fragmented dry dock to generate a permeable space; creating continuous visual links and merging circulation with function – viewing 'transition as program' where collaborative areas intertwine with more intimate moments around the circulation loop.[13] We viewed the proposal as both field and object. It had the potential to contract as a unified formal whole to hold more intense concentrated programmes, and at times as a collapsible dispersed field of spatial events and programmatic interventions.

The application of our design research allowed us to reflect on the future possibilities on this specific way of working and how might it inform future iterations of design studios and projects. It reinforced the iterative process and the importance of creating a 'framework for judgement' on how to evaluate the success of the experimental outcomes. It also allowed us to experience the transition between the highly diagrammatic outcomes of procedural experiments to the constraints (and opportunities) of real world parameters such as budget, construction and logistics. This was important to me as I continually elaborate in my design studios that I am not interested in fantasy but in the intersection between ideas, speculation and the real.

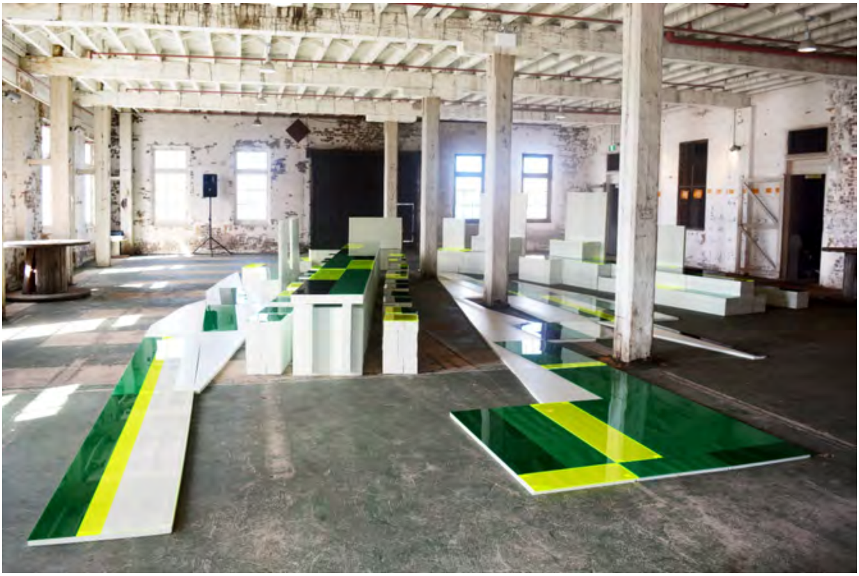

Figure 9: The Public Programme and Education Hub for the 20th Biennale of Sydney project by Superscale. Compact 'object' version. Image by: Superscale.

Figure 10: The Public Programme and Education Hub for the 20th Biennale of Sydney project by Superscale. Dispersed 'field' version. Image by: Anton Rehrl.

Design Studios & Practice: Lessons Learnt & Learning

Multifaceted Weekly Focus

Creating a multifaceted weekly focus for students that engages with multiple questions and outcomes is important for their development and the potentials in seeding future research interest. For example; a weekly layered task in a studio may contain the following ingredients;

a) Conceptual Agenda relating to the ambitions of the studio;

b) Propositions and position on the type being investigated;

c) Typological Research that captures a behaviour that students' could amplify;

d) Procedural systems to aid in the manifestation of the ideas;

e) Architectural Representation (both conventional and speculative)

In the first half of semester, it is important to emphasize the production of ideas and propositions, but this 'layering' allows engagement at multiple levels.

Arsenal of Ideas

Students generally produce five separate propositions that tackle different areas of the research focus and building brief (i.e. one proposition may excel in spatial strategies, another in ornamental strategies, or another in form, etc.). Students must be given an opportunity to reflect and consider what they have discovered and generate an 'Arsenal of Ideas'.[14] Their handbook of strategies and propositions contain the outcomes of their intense experimentation of ideas that they can turn to for the rest of the semester but also for future endeavours beyond the current studio. The handbook plots out a strategic trajectory for the development of their project.

Collaborative Assembly for Speculative Experiments (CASE Groups)

Learning does not stop beyond the walls of the design studios. It is essential to create a supportive environment (not just studio leader to students but also students to students) that extends beyond the design studio allowing students to be comfortable in discussing with all studio members. In my design studios, I have progressively developed the weekly CASE groups where students are allocated a different group each week. Students discuss the development of their work with interchanging students to ensure that they not only discuss about work, but also establish a supportive relationship with all students.

Diagram to Real: A Consistent Translation

It is also equally important to ensure a framework for deliverables that results in an architectural proposition with formal architectural drawings to ensure that students 'practice' transitioning from the diagram to the real. I continually emphasize the importance of translating the diagrammatic outcomes to real world constraints as it gives the students a peek to the realities of the discipline. This is where our application of our research in practice is impactful as it provides a glimpse into the constraints and opportunities in working in this way in the real world. This is particularly useful in the second half of semester when studios shift into design development mode.

The Rallying Call. Quasi-Group Work.

Setting a task that involves quasi-group work can be a useful tool in creating an environment of camaraderie and has the potential to elevate the research outcomes and quality of work from the design studio. These tasks are essentially the merging of individual works to a larger whole, creating a more impactful outcome. The success is reliant on the studio cohort working together without losing their individual voice.

Plant a Seed

The design studio is a fertile testing ground for the discovery of research interests that have the potential to launch longstanding research trajectories. From my experience, being exposed to a fragment of typological and procedural possibilities in a past design studio was the seed that catapulted a research arc that has impacted my way of working as student; as academic and as practitioner. Through layering design studios with multiple potential research questions that not only concerns the larger studio agendas, but also a multitude of smaller fragments that may be interchangeable and inter-relatable with other platforms; that seeds of new knowledge may be planted by future students.

References

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[1] A RMIT Master of Architecture Design Studio led by Professor Vivian Mitsogianni in Semester 2, 2009 that explored rule-based design processes and investigations on contemporary learning environments.

[2] At RMIT Architecture, Major Project students are encouraged to, 'take risks and attempt to see architecture anew.' And that, 'Projects should form the beginning of an exploration of architectural ideas that can set the agenda for the first ten years of your original and insightful architectural practice.' Major project supervised by Professor Vivian Mitsogianni.

[3] Christopher CM Lee and Sam Jacoby, "Typological Urbanism and the Idea of the City", *Architectural Design* 81, no. 1 (2011): 19; Sam Jacoby, "What's Your Type?", in *Typological Formations: Renewable Building Types and the City,* (Belgium: AA Publications, 2007), 155.

[4] The SUPERWORK Series included Bachelor of Architecture Design – Design Studios; Superwork1 (2016), Superwork2: No Typical (2016) and Superwork3:CO-The Docklands Cotton Mills Project. These studios focused on the development of a vertical corporate campus as an emerging typology for urban development in suburban contexts. The studios also explored the changing nature of work, its continued evolution and contribution to our cities that continued to the Superwork3 studio.

[5] Docklands Cotton Mills was an industrial complex built in the 1920s that became largely unused in the late 90's and early 2000's. Now it has slowly transformed into a hub for small businesses, design studios, artists and creative industries.

[6] At the time of the Superwork3 studio, our practice was also developing and designing a self-initiated and self-build collaborative work environment that explored notions of typology and new models for shared workplaces. We used this to inform the parameters of the design studio and to overlay our current research findings from practice into the studio; Superscale is an ideas and research-led design practice led by Patrick Macasaet and Vei Tan.

[7] I have been exploring this throughout all design studios I have been running and investigating how it might affect programmatic and spatial relationships within work/live/learn typologies. It asks; How might the deformation (or break-up) of the horizontal slab and vertical partitions re-think the formal, programmatic and spatial organization of the work/live/learn typologies? How might these affect the sectional and planning relationships within these types?; Similarly, this is another exploration I have been investigating. How might voids be deployed as a strategy for vertical connectivity, practical and environmental requirements, urban connectivity, etc.? What other models exist rather than the monumental void? How can voids be deployed beyond the typical monumental atriums or grand large spaces? How can voids be seen as operative?

[8] Vei Tan (Co-Director, Superscale) presented her experiences in developing, designing and running a collaborative co-working space and Mark Bourjau (DCM Body Corporate Chairman) gave the students an in-depth site tour and detailed the aspirations of the complex. Both contributors supported and had a massive input in the design of the practical brief.

[9] The Superwork3:CO final presentation and exhibition was held at the Dockland Cotton Mills. The event was assisted by a number of guest critics to include: Tina Atic (RMIT University and Monash University Sessional Academic), Chelsea Koh (Linkon Projects), Vincent Lai (Meitrix), Suheri Purnomo (DRC Architecture), Mery Samosir (Tandem Design Studio) and, Vei Tan (Superscale & MIMAW). A separate discussion with Mark Bourjau (DCM Body Corporate Chairman) was held a few days later.

[10] At the time of writing, I am currently running the ‘Learning Frontiers: RMIT Urban High’ Master of Architecture Design Studio, expanding the series to include speculations on future learning environments.

[11] The SUPER Series studios also includes SUPERNORMAL 1 (2014) and SUPERNORMAL 2 (2015) co-led with Helen Duong as a Bachelor of Architecture Design – Design Studios. It also explored typological rule-based experiments with a more site-specific approach in the design of future libraries in the west. These two studios were the precursors to the SUPERWORK series.

[12] Design Team included: Bing Jie Chang, Justin Dinh, Tracey Doan, Vincent Lai and Yang Ren and led by Vei Tan and Patrick Macasaet; Open Agenda focused on developing the possibilities of design research in architecture and the built environment and aimed at supporting a new generation of experimental architecture in Australia and New Zealand.

[13] I coined this term as a student in the Formfield 2 Design Studio where it explored notions of programmable circulation and transitory spaces, amplifying their function to more than just circulation strategies but also embedded learning environments.

[14] I have been developing this model as a way for students to take a ‘breather’ and digest what they have been producing and doing during the semester. It allows students to re-focus their projects and stabilize a position for their projects.

ADR18

Practice Perspectives

Chaired by Catherine Lassen

Developing a Provisional Model of Design Research

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Director, Andrew Burns Architecture, Sydney

Abstract

The legitimacy of design research as a mode of inquiry is reliant upon the capacity for unique knowledge to be generated in a manner that is systematic, accessible and transferable; *systematic* in that it is generated according to a clearly articulated methodology, *accessible* in that through the methodological approach outcomes and insights gain legibility, and *transferable* in that this legibility enables value to be derived by others outside the research. This paper seeks to plainly outline steps to date in a practice-based design research project undertaken by the author's architectural practice, considering the process in light of the above-stated demands of qualitative research. If the work is able to satisfy the above criteria, it follows that it may be able to contribute a response to the challenges often associated with design research, that it often contains tacit knowledge, defined by Yasser Megahed as 'a kind of knowing that is not separable from the perception, judgement, or skill that the knowledge informs' and problematized by Shane Murray as diffuse to those outside the specific design process and opaque to those outside the design discipline.

Developed within the newly established practice-based research program at the University of Sydney, the research tests a potential methodology of practice-based research, whilst also serving as an example of the research methodology enacted. The tools and techniques of the research have been developed sequentially, to address practical problems of design research as they have emerged during the process. The research methodology centres on the development of a provisional, externalized, architectural knowledge structure; *provisional* in that it's claims for utility are temporal and limited, *externalized* in that it is documented to enable access and traceability, and *architectural* in that it is based on disciplinary knowledge and not dependent on knowledge from associated fields such as philosophy or science. The knowledge structure in this instance is a series of 'concept matrices' based on processes of categorization, transformation, hybridisation and extremitisation, deliberately constructed to broaden the potential concept base of the practice and to locate the concepts within established work in the field. In this manner, the matrices serve as both analytical and generative devices.

Importantly, the concept matrix process exists as a separate entity to specific design projects, whilst iteratively informing and being informed by those projects. This separation enables the research to be progressed regardless of whether a relevant design commission is available at any particular time. A core suggestion is that un-buttressed by the traditional conceptual triggers of site, client and brief, the concepts explored gain a level of intensification. As projects are developed, design decisions are documented, seeking to make accessible tacit knowledge employed during the process.

At the mid-point of the research, this paper will reflect on the process to date, identify emerging insights and questions and relate the research to current discourses of design-based research.

Introduction

The legitimacy of design research as a mode of inquiry is reliant upon the capacity for unique knowledge to be generated in a manner that is systematic, accessible and transferable[1]; *systematic* in that it is generated according to a clearly articulated methodology, *accessible* in that through the methodological approach outcomes and insights gain legibility, and *transferable* in that this legibility enables value to be derived by others outside the research. This paper seeks to plainly outline steps to date in a practice-based design research project undertaken by the author's architectural practice, considering the process in light of the above-stated demands of qualitative research. If the work is able to satisfy the above criteria, it follows that it may be able to contribute a response to the challenges often associated with design research, that it often contains tacit knowledge, defined by Yasser Megahed as ‘a kind of knowing that is not separable from the perception, judgement, or skill that the knowledge informs’[2] and problematized by Shane Murray as diffuse to those outside the specific design process and opaque to those outside the design discipline.[3]

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At the mid-point of the research, this paper will reflect on the process to date, identify emerging insights and questions and relate the research to current discourses of design-based research.

Motivation and Practice Background

The author elected to undertake a practice-based PhD in order to increase the rigour and criticality of the practice, systematizing the knowledge base of the practice and seeking to broaden the design output from approaches that gravitate to refined contemporary iterations of established concepts, towards genuine conceptual innovation. To illustrate this desired evolution, the practice’s Cranbrook School Wolgan Valley Campus[4] (figure 1) project generally accords to established 18th century concepts of terraforming, realized in a refined contemporary manner, whereas a project such as SANAA’s Rolex Learning Centre represents genuine conceptual transformation; terraforming in light of contemporary construction possibility; an elevated topography enabled by advanced structural analysis. Whilst the Wolgan Valley Campus project may be regarded as a gradual, worthy evolution, the SANAA project represents a leap of transformation. In this spirit, a primary motivation of the research is to create a framework whereby such leaps may be readily achieved. This is a significant challenge and success is by no means a given.

Figure 1: The conceptual transformation of SANAA's Rolex Learning Centre and the established terraforming of the Wolgan Valley Campus project.

Established in 2008, the author's architectural practice began by undertaking small residential projects and moved towards cultural, public and hospitality projects often in landscape settings, exemplified by the Australia House[5] project of 2012 (figure 2). Identifying this interest of the practice, the author elected to narrow the focus of the research to the interface of architecture and landscape, aligning the research focus with the likely commissions to be received by the practice, with each commission serving as an opportunity to progress the research.

Figure 2: Australia House

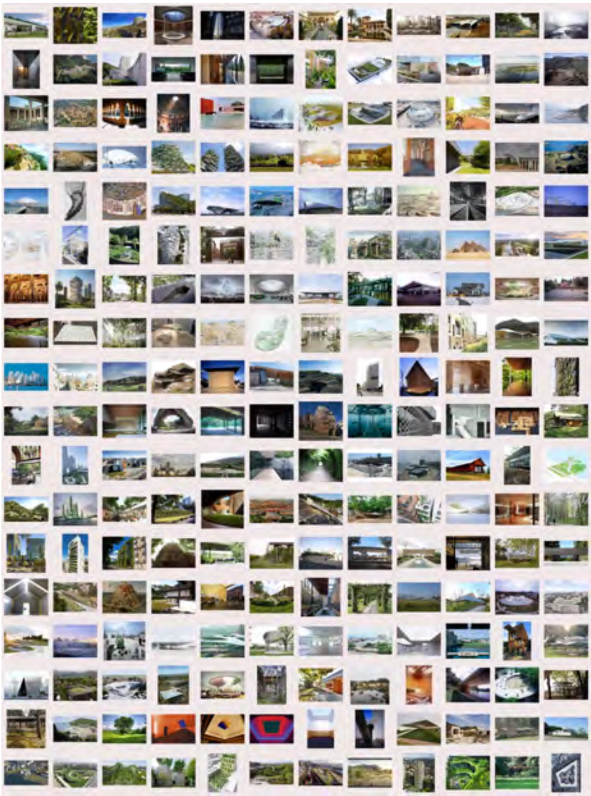

Figure 3: Surveying projects that interface architecture and landscape.

Establishing a Research Methodology; Concept Classification / Transformation / Hybridisation and Extremitisation

Classification

In order to survey the contemporary field, the process towards a system of concept generation commenced by gathering examples architectural projects, loosely selected on the basis that the dominant architectural idea concerns the interface of architecture and landscape (figure 3).

In order to categorise these project examples, a provisional system of classification has been established, based upon four broad categories; terra strategies, garden strategies, boundary strategies and diffusion strategies; summarized in the following sketch (figure 4) and according to the following definitions:

- *Terra strategies* – concepts based on manipulation of the ground.
- *Garden strategies* – architectural concepts derived from gardens.
- *Boundary strategies* – concepts based on the interface between interior and exterior.
- *Diffusion strategies* – concepts based on the diffusion of the architectural object.

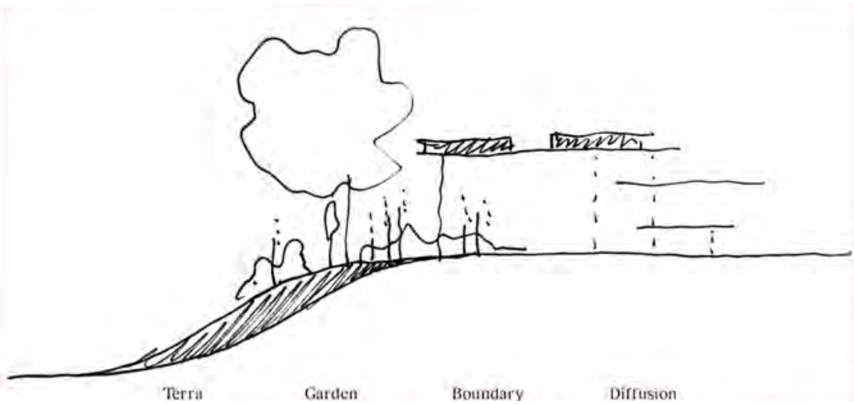

Figure 4: Sketch by author.

Importantly, the above categories are not posed as a definitive classification system for the interface of architecture and landscape, but rather as a provisional system to support a movement from vague concept dispositions towards a productive knowledge framework. Whilst initially, some aspiration was harboured to provide a comprehensive account of the interface of architecture and landscape, this was promptly discarded in a frank recognition of the limitations of the research, whereby the content is perhaps personal in nature and of dubious transportability, whereas the form (i.e. the system and its performance) may have benefit, transportability and accessibility beyond the particular concerns of the practice.

From the initial classification, a series of subcategories are identified, as follows:

Terra Strategies	Garden Strategies	Boundary Strategies	Diffusion Strategies
- Terraforming - Cuttings - Mountain schemes	- Pavilion / garden equivalence - Pathway schemes - Planted buildings - Ruins	- Courtyard schemes - Perimeter schemes - Verandahs - Framing - Oculus schemes - Operability schemes - Reflectivity schemes	- Volume diffusion - Frame diffusion - Trellis diffusion - Planar diffusion - Particle diffusion

Table 1: Sub-categories of classification.

Transformation

Following the process of classification, the secondary process tested is one of concept transformation, whereby each sub-category is transformed according to a ‘dynamic’. To return to the SANAA example, the Rolex Learning Centre is considered according to this system as a subcategory of ‘terraforming’, transformed according to the dynamic of ‘contemporary construction possibility’ to yield a new concept of ‘thin topographies’. The process of determining dynamics (contemporary construction possibility, concept inversion, social imperatives, local references, sculptural transformation, extension / multiplication) has been one of necessity, whereby projects are identified as related to the primary concept but transformed in some way. When a dynamic is identified, extracted from precedents, the dynamic is then re-applied to all other primary concepts, generating a transformation matrix (refer figure 5 for diagram and figure 6 for the current concept transformation matrix). In some instances, there are existing project examples that accord to the transformed concept but in other instances there is no such project example and in this instance the process becomes generative.

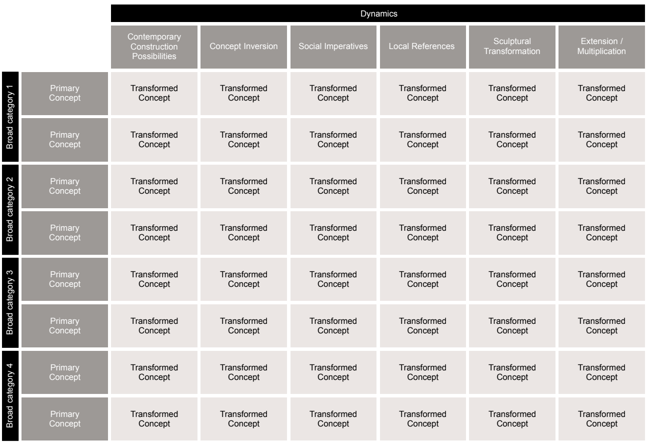

Figure 5: The basis of the concept transformation matrix.

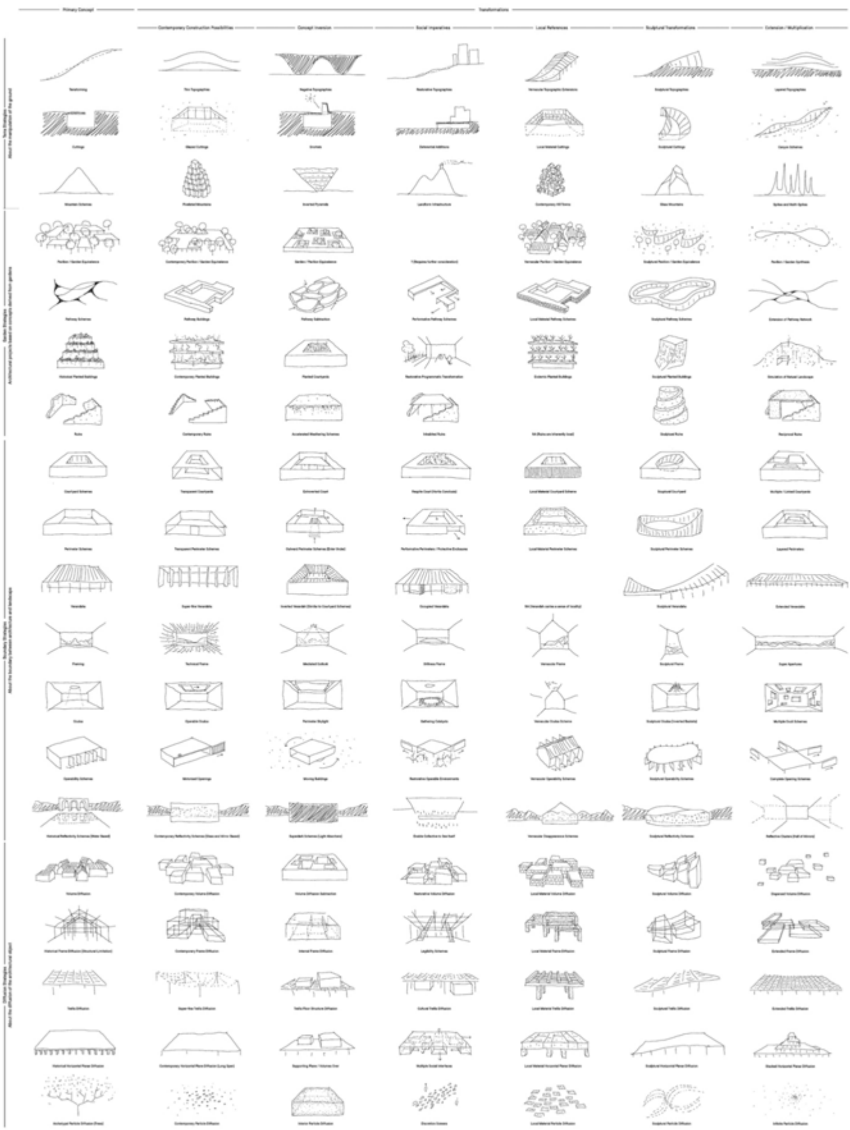

Figure 6: Current Concept Transformation Matrix.

To provide a secondary example of the system at work, the Tippet Rise Art Centre project by Spanish studio Ensamble (2017, figure 7) clearly bears relationship to the primary concept of terraforming. In this example, the dynamic at play is identified as ‘concept inversion’ yielding a new concept with a name applied 'negative topographies' whereby the resultant form is based on a process of topographic subtraction. Once identified, the dynamic of concept inversion is in turn applied to all other primary concepts, in some instances generating an idea without contemporary precedent, such as a concept of 'pathway subtraction' as an inversion of 'pathway schemes' (Figure 8).

Figure 7: Tippet Rise Art Centre by Ensamble Studio.

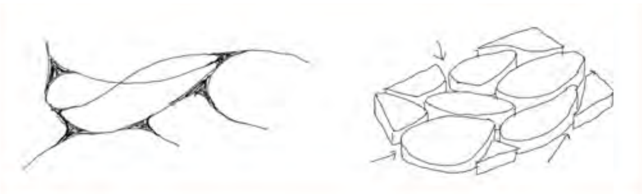

Figure 8: Concept inversion in practice, pathway schemes to pathway subtraction.

The various names of concepts are not intended as definitive and there is an open question as to whether the naming is necessary, or whether the concept sketch can adequately hold the content and avoid potential reduction caused by naming. Nonetheless, the transformation matrix serves as a tool of analysis; locating concepts in a wider framework; whilst simultaneously possessing a generative quality; identifying potential new concepts through systematic process. Whilst the selection of categories and dynamics is clearly subjective, the process of application of dynamics is systematic, responding to an initially identified criteria of qualitative research.

Hybridisation and Extremitisation

Following processes of concept classification and transformation, a tertiary process of concept *hybridisation* is introduced, whereby each primary concept is considered in combination with every other primary concept (refer figure 9 for diagram and figure 10 for the current concept hybridisation matrix). For the purpose of this exercise, the twenty primary concepts from the transformation matrix are considered, rather than the full 140 concepts (twenty primary concepts transformed in light of six dynamics), which would result in an unwieldy matrix of some 19,600 concepts. Such volume would be of diminishing benefit and would divert energy from the key intent of applying the system of concept generation to actual projects from within the architectural practice. In this scenario, a license has been claimed for each primary concept to be considered as a proxy for all transformed iterations of that concept, enabling the most promising combination to be pursued. This is a clearly subjective process and whereby the reasoning for each combinatorial decision can be traced, it is beyond the scope of this paper to do so.

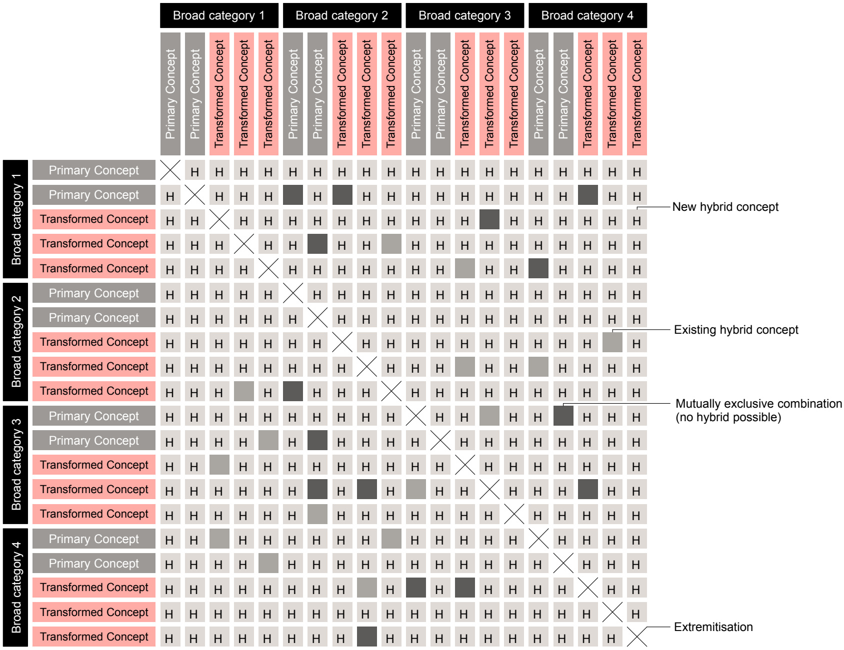

Figure 9: The basis of the concept hybridisation matrix.

Figure 10: Current Concept Hybridisation Matrix.

Significantly, the hybridisation matrix increases the available range of categories and enables precedents to be more accurately located than can be achieved by the transformation matrix. As an example of concept hybridisation, the Greenland National Museum of Art by Danish / American practice BIG (2010) is identified as a hybrid of glazed courtyard schemes (a transformation of perimeter schemes in light of contemporary construction possibility i.e. glass technology) with terraforming (Figure 11).

Figure 11: Greenland National Museum of Art by BIG.

The process of concept hybridisation brings with it a range of questions; in particular whether concept hybridisation results in dilution of conceptual clarity or whether it yields valuable, unique concepts, whether the hybridisation can extend beyond simple formal hybridisation to have programmatic implication and whether the process of hybridisation requires secondary processes of synthesis to achieve convincing integration.

It is noted that hybridisation and extremitisation are grouped, the reason being that if hybridisation the result of a concept blended with another concept, extremitisation is considered as the multiplication of a concept with itself, a convenient short-hand that occupies the diagonal axis of the hybridisation matrix.

Mechanics of a Research Methodology

Given the establishment of the processes of classification, transformation and hybridsation / extremitisation, the task becomes to relate these processes explicitly to the projects of the practice. The research methodology oscillates between the non-project work of devising and iterating the matrix, with project-based work as the concepts are applied to projects from within the author's architectural practice (Figure 12). The research methodology therefore integrates two forms of knowledge; project specific and independent; responding to a practical challenge of design-based research encountered during the work; namely the occasional absence of appropriate projects to apply the research. During these periods, the matrix can be extended and refined, broadening the conceptual base that can be applied when appropriate projects arise.

According to the research methodology, specific projects in turn inform understandings at the systematic level and are underpinned by reflective work, generating short texts that document insights gained and cumulatively provide a body of written content as source material for an eventual thesis. As noted on the methodology diagram, as the research progresses, the system is gradually consolidated.

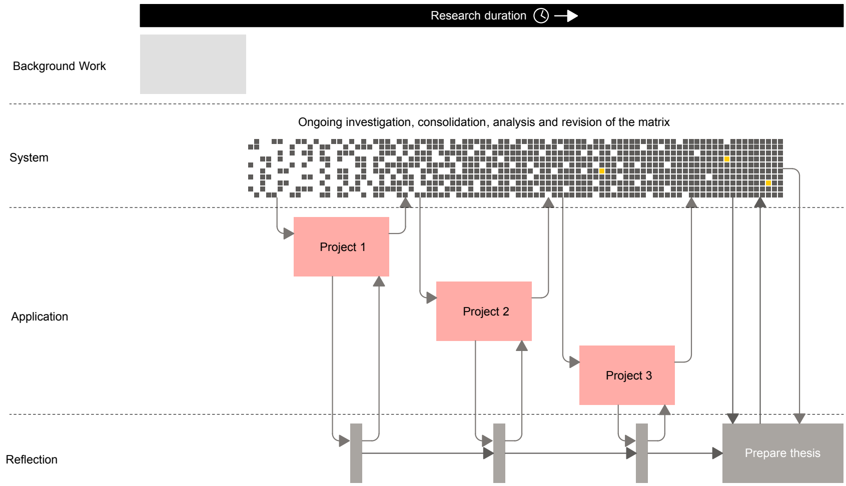

Figure 12: Research methodology

Test Driving the System

The establishment of the research methodology is a key milestone in the design research process. The following step is to 'test drive' the system, seeking to apply the processes of concept generation to actual projects in order to test the effectiveness of the system. As discussed with the research supervisor, a focus has been placed on 'trusting the process,' to enable insights to be gained through consistent application and avoiding premature conclusions.

The nature of practice has forced a shift in the research methodology. The initial intention was to undertake three-four optimal projects, closely aligned to the research task. Such is the nature of practice that perfect scenarios rarely arise and on this basis the emphasis has moved towards putting as many of the projects of the practice through the system as practical, including a range of architectural outputs including concept design phases, competition submissions, invited expressions of interest, house projects and invited pitches. This is undertaken in a manner that accepts ongoing improvement and seeking a gradual transition towards increasing conceptual clarity and innovation.

This process highlights tensions inherent in practice-based design research; namely that the research aspires to rigour and clarity, yet opportunity for application is at times imperfect and unclear. Nonetheless, if a research basis enables steady progression through imperfect scenarios, this constitutes a significant affirmation of the value of design research and its potential to orient and refine practice.

The projects subjected to the research methodology are outlined below, consisting of the following:

- Lightfolk village; a direct commission for a cross-subsidised hospitality / community project on the Mornington Peninsula for a family foundation. This project utilizes hybridisation of pathway scheme and village scheme concepts, enabling buildings to be flexibly distributed to support tree retention, whilst providing the client's desired rural identity. Additionally, as the landform falls away, the elevated pathway loop retains a consistent height, thereby resolving site challenges of accessibility, whilst creating the experiential benefit of the accommodation forming 'treehouses' in support of the client's intent to create a memorable hospitality experience (Figure 13.1).
- Marchione House; a new house in a middle ring suburb of Sydney, comprising a long span ground floor structure with a series of upper level volumes set within roof gardens. Whilst partially diluted in diagrammatic clarity, the upper level generally accords to volume diffusion concepts from the transformation matrix. (Figure 13.2).
- Montessori East K-12; an invited tender submission for a major $20M campus in inner city Sydney. As part of the tender submission, the practice's research methodology was outlined and a series of preliminary concepts identified, all derived from the transformation and hybridisation matrixes in various forms. (Figure 13.3).
- Al-Ula resort; an invited two stage competition submission for a major $180M resort in the remote Sheeran Desert region of Saudi Arabia, invited by the recently established Royal Commission for Al-Ula. The short submission required an initial response to the project and this featured the suggestion of a 'canyon scheme' derived from the transformation matrix and offering experiential benefit, evoked through abstract rendering. (Figure 13.4).
- Sekisui House pitch; an invitation to present the approach of the practice to Japanese developer Sekisui House, with an intention to potentially collaborate on a current multi-staged project at Wentworth Point, Sydney. In a fortuitous synergy, the lead international architect for the project is Kengo Kuma, whose work forms a substantial part of the 'diffusion strategies' component of the research. A series of quick concepts were developed, incorporating various terraforming strategies to support urban design initiatives of the masterplan and featuring a pavilion proposal based on concept inversion of a perimeter scheme. The proposal has resulted in engagement for eight and twelve storey apartment buildings (Figure 13.5).
- Barilla Pavilion competition; an open international competition for a substantial pavilion for the Italian pasta company, incorporating a hybridisation of rectilinear volume diffusion; to create formal resonance with the existing industrial campus; with pathway schemes; to create a playful movement system that supports discovery and serendipitous experience; affirming desired future directions of the company to holistically evolve beyond an industrialised base. (Figure 13.6).

Whilst it is beyond the scope of this paper to describe each of these projects in detail, they are graphically summarized below.

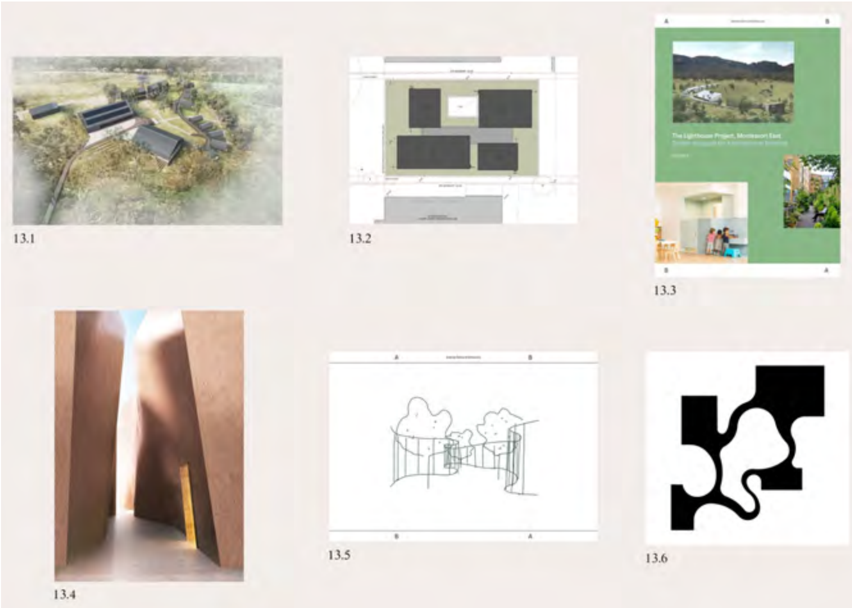

Figure 13: Current practice projects.

Emerging Insights

The research has to date begun to yield a series of insights, both at the level of innovative concept generation and more broadly about the value and limitations of systematic concept generation and the mechanics of practice based research. The generation of concepts without the buttresses of client and site can limit conceptual specificity but potentially enhance clarity – there is nowhere to hide. Whilst it is suggested that the research process has improved the conceptual clarity and inventiveness of output of the author’s practice, there is work to be undertaken to demonstrate this, potentially through a comparative analysis of a series of projects prior to and during the research. As a working premise, design research is suggested to differ from standard practice in that it is underpinned by a research base that ultimately yields transportable content and re-informs the project. The difference, or delta, between the design outputs of standard practice and those of design research practice may be considered as a measure of the value of the research, as summarized below (Figure 14).

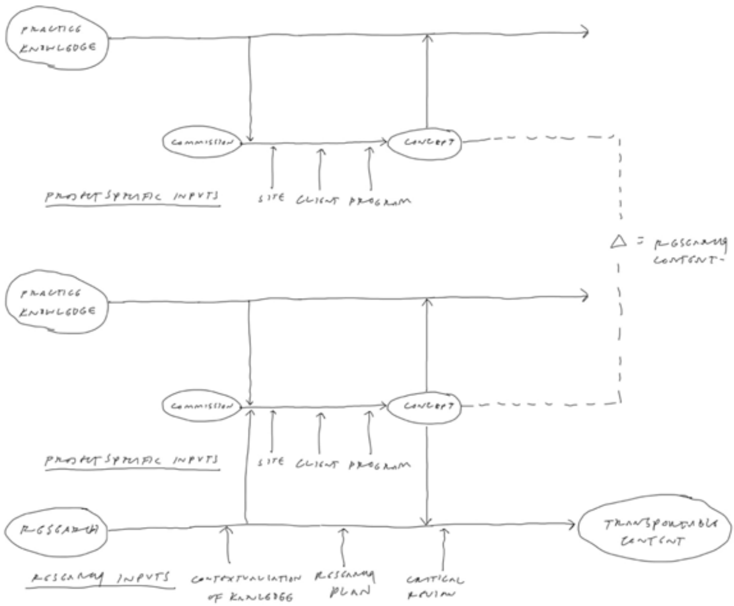

Figure 14: Research informing practice.

The recalibration of the research methodology from awaiting perfect scenarios to commencing imperfect application has proven productive, offering insights about the interrelation of conceptual clarity and provisional reality. Whilst at present this may simply represent a truism of 'start and refine', it may provide further insight into the challenges of practice-based research as the research progresses.

The research externalizes a process acknowledged by the author to contain a mix of subjective and objective content. There is more work to be undertaken to map this interface of subjective and objective content but the elements and dynamics at play have begun to be consciously identified. The anticipated approach is not one of removing subjective elements, but rather explicitly understanding how they interface with objective content. The gradual process of accepting the inevitable reduced transferability of subjective knowledge has served to focus the research to identify genuine potential for transferability, whilst reducing inappropriate claims of a universal system, instead operating in a more relaxed and open-ended manner.

A key insight has been the capacity of concept hybridisation to solve complex design problems in a way that retains conceptual clarity, or moreover superimposed conceptual clarities. The resolution of these distinct concepts offers potential to generate unique architectural outcomes that may at first appear unresolvable or at least problematic. Whilst the author is persuaded of the utility of concept hybridisation, there is work to be undertaken to categorically demonstrate this utility, anticipated to be through case studies of projects from outside the practice, such as the North Zealand Hospital by Herzog and de Meuron and the Barilla Pavilion concept by the author.

It is acknowledged that further work must be undertaken to locate the system of concept generation within previously established systems within the discipline of architecture and those outside the discipline; archival processes common to art practice, morphological matrix processes of product design and innovation programs common to business management. Furthermore, the problematic aspects of totalizing systems from the design methods movements of the 1960s and 1970s require treatment.

Towards a Model of Practice-Based Design Research

If we return to the criteria for qualitative research outlined at the beginning of this paper; that research should be *systematic*, *accessible* and *transferable;* the following responses are provided.

The research possesses a systematic quality, utilizing a methodical procedure that sits outside business-as-usual architectural practice and has begun to generate concepts. Attempt has been made to externalise the process and make accessible within this paper, enabling peer review and seeking to move beyond tacit knowledge. It is hoped that the value that the practice is deriving from this research process is evident and moreover that aspects of the system may be utilized by others, outside the practice, therefore placing the research on a trajectory towards transferability. The introduction of a provisional, externalized, architectural knowledge structure offers a potentially useful tool, regardless of form[6], that contrasts to well-developed 'instantiated reflection' modes of design research[7] and provides an alternative approach. The creation and articulation of a tool that informs design process offers the promise of traceability of decision-making, allowing greater access to core decision-making and serving to address a primary concern about design as a mode of research, namely that design impulses are often suggested as 'beyond explanation and so the production of architecture is left mythologised rather than subjected to clear analysis.'[8]

References

[1] Yasser Megahed, "On research by design," *ARQ: Architectural Research Quarterly* 21, no.4 (December 2017)*:* 338-343, p.338.

[2] Megahed, "On research by design", 340.

[3] Shane Murray, 'Design Research: Translating Theory into Practice', in *Design Research in Architecture: An Overview*, edited by Murray Fraser, p. 95.

[4] The first stage of the Cranbrook School Wolgan Valley project has recently been completed. The project has been exhibited in the Mori Gallery Tokyo (July 2018) and will be featured in the September issue of Tokyo A+U.

[5] The Australia House commission was obtained through an international competition, judged by Tadao Ando. The completed project received the Jorn Utzon Award for International Architecture 2013.

[6] The matrix-based process is not suggested as the sole form of knowledge structure but only as the structure elected by the practice.

[7] Richard Blythe and Leon van Schaik, 'What if Design Practice Matters', in *Design Research in Architecture: An Overview*, ed. by Fraser, p. 61.

[8] Jeremy Till, 'Architectural Research: Three Myths and One Model' in *Building Material,* 12/2007, Issue 17, Architectural Association of Ireland, Dublin, 2017, p. 4.

Composing the Whole Thing: Design Research in Peter Eisenman's Recent Studio Teaching

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Abstract

A central mode of thinking for built environment practitioners generally and architects in particular is that based on part to whole relationships, the idea that fractional relationships necessarily characterise coherent objects and building ensembles and in turn reference nature as the basis for beauty. The notion that all parts relate to a whole can be taken as one index of the limits practitioners, educators, and scholars have identified in certain modes of thinking and practice whether at the scale of the building or the scale of urban form. This paper pursues research into alternate modes of architectural design that challenge perceived limits of part-whole logics, revealing other manners of thinking that deploy specific form-generation strategies and devices and contribute to a practice that embraces complexity and in turn reveals unforeseen potentialities on the edge of design research. The paper does this through the analysis of the work of architect Peter Eisenman (b.1932). While there is evidence of this temperament at play in office projects, the paper focuses on Eisenman's university studio teaching. Through an analysis of select university studios, the paper reveals instances in Eisenman's teaching that promote different issues, different problematics, and singular form-composition strategies that together embrace ambiguity through such notions as partial fragment, superposition, and aggregation. Referencing published and unpublished teaching materials and student work, the paper examines Eisenman's three-year Venice Project studio (2009, 2010, 2011) and Aggregation Project studio (2013) delivered at the Yale School of Architecture. The paper contributes to secondary scholarship on Eisenman with its focus on a little studied aspect of his work, adds to investigations in design research, and is aligned with the conference theme scholarship and theory of design research in architecture.

Introduction

An underlying assumption of this paper is that the various activities of the university architecture studio constitute a form of critical experimentation and that these activities contribute to advancing disciplinary knowledge. Two propositions - one conceptual, one methodological - underpin this paper's development of that assumption. The first is that design-led research in the university architecture studio contributes to architectural knowledge in a manner no less vital or effective than more traditional archival, historical, and text-based academic methods. The second proposition: investigations undertaken in the studio at their most creative emerge from a deep critical engagement of architecture's interiority with something outside the discipline.

A survey of singular approaches to the university studio will be used to develop a preliminary response to these propositions. The examples are Peter Eisenman's Venice Project studios, a suite of studio problems unrolled over three years (2009, 2010, 2011) and his Aggregation Project studio (2013), all undertaken at the Yale School of Architecture.[1]

An analysis of the Eisenman studios provide a dense range of highly charged and differentiated approaches to the architecture studio as a realm of critical work on forms and on ideas. Each is distinguished by specific kinds of architectural issues, problems, sites, briefs, and a range of strategies for analysis, project development, and visualisation. Each, it will be shown, is structured and run to establish the architecture studio as a form of open-ended research.

The Eisenman studios provide a particularly apt beginning to a larger examination of the university architecture studio as a form of experimental design research. This is due not only to the depth of studio data and documented student work available over multi-year periods, but also because they represent a range of approach, scale, and thematic-conceptual focus. Eisenman's studios, I will argue, focus on potentials resulting from the confrontations of discipline specific formal elements and problems internal to architecture with ideas and form generation strategies outside architecture, taking analysis as the first step and fundamental basis of the design process.

There has been limited historical work on the role and theoretical reach of specific university studios, and ones based on multiple year surveys is even more rare. Exceptions include work on John Hejduk's studio program at Cooper Union,[2] and studies on and documentation of Colin Rowe's graduate urban design studio at Cornell University.[3] In this context, the present paper is intended to, if not inaugurate, at least provide focus and some key themes on this problem to be subsequently developed in future research.

The majority of secondary material on Eisenman has focused on his architectural design projects, the relation of his projects and writings to architectural theory, or the trajectory and place of the projects within the recent history of the discipline or Eisenman's own practice. Other than brief references, there does not yet exist a body of secondary work on his approach to teaching. Robert Stern's preface to the exhibition catalogue *Palladio Virtuel* is one exception. Stern alludes to, but does not develop, two aspects of Eisenman's teaching. He claims that Eisenman sees building and teaching as one activity, and different from an emphasis on the contemporary, the 'here and now', Eisenman's approach is distinguished by bringing the entire culture of architecture to the studio.[4] This will be evident in the Venice Project studio, as I will show below. Stan Allen makes a brief reference to seminars given by Eisenman at Princeton in the early 2000s in his useful introduction to *Ten Canonical Buildings 1950-2000*. Allen does not however develop nor contextualize the structure and pedagogical stakes.[5]

I have selected these four studios – Venice Project studios I, II, III and Aggregation Project studio – for pragmatic as well as strategic reasons. There is reasonable documentation of student work alongside teaching materials to allow comparative assessment. There is also, I will discuss and as Eisenman himself alludes to, a swerve in the 2013 studio from previous approaches and I will try to articulate the terms of that departure.

Material on Eisenman's studio teaching at the Yale School of Architecture as well as resulting student work has been primarily sourced from *Retrospecta*, the annual publication of student work and events at the Yale School of Architecture. It has been supplemented by unpublished studio outlines which set out the key ambitions, provocations, and references for each year. Consistent with the limits of this conference paper, in this paper I endeavour to formulate the research questions and key terms of reference, trial the methodology, and outline findings based on the surveyed studios. Future research will refine the approach, expand on the primary source materials and case studies, and further develop and contextualise the findings opened here. I discuss below possible immediate lines of research focus in the concluding section.

The paper aligns with two of ADR18 conference themes: scholarship and theory of design research and design research education. I'm interested in exploring the potential of the studio as research platform in itself and as a form of critical and creative engagement with the discipline. The paper is also intended to establish preliminary evidence that the Eisenman studios can be read as contributing to architectural knowledge and thus function as regimes of research.

Analysis

In this section, I examine the topics, thematic ambitions, and protagonists in each of the four Eisenman studios under study. Student projects are referenced to illustrate responses to the kinds of architectural problems being considered.

Venice Project Studios

A multi-year studio developed and delivered at the Yale School of Architecture in 2009, 2010, and 2011, Eisenman's Venice Project studios were organized around a series of specific problems and conditions that engaged ideas, devices, and forms in the broadest and most ambitious sense. A close reading of studio outlines reveals four key elements in each, swinging between those that might conventionally be thought as either internal or external to the discipline.[6] The character and trajectory of the studio is suggested in a review of these four elements:

- a pair of ideas, a polarity as will be seen in most but not all cases,
- a type-specific building, canonical project, or urban situation to be engaged critically,
- the provocation to explore the generative possibilities of a contemporary theoretical lens for working on architectural problems, and
- a set of formal and transformative operations.

A functional brief was always also in place, though was specifically to be treated in a perfunctory manner so as not to distract students from other issues according to studio outlines. Together, these elements informed the orientation and method of the studio's work. In terms of studio structure, at their most basic, the Eisenman studios were divided into an analysis phase (nominally four weeks, or one third of a fourteen week semester) and a design or project phase (the remaining eight or nine weeks, or two thirds of a semester).

The first Venice Project studio dealt with rhetoric and grammar, confronting the sixteenth century proposals of Alvise Cornaro for Venice's basin and their impact on Palladio, with Guy Debord's notion of détournement – which we can translate as destabilisation - and Pier Vittorio Aureli's reading of the city as an 'archipelago of monuments.'[7] Students were to transform Cornaro's ideas differently manifest in the charged setting of a real and virtual Venice: the difference intended to render the creative potential for architecture through conjectural proposals spurred by the opening provocation of and architectural engagement with rhetoric and grammar.

The structure of the studio mimed the ambitions of Eisenman: conflating Cornaro with Palladio read through the lens of Debord's idea of détournement and studying the impact both in terms of method or technique interrogating the architectural problem as framed and, in turn, generating a physical response following a study in part of previous urban scale proposals for the city. It is worth citing a segment of Eisenman's studio outline to get a sense of the intent: 'This studio examines Cornaro's proposal in light of Palladio, and examines the technique of overlay as not simply a mode of collage, but instead turning to Guy Debord's concept of détournement.'[8]

Eisenman further clarifies the intent: 'using a process of détournement [destabilisation], and beginning from Cornaro's scheme we will attempt to keep his project somewhat intact… What that means and how it will be done is the subject of the studio.' As a further explanation he notes: 'The result is to be manifest in tectonic means appropriate to the site's history and today's context.'[9]

Two student projects can be taken as placeholders for studio outputs resulting from this provocation. Aidan Doyle and Palmyra Geraki's proposal replaces the Rialto Bridge in a new analogical manifestation of Palladio's design for the site. A rotated plinth is let loose in the canal and is stabilised provisionally, locked into place along organising axes and punctuated by a series of what the visiting studio jury characterised as fetish objects.[10] Craig Chapple and Matthew Persinger's approach is radically different in location and type, proposing a linear organisation that conceptually ties the mainland to the Stazione Termini. Three Palladian building forms are claimed to function as different threshold conditions as an echo of Cornaro's proposal.[11]

In the second year, the polarity announced in the studio outline is that of genius loci (spirit of place) versus zeitgeist (spirit of present time). The precedent and study site for the studio were Le Corbusier's project for the Venice Hospital in Cannaregio, the latter taken as launching an engagement and transformation of the mat building typology. The place of the contemporary lens is occupied by Michel Foucault's concept of heterotopia, a condition in which simultaneously several perhaps incompatible places exist.[12] According to the studio outline, students were to explore this condition of simultaneity through a strategy of what Eisenman calls superposition. The term superposition is used to describe a condition of layering which preserves specific qualities of each layer as distinguished from superimposition conceals qualities in the overlapping zones. Eisenman's challenge to the students, springing from a confrontation of these terms, was to 'attempt to locate possible architectural capacities in the space between the evolving concepts of place [genius loci] and presentness [zeitgeist].'[13] The reference to locating 'possible capacities' through the process of project development can be taken as shorthand for a core studio ambition.

Only one student project has been partially published but it can be used to illustrate possible outcomes. Jonah Rowen and Daniel Markiewicz's project for Venice Project II proposed a plinth that extends into the lagoon on the site of Le Corbusier's proposed hospital. Internal spaces are organised around a series of sunken courtyards and the project as a whole was suggested to critically invert organising principles of the unbuilt Venice Hospital while capturing the latent urban character of Cannaregio.[14]

In Venice Project III, the polarity or idea pair is figure and typology. This pair itself is further complicated by a confrontation with – or overlay on - the notions of *disegno* and *colore*, a dialectical pair proposed to mark differences between the Florentine painting of Pontormo (on the side of *disegno*) from the Venetian painting of Giorgione (on the side of *colore*). A further complication is introduced with the addition of Aldo Rossi's Gallaretese Housing and Cemetery of San Cataldo in

Modena as formal-typological models to be transformed. Two project sites further echoed this conceptual doubling, with studio members working in pairs simultaneously on a site in Florence (the Piazza della Signoria) and one in Venice (the Arsenale basin).

In this third year of the studio, Eisenman sets out the problem as continuing an investigation into 'aspects of the architectural discipline.'[15] It is worth citing the outline at length, in part to start to tease out the differences from previous years.

> This studio will engage the problem of figure—or the fragmentation of figure—and typology in architecture today by tracing an invented lineage through central and northern Italy, from Pontormo in Florence to Giorgione in Venice, from Aldo Rossi's Gallaretese II housing in Milan to his Cemetery of San Cataldo in Modena. These precedents will serve as transformative or possibly "analogous" projects in their Florentine and Venetian settings. The opposition of the Italian terms *disegno* and *colore* will also inform the technique and method of the studio's work.[16]

There is value in unpacking further the studio ambition and its differences from the Venice Project studios. The most striking difference in Venice Project III is that students were to develop parallel projects on sites of great diversity: the almost absent ground parasitically edging into but not occupying the Piazza Signora in Florence versus the necessarily artificial island non-ground site of the Arsenal Basin. This doubling paralleled the duplication of protagonists to include painters and aesthetic debates around disegno versus colore. Process and final models and drawings of students Miroslava Brooks and Amy DeDonato mark possible transformations from generic to specific forms according they argue to the logic of partial figures as one illustration of the issues explored in the studio.[17]

An attempt to draw principles or conclusions with further application, to generalise lessons out of the three Venice Project studios, is difficult. That said, an accounting of the ambitions, if not hypotheses can be tried and a close reading of the unit outlines yields some clues. Polarities, that of *genius loci* and *zeitgeist* for instance, are proposed as hypothetical frameworks for a critical approach to analysis and the development of specific responses to sites which in parallel prompt transformations of design principals in canonical projects from architecture's past or more generic typologies (mat, slab, tower). Eisenman deploys all these as one means to encourage studio members to try via form and physical means to locate possible critical architectural capacities in the space between the various terms.

Eisenman hints at such ambition in the second year's studio outline where he discusses the investigation of the possibilities of grammar and rhetoric as operative linguistic devices in architecture.[18] This is one way to formulate the research problem then tested in the student projects: not so much a 'what is' the space between the two terms of the polarity, but how might one formulate the architectural question of the two such that something new is revealed.

This generative nature of the Venice Project studios, this opening of possible futures or capacities in architecture, is one way to characterise the specific research problem interrogated by Eisenman. I will return to this in the concluding section of the paper.

Aggregation Project Studio

Eisenman himself characterises the Aggregation Project studio as a departure from previous studios. Which are the important or distinguishing deviations? Different from Venice, the studio is not announced as a multi-year exploration. Rather, there appears to be some current urgency that prompted in part the specific orientation and elements: a specific debate that Eisenman wanted to engage via the studio. The contemporaneity is thus distinctive as compared to the Venice Project studios which individually considered historical and virtual pasts - Cornaro's 16th century plan for the laguna, Le Corbusier's unbuilt Venice Hospital - and what might be characterised as general conditions (figure versus ground; genius loci versus zeitgeist). In the aggregation studio, it is a digital practice of parametric or algorithmic-based design that is at stake.

Run in the Fall 2013 semester, and taking a site in Rome, the Aggregation Project studio charge was 'to re-define the term – aggregation – as a critique of the digital, which has become synonymous with homogeneous, continuous space.'[19] More specifically, students were asked to develop architectural responses to the question of a kind of heterogeneity that, following Jeffrey Kipnis, offers another form-space model that differs from the parametric and results in a singular as opposed to continuous, extensive space.

The process for approaching the question along two poles was suggested in the studio outline. One pole is framed around ideas of ground, or questions of ground as datum, in part complicated by locating the studio brief in Rome on a site charged with history: the Piazza del Cinquecento adjacent to the Stazioni Termini and the Baths of Diocletian. The second pole is a strategy of three overlapping typologies: mat, slab, tower. The brief to be accommodated was a 20,000 m2 Library of Rome.

Two different student solutions are reproduced in *Retrospecta* and suggest the potential range of outcomes. Brandon Hall and Evan Wiskup proposed extensions of the Stazioni Termini slabs to bracket the Piazza Library spaces then creating a blurred new ground that extends into the arrival hall of the Stazioni.[20] Taking a different tactic, Elisa Iturbe and Brittany Utting propose a 'stich': a narrow building-space that alternately compresses and releases as it runs between and binds together the Baths and the Stazioni.[21]

Observations

In order to inaugurate a larger study of the university architecture studio as a form of critical experimentation that advances architectural knowledge, specific approaches to the studio have been briefly surveyed. What, if anything, do they share? Are there generalizable lessons on the workings and reach of the university architecture studio as a realm for research one could extend out to or apply elsewhere? What are the important differences? Finally, which future lines of inquiry should be followed to further test the opening proposition that studio-based research contributes to architectural thinking, and that work in the studio at its most creative emerges from a critical engagement with something outside?

Similarities and Differences

The Eisenman studios, to state the most basic, can be read as investigations of specific architectural problems, whether work on architectural precedents, form generation strategies, the traditional versus modern city dialectic, or the design process itself and more generally as the aim of the pedagogic enterprise.

Looking more pointedly, four characteristics seem to be in common. First, there is an emphasis on precedent, whether an architectural problem to be taken on again or as a formal solution to be collaged onto a specific project site in a spirit of conjecture. Second is repetition: studio problems are repeated over several years with variations and refinements. In the case of Eisenman’s Venice Project studios, a framework is adopted and replacement terms (of concept couple, analytic component, site) introduced. So duration, variation, and the implication of a shared studio culture are all implied and used. Third, there is an explicit effort to remain open to the new, and to renewal generally. In the case of Aggregation Project studio, this occurs perhaps at the level of contemporary thought. Or in Venice Project studio I, it is the force of the specific city to reshape thinking and forms that is the vehicle for renewal. Fourth, the functional brief or space program is down played or even absent. Eisenman downplays function over a privileging of other architectural issues and conditions whether a concept (group in the Aggregation Project), or an eclectic and coherent shape or form.

There is a fifth aspect, related to transmission and reflection: the process and outcomes are documented. Publications by Yale School of Architecture have ensured the partial documentation of student projects and in certain years highlights from the final jury deliberations, allowing the ideas and form capacities to further resonate.

Table 1 charts the main elements of each studio in order to start to map the range of architectural issues at stake in the four studios.

	Venice Project studio I	**Venice Project studio II**	**Venice Project studio III**	**Aggregation Project studio**
Polarity		place (genius loci) versus presentness (zeitgeist)	Figure versus partial figure; disegno vs colore	Aggregation versus digital; non-homogeneous versus homogeneous
Protagonists: inside the discipline	Alvise Cornaro	Le Corbusier's Venice Hospital;	Aldo Rossi, Gallaretese II; San Cataldo Cemetery, Modena	Patrick Schumacher; Jeffrey Kipnis idea of heterogeneity
Protagonists: outside the discipline	Guy Debord and the idea of détournement (destabilisation)	Michel Foucault's idea of heterotopic space as opposed to the utopic	Paintings of Pontormo, Florence vs Giorgione, Venice	
Typology		mat		tower, slab, mat
Site	Venice	Cannaregio, Venice	Piazza della Signoria, Florence; Arsenal Basin,Venice	Piazza del Cinquecento, Rome
Brief	Cornaro's scheme varied	Regional Centre for the Veneto,	Residential (70 apartments, 90,000 gsf)	Library of Rome (20,000 m2)

Table 1: Matrix of terms in four of Peter Eisenman's advanced architecture studios.

The differences are both evident and subtle. The scale of investigation is the most visible. The variations run from multi block (Cannaregio, Piazza del Cinquecento) to infill (Florence). The attitude toward context, site, and ground varies, as does the underlying assumption about autonomy. At a different scale and in a different realm the challenge of deploying a challenge to figure/field relationships in favour of figure-figure passes through a filter or is indexed against proto cubistic composition devices not only in plan but spatially, which endeavour to realize an 'and-and' as distinct from an either or, condition.

Another way to distinguish the difference of approaches, and to clarify the question of their critical contribution to the discipline, is to endeavour to formulate the research problem the studios could be said to be treating.

As briefly discussed earlier, the research problem in Eisenman's Venice Project studios might be characterized as form research using operative frameworks delimited by aspects formed in binary couples (rhetoric/grammar, *genius loci*/*zeitgeist*, figure/typology), used in turn to read projects and places from the history of the discipline (Rossi's Gallaretese Housing, Le Corbusier's Venice Hospital, the Rialto Bridge). It is a parallel and self-complicating dialectic that takes on multiple aspects (historical, real, contemporary) and internal conditions of any architecture. Eisenman appears, in other words, less to interrogate specific conditions than to stage the differences between the synthetic activities of the design process itself and the discipline and practice of architecture as that which is beyond the functional and iconographic facets of building design.[22]

To try another formulation, Eisenman's field of inquiry can be seen to be simultaneously context based – whether the Arsenal Basin in Venice or the Piazza Signora in Florence – and deeply engaged with architecture's future by a parallel confrontation with architecture's past (its insides) and an openness to the potential in concepts and ideas from other realms (architecture's outsides). The stakes can also be claimed to be based on a trajectory or context of forms, ideas and places, whether the mat building type, Cornaro's *bacino*, Rossi's San Cataldo Cemetery, or Le Corbusier's Venice Hospital. It is deeply engaged with architecture's future by a parallel confrontation with architecture's past and an openness to the potential in concepts and ideas from other realms, whether the grammar/rhetoric polarity, Michel Foucault's heterotopia, or Debord's *détournement*.

To that extent and in their differences, all four studios might be said to share an optimism about the future that is so intense that it's the present, in the end, that is approached. It is an endlessly reinvented present, rendered by individual imagination, the city, and the art of composing a building.

Next stages of research

Additional research is needed to further examine the beginning assumptions and refine the research questions opened here. Immediate lines of inquiry might expand the case studies to include Eisenman's mid 1980s city studio run over three years at Harvard's Graduate School of Design. In addition, this narrow survey of his studio teaching would be invigorated if considered within the context of Eisenman's larger office practice and historical-theoretical projects. Such a move would reveal compounding influences between the various activities and provide further evidence of the university studio as site of knowledge production to return to the open questions.

In addition, systematic consideration of the range of architectural-urbanistic problems, their spatial conditions and formal characteristics should be attempted, other university programs examined, and additional close reading of studio materials from Eisenman undertaken to further expand the opening propositions.

The Eisenman studios can be seen as efforts to interrogate architecture and its possibilities through the university studio as a field of constant renewal. In that sense, studio work does not lead to conclusions. Or perhaps it is more accurate to say that conclusions are endlessly deferred except in a provisional sense, the activities of the university studio creating conditions of possibility for new architectural categories, conditions, forms, and ideas to emerge and which resist specifically returning – at least for Eisenman - to a part to whole bias in favour of an endlessly open and positively ambiguous mode of thought and practice characterised by such notions as partial figuration and a new idea of aggregation. They thus provide only provisional models and strategies for responding to this paper's opening questions and the ambition of a more nuanced mode of design research through the university studio project

This inconclusive nature of studio research can be given a closing word by Henry Cobb, one that suggests the potential for all built environment studio-based disciplines. In the mid 1980s Cobb was Chair of Architecture at Harvard University's Graduate School of Design, and he wrote the introduction to a catalogue that resulted from a multi-year studio led by Eisenman in those same years. In the university studio, Cobb notes, 'conclusive results are scarcely to be expected… what emerges is an array of new questions together with new strategies for pursuing them. To me this seems an entirely appropriate outcome for an experiment in architecture carried out under the aegis of the university.'[23]

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References

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[1] Peter Eisenman (b.1932) is an American architect, educator, and theorist, and principal of New York based Eisenman Architects. He has taught at the Universities of Cambridge, Cooper Union, Harvard, Ohio State, and Princeton. He is currently Professor in Practice at the Yale School of Architecture. Eisenman has published extensively. Recent books include *Diagram Diaries* (1999), *Ten Canonical Buildings: 1950-2000* (2002), *Giuseppe Terragni: Transformations, Decompositions, Critiques* (2003), *Inside Out: Selected Writings 1963-1988* (2004), and *Written into the Void: Selected Writings 1990-2004* (2007).

[2] On Hejduk's Cooper Union studios, key secondary sources include: Ulrich Franzen, Alberto Pérez-Gómez, and Kim Shkapich, editors, *Education of an Architect: A Point of View, The Cooper Union School of Art & Architecture* (New York: The Monacelli Press, 1999), original version published in 1971. John Hejduk, Elizabeth Diller, D Lewis, and Kim Shkapich, editors, *Education of an Architect* (New York, Rizzoli, 1988).

[3] Key secondary sources on Rowe's studio teaching at Cornell include: Steven Hurtt, "Conjectures on Urban Form. The Cornell Urban Design Studio 1963-1982," *The Cornell Journal of Architecture* 2 (1982): 54-78. David Blake Middleton, "Studio Projects," *The Cornell Journal of Architecture* 2 (1982): 78-141. Colin Rowe and David Blake Middleton, "Cornell Studio Projects and Theses," in Colin Rowe, *As I Was Saying* Recollections *and Miscellaneous Essays. Volume 3 Urbanistics*. ed. Alexander Caragonne (Cambridge, Mass.: The MIT Press, 1996), 5-84.

[4] Robert Stern, "Preface," in *Palladio Virtuel*, pamphlet to accompany the exhibition of the same name, 20 August – 27 October 2012, exhibition curators Peter Eisenman with Matt Roman (New Haven: Yale School of Architecture, 2012), s.p.

[5] Stan Allen, "Eisenman's Canon: A Counter-Memory of the Modern," in Peter Eisenman, *Ten Canonical Buildings 1950-2000* (New York, Rizzoli, 2002), 9-12, 9.

[6] Peter Eisenman, "Unit 1104a. Venice Project I - Alvise Cornaro and the Venetian Laguna," Yale School of Architecture, Fall 2009, unpublished architecture studio outline. Peter Eisenman, "Unit 1106a. Venice Project II - Le Corbusier and the Visionary's Venice," Yale School of Architecture, Fall 2010, unpublished architecture studio outline. Peter Eisenman, "Unit 1104a. Venice Project III - Figure/Disfigure," Yale School of Architecture, Fall 2011, unpublished architecture studio outline. Though unpublished, summary details for each of the three Venice Project studios can be found in respective issues of *Retrospecta*, an annual journal of student work and activities of the Yale School of Architecture separately referenced below.

[7] Eisenman, Venice Project I, unpublished studio outline. The notion of *détournement* is defined by Guy Debord in his *Society of the Spectacle* as 'the antithesis of quotation'. For Eisenman, one aim of the studio was to transcribe this idea into an architectural device of 'overlay', one which he proposes differs from or is more than a simple technique of montage or collage. (Eisenman, Venice Project I, unpublished studio outline) See: Guy Debord, *Society of the Spectacle*, trans. Donald Nicholdon-Smith (New York: Zone Books, 1995).

[8] "Venice Project I: 1104a Advanced Studio," in *Retrospecta 2009*-2010, ed. Con Vu Bui, Christos C. Bolos, Justin Trigg and Diana Nee (New Haven: Yale School of Architecture, 2010): 34.

[9] Eisenman, Venice Project 1, unpublished studio outline.

[10] "Venice Project I," 34-35.

[11] "Venice Project I," 36.

[12] "Venice Project II: Le Corbusier and the Visionary's Venice. 1106A – Peter Eisenman, Venice, Italy," in *Retrospecta 2010-2011*, ed. Amy Kessler, Edward Hsu and Yasemin Tarhan (New Haven: Yale School of Architecture, 2011), 44-45. See also the unpublished studio outline.

[13] "Venice Project II," 44.

[14] "Venice Project II," 44-45.

[15] Eisenman, Venice Project III, unpublished studio outline.

[16] Eisenman, Venice Project II, unpublished studio outline. The polarity *disegno*, drawing or design more generally with an emphasis on line as the basis of composition, and *colore*, or colouring with an implied reliance on patches of colour or shape as the beginning, has a long tradition and is typically formulated in art historical contexts as geographically differentiated. Artists from Renaissance Florence are often placed on the side of *disegno*, Venetian artists of the same period on the side of *colore*.

[17] "[Venice Project III] 1104A Advanced Design Studio. Peter Eisenman with Matt Roman," in *Retrospecta 2011-2012*, eds. Tyler Collins, Leeland McPhail and Evan Wiskup (New Haven: Yale School of Architecture, 2012), 47-48, 137-138. See also the unpublished studio outline.

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[19] "A Project of Aggregation. Peter Eisenman," in *Retrospecta 37 2013-2014*, eds. Dov Feinmesser, Jenny Kim and Andrew Sternad (New Haven: Yale School of Architecture, 2014), 102-104, 102. See also: Peter Eisenman, "1105a. A Project of Aggregation," Yale School of Architecture, Fall 2013, unpublished studio outline.

[20] "A Project of Aggregation," 103.

[21] "A Project of Aggregation," 104.

[22] Eisenman circles around these distinctions in the studio outline for the final Venice Project studio.

[23] Henry N. Cobb, Foreword, in J. J. Marvel, ed., *Investigations in Architecture: Eisenman Studios at the GSD 1983-85* (Cambridge, Mass.: Harvard University Graduate School of Design, 1986): 5.

Oblique Speculations: A Study of Frank Lloyd Wright's Grid in the Drawings of Edwin H Oribin

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Abstract

During the late 1920's in the true wilderness of Arizona desert, Wright freed himself of the orthogonal prepositions and right angles of his early Prairie houses to develop a geometry of oblique lines; an interest first demonstrated in the Ocatillo desert camp, a temporary workplace for the design of San Marcos Project (1929) and Taliesin West (1937-1959). The concept was further developed in the Hanna house (1937) and other Californian houses of the late forties and early fifties which used diamonds and hexagons as underlying grids. Levine has argued that the spatial experience of diagonality in Wright's work recalls Piet Mondrian's diamond grid paintings (1921) and Theo van Doesburg's diagonal counter compositions (1924-1925) thus establishing a connection between his architectural work and contemporary European art. This paper seeks to understand the transfer of this principle to Australia as illustrated in the work of the Queensland architect Edwin H Oribin. Oribin who worked in Far North Queensland started his practice in 1953 and designed his first home and studio (1958-1960) based on the diamond grid. This research paper examines his use of the oblique grid and its relationship to the architectural plan forms of Frank Lloyd Wright. The study will also argue that this compositional manipulation with the use of thirty/sixty degrees triangles is not only to make buildings more expressionistic but also allows the development of a new spatial freedom that moves beyond the formal order of the orthogonal grid. This design research assumes that oblique grids are essentially complex systems that function as a template for future design applications.

Introduction

Grids have been used throughout history as an organization tool of architecture to enforce regularity, symmetry, order and balance. In the contemporary design practice however, grids are considered an outdated device to control the design process. Networks and their inherited complexity are preferred for analysis and design of the built environment. This paper attempts to disclose the dynamism of oblique grids that develop micro-networks of their own, using lines and nodal points, creating unique rule-sets and patterns without recognition of the underlying grid. The analysis technique is based on the theory of complexity and emergence while using historical evidence from the drawings of Edwin H Oribin and Frank Lloyd Wright.

Complexity is not a methodology rather it is a conceptual framework for understanding the world. Murray Gell-Mann (1995/96) traces the meaning to the root of the word. Plexus means braided or entwined, from which is derived complexus meaning braided together, and the English word "complex" is derived from the Latin.[1] A classic example is human brain consisting of about 100 billion neurons and 100 trillion neuron connections. Each neuron is relatively simple (compared to the whole brain) and there is no central control. Somehow the huge ensemble of neurons and connections gives rise to the complex behaviours we call 'cognition' or 'intelligence' or even 'creativity'.

Being part of a current PhD project, the focus here is on the predicament between architectural design and complexity theory and to conjecture forthcoming architectural design approaches.

Edwin H Oribin: A brief biography

Edwin H Oribin (1927-2016), a self-taught architect from Far North Queensland, was born in Cairns. From an early age, he developed an interest in drawing and designing wooden planes and gliders. In 1944, he secured a five year apprenticeship with SG Barns who was an established architect in Cairns. During this time, he also started studies in Architecture by correspondence from Nangle Institute of Technology, Sydney. By 1949, Oribin finished his training and moved to Brisbane with his family to prepare for the Queensland Board of Architects examination. He became a registered architect in 1953. During his time in Brisbane, Oribin worked with Vick Embeldon and as a token of appreciation he gave him a copy of ‘The Architectural Forum’ (1938) that featured the work of American architect Frank Lloyd Wright. This work proved to be a lifelong influence on Oribin’s architectural career.[2]

After returning to Cairns in 1953, Oribin began a partnership with Barnes and the firm became known as S.G. Barnes and Oribin (1953-59). For him, it marked a period of immense creativity that was to continue for the following two decades. During this period many buildings were designed, documented and built, often solely by Oribin, and others under the general oversight of Barnes. Oribin’s First House, which is a major case study in this paper, was built in 1958 and signalled the start of what might be described as Oribin’s signature architectural style. In 1960, the house was followed by the construction of an attached studio.[3] Both were featured in the 1964 publication of ‘Building Ideas’ which also included a mention of Tanner House.[4] The publication increased public awareness of Oribin’s work and established his reputation in Cairns and surrounding areas. In the mid-1960s, Oribin made a four week trip to Japan and stayed in the decaying Imperial Hotel designed by Frank Lloyd Wright.[5]

Oribin’s achievements received very little attention during his architectural practice. As Alice Hampson observed in her 1987 thesis that ‘because publications in the architectural field are predominantly limited to the south-east Queensland region, many Far North Queensland architects have, to date, received insufficient recognition.’[6] It was only in 2013, when four of Oribin’s projects, Oribin’s Studio (1960), Mareeba Shire Hall (1960-61), St Paul's Anglican Church (1958-59), and St Andrew's Presbyterian Church (1961) were registered in the Queensland Heritage Register and the same year Oribin House and Studio received the "Enduring Architecture Award" at the Australian Institute of Architects Queensland chapter.[7]

Sources

There are no surviving archival records from Oribin’s office. He described himself a man of the present and the future and confessed to destroying all plans and records as the years went by.[8] In 1997 a B.Arch. thesis was conducted at the University of Queensland by Martin Majer under the supervision of Peter Skinner where he collected copies of original drawings from public offices, councils and documented a number of Oribin’s projects. His findings are kept at the Fryer Library at the University of Queensland as an open-access collection of 160 architectural drawings of Oribin's buildings designed between 1956 and 1997.[9] This is the primary source of information for developing this document. Apart from that, there is an unpublished autobiography provided by the family that gives an overview of

Oribin's life. Oddly, his architectural practice is given very little consideration in this text.

Lessons from Diagonality

'When Dad builds,' wrote Wright's son John in 1946, 'he sees things out of the corner of his eye. He never looks straight at them.' The diagonal axis, as argued by Neil Levine, has always been an explicit or implicit underlying principle of order for Wright.[10] This aspect of Wright's work, I argue, can be attributed to the influence of Louis Sullivan for whom he worked from 1887 to 1893. If we study the first plate of Louis Sullivan's system of ornament we see a square inscribed by another square with corners forced out by diagonal lines to give way to a special motif.[11] This treatment of corner and use of diagonal grid might be the first lesson of diagonality for Frank Lloyd Wright. He then used it further for 'the destruction of box' and opening up the plans for Prairie houses along the diagonal lines of corners.[12] James Dannis in 'Ornamentation and the Organic Architecture of Frank Lloyd Wright' (1965) argues that;

> Similarities between [Sullivan's] 1903 decoration and the large ground plan of the late fifties are found in the extended or overlapping triangles, and the combination of several shapes to create new ones, for example, two triangles become a diamond shape. Thus, in the end early surface decorations are, in effect, taken down from the old walls and windows to become extended spatial determinants of Wright's last ornament-buildings.[13]

The aspect of diagonality in Wright's work is praised by Vincent Scully in his 1952 article where he used the term 'diagonally reflex plans' for his work and described diagonals as having the power to destroy boundaries and to create reflex that makes them live and grow as spatial forms.[14]

Frank Lloyd Wright's work was published extensively in Australian journals; 'Building', produced by George and Florence Taylor; 'Art and Architecture', 'The Salon', and 'Architecture in Australia', published by the Institute of Architects of New South Wales; 'Real Property Annual', renamed 'Australian Home Beautiful' in 1925 and 'Journal of Proceedings of the Institute of Architects of Victoria', constituted the major literary sources.[15] This parallels the broader publication of Wright's work internationally, specifically the three dedicated issues of 'The Architectural Forum' in 1938, 1948 and 1959. Philip Goad discussed the influence of Wright's ideas on Australian readers in his 1992 thesis;

> From 1954, with the publication of Wright's 'The Natural House' and his much touted revival on the American architectural publication scene, there was unconsciously spawned in Australia, a new generation of Wright followers who would also extend and produce highly original interpretation of organic architecture through to the 1970's.[16]

Oribin was also among those architects who got inspired by the architecture of Frank Lloyd Wright and its connection with nature. During a personal communication with architect Grant Spork in the late 1980's he acknowledged the influence of Wrightian philosophy on his own architecture.[17] He not only possessed architectural magazines that featured Frank Lloyd Wright's work but also owned a number of books on Wright including: 'Frank Lloyd Wright' by Vincent Scully Jr. (1960), 'The Future of Architecture' by Frank Lloyd Wright (1953) and 'A Testament' by Frank Lloyd Wright'(1957). Fellow Queensland architect Rex Addison later bought these books from a local book seller where Oribin sold them later in life.[18]

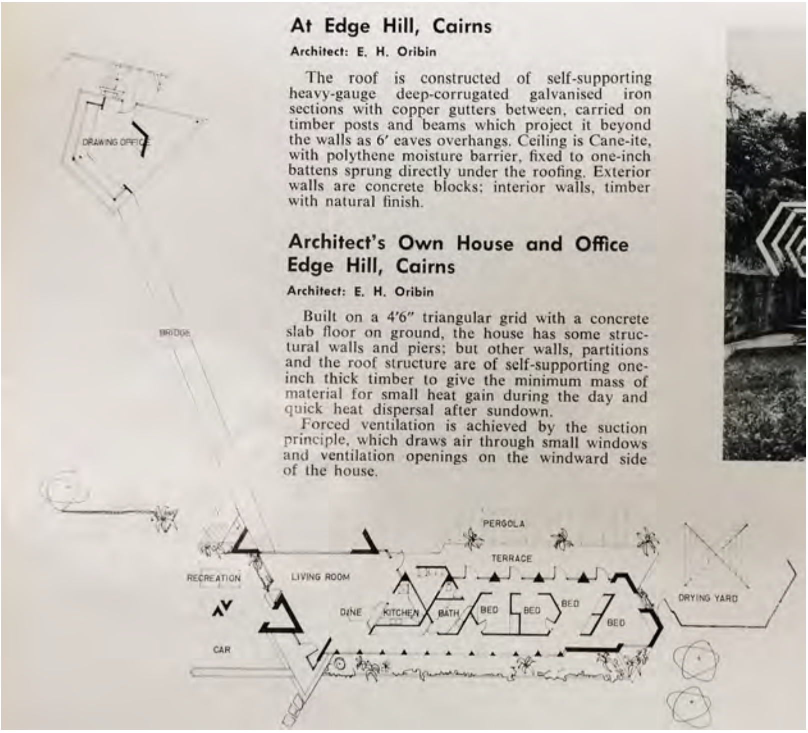
In 1957-58, when Oribin bought land for his first home on the corner of Mullins Street and Heaver Crescent, Cairns, it proved to be an opportunity to experiment with oblique speculations of the diagonal grid as practiced by Frank Lloyd Wright. In his biography he wrote;

> During my time at the Commonwealth Department of Works office in Brisbane a lot of the discussions we had were centred on the work of the American Architect Frank Lloyd Wright and I was very attracted to his general concepts and particularly on how some of his ideas could be adapted to the design of tropical buildings. His whole design philosophy was based on getting away from square boxes and the use of triangles and other geometric shapes to create workable and exciting spaces in which to live… I had studied many of Frank Lloyd Wright houses and was attracted to some of his which were planned on a triangular rather than a square grid and so I designed the Mullins Street house on a 4 foot 6 inches 60-degree equilateral triangular grid.[19]

To integrate the house with the site, Oribin spent hours studying the path of the sun, moon and wind movements. It was a wide site but shallow from front to back so based on airflow theory, he designed a 15-degree pitched roof to create a low pressure at the back of the house to suck air through the small windows on the front facade. The wall partitions for the bedrooms were also raised above the floor to allow natural ventilation. Light entered the house in a beautiful way through a strip on the eastern side at eave level penetrating the entire width of the house. Transversely, across the bridge, Oribin designed the Studio (1960) based on the same 60/120-degree angles with wide glass front facing South for maximum natural light.[20]

Figure 1: Own House. Heavey Crescent, Edge Hill, Cairns, Queensland. Edwin H. Oribin.[21]

Figure 2: Own Studio - Office. Heavey Crescent, Edge Hill, Cairns, Queensland. Edwin H. Oribin.[22]



At Edge Hill, Cairns

Architect: E. H. Oribin

The roof is constructed of self-supporting heavy-gauge deep-corrugated galvanised iron sections with copper gutters between, carried on timber posts and beams which project it beyond the walls as 6′ eaves overhangs. Ceiling is Cane-ite, with polythene moisture barrier, fixed to one-inch battens sprung directly under the roofing. Exterior walls are concrete blocks; interior walls, timber with natural finish.

Architect's Own House and Office Edge Hill, Cairns

Architect: E. H. Oribin

Built on a 4′6″ triangular grid with a concrete slab floor on ground, the house has some structural walls and piers; but other walls, partitions and the roof structure are of self-supporting one-inch thick timber to give the minimum mass of material for small heat gain during the day and quick heat dispersal after sundown.

Forced ventilation is achieved by the suction principle, which draws air through small windows and ventilation openings on the windward side of the house.

Figure 3: Oribin's home and studio as Illustrated in Building Ideas[23]

Oribin's First home and Studio are similar in composition with Wright's diamond module houses. The idea of using the oblique angle, which was first used by Wright in the Ralph Cudney project, San Marcos in the Desert in 1927 was expanded in the Hanna house (1937) and its descendants of the late forties and fifties. In the 1938 publication of Architectural Forum, Wright compared the hexagonal grid of the Hanna house to 'a cross-section of honey comb' and maintained that its 'flow and movement' gave a reflexiveness to the space, allowing it to open and close, expand and contract, and, indeed, almost to return back on itself in a continuous curve.[24] In these projects, while using a triangular/diamond grid the resulting spaces are neither hexagons nor triangles but rather oblique speculations of the unknown. An example is the Mrs Clinton Walker house near California (1952). The living room is almost a complete hexagon from which protrudes a wing of triangular bedrooms. Similarly, Randall Fawcett house (1955) and George Ablin house (1958) are based on triangular/diamond module with some modifications.[25] In all of these projects, the underlying grid formulations are similar, but the resulting interior spaces create infinite disparity and pattern (see Figure 4).

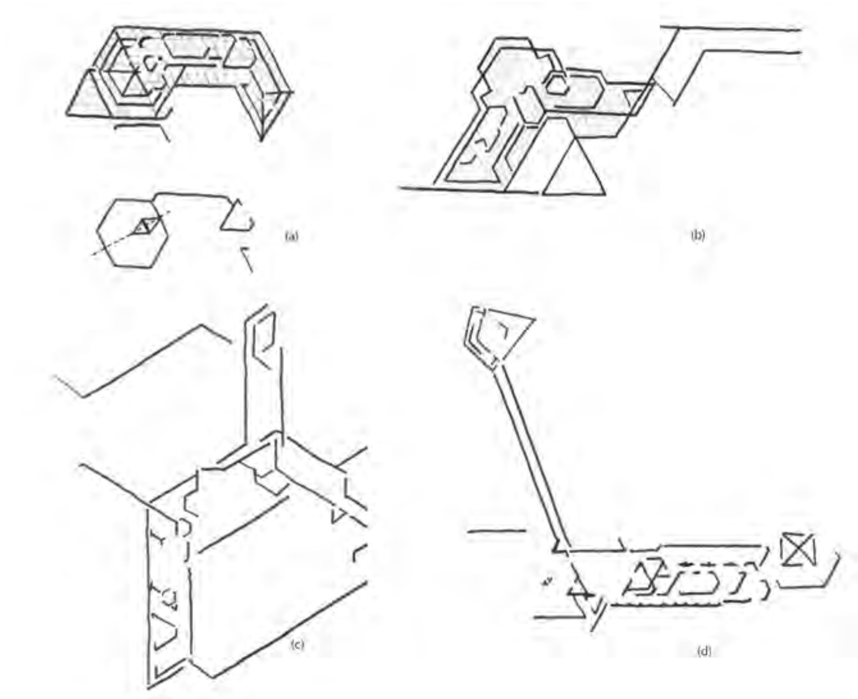


Figure 4: (a) Mrs Clinton Walker house (1952), (b) George Ablin house (1958), (c) Randall Fawcett house (1955), (d) Oribin's home and Studio (1958-60).[26]

Complexity theory for Architecture

During the past decades, complexity theory has evolved as a new discipline challenging the classical linear worldview. For architects, the advent of this new science offers the chance to reconsider design approaches and to invent new strategies for the analysis of historic buildings. Melanie Mitchel in 'Complexity: A Guided Tour' (2011) defines a complex system as;

> A system in which large networks of components with no central control and simple rules of operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution.[27]

Rather than offering new discoveries, complexity theory suggests a new viewpoint on many known phenomena, particularly those found in nature. Examples include chemical reaction cycles, weather systems, anthills and cities. Typically, complex systems are 'open' that keep on exchanging energy with their surroundings unlike 'close' systems that will settle into stable equilibria. Bovill's 1996 work, 'Fractal Geometry in Architecture and Design', was the first major exploration of the complexity of nature and architecture. He calculated the visual complexity of architectural plans and elevations using Mandelbrot's box counting method.[28] Also, Charles Jenks in 'The Architecture of the Jumping Universe' (1996) explains the complexity of self-similar systems as;

> Virtually all those who referred to 'organic architecture' insisted on work that shows self-similarity. 'Unity with variety'. They often mimic nature's patterns of organization and, in designs, 'naturally' repeat a formal idea at many scales and, just as inevitably as a flower, provide several foci. Bruce Goff is exemplary in this respect. Self-similar triangles, hexagons and trihexes organize his Price House - from the very large to the very smallest detail. Sixty-degree angles, their multiplication and subdivision, recur in all sorts of forms and materials.[29]

Based on the above discussion, I propose that one way of understanding oblique grid compositions is to consider the plan as a complex system that develops as a result of interaction between the functional and formal variants of the building program. In case of Oribin's house project, the 60/120-degree diamond grid is a three-line grid where the intersecting shorter side of the diagonal creates equilateral triangles and six of these adjoining triangles generate hexagonal spaces. Each node has six connectors and can be further classified as 'Anchorage' and 'Shrinkage' nodes where anchorage nodes define the outer lattice/boundary of the system and shrinkage nodes define the pattern/form inside (see Figure 5).

Once the basic forms are formulated, a sub nodal system can be developed resulting in secondary/tertiary spaces (Self-similar systems).

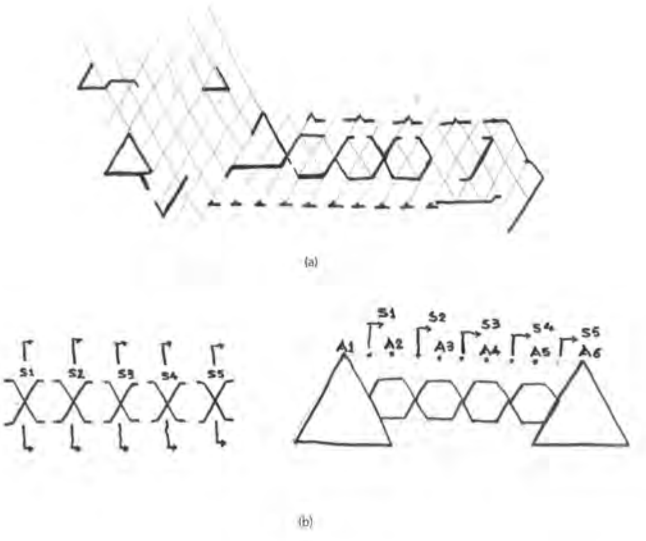


Figure 5: Analysis of Oribin house plan based on complex systems theory. (a) Outline underlying geometric formulations. (b) Marking outer boundary nodal points termed as 'Anchorage' and central axial nodal points defining linear formal arrangement termed as 'Shrinkage'.[30]

The positioning and interaction of these nodal points can be automated with intelligence (functional and form defining rule-set) to interact with each other and the environment resulting in the smart emergence of form. This can be achieved with already developed mathematical models like cellular automata which can simulate complex systems using simple rules of generation. This concept of simulating growth was first introduced by John von Neumann and further researched by Stephen Wolfram, recently published as ‘A New Kind of Science’ (2002).[31] Once the basic data is manipulated within these animated environments, the program is run over specific periods of time and patterns start to emerge by self-organization. In order to translate these patterns to architectural compositions these programs are then linked to form defining 3D software resulting in an array of building forms.[32]

The proposed design research method is based on modelling technique of complex systems with focus on morphology, emphasizing the adaptive or generative properties of architectural form. This approach is already being experimented in design studios like the Architectural Association, Design Research Lab (AADRL), London where in 2013 a workshop was conducted titled: ‘Cellular Automata: Evaluating the Edge of Chaos.’ The aim of the study was to develop an algorithm that analyses data from complex systems and manufacture a ‘physical model of the variations’ catalogue and graphical explanation of the desired result.[33] My argument here is that we can extract data from the historical reading of architecture and while using complexity theory and models of cellular automata, manipulate it for experimentation in architectural form. This could be an interesting analysis of understanding what Wright meant by “Organic.”

Conclusion

The above comparison of Wright and Oribin’s work, demonstrates a consistent and continuous evolution of form, while it is not assumed that the principle of diagonality explains all, it can be seen as a powerful tool of coherence that connects their work. The diagonal axis breaks the confines of symmetry, formal order and orthogonal rigidity and conveys the openness, flexibility and reflexivity of the oblique. With the assistance of self-generating mathematical models, this particular logic of the grid not only sanctions understanding of a particular order but also enables us to predict future permutations/combinations. The most important aspect of this research is the process; taking raw data from plan drawings, finding a pattern and then defining rule-sets in the interpretation of that pattern. The design research implications that arise from this study based on complexity theory can be further explored by developing catalogues of oblique grid formulations and will be the next step of my ongoing thesis research.

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Estranged City – John Hejduk's Venice Collage

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Abstract

This article focuses on collage as technique in architecture and its derived effect of estrangement. It establishes a point of view which takes the argument back to John Hejduk's city collage strategy in his proposal for Cannaregio around 1978. By comparing Hejduk's drawing 13 Watchtowers of Cannaregio with the map of Venice, architectural features that are impossible to exist in the given site are spotted in the illustration. The displaced elements are found to be modified churches, cathedrals and convents elsewhere in the city. Refusing to propose the project based on actual site, Hejduk composed a fictional one by collaging landmarks of Venice in the district of Cannaregio. The technique of collage has a deep reference to the dot-the-dot game of Texas Rangers in 1950s, inspired by surrealists' game Exquisite Corpse. Both games are dependent on the technique of assemblage–the technique of shock as Manfredo Tafuri mentioned.

This city collage is not only the essence of John Hejduk's transformation of his reflection upon urban issues in the 1970s, but also the central mechanism employed in his further Mask/Masque projects. Building on Anthony Vidler's model of estrangement as architectural mechanism, the analysis leads to a critical discussion upon the fundamental purpose of city collage: to achieve the effect of estrangement by prolonging the process of observation in urban space. The Collage is related to the concept of estrangement proposed by Viktor Shklovsky in literature and Bertolt Brecht in theatrical preforming, as well as in definition of the *flâneur* (wanderers) in metropolis according to Georg Simmel, Siegfried Kracauer and Walter Benjamin. Therefore, by discussion upon the wide application of collage and its derived effect of estrangement in the 1970s, the article provides an insight to the possibility of collage technique serving as essential weapon against the materialization of architecture in contemporary city.

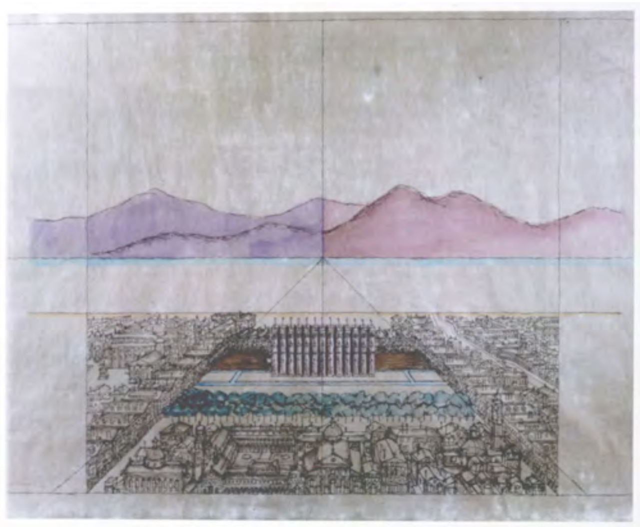

Figure 1: John Hejduk, 13 Watchtowers of Cannaregio, c.1978.

A Seminar in Venice

The life and professional career of John Hejduk (1920–2000) have been through a long procedure of transformation, one of which happened when the American architect claimed to have converted from optimism architecture to pessimism architecture.[1] As Michael Hays claimed, " Europe and Venice are for Hejduk part of the symbolic authority that controls and legitimates all cultural production".[2] The enchantment of Venice has haunted John Hejduk's Mask/Masque projects whose name has a clear reference to Venetian Carnival dated back to 13th century. In order to understand the Mask/Masque series and the late career of John Hejduk, it is inevitable to investigate the Venice Projects of John Hejduk as a connective and transitional work in the late 1970s.

The time was around 1978, when John Hejduk, along with Raimund Abraham, Carlo Aymonino, Peter Eisenman, Bernard Hoesli, Rafael Moneo, Valeriano Pastor, Gianugo Polesello & Giuseppina Marcialis, Aldo Rossi and Luciano Semerani, participated in a seminar organized by the city of Venice and Instituto Universitario di Architettura di Venezia(IUAV), being asked to explore new urban strategies for Venice.[3]

The site of *13 Watchtowers of Cannaregio* was located near the current Santa Lucia railway station, in sight of the unbuilt hospital drafted by Le Corbusier between 1964 and 1965. Yet by comparing Hejduk's drawing with the map of Venice, something incongruous occurs: The surrounding buildings do not quite match the actual site–several architectural features are impossible to be spotted in this area. On the left side there stands the Basilica dei Santi Giovanni e Paolo, which could hardly be mistaken with its renaissance equestrian statue of Bartolomeo Colleoni. The upper part of Chiesa di San Marcuola is spotted on the bottom left. The middle bottom part is Palladio's Chiesa di San Giorgio Maggiore after reorganization. On the right, lies the unusual form of Chiesa di San Geremia …None of these mentioned cathedrals is actually located in the given site of Cannaregio area.

Figure 2: Basilica dei Santi Giovanni e Paolo in Hejduk's illustration.

Figure 3: Basilica dei Santi Giovanni e Paolo Satellite Map.

Figure 4: Chiesa di San Giorgio Maggiore in Hejduk's illustration.

Figure 5: Chiesa di San Giorgio Maggiore Satellite Map.

The Site as Fiction

"In the way that surrealism tends to create a collective myth it must gather together the separate elements of the traditional myth, beginning with those which proceed from the oldest and strongest traditions."[4] — André Breton

"Fiction is more tactile."[5] — John Hejduk

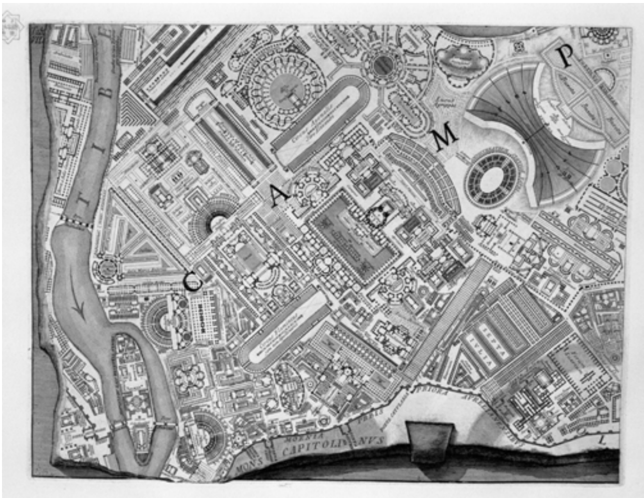

Figure 6: Giovanni Battista Piranesi, Campo Marzio,1762.

Contrary to almost all of his competitors, Hejduk designed a fictional site instead of the given one, in which architectures would have been more in scale with the Cannaregio area. John Hejduk's city collage–or, to be more precisely, his bricolage –reflects an evocation to historicism by suppressing the city into an ideological plan composed with landmarks and dwellings connected by canals. Similar to Piranesi's Campo Marzio referred by Manfredo Tafuri, the struggles of scale and continuity between architecture and city display an epic tone. The drawing wasn't aimed to interpret the district of Cannaregio, but the city of Venice as the whole impact–a miniature of one city. As the theatre of memory by Giulio Camillo who seeks to aid the memorization of complex sets of information by visualizing memory in place–the method of loci, John Hejduk presented the illustration that shows identity of Venice with selected representative architectures in the city. Architectural assemblage–the technique of shock–interrupted the whole original urban plan.

At that time, Venice was losing its popularity, which led to two consequences: First, the main subject of urban observation would transform from local people to perspective of foreigners in the following years. Therefore, Hejduk's collage is designed for two kinds of observers: As for foreigners, the collage represents a conjunction of landmarks in Venice city that reveals the city identity, while it is easier for the local citizens to detect the discrepancy between the drawing and the reality. In another word, only those who are familiar with the city can sense the disjunction and anachronism that Hejduk´s city collage produced. Secondly, Venice no longer needed new buildings for inhabitation. On the contrary, according to John Hejduk, what the city needed is cemetery. The architect's prophecy and judgment upon the city, that from generations to generations, history (landmarks) remained important while dwellings faded, was presented as the following method: Historic buildings are depicted concretely, while residential houses are abstracted into a unified form. Similar approach also could be found in his early project *Cemetery for the Ashes of Thought*, where the *Molino Stucky Building* is re-illustrated specifically while the cemeteries are shown as abstract cubes installed within the wall. In both projects, Hejduk showed great interest in the dilemma in Venice between historicism and abstraction.

These collage strategies are also applicable in his later Mask/Masque Project. In *Victims*, the three elements–generation, history and dwellings–are represented as grid (trees that was planted every 30 years), historic buildings and *structures* invented by Hejduk.[6] In addition, both Venice project and *Victims* included decisions made by the citizens, a circulating transportation system as well as a pre-settled script. On the one hand, this consistency proves that *13 Watchtowers of Cannaregio* was the predecessor of the Mask/Masque projects, and on the other hand, it also provides the basis for further analysis of intentions and methods behind the collage city drawing and fictional site.

Figure 7: Bernhard Hoesli, Colin Rowe and other members of the Texas Rangers, Dot-the-Dot drawing, c 1956.

Collage and estrangement in Hejduk's Cannarregio project

The city collage of John Hejduk could be dated back to his early academic years when the Texas Rangers invented a rotating drawing game called *dot-the-dot* in 1950s. During the game, each collaborator was asked to draw real buildings connected by unreal fragments in turn on a blank sheet of paper. In the end, a collection of urban planning was laid out as the result of the night, consisting of both real and unreal architectural elements.

Irrelevant scale, displaced architecture and mixture of the real and the unreal…These three main principles could also be detected in *13 towers of cannaregio*: Dwellings in the illustration are standardized as a unified building for inhabitation (the unreal) and are used as space fillers among displaced cathedrals (the real). The height of the dwelling is as tall as the transept of the *Basilica dei Santi Giovanni e Paolo*, showing a disproportionate character. The illustration is a total fiction, invoking the discussion in between the imaginary identification and the reality.

As Mark Morris pointed out, the *dot-the-dot* game has its own roots in surrealists who initially invented the collage game of *Exquisite Corpse*.[7] By returning to the origins–correctly identifying the consequences of the surrealistic game as series of collectively assembled words or images–one can trace the deep intentions hidden behind John Hejduk's Venice collage. Architectures, according to Tafuri, "were pitilessly absorbed and deprived of all autonomy, despite their obstinate wish to assume articulated, composite configurations." Only through the technique of *shock*–a delicate skill of assemblage–could architecture fight against its dissolution in the city. The surreal result of *Exquisite Corpse* games lies in the pleasure of interruption–a pleasure that could only be achieved by *bricolage*–assemblage of current materials. This is exactly what Hejduk did in *13 towers of Cannaregio* – to return the autonomy to architecture by displacement of architecture.

Estrangement effect from literature

Since Shklovsky proposed *ostranenie* as a literature concept, the word has been given a double meaning: making strange, and pushing aside. For Shklovsky, it is a technique employed to fight against ignorance towards familiar things in daily life. It is interesting to take a look at the dual significant of the word *context.*[8] The word is a relation between the object and its placement. In a way, to take one word out of its "context" (literally) is to take one thing out of its environmental "context" (spatially). This gives us a possibility to relate the displacement of architecture with the estrangement in literature.

"Habitualization" Viktor Shklovsky claimed, " devours works, clothes, furniture, one's wife, and the fear of war…. The technique of art is to make objects 'unfamiliar,' to make forms difficult, to increase the difficulty and length of perception because the process of perception is an aesthetic end in itself and must be prolonged."[9] Sklovsky's declaration clearly pointed out the enemy of art: the common ignorance in daily life.

Shklovsky's claiming also explained the main objective of this technique: to prolong the process of perception. The collage itself did increase the observation time for certain buildings. As the most practical category of art, architecture has faced the disregard of its inhabitant. As a result, the demand for autonomy of architecture is called into being. In order to avoid objectification, feeling of habitualization has to be reduced, while additional observation time should be given to architecture. The discontinuity caused by implantation of exotic architecture in the urban space drives attention of citizens among whom the uncanny feeling spread. Hence estrangement effect has its place in the city. It is possible to deduce that the unique uncanny temperament of Hejduk's architectures is a result of the architect's application of displacement as an estrangement operation. Hejduk's objective, especially in his late years, was using displaced architecture to enact the estrangement of urban space, although many critics do not take into account a shift in his thinking during Venice Projects.

Evidence that could show Hejduk's concern about estrangement effect is John Hejduk's quotation of Bertolt Brecht–one of the most representative of estrangement effect in theatre performance–from *Threepenny Opera* in the *Cemetery for the Ashes of Thought.*[10] Ever since, the architect's reference to theatre and performance was quite obvious. Hejduk used to compare his Masque/Mask projects as works of Ingmar Bergman, referring the structures of Mask project as characters in his theatre–a traveling troupe.[11] Each "actor" has a specific role to portray. As long as the cast are arranged properly, the performing will be conducted automatically (with pre-written scrip, of course). Therefore, the construction could be carried out without the presence of the architect. The factor of the anthropomorphic was central to his Mask/Masque's mobility. This autonomy of architecture makes it possible for building to move individually among cities and continents. Architectures are thus liberated from the limitation of architects.

Estrangement as technique in architecture and city

"Hejduk's refusal to settle (to posit a solution, to colonize a place, to arrive at an answer, to quiet our nerves) is perhaps a plea for more time to practice."[12]

Many scholars, as well as John Hejduk himself, have remarked upon the nomadic quality of Mask/Masque Projects. Antony Vidler, to whose study, the *Uncanny Architecture*, we owe the most meditation on the concept of estrangement, invokes Sigmund Freud, Georg Simmel, Krakauer Siegfried, Walter Benjamin and Charles Pierre Baudelaire in order to introduce the concept. According to Vidler, the estrangement in architecture invokes a displacement of the site. Hejduk's awareness of architectural autonomy is mainly reflected in the aspect of architectural mobility–that the building could, as the automobiles, be detached from its context and be moved to another place, while still maintain its essence.

In a conversation with David Shapiro, John Hejduk stated his new way of practicing architecture: He built a repertoire of 400 pieces of structures first. People come to his office, pick structure that they want to build, and construct them in different places.

"A strange, slow and irresistible transformation develops over Riga. A new series of buildings and structures take place inside and around the old ones. Those in agreement with our earlier images of the city."[13]

When these foreign structures were built, the lack of continuity between the structures and the context produced an extremely disturbing atmosphere around them. With the implantation of exotic structures, suddenly the daily scene seems to be different from what they used to be. Therefore, the original urban scene was transformed into uncanny territory.

> "Do we inhabit the house (only one person at a time, it seems), or does it inhabit an environment of its own creation, projected out of its claim to emplacement, and necessarily independent?"[14]

Michael Hays's questions about the parallel relation between man inhabiting house and house inhabiting an environment is worthy of mention. In this comparison, the house is regarded as a similar identity to human being. With the exotic appearance and bohemian character, the structures thus own their autonomy. These personalities "are closed and defensive; opaque and unforgiving; they prescribe and enact rituals; they read and write texts. Like the narrator, these heroes are tourists and shamans whose identities are not determined by the community they inhabit but a instead fixed by their own physical and spiritual itinerary; they are the 'other' whose foreign character threatens the society".[15] The refusal attitude has, no doubt, brought strange or even threatening feeling to the peaceful city. Like a knife cutting into the skin, the whole body (the city) has to respond to the heterogeneity of these structures.

The wondering autonomous character of Hejduk's *structures* invokes Benjamin's description of *flâneur.* The *flâneur* owns a dual identity: a wanderer and a detective–wanderer as a disguised masque while detective is the true essence of *flâneur.* In this manner, the *flâneur* is able to keep distance from the city and capitalism by masque of camouflage.

"The flâneur is that character who retains his individuality while all around are losing theirs and derives pleasure from his location within the crowd, but simultaneously regards it with contempt."[16]

The *flâneur* resisted the influence by refusing the complete conversion of becoming a "timely" person. The estrangement effect, in this sense, might be characterized as the central method for human being to observe his environment without losing himself under the influence of the city. Agamben regarded the "urban-observation with distance" as the essence spirit of the contemporary.[17] It provides a man with a special vision of perception towards his own time.

"Contemporariness is, then, a singular relationship with one's own time, which adheres to it and, at the same time, keeps a distance from it. More precisely, it is that relationship with time that adheres to it, through a disjunction and an anachronism."[18]

What could be more appropriate than the technique of assemblage that presents the *disjunction* and *anachronism* in a city? The Venice Collage that John Hejduk purposed in 1976 was more than a unique and fascinating way of interpretation that reflects the architect's thoughts upon the site. The undercover operation of displacement that the technique of collage contains is also the essential mechanism that John Hejduk employed in order to achieve the estrangement effect in architecture and urban scale. By doing so, the process of observation upon architecture and city is prolonged. It is the modern machine of observation that could provide us with a contemporary perspective–The eyes of an outsider. The Masques that followed in the late career of John Hejduk and the collage characteristic of Victims derive from his Venice collage in the middle 1970s or maybe earlier, the *dot-the-dot* Thursday night in 1950s.

Estrangement and Collage in architecture in 1970s

"S: John, we live in an age in which a lot of minor criticism concerns context, if these are built, are they built without context? How do you deal with critics who would speak of these as maybe too nomadic? How would you respond to that?

H: Nomadic. Because we are in a nomadic time."[19]

Le Corbusier´s early admiration towards automobiles led to a discussion of nomadic architecture. It wasn't a coincidence that Rem Koolhaas (*story of the pool*, 1977), Aldo Rossi (*Theater of the World in Venice*, 1979) and John Hejduk (*Venice Projects*, 1976) expressed similar concerns upon architecture's mobility. Especially Rossi, whose theory has deeply influenced Hejduk during their time in ETH, constructed the theatre based on the classical prototypes of *anatomical theater of Padua* and the *Shakespeare Globe Theater.*[20] The theatre provides a possibility of attaching the classic theatre space on a contemporary mobility.

In this sense, the rituals of lepers, the story of the pool of Koolhass, the theatre of Rossi and the vagabond architectures in diary construction of Hejduk share a common characteristic of an unplanned route, in other words, the *dérive*, a similar concern of *Situationist International* (SI) theory, meaning "an unplanned journey through a landscape, usually urban, on which the subtle aesthetic contours of the surrounding architecture and geography subconsciously direct the travelers, with the ultimate goal of encountering an entirely new and authentic experience."[21] If the *dérive* of a man is the fight of a person against the immutable city where he lives, the *dérive* of a house is the protest to the context where it stands.

The city is a big theatre, so did Tafuri mentioned in his book *the Sphere and the Labyrinth*. "The theatrical place itself must dissolve into the city. In such a place, one can only elaborate the grotesque annihilation of the soul, or the equally grotesque attempt of the soul to reappropriate the objects in revolt."[22] Hejduk has put his theory into practice. By applying certain estrangement strategy between the architecture and the city, a new relation arises. The chronotope (foreign structure) of Hejduk opens an exotic invisible gate –both temporal and spatial–on the site. The nomadic masque/mask projects, the traveling troupe of Hejduk's theatre, the structures on the wheels, are Hejduk's urban-observing machines which could collapse the time to still rocks and twist the space to a foreign atmosphere.

From collage to Copy/paste technique

The *Exquisite Corpse* of Surrealism, the *dot-the-dot* game of Texas Rangers, the Venice Collage and Masque Projects of John Hejduk…They all rely on the same mechanism–the technique of assemblage. This article verifies its origins in architecture of John Hejduk, revealing its profound objective: The daily perspective could only be resettled by disrupting and reorganizing the city. It leads to estrangement effect in architecture achieved by prolonging the process of observation. Thus, architecture gets rid of its materialized image and regains its autonomy in the city.

Today, architecture is even more lost in the torrent of commercialization. While on the other hand, collage has been a rising technique since the wide application of digital rendering in architectural industry. Hejduk's relating the collage technique to the estrangement effect points out the mechanism that could evoke architectural autonomy in the immediate present.

Reference

[1] John Hejduk, *Mask of Medusa: works, 1947-1983* (New York: Rizzoli Intl Pubns, 1985), 355.

[2] Michael K. Hays, "Of mirrors and ashes and Beginning Again: A note on Hejduk's Instauration of Brunelleschi's Experiment," in *Appearance & Materiality* (Chile: Ediciones ARQ, 2017), 94.

[3] The project *13 towers of Cannaregio* is the third projects among the three projects that John Hejduk has prepared for Venice from 1974 to 1980. The other two is cemetery for the ashes of though and house for the inhabitant who refuse to participate. The actual date is unknown.

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[5] Hejduk, *Mask of Medusa*, 125.

[6] Hejduk learnt the concept of 30 years as a generation from Spanish philosopher Ortega y Gasset. Hejduk, *Mask of Medusa*, 81.

[7] Mark Morris, "All Night Long: The Architectural Jazz of the Texas Rangers," *Architectural Design* 83, no. 5 (2013): 20-27.

[8] Encyclopedia Britannica, context. *noun*. 1.the parts of a piece of writing, speech, etc, that precede and follow a word or passage and contribute to its full meaning; 2.the conditions and circumstances that are relevant to an event, fact, etc.

[9] Viktor Shklovsky and Reis Marion, "Art as Technique," *Russian Formalism Criticism: Four Essays* (1965)

[10] Hejduk, *Mask of Medusa*, 359.

[11] "*So it is almost 'Bergmanesque'. Bergman had his cast of characters who were all in these wonderful films. Sometimes they were in the film sometimes they were not in the film. So there was a network of people stories characters. I also have in architecture a similar network going.*" John Hejduk and David Shapiro, "Conversation. John Hejduk or the architect who drew angels," Architecture and Urbanism, vol. 224(1991): 60.

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[17] "The contemporary is the untimely", noted by Roland Barthes, quoted by Agamben who argued that, the concept of estrangement effect is, first of all, the key to "contemporariness". Roland Barthes, "The contemporary is the untimely" (lecture, College de France, Paris)

[18] Giorgio Agamben, *What is an Apparatus? And Other Essays* (Stanford: Stanford University Press, 2009), 39 - 54

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[20] "The encounter with Rossi cut a crease in Hejduk's career, which between 1973 and 1975 would fold back on itself in a re-examination of accomplishments thus far and a reconsideration in the light of what Hejduk saw in Zurich. Michael K. Hays, "The Desire called Architecture", *Schriften der Bauhaus-Universität Weimar* (Professur Theorie und Geschichte der modernen Architektur, 2008),118.

[21] Guy Debord, Définitions: Internationale Situationniste 1 (Paris, June 1958)

[22] Manfredo Tafuri, *The sphere and the labyrinth: Avant-Garde en Architecture from Piranesi to the 1970s* (Cambridge: MIT Press,1987).

ADR18

Innovative Technologies

Chaired by Dr Arianna Brambilla

PAM: Parametric Adjustable Mould

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Abstract

This paper discusses the invention of a parametric adjustable mould frame that enables manufacturing of variable shaped concrete panels with a single formwork as rain screen cladding systems. Standard industry means of casting doubly curved concrete panels require extensive formwork often using Expanded Polystyrene Foam which is discarded after use. This generates an enormous amount of construction waste in the process of casting complex doubly curved panels; this contributes directly to the cost of the panel, making forms with complex surface geometry costly to manufacture and impractical to produce. The impact of the research provides a sustainable mean of constructing complex form and geometry. The paper is focused on the design methodology of the numerically controlled mould frame and its workflow, bringing together a multi-disciplinary approach to the design of the device. The paper concludes by discussing how such design methodology can be a useful strategy for applied research.

Introduction

This paper presents a novel fabrication method using an adjustable mould frame for casting doubly curved concrete panels. The design and fabrication of the project are undertaken by a team of two architects and an engineer aiming to explore the design potential of the fabrication process. The bespoke computer numerically controlled (CNC) machine called: Parametric Adjustable Mould (PAM) consists of a single adjustable mould which receives translated digital information from a panelised surface using a custom script to actuate the mould into desired positions for concrete casting. The translated data of the virtual surface is made possible through the transformation of the doubly curved ruled surface geometry. Once cured, the concrete panel is removed from the mould with no immediate waste. The project eliminates the need for individually unique mould design in the manufacturing of doubly curved panels, thereby reducing manufacturing waste and improving cost efficiency.

This paper contributes to design research through firstly aligning construction problems faced in practice with advanced fabrication technology. This novel CNC machine can make designing with complex geometry more viable and economically feasible through innovative fabrication methodology. The workflow outlined in the paper demonstrated research for design that moves beyond standard digital fabrication techniques and solutions. Secondly, through design research, the project indicates that research in digital technology could address problems encountered in the construction industry through a radical rethinking of our current construction techniques.

Background

With the increased use of computation tools in architectural design, architects and designers are increasingly exploring the use of complex curvature surface in their designs. Producing bespoke and variable panels allows buildings to be distinctive and increases the perceived value of the asset, particularly for civic or cooperate signature buildings. However, the realisation of such geometry is often limited by current machinery, method of manufacturing, and cost; some of these are outlined below.

Historical Precedent for The Variable Mould Design

Traditional techniques to fabricate doubly curved concrete panel without adjustable mould utilised sand casting as exemplified in the Philip Pavilion by Ianis Xenakis and Le Corbusier, and re-usable timber formwork as demonstrated in the projects of Felix Candela and Nervi.[1]

Variable parametric mould have been of research interest in recent years, and a few systems have been put to the test in practice including earlier work by Renzo Piano for free-form plastic panels.[2] Most variable mould designs are based on single-direction multi-point stretch-forming processes, where actuated pins or armatures define the surface curvature.[3] There are also other techniques such as incremental sheet forming and flexible roll bending, some of which are still under development.[4]

Other researchers have looked towards deformation processes using robotic manipulator arms.[5] While there is little or no tooling involved, the effort to produce individual surfaces adds to the manufacturing time and cost. The critical advantage of deformation processes used in PAM is that once the tooling is established such as the mould, multiple panels or components can be produced efficiently from the same toolset.

Cost Implication and Waste

Cost has always been the primary constraint in building projects with complex geometry, especially those with double curvature surfaces, as the tooling process behind the manufacture of such surfaces is often costly for a one-off project. The main tooling cost is the preparation and production of moulds to adequately control the surface deformation of material into the precise form. Both subtractive (CNC milling) and additive (3D printing) procedures for producing double-curved surfaces can often only provide one-off surfaces.

As outlined in previous section, the deformation process potentially eliminated the need for lengthy additive and subtractive procedure. Lee and Kim described several advantages of this procedure, including speed of manufacture and low production cost even for short runs.[6] This is demonstrated in the Dongdaemun Design Plaza project by Zaha Hadid Architects. The built project consists of over 16,000sq meters of double-curve metal cladding surface. Utilising a combination of multipoint forming machines and robotic arm laser cutters; the cost of the individual doubly curved panel is reduced from USD$7000 to USD$260.[7]

In addition to inhibitive costs, current techniques often produce a considerable amount of waste and embodied energy during the manufacturing process. The Spencer Dock Bridge in Dublin, Ireland is a case study that deployed CNC milling techniques.[8] To produce an undulated doubly curved soffit to the bridge, the formwork was constructed from CNC milled polystyrene (EPS) blocks sprayed with polyuria. Once the concrete was cured, the formwork was removed and discarded.

In response to the wastes produced from such construction techniques, the Irish-Australian based construction company Laing O'Rourke has developed robotic 3D printed re-usable wax moulds called FreeFAB, using an additive procedure to eliminate waste for pre-cast concrete and glass reinforced concrete (GRC) production.[9] PAM shares similar waste concerns with the FreeFAB project. The advantage of our invention over FreeFAB is that it reduces the production time, in particular, the 3d printing and milling process. The downside of PAM is that, like most machinery, the scale of the panels is limited by the size of the machine.

These emerging technologies and fabrication techniques used in fabricating complex curvature in concrete demonstrate an industry-led demand for innovative solutions to real construction problems faced by the building industry.

Design Methodology

The design of PAM emerges from an adjustable ruled-surface prototype developed through the studio teaching of the first and second authors (Figure 1). The model has a series of 3D printed universal ball joints connecting a fixed-length edge frame with a set of flexible cables acting as rulings to describe a variable-ruled surface when the frame is adjusted. This physical 'parametric' model contains all the basic parameters necessary to describe a quadric ruled surface, in this case, a hyperbolic paraboloid. Similar 'parametric' models by mathematical model maker Fabre de Lagrange can be dated back to 1872.[10]

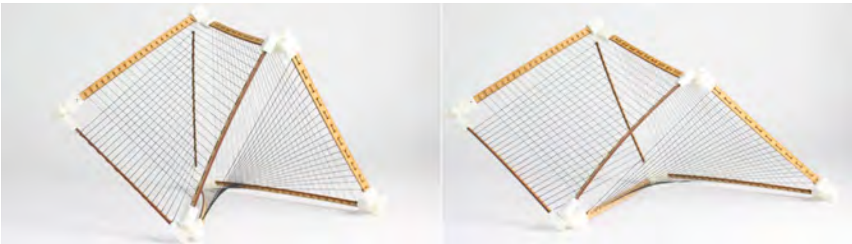

Figure 1: Physical parametric model showing variable ruled surface geometry.

The descriptive geometry of the hyperbolic paraboloid model is used as a hypothesis by the research team at the start of the research project. If variably shaped surfaces can be described by a straightforward system using four nodal points, then can the geometry be applied to a mould design for casting and produce different shaped panels from a single mould?

Descriptive Geometry to Design

The panel geometry described by the model in Figure 1 is a hyperbolic paraboloid with quadrilateral boundaries of equal length, otherwise known as rhombi. Thus, their diagonals intersect at right angles. The transformation of the panel surface between its potential forms can be understood as follows: the trajectory at opposing corners of the panel edge is the intersection of two spheres (radius = edge length), where the centre point (CP) is based on the remaining two corners of the panel as illustrated in Figure 2.

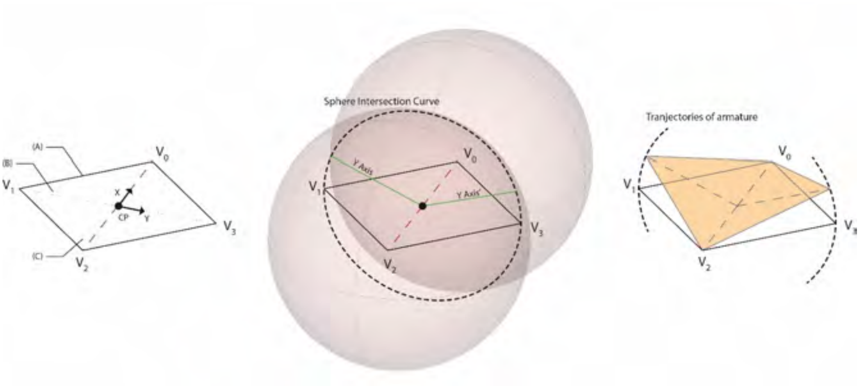

Figure 2: Descriptive geometry model showing the translation of the physical parametric model.

To described any variable geometry based on a typical flat square lying on the XY plane as illustrated in Figure 2 (left), only three fundamental parameters are required to measure any changes in the geometry. The first parameter is the edge length. In this model, the edge length is predetermined and constant. The second parameter is the skew (α or alpha) which is described as a ratio relative to the perfect square on XY plane. Lastly, a change of angle in degrees (β or Beta) about the X-axis. The shift in skew results in a change along the X-axis which results in relative change along the Y-axis), provided the four sides of the panel are all equal. The resulting trajectory to describe any variable-ruled surface within the constant edge length is, therefore, a simple arc action about CP (figure 2) which is feasible to be translated into numeric coordinates and is useful in the design of the machine.

Following the above analysis, we can take most freeform curve surfaces digital model and panelise them. Taking one corner of the freeform surface as a starting point (point W illustrated in Figure 3), we can iterate the process using a custom Python script in McNeel Rhinoceros, with Grasshopper v0.9.0076 to find the intersection of equal edge lengths on the surface (point Y & Z followed by point X). These known points (W, Z, X and Y) are equivalent to the vertices (V_1, V_2, V_3, V_4) of the panel in the mathematical model discussed in Figure 2. An algorithm summarising the above mathematics is developed to translate the panelised wall panel into linear motion for the actuators. To describe every panel, we only need to extract the skew and Beta angle of each panel.

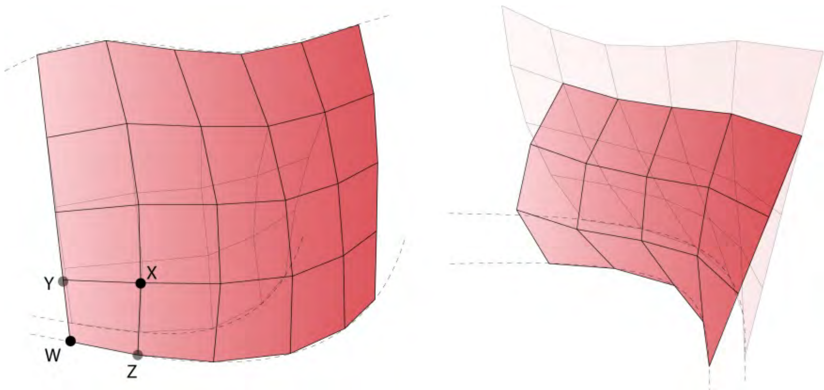

Figure 3: [Left] Panelised wall from free-form surface; [Right] geometry generated using Kangaroo Physics.

Design of PAM

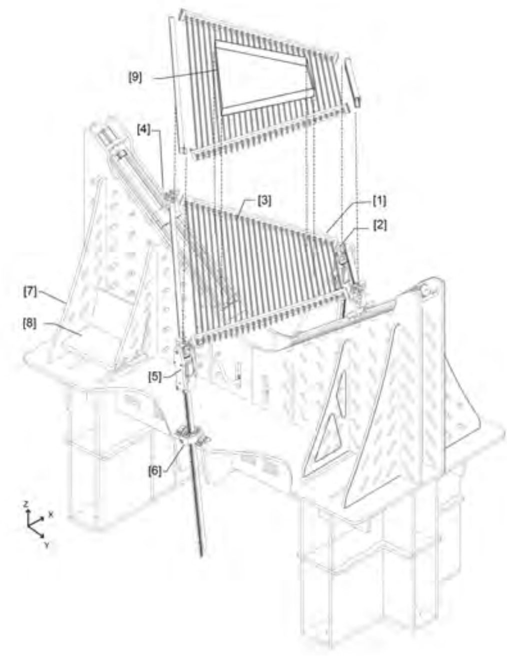

Figure 4: Design of PAM.

PAM machine is design based on the knowledge of the geometric model described in “Descriptive Geometry to Design”. It is a result of three iterations of design and prototyping. The device consists of a mould frame [1] and four numerically controlled actuators; see Figure 4. The mould frame includes a tri-axial joint [2] on each corner of the quadrilateral frame which is infilled with an array of parallel steel rods acting as ruling surface [3]. The spatial relationship of the four corners of the mould frame is defined by two opposite sets of steppers or actuators. The first set of opposing steppers or actuators is inclined on the sub-frame of the machine [4]. The second set of steppers or actuators [5] is mounted on a leadscrew which is not constrained with a swivel joint [6] and can move in the vertical direction; it inclines in the X-direction as a result of the movement of the first set of steppers. The mechanism is elevated off the ground by a sub-frame [7]. The machine is operated using a computer [8] and a microprocessor wired to the actuators. The design of the device is for concrete casting, and it has a bespoke Room-Temperature-Vulcanizing (RTV) silicone mould [9] which sits in the centre of the frame [1]. The silicone is allowed to slide on top of the rulings when the mould is moved into position.

This configuration of PAM can produce concrete panels up to 850mm x 850mm; their thickness can range from 9mm to 50mm. Figure 5 shows the limits of current design. Any asymmetrical panels are trimmed down to surfaces based on rhombi. Though, it is theoretically possible to panelise any doubly curved form with quadrilateral panels of equal edge length using the spherical intersection method discussed in Figure 3. Asymmetrically cut panels may be required when solving the edge condition of the doubly curved form or possibly when transitioning between panel sizes (figure 5 - right). The limitations of panel curvature and skew are due to the current physical limits of the gimbal joints located at the vertexes of the frame. There is still room to increase the curvature limits; however, the following figure 5 - left indicates the current curvature constraints.

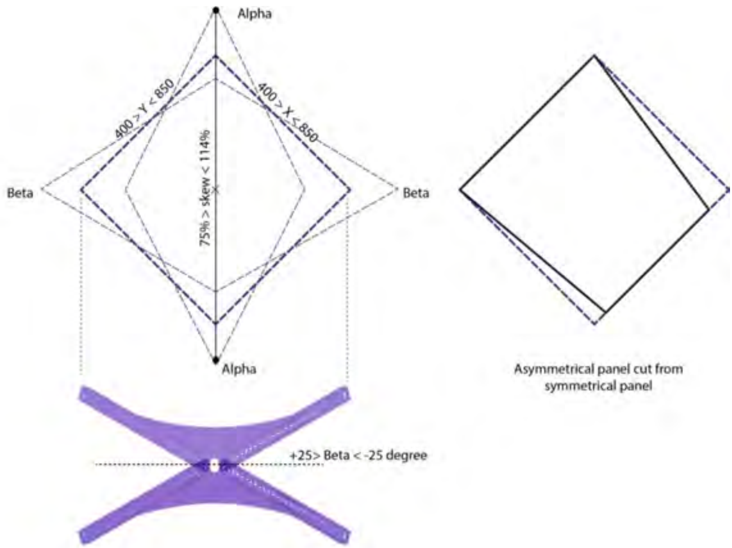

Figure 5: [Left] Diagram showing limits of the current machine; [Right] Diagram showing asymmetrical panel cut from the symmetrical panel.

Cross-disciplinary Knowledge

The design of the machine requires the research team to integrate cross-disciplinary knowledge. The design team compounded their skills to succeed in both the problem-solving and puzzle making aspect of the research.[11] Figure 6 illustrates the compounding knowledge required to design and fabricate the device. This includes what the first author described as background knowledge. That is, knowledge gained from the precedent studies, current fabrication methodology and the tacit understanding of the casting process; the know-how. The mathematical and geometric model described in “Descriptive Geometry to Design” served as a pivotal moment in translating the know-how into a possible solution for the research. Another sets of knowledge comes from the engineering and mechatronic discipline. Here the design of the prototype gives form and meaning to the techniques. The code translates the mathematical model into an algorithm that delivers instruction for the stepper motors; more precisely as number of turns. This is translated from the skew and beta analysis of the panel; the fundamental parameters described in “Descriptive Geometry to Design”. A microprocessor is used to create the serial hand-shake between the software and the hardware to deliver the desired outcome.

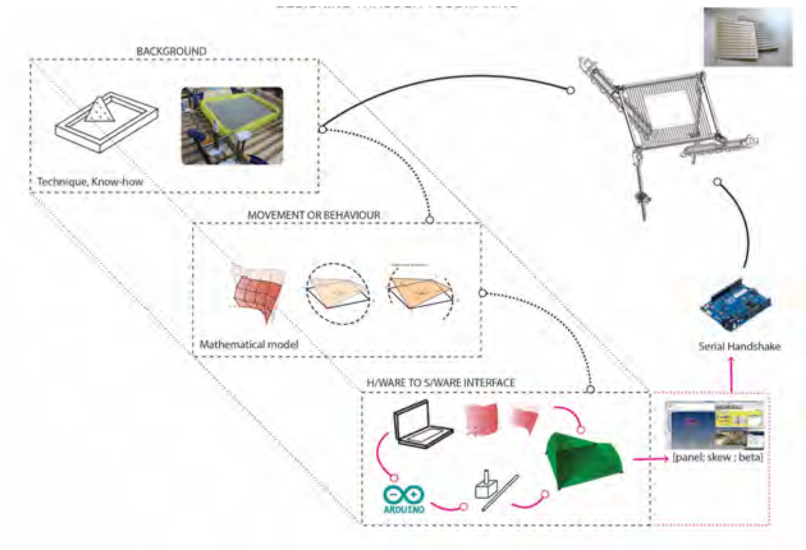

Figure 6: Compounded knowledge in the design and fabrication of PAM.

From a user point of view, the workflow in using the device is more streamlined as illustrated in Figure 7. The knowledge structure is already collapsed in the machine to create a more linear flow of information from the panelisation of the virtual surface to the concrete cast panel. It is worth noting that the compounded nature of the cross-disciplinary knowledge outlined in figure 6 is critical in streamlining the user workflow into a manageable stream, which would otherwise render the device unusable or not fit for purpose.

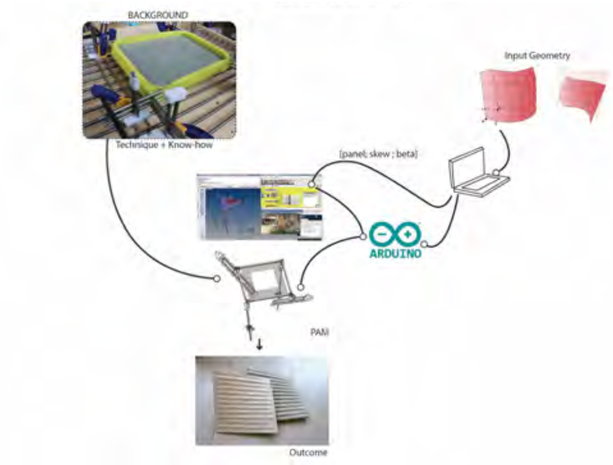

Figure 7: User workflow.

Fabrication Procedure

Figure 8 illustrates the fabrication procedure for doubly curved concrete panels using PAM; the fabrication steps explained below.

1) Firstly, the mould frame is set at default position (where the skew = 1 and beta =0).
2) Concrete is mixed and poured into the RTV silicone mould. The concrete is level with a float manually. The research team used a PVA fibre reinforced concrete (FRC) mix to enable the casting of the thin concrete shell.
3) The geometry is defined through the software. The custom script allows panel geometry to be translated into length for the steppers. The code is translated via the Arduino™ microprocessor; the output code consists of {panel number, Skew, Beta}.
4) At 18 degrees ambient temperature, the mould can be moved into position after 45min. The mould is covered with plastic film to allow the concrete mix to cure and to avoid excessive moisture loss.
5) The concrete panel is de-moulded from the silicone after 18 hours.

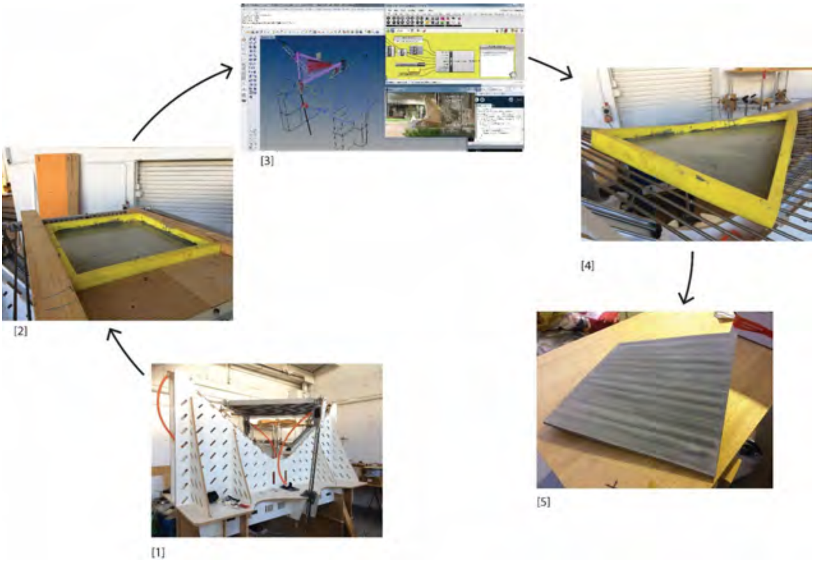

Figure 8: Fabrication procedure of doubly curved panel using PAM.

Outcome: Verification and Future Research

The resulting panels from PAM are digitally scanned using an Artec Eva 3D scanner with +/- 0.02mm accuracy. The digitised panel is overlaid on the original digital surface to check for accuracy at 1369 evenly distributed points across the surface. A custom script is written to measure the discrepancy between the scanned and digital surfaces.

Verification of Results

Three test panels with different beta angles were tested. Figure 9 shows the resulting deviation of the scan from the digital surface from test panel 01. The cross-section deviation ranged from -3.36mm to 2.59mm; across the entire surface the maximum differences were -3.56mm to 3.52mm. Table 1 shows the results across the three test panels.

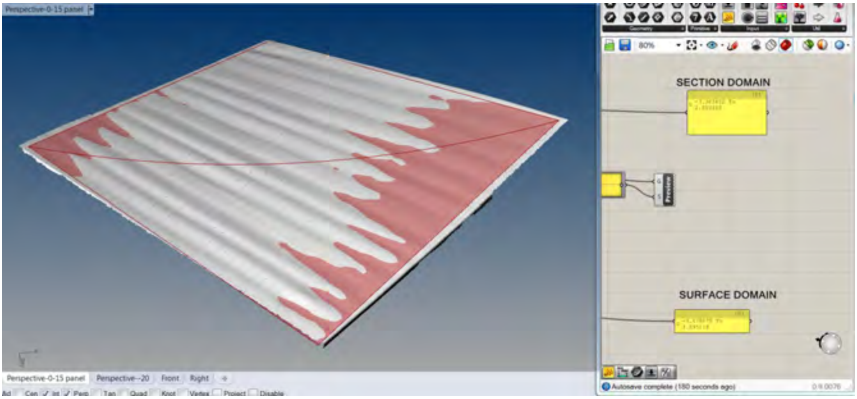

Figure 9: The verification of the scanned concrete panel against the digital surface.

Panel	Beta	Skew	Cross Section Deviation	Surface Deviation
1	-15	0	-3.36mm to 2.59mm	-3.56mm to 3.52mm
2	-18	0	-2.23mm to 3.31mm	-3.42mm to 3.31mm
3	-20	0	-4.14mm to 4.73mm	-4.59mm to 4.65mm

Table 1: Summary of verified data from the test panel

The thicker profile causes the above average deviation observed in Panel 3. This is because of the increased spacing of the ruling as the Beta angle increases; by decreasing the spacing between the steel rods, the deviation margin could be further reduced.

Future Research

The current design of the machine is used to cast panel up to 10mm thick using fibre reinforced concrete mix with potential application as a rain-screen cladding system. As the panel thickness increase, the edge of the panel also twists; mimicking a hyperbolic paraboloid surface. The research intent to consider robotic milling of the side so the panel could be butt together. This will enable the panel to be formed into a vault structure, and the panel could be engineered as a load-bearing structure.

Conclusion

The paper discussed the methodology behind the design and fabrication of a novel CNC machine. The knowledge structure in the design process brings forth a design research methodology that embodied the manufacturing procedure with the numerical control device. The cross-disciplinary knowledge in the design process produces an outcome that is innovative compared to the current state of the art with potential impact on how curve concrete panels could be manufactured in the future. The unique automation procedure developed from a mathematical model suggests a useful strategy for applied research where immediate construction waste for the production of the doubly curved concrete panel could be eliminated; reducing the embodied energy of such construction techniques.

Acknowledgement

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A Design Tool for Shell Structures made of Curved Sandwich Panels

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Abstract

Due to their excellent combination of space-enclosing, heat insulating and supporting function, steel sandwich panels are used for roofs and walls. In addition, freely formed structures are playing an important role in contemporary architecture. Free formed shell structures offer a higher potential in architectural design and an optimized load-bearing capacity. The necessary manufacturing technology for curved flexible cover plates and an understanding of their mechanical behaviour are to be investigated in an interdisciplinary research project with architects, civil- and mechanical engineers.

Profiles with variable cross-sections can be produced by means of flexible roll forming. In a further forming step, these initially flat panels are to be formed into curved panels by rolled-rounding. Cylindrical and tapered components can also be produced.

To plan hall roofs with these panels more efficiently, various planning tools that take these production steps into account have been developed. Doing so, the variable joint geometry is taken into account as well as the shape of the cut and the general conditions of the roll forming lines. Curved panels and the range of shapes that can be expanded with them could also open up new markets, since more representative architectural structures with sophisticated geometries made of sandwich panels could become feasible (see Figure 1).

Figure 1: Visualization of a possible hall roof made of curved sandwich panels.

Introduction

In an interdisciplinary project the basics for the production and architectural application of curved sandwich panels are investigated. Three institutes of the Technische Universität Darmstadt (Germany) are involved in the project, which is being financed by The German Federation of Industrial Research Associations (AiF) for the period of two years: Institute of Steel Construction and Mechanics of Materials (ISWF), Institute of Production Technology and Forming Machines (PtU) and Institute of Structural Design and Construction (KGBauko).

The research project is organized in four areas. The first area (researched by KGBauko) is intended to determine the range of parameters in which the various possibilities for bending of the elements are evaluated from an architectural point of view. The second area (considered by ISWF) includes experimental and numerical investigations of the mechanical properties of curved elements. The third step (researched by PtU) is the development of a process chain with which the elements can be manufactured industrially. The last area (researched by KGBauko) is considered to develop a design tool, that will allow to design future building geometries with given boundary conditions determined in the project. Finally, the results are evaluated and interpreted.

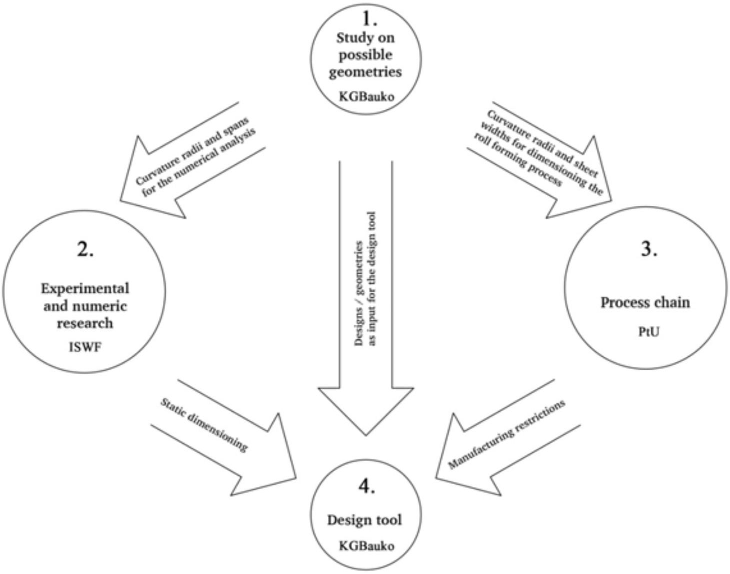

Figure 2: Structure of the research project.

State of the art

Only a few example buildings with curved sandwich panels are already realized. The only project that uses this as a load-bearing structure is the dome of an exhibition hall in Hannover (Germany) with a diameter of 30 m.[1] Built in 1970, this cupula is extremely light, the sandwich construction only weighs 30 kg/m^2 instead of 200 kg/m^2 which a comparable reinforced concrete dome would weigh. However, the panels were produced manually and the joints between the panels still had to be filled with foam in situ.[2]

Another example are the sandwich panels from Italpanelli (see Figure 3).[3] Unfortunately, these do not function as a flat supporting structure but are dimensioned like a single span girder made of trapezoidal sheet metal. In addition, they have a corrugated trapezoid structure on the outside and are therefore mainly used in industrial construction.

Figure 3: Loading test of a curved sandwich panel

Parametric planning of complex building systems

The modern planning of buildings is increasingly determined by BIM - Building Information Modelling. The declared goal is to design, construct, calculate and evaluate based on the same model. On the one hand, this is intended to reduce cost and error sources; on the other hand, it offers the possibility of parameterizing repetitive processes.

Modern CAD programs offer the user the possibility of using pre-drawn models of windows, doors, etc. in their project. This very efficient way of drawing also ensures that the dimensions and connections drawn in automatically are correct. And since these models represent real products it is possible to calculate quantities, mass data and costs within the same program.

This type of BIM usage is designed to make everyday tasks easier for the user. Complex tasks or special components usually remain unconsidered and must be individually supplemented. Since the BIM model is also changed here, this can quickly have negative evaluation effects.

For this reason, more and more design tools are being created that enable the integration of special construction systems.

The realization of those design tools can be done either as a standalone program or as a plugin for existing CAD software. The difference can be seen in the following examples.

Schüco, a German façade company, developed a design tool for façade systems that can be used within Grasshopper and Autodesk Revit™. It allows the user to integrate and customize a selected façade system into his / her pre-drawn model. The finished result can then be saved as a xml-file and sent to Schüco, which can produce the facade with a perfect fit using CNC milling machines.[4]

Another example is the software Easy™, a standalone software for form-finding, calculation and cutting of textile structures. The user is given the opportunity to plan buildings almost completely to production readiness just within one program.[5]

These examples demonstrate, that BIM is already being used in the building industry but cannot be seamlessly linked together yet. Similar to Schüco Parametric Systems, the design tool described above is intended to be implemented as Grasshopper™-plugin.

Production processes

The cover plates of sandwich panels are usually produced by roll-forming. Profiles produced this way are used in vehicle and plant construction as well as in the building industry. In this process, sheet metal is uncoiled and in several steps by means of a series of different rolls incrementally transformed from flat sheet metal into a profile-like semi-finished product. Simple U-profiles, pipes, trapezoidal sheets or the cover plates of sandwich panels are possible. The process is very reliable and offers the advantage of consistently high production speed.[6]

Current research projects aimed at extending this technology for profiles with variable cross-sections.[7] Hence it is necessary to move the individual rolls of the profiling stands translatorically and rotatorically along the flexible sheet edges (see Figure 4). This technology is already used for aluminium profiles for roof cladding by companies like Kalzip or BEMO Systems.[8] It could also be used to produce the cover sheets of single or multi-curved sandwich panels. Since the rolls can react flexibly to the curvature of the strip edges, this technology allows the serial production of different geometries in contrast to most forming processes, such as deep drawing, which always produce the same panels. This means that a wide range of shapes can be produced with just one machine.

In a further forming step, these initially flat panels are to be formed into curved panels by rolled-rounding. Cylindrical and tapered components can be produced just by rolling. Depending on the machine concept, the sheet is bent between several adjustable rollers.[9]

In a process chain that combines these steps, the cover plates for curved sandwich panels can be produced (see Figure 5).

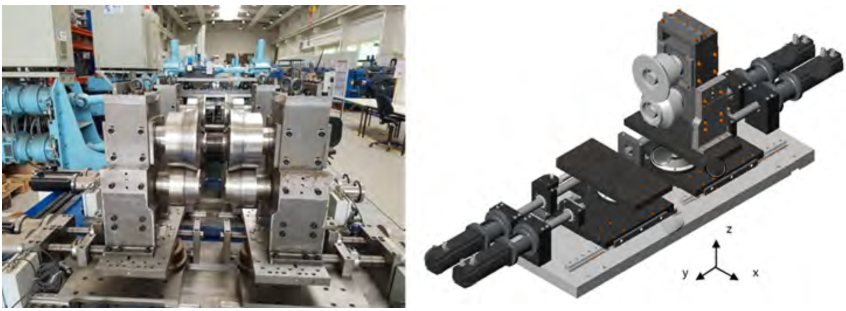

Figure 4: Flexible roll forming machine.

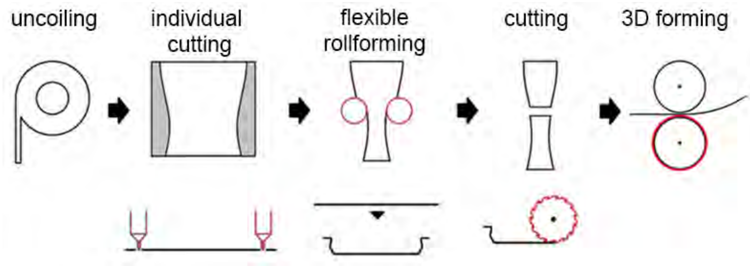

Figure 5: Process chain for curved Sandwich panels.

Production Processes and resulting Geometries

These production processes also result in design restrictions, that must be taken into account. They result from the design of the roll-forming line and the subsequent roll-rounding. These restrictions include, for example, the minimum curvature radii that can be achieved and the maximum permissible panel widths. Therefore, the achievable shape spectrum of future buildings is largely defined by the degree of deformation of the successive roll-forming and roll-rounding processes.

At the beginning of the research project, levels of deformation were defined which take these forming steps into account. Depending on the degree of deformation achieved, conclusions can be drawn about the architectural form spectrum that can be achieved (see Figure 6):

Deformation level 1: Single curved panels with parallel edges (see Fig. 6):

- No flexible roll forming is necessary for this complexity level, a conventional roll forming line with downstream roll rounding is sufficient.

Deformation level 2: Single curved panels with non-parallel edges.

- At complexity level 2, flexible roll forming is followed by a roll rounding process.

Deformation level 3: Single curved conical (bent and twisted) panels with non-parallel edges.

- Complexity level 3 works according to the same principles as complexity level 2, but by tilting the round rolls during the rolling process twisted components can be produced.

Deformation level 4: Biaxially curved panels with non-parallel edges.

- These geometries cannot be produced using flexible roll forming and roll rounding; they will therefore not be investigated further in this research project.

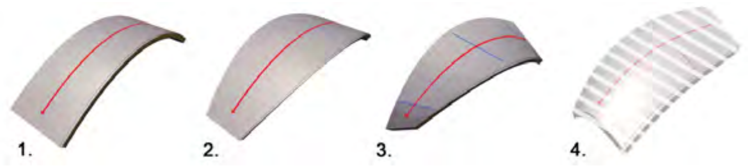

Figure 6: Deformation levels.

Design tool

The design tool is realized in the parametric CAD software Rhino™ and Grasshopper™. The design process is divided into four steps (see Figure 7). In step one, a free form is created, followed by an approximation / panelling. Based on these panels a detailed model is created. In the last step, this model is evaluated. All steps can be accomplished parametrically, which enables a fast creation of variants or iterations.

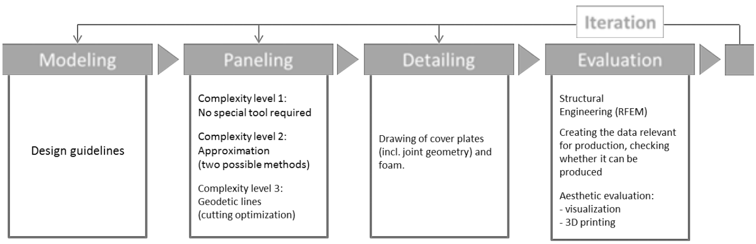

Figure 7: Structure of the design tool.

Step one: Modelling

In order to practically model doable forms various conditions have to be considered. For example, there is always a main direction of tension because forces cannot be transmitted well through the joints as through the panel itself (how anisotropic the structure behaves, has not been researched yet). Additionally there are conditions like the maximum span and minimum curvature radii. This information will result from work package 2 and 3 and are to be formulated as design guidelines. These guidelines include acceptable ratios of span and curvature radius.

Step two: Panelling

Depending on the complexity level, a different panelling approach is required. For complexity level 1, only the width, radius of curvature and span are variable. No special tool is required for this complexity level.

Complexity level two is much more challenging. Especially if geometries are to be produced away from sphere, torus or ellipsoid, since it must always be guaranteed that the strips are not twisted.

In order to design such load-bearing structures, a freeform surface should always be specified first, which is then approximated.

Two approximation methods have been included to achieve this. One method is the generation of strips from cutting curves and the subsequent intersection of these strips (see Figure 8).[10]

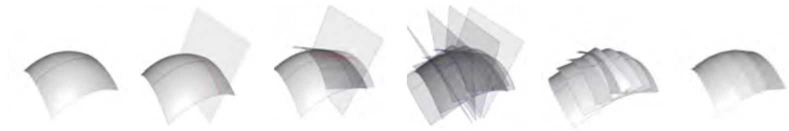

Figure 8: Method to generate strips without twist.

Another possibility of approximation with non-twisted stripes is to draw parallel lines along a section of a free-form surface and generate the panel as translational surface of these lines.

With panels of complexity level three, free-form geometries can be approximated almost without any restriction. Probably it will not be possible to experimentally investigate this level of complexity within this research project. It offers potential not only because of the wider range of possible shapes, but also with regard to cutting optimization. As it is already common practice in textile construction, free-form surfaces can be cut along geodesic lines.[11] Geodesic lines on free-form surfaces are curves, that connect two points on the surface with the shortest distance. Using the geodesic component of Grasshopper™, a tool has been developed that divides an area into strips with geodesic lines as boundary curves using a maximum width given by the roll-forming machine. This results in more symmetrical strips with minimal waste (see Figure 9).

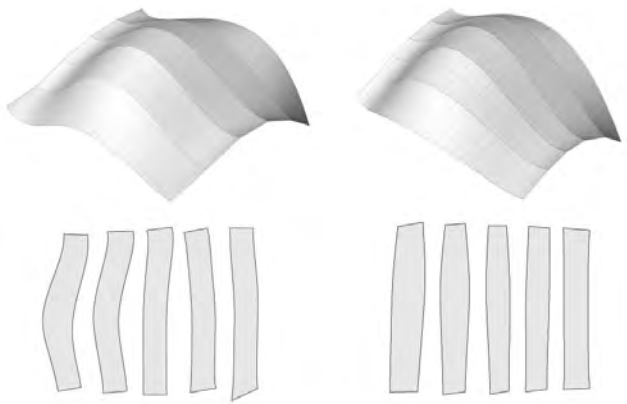

Figure 9: [Left] Strips generated using Isocurves and their unfolded version; [Right] Strips generated using geodesic lines.

Step three: Detailing

Based on the created panel layout, a parametric model of the cover plates and the foam can be created. Especially the joints between the panels are a critical point for the final structure and a great challenge in the manufacturing process. Therefore, they have to be constructed and considered in detail. Even with complexity level two, the angle in the joints does no longer remain the same for one panel but changes over the course of the joint (see Figure 10).

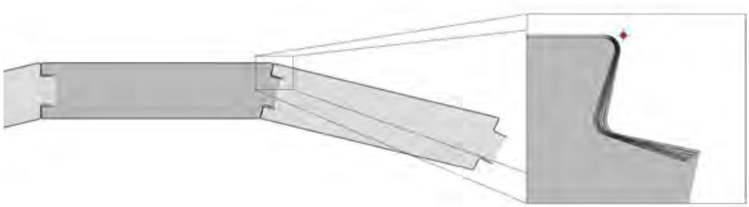

Figure 10: [Left] Sandwich panels with a simplified geometry; [Right] The angle in the joints changes over the course of the panel

Different joint geometries for a final product are possible, depending on the area of application. In this research project a simplified geometry is created in order to prove the basic feasibility with reduced costs. However, using the design tool, different parametric variants can easily be visualized and discussed (see Figure 11).

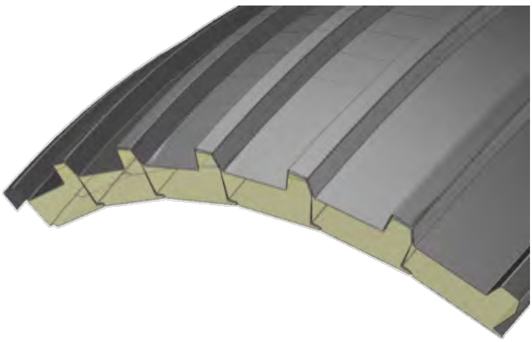

Figure 11: Resulting 3D Model

Step four: Evaluation

The model created in this way is evaluated in three different areas. First, it must be checked whether all panels can be produced with a given roll forming line. For this purpose, the detailed model is analysed. The curvature radii and cut of the cover plates can be taken from the unfolded sheets and compared with the specifications. Another important point is the angle in the joints, which is no longer the same even at complexity level two within a panel but changes along the profile (see Figure 10). These angles must also be within the specifications. The specifications required for this are currently still being determined experimentally.

Secondly the static load capacity is to be evaluated. The static tensile strength of curved sandwich panels with flat covers is still under experimental determination (see Figure 3). The goal is to use the data obtained from material tests to improve evaluation and calibration of FEM models. These models are to be calculated with the software RFEM™, therefore an interface was developed which allows the models transfer created in Rhino™/Grasshopper™. Since the foam in sandwich panels has a high anisotropic stiffness, it was particularly important to also transfer the respective orientation of smaller parts of one panel. In the future, it will be doable to simulate the load-bearing behaviour of these panels without a great human effort (see Figure 12).

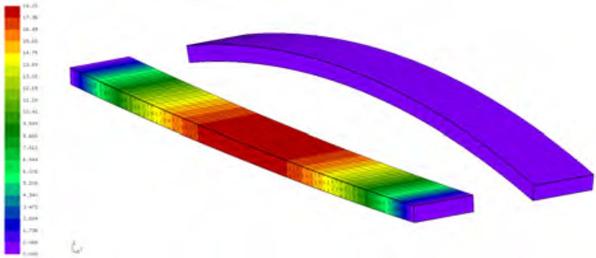

Figure 12: Comparison of the displacement of a flat panel and a curved panel (max. 18.22 mm). This FEM Model, still need to be validated by experimental results.

The third criterion is the architectural and aesthetic assessment of the planned structure. Again, the parametric models are an important tool. They form the starting point for visualizations and light simulations (see Figure 1 and 13). In addition, they can be printed in 3D and evaluated as a physical model. Since the detailed model is largely automated or generated parametrically, variants can be developed and compared quickly. This comparison is particularly helpful in the architectural design process.

Conclusions

The basic functions of the design tool have already been prototypically implemented in Grasshopper. At the moment static tests, tests to roll-forming of the cover plates and foaming of the elements are in progress. The results of these tests still have to be considered in the design tool.

Another area to be worked on is the usability of the design tool. At the moment, the individual steps of the design process are only prototypically implemented in Grasshopper and are complicated to operate. The tool will therefore be further developed and documented respectively to be further used by architects with basic Grasshopper knowledge.

The development of a design and calculation tool for curved sandwich panels extends the creative freedom of architects and engineers. The possibility of creating double-curved shapes with sandwich panels offers considerable advantages not only from an architectural but also from a static point of view. In contrast to flat panels, the curvature allows spatial load-bearing effects to be activated, which allows the structural frameworks to be statically optimized.

Used correctly, the finished design tool will offer a complete solution that supports the user from the design through the calculation to the realization of their project. Due to the standardization of the individual design steps it increases efficiency and can help to improve time effort and the resulting quality.

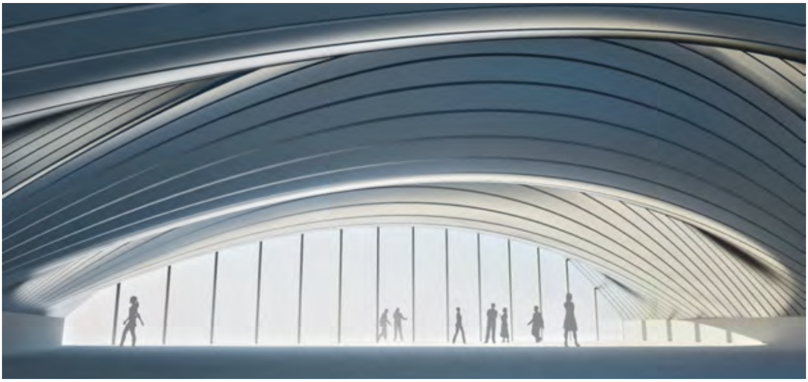

Figure 13. Visualization of a hall roofing made of curved sandwich panels with Deformation level 3

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Design Research between Academia and Practice: Systems Reef – Developing A Robotic, Carbon-Fibre Wound, Integrated Ceiling Structure

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Abstract

Architectural practices are increasingly dealing with complex design and planning tasks, particularly for construction and advanced manufacturing industries where assembly and automated processes are prevalent in many sectors. The ability to consider and explore new pathways for design can be of economic significance, and investigating uses for industrial robots towards novel material, practical and large-scale applications provides a unique opportunity. Innovation within the Australian construction industry is relatively low compared with other developed countries globally. The construction industry in Australia has one of the highest % shares of GDP and employment but ranks third lowest in digitization of all sectors. In this context, design research conducted as collaboration between academia and practice can be used as a framework to actively and directly engage architectural firms in the accelerated developments in construction robotics and advanced manufacturing, and simultaneously enable academic researchers to develop prototypes and proofs-of-concept through applied case studies. Such applied research in and through design then allows practice and academia to rethink the way that architecture can operate.

In this paper, we present the project 'Systems Reef', an applied design research into the onsite, robotic carbon fibre threading of a bespoke ceiling system for a commercial building. The paper first introduces combinatory threads of research including workspace scenarios, data distribution, flexible team organisation and robotic applications, and discusses strategies for bridging knowledge dimensions and establishing joint learning essential to the research. In the second part, the paper reports on the consecutive phases of design research; from developing prototypes for robotic carbon fibre threading towards onsite building fabrication for a new infrastructure distribution system. We discuss criteria, benefits and results of the project, and conclude with an outlook towards future potentials of design research for 'Systems Reef'.

Introduction

Advanced manufacturing has introduced significant changes to the production and construction industries in recent years, through automation, optimisation, precision and customisation of work processes, for manufacturing of building or industry components and products, and for optimising labour. In this context, robotic technologies show a wide-ranging potential for informing design approaches, material applications and building methods. Yet builders and fabricators, but more importantly architecture and design practices are often unfamiliar with robotic technology. Robotic fabrication requires in-depth technical knowledge for equipment and material processes, and an understanding of continuous workflows from design to production, such as handling a continuum of design data inputs and fabrication outputs feeding into each other. Systems and methods by which robotic processes can be developed, prototyped and then integrated within a construction site require an understanding for sequencing robot-human interactions, and how to measure and adapt different routines needed during the on-site fabrication of a project. These aspects present challenges but are also large areas for exploration through research and practice. Moreover, robotic applications can also foster novel design solutions, decision-making methods between designer and producer/manufacturer, new organisational structures. Hence, a critical step is the development of design research as an underlying technical foundation performed through interdisciplinary collaborations between industry, academia and government institutions.

All research constitutes ways for knowledge to be explored, captured and disseminated,[1] but design research particularly extends research through different methods of enquiry. We consider design research as research through design, that is, as the development of knowledge through designing, prototyping, process development and material investigation for a design solution. Whereas research fundamentally frames questions and hypothesis for theoretical investigation and understanding, design is an embodied action and dynamic process. ‘Systems Reef’ presents here a specific use case that formed the basis of our research, whereby we identified a real world problem with no known pre-existing solution. This enabled us to test the viability of potential options real time with users and create a feedback loop for the research. Design as a discipline integrates reflection and inquiry with tangible results.[2] Design combines a subjective process of search and research and a generalizable method that moves from prototype to practice.[3] Design research can thus establish a foundation for design innovation and produce concrete results. We argue that design research offers a unique problem space, whereby design research acts as shared tool for practitioners and researchers to invest in critical enquiry, to develop systemic thinking, to access and combine ranges of experience and expertise for a knowledge economy from design to industry applications.

Figure 1: Robotic carbon-fibre winding of a new integrated ceiling system in simulated ceiling environment with obstacles.

Our approach towards design research as collaborative endeavour is illustrated in the following by ‘Systems Reef’, a project that explores the potential and viability of robotic onsite construction by investigating carbon fibre reinforced polymers (CFRP) for a bespoke ceiling infrastructure system for a flexible workspace scenario (Figure 1). This case study was developed over a 9-month period (2017-2018) by the Robotics Lab (DMAF, The Sydney School of Architecture, The University of Sydney) and architecture practice BVN (Sydney) and explored a design research framework that allowed both partners to develop research, designs and industrial solutions for construction robotics directly.

Research Project: Project Scope and Multi-Disciplinary Threads

The project scope for ‘Systems Reef’ spans multiple problem spaces and cross-collaborative threads; from workspace for flexible team organisation to acoustic performance integration, from prototype development for robotic CFRP applications to the navigation of onsite fabrication and constraints:

Workspace survey towards flexible scenarios: In highly collaborative organisations, workplace structures necessitate flexible and reconfigurable environments.[4] Standard office-ceiling grid systems (1950, US Patent Bibbs) conceal building services and provide acoustic attenuation for spaces. However, these systems are monotonous and limit physical changes. Spaces that support innovation can be delivered by flexible workspaces.[5] Changing work and team constellations require a different organisational approach to general fit-out, table arrangements, data provision, and lighting integration.[6] The research conducted two surveys to understand the general capacity and performance of the existing open-plan workspace (BOSSA/Building Occupant Survey System).[7] Providing flexibility for desking independent from services and physical infrastructure limitations enables user agency, increases self-organisation of teams and supports highly dynamic activities, factors that can be critical to the future success of contemporary business.

Acoustic performance in open-plan office: General noise levels produced by multiple talkers can be high specifically in open plan offices, and so speech distraction can be a significant cause of dissatisfaction and loss of productivity.[8] Ceiling treatment in open-plan work environments can provide an essential way of ameliorating distraction from unattended speech, so that communication becomes more comfortable, and lead to a more relaxed vocal effort.[9] The research conducted surveys to understand existing conditions. It then framed design strategies for reflecting sound back to the source, followed by on-going research work into physical testing of prototypes towards site-specific deployment of acoustic reflective ceiling structures integrated into the project scope. An integrated workflow of computational design and digital fabrication technologies was created, allowing for the customised and programmable conditioning of spaces based on acoustic performance.

Development of robotic applications and configurable material practices: Recent advancements in CFRP technology and computer-controlled robotic manufacturing enable threading with consistent and reproducible material qualities. Substantial research includes carbon-fibre polymer composites formed over moulds or core-less fibre winding,[10],[11] coreless[12] and structure-focused winding[13] or semi-autonomous deposition by mini-robots.[14] Our research expanded a robotic filament deposition of fibre composites towards a context of on-site, on-ceiling industry-scale application, as a material response to flexible spatial programming, and with different structural performance implementing local constraints.

On-site, overhead and adaptable robotic fabrication: Recent projects have expanded the fabrication space from closed settings towards scenarios of onsite and versatile live robotic construction with mobile adaptive in-situ fabrication,[15] or aerial robots,[16] and onsite fabrication in the carbon-fibre threading.[17] These systems build on live-data feedback with sensing and feedback control as part of robotic programming and fabrication. In contrast, this research prioritised developing a reconfigurable and robust work protocol for variable project constraints, allowing robot and humans to inter-operate in an inhabitable environment where human flows and obstacles were unpredictable.

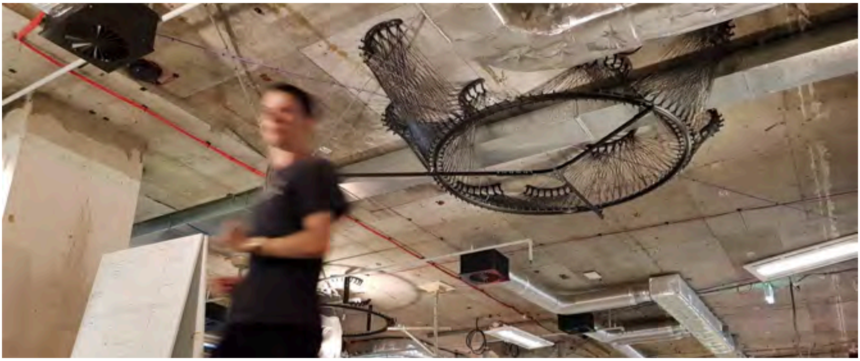

Figure 2: Robotic carbon-fibre winding of a new integrated ceiling system as a collaboration between applied research and industry (University of Sydney and BVN).

Collaborating between Knowledge Dimensions

A key aspect for design research lies in new knowledge to be produced though the interaction of thinking, experience and action that 'conjointly play a role in learning'.[18] Collaborations between research and practice through design are particularly useful here; in bridging different dimensions that support problem solving, whereby (disciplinary) limitations can be overcome by working collaboratively and outside the 'immediate constraints of practice'.[19] Developing design research through inter-organisational arrangements between practice or industry and academia extend to a variety of engagement levels, from contract research, use of equipment, to skill training and joint and equal research partnerships.[20] This potentially allows practices to rethink the way they operate, and academia to extend research limitations. Yet in order to do so successfully, designers and researchers must then fundamentally deal with learning methodologies that may differ between both groups. A systematic and organised enquiry into a defined problem with multiple feedback is essential for results and processes to become goal-oriented, knowledge-directed, and communicable,[21] and this is irrespective of the organisational body that undertakes the enquiry.[22] Importantly, different resources and knowledge can be combined to support active decision-making processes. Pursuing a system enables mutual learning and synchronisation of known dimensions and disciplinary expertise, across a range of criteria.

In 'Systems Reef', design research was characterised by a joint and ongoing development, undertaken by a large team with different skill sets, and thus design and prototyping required a concerted and continuous effort of mapping objectives and framework forward (Figure 3). From the outset, we developed a shared pathway through mapping out crucial questions with priority, high-level exchange of information, brainstorming to enable common areas of interest, and define research objectives.

Figure 3: Initial sketches and concept diagrams continued to final discussions onsite.

On a level of consultancy and sharing research foundations, this included connecting to ongoing design processes (workspace design) by providing surveys and analysing, and testing and evaluating existing work conditions (acoustics). On a level of shared technological and infrastructure equipment, this included research training phases for robotic technologies and continuous phases for robotic prototyping towards applied onsite robotic winding, thus shifting the robotic fabrication lab between institutions. As a consequence, academic and industry research partners were able to invest profoundly and across dimensions from design development, workspace, robotic fabrication, and organisational management (Figure 4). Hence, the multidisciplinary team moved across building a shared body of generalised knowledge towards the understanding of workspace conditions to develop problem-solving capacities for data distribution. Then, we developed insights, techniques and processes into new areas of 3D printing and robotic weaving, and evaluated these against design creation and cost effects driven by project management and production aspects. We bridged our first differences in objectives, from multiple computational design and simulation applications towards prototyping and onsite manufacturing), and developed tactics for meta-learning, as exchanges between design tools. Finally, we established strategies for learning on an individual and a collective level, across team members and institutions.

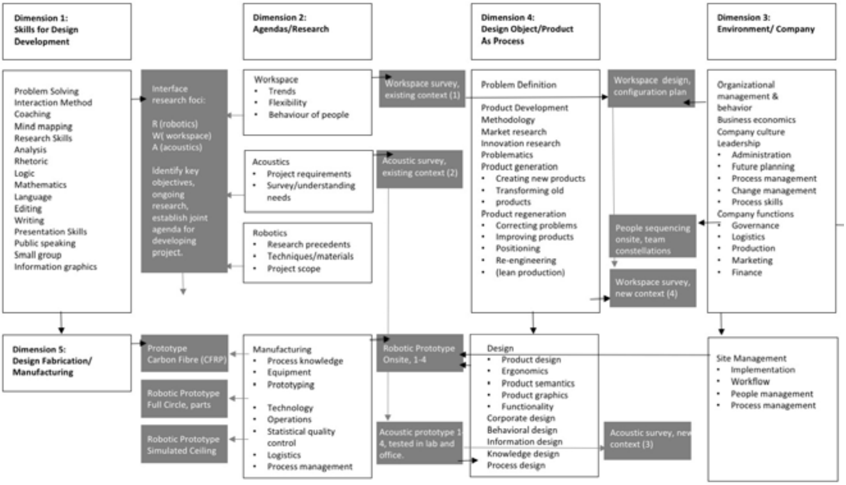

Figure 4: A taxonomy: dimensions of design knowledge, phases and prototypes.[23]

By adopting a multi-modal and multidisciplinary approach in this project, designers, researchers and professionals with different background knowledge and expertise worked directly together to integrate expert knowledge other than their own, develop synergies, and so push the boundaries of construction robotics. Key phases are introduced in the following to further discuss framework and systemic thinking across the fields of workspace, acoustics, and design for robotic fabrication and construction.

Research Project: Key Objective and Phasing

Robotic technology has introduced aspects of automation, optimisation and customization to manufacturing and fabrication processes, and thus provides a considerable potential for construction industries.[24] Human-robot collaborations for robotic-aided fabrication and onsite building sequencing are furthermore currently of substantial interest to robotics research. Consequently, design research for 'Systems Reef' centred on the development of an integrated infrastructure to support the agency of networked, dynamic and self-organising teams. To this extend, multiple soffit-hung, rotational and retractable data booms were to be situated within an existing ceiling of a commercial building. Each boom holds a capacity to feed eight desks in direct vicinity and provides fibre-optic data, electrical cabling and integrated lighting.

For the data network to be adaptable to complex activities, the system had to be compliant with standard building requirements, and afford onsite and data-responsive advanced manufacturing. Hence, carbon fibre robotic threading was chosen to secure the data booms within existing ceiling services. We chose to use CFRP as a 'non-standard' material to explore possibilities, and enable industry to consider new materials as a catalyst for innovation and rethinking current practices. The research developed knowledge for the complex, overhead and onsite robotic weaving across an existing ceiling condition that constitutes a three-dimensional structure. Distinct multiple robotic weaving deploys here intrinsic material properties and structural performance of a resulting fibre mesh to negotiate forces inherent in the system, and a travelling point load presented by temporary towing of the data cable. To do so, essential knowledge for geometry, weaving syntax, material constraints, structural performance and robotic feasibility, including evaluation of prototypes, had to be developed.

Phase 1: Developing Systemic Thinking and Design Capabilities

In the first phase, the team explored options for concepts, geometry, material studies through multi-scale models, scripts and robotic workspace in parallel to produce a knowledge base for the project:

Conceptual brainstorming and definition of common denominator. Precedents, concepts, diagrams, presentations and modelling workshops were conducted to arrive at a project approach and common design language. This allowed the team of researchers to visualise and discuss opportunities for shape, geometry, material applications and project scope (Figure 5).

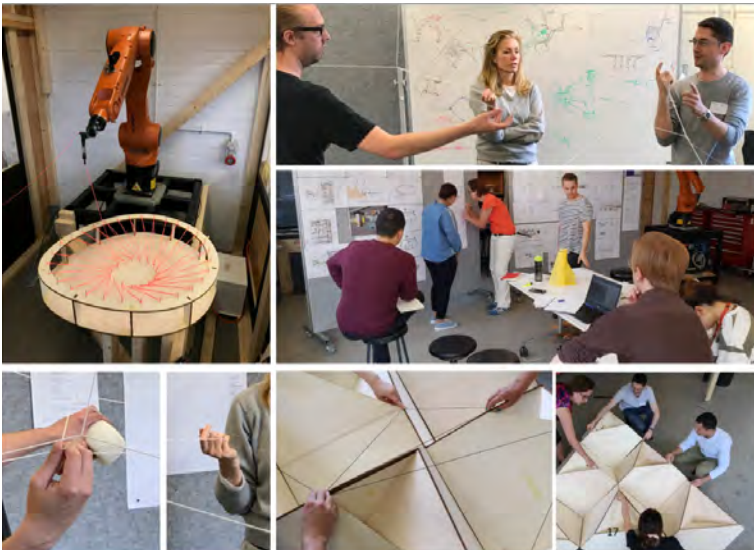

Figure 5: Design languages and strategic development of communicable visuals.

Global Geometry. The team developed a range of possible shapes in Grasshopper (GH) as a function of rule-based connections between a point matrix relative to boundary conditions. The global geometry conceptually followed by generating a model based on a number, relative distance, position and weaving between the circular boom, and inside and outside soffit hooks. This approach provided a catalogue for testing the structural fitness of the shapes with tension-compression forces exerted to the system (Figure 6). The geometry displayed here requires four robot positions; one inside and three outside to produce resulting surfaces.

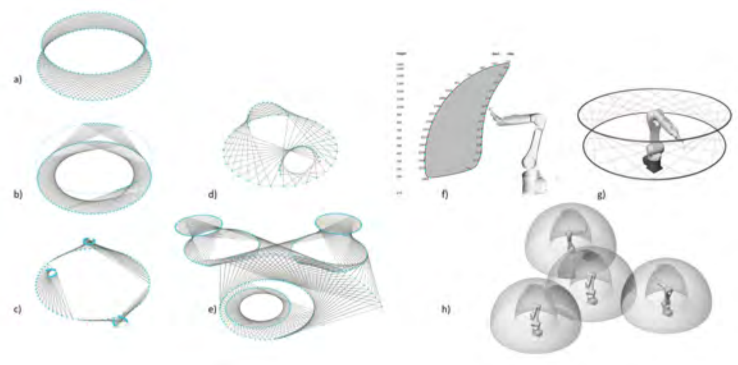

Figure 6: Diagramming potential robotic prototypes (a-e), robotic workspace and reach (f), confirmation of primary weaving access (g), and robotic work volume intersections (h).

Situating data distributors. A generic script (kernel/circle packing, GH) was deployed to reference a data tree structure with organisational centres (booms) to minimise distances while accounting for existing obstacles (HVAC, columns). We applied a generative design for optimised shortest path distribution of power and data cabling, and one optimisation was chosen as macro-topography and referenced with a 3D scan. These initial 3D surveys provided an overall placement of data booms within the existing ceiling structure and indicated a preliminary installation of the future prototypes.

Developing material and fabrication process. Researchers explored many physical and scaled studies in builders' rope and carbon fibre reinforced polymers (CFRP) on customised looms as a comprehensive description of morphogenetic weaving patterns, where the differentiated fibre layout weaving becomes a gradient variation of material properties and geometry.[25]Customisation of the fibre threading process also included changes to the carbon fibre x-winder and development of a series of end-effectors for threading the fibre (Figure 7).

Weaving syntax. The robotic simulation in KUKA|prc follows the global geometry and consolidates the weaving syntax for the doubly curved carbon-fibre surface woven in multiple step-over for each ceiling hook. Priority is given to maximising fusion between laid carbon-fibre threads.[26] For internal weaving, ceiling hooks and ring hooks form concave arcs relative to the robot position, with a surface 'lofted' between both arches that are also concave relative to the robot. The script orchestrates weaving density, access angle of end effector reach towards hook heads, and exact position of fixings as a primary starting point of a weave (Figure 8). These preliminary studies enabled the research team to move forward into two research prototypes that confirmed the economic, aesthetic and structural feasibility

Figure 7: Material computation models: Development of weaving models (analogue string weave, robotic string weave, robotic carbon-fibre).

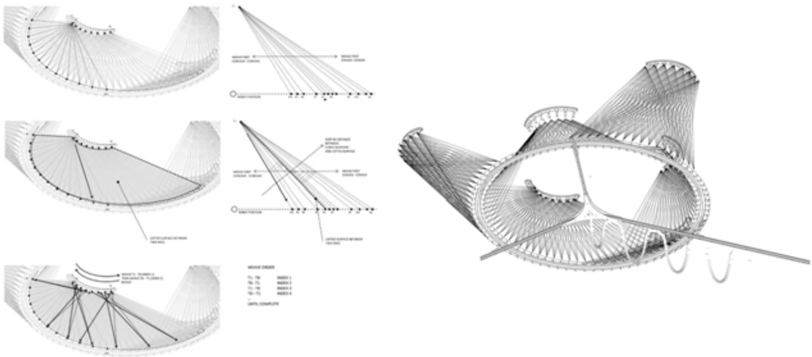

Figure 8: Robotic weaving sequence applied to all prototypes (left), data boom with integrated carbon-fibre weaving (right).

Phase 2: Prototyping

The second phase centred on the development of the robotic threading for a series of prototypes from generic and full circle carbon-fibre deposition to prototyping in a simulated ceiling context.

Prototyping at 1:1 scale. As a proof of concept, robotic weaving was prototyped within two large-scale circle segments to test sequencing for weaving, test density patterns, overcome blind spots in robotic reach, and to achieve correct turnround at hook positions (Figure 9). The robot is placed centrally and weaves inside across 360 degrees. By transferring weaving patterns first into a sequence in a string (builders rope, first stepover), and then retracing in industrial carbon fibre strength and stiffness for the carbon fibre laminate could be evaluated. Results indicated that sufficient structural capacity results from material properties for a multi-directional layer with five stepovers. Further robotic studies replaced the closed upper circle with circle segments to increase reachability and navigation towards multiple ceiling hooks.

Figure 9: Simulated office ceiling, phase1 (ideal complete weave, a), multiple stepovers overcoming blind spot (b), and carbon fibre final (c).

Figure 10: Prototype 2 in simulated office ceiling, phase1 (inside three hooks, a) and onsite results carbon fibre threading inside and soft fabrication outside (b).

Prototyping in a simulated site context. The robotic workspace was further tested relative producible dimensions against four different site conditions for boom prototypes, given the current ceiling interruptions (HVAC). While the boom set-out is predetermined through the desking location, all positions for hooks are adaptable but relative to the total number of required robot positions. The robot motion script is from the start constructed to privilege variability and allow a maximum of updates relative to criteria adaptations. At this stage, the script orchestrates weaving density, access angle of end effector reach towards hook heads, and exact position of fixings as the primary starting point of a weave. This enabled the research to move seamlessly into further development of the script for prototype 2, where the two complimentary rings and closed weaving was exchanged for multiple hooking points. Producible dimensions of one robot workspace take into account three initial, inside weaves and further consecutive 3-8 external weaves within the same ceiling context (Figure 10).

Phase 3: Developing Applied Design and Project Delivery

The third phase transferred updated scripts and workflow for integration with the added challenge of weaving inside a ceiling void, for testing the robustness of the robotic protocol and manufacturing four differentiated design solutions.

Developing adaptability and robustness. In-between standard obstacles and non-go zones set by different existing service elements including beams, HVAC, cabling, fire outlets, and core areas were embedded into the script, so suitable data solutions for manufacturing could be generated. Adaptability in the script provides an inbuilt tolerance that also caters for misplacements of soffit fixings due to human error, or previously unregistered site constraints. By re-referencing a fixing point once it is placed, the script maintains a capacity to semi-autonomously update robotic threading patterns, in response to system positioning, location, and available fixings points.

Choreographing robotic fabrication in a moving building site. The team conducted a standard procedure for set-up and calibration to respond dynamically to conditions of the building site. The robot was located on a platform and calibrated by determining the project origin through manual tracking. These actual data were referenced against the original 3D data scan and corrected through adaptability embedded in the script, simulated in Grasshopper and KUKA|prc to check sequence of robot positions and corresponding hook positions. Discrepancies in hook positions and robotic tooling path could thus be adjusted. Then, a robotic threading fabrication was deposited as a 'dry-run' in builders rope before fabricating in carbon-fibre. This process orchestrates 16 robot positions required for four weaving solutions, taking into account also the people and desk movements to enable continuous work across the office environment and its ongoing operation during construction.

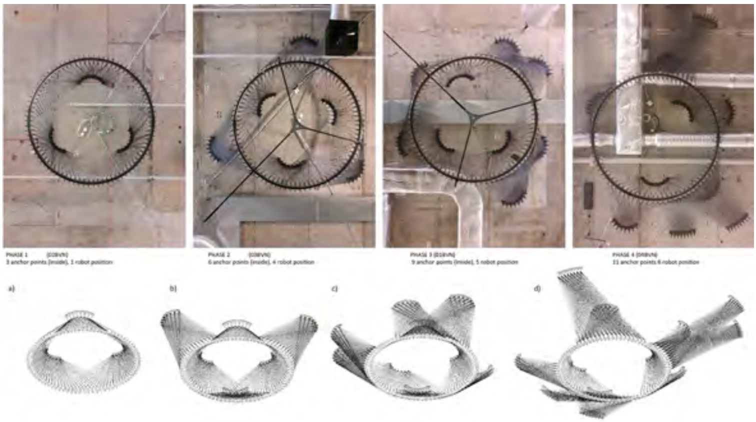

Figure 11: Robotic Model as Prototype. Staging of prototypes and incremental variations: minimal/1 robot position (a); optimized/4 robot positions (b), maximum interrupted/ 5 (c), and maximum robot reach (d).

Developing diversity across four differentiated robotic weaving prototypes in situ. The complexities of onsite robotic weaving across existing ceiling conditions is expressed as unique three-dimensional structures that deploy specific material properties and exhibit particular structural characteristics. Each prototype is a discrete event within the overall process, fabricated in individual locations, whereby each geometry navigates the ceiling context of obstructive services (see Figure 11). Each started with weaving three inside hooks from the first primary position, with the constant weaving of 1-3 external ceiling hooks per following robot position. Criteria values were: a minimum robot calibration and weaving time with one robot position and three inner hooks only resulting in sufficient structural stiffness (11.a); an optimized version with three internal and three outer hooks across four robot positions (11.b); a maximum diversity weave due to prevalent interruptions with five robot positions (11.c); and maximum robot reach and surface span within robot work envelope (11.d).

Through robotic design tools (both relative to processes within the computational design and advanced manufacturing), the research could account for and expand limitations of precision and optimisation, dimensional tolerance and material resistance. By encouraging variation and differentiation instead of geometric simplification, standardisation and repetition, the robotic design model was advanced towards four differentiated prototypes of an integrated ceiling system that conditions flexible workspaces through data and light distribution.

Discussion

Common learning practices in research collaboration between practice and academia are a challenge, but more importantly offer an immense potential to go beyond immediate organisational constraints. Establishing a combined research agenda and systemic thinking across disciplinary fields proofed invaluable for the research team to combine different areas of expertise, and so be able to situate the research value in a field where sub-problems such as workspace, or CFC had been initially already explored but not been brought together. Developing pathways for a range of research activities jointly engaged researchers in phases from design, analysis, material and structural performance, whereas previously they would have been allocated only parts of this multi-dimensional problem space.

The research found that the objectives of the project could collaboratively be defined after a wide-ranging brainstorming regarding available expertise, research scope and general project requirements. As the project contained several complex and intricate problems, it was essential to decompose design aspects into several subprojects, but equally important to regularly interface objectives and methodologies across subgroups. A definition of project tasks and milestones was formulated at the outset, changes occurred, and so clear communication of developmental stages was important. The project contained strands of enquiry that differed between project partners, ranging from the application of universal design- and technical-based methods and tools towards optimising these for project production. To benefit both research investigators, continued and opened discussions in regards to strengths, limitations, and critical points were used to align these agendas. Finally, the parallel documenting of design methods in all phases allowed for updating team members regularly, and further served as an evaluation tool for all procedures.

Impacts and benefits of the research project, and particularly the move from basic research towards practical application, extended the design possibilities for both. This is demonstrated by the refinement of infinite geometric variety towards an ability to build high-resolution, design-engineering products. In adopting variable and adaptable methods towards customisation across four prototypes, the team derived solutions for advanced material deposition in carbon fibre that could be tested and evaluated under project criteria (material, structure, deposition, etc). The design research case study could thus invest in methods for robotic fabrication that specifically incorporate workflows for exploring construction sequence, negotiation of material forces, and robot motion protocols. While this particular study into onsite robotic weaving represents a defined and thus single design problem, this further indicates ways in which designers and researchers can facilitate productivity, design flexibility, on-site safety, and cost reduction for the construction industries.

Conclusion

Design research for ‘Systems Reef’ enabled us to establish strategies, project scope and bridging interdisciplinary knowledge and research strands between flexible workspace in open office environments, acoustic performance criteria, novel robotic applications and material practices and onsite fabrication. Future research work could extend these individualised solutions for construction robotics by shifting the project scope and continuing into human-robot collaboration through construction visualisations for the human counterpart. This could also extend to semi-automating weaving processes through adaptive robotic protocols based on real-time sensor feedback or mobile robotic platforms, or further investigation of structural dimensions for threading robotic carbon fibre as integrated ceiling component. Between these options, the design research could proceed as basic research, such as industry mass customisation, or as a hybrid between both. Significantly, there exists the potential to consider producing the entire infrastructure system through its relationship with a flexible and self-organising workspace as initial setup, whereby robotic fabrication processes could be scaled up to supplement the entire ceiling topography.

The design research provided a methodology to synchronise and expand expertise and knowledge between research partners with different objectives – the method-oriented focus of basic research in academia, and the applied industry agenda of practice. Design research conducted jointly between practice and academia offers a potential to rethink the way that architecture practices operate, and at the same time allows academic researchers to develop proofs-of-concept through applied case studies. In a context of developing research for construction industries, particularly research into robotic fabrication processes for practical and large-scale applications can provide a platform and framework for architectural firms to pursue novel solutions for the constructions trades, and define new professional roles that reposition the architect again at the building site. Architects are then no longer limited to merely designing buildings but extend their work towards generating processes for human-robot collaborations, orchestrating constraints as much as sequences for environments that evolve through design research innovation.

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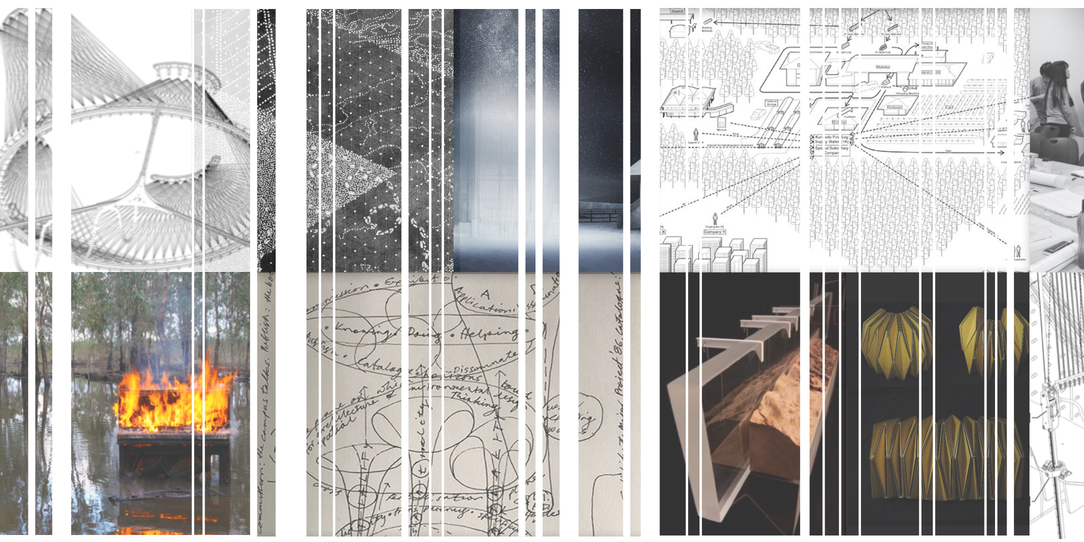
Hosted by the School of Architecture, Design and Planning at The University of Sydney on the 27th and 28th September 2018, the inaugural Annual Design Research Conference (ADR18) is devoted to design research in built environment fields of architecture, landscape, interior, and urban design.

The aim of the ADR18 Conference is to address problems associated with producing valuable design research outputs in ways that are comparable to those of more traditional research methods. The conference focuses on:

- The role of Non-Traditional Research Outputs within increasingly metric-driven research environments
- Methods for increasing the representation of design research in these metricated environments
- And the creation of a new forum for design researchers to gather, present and discuss their work

These foci, developed into the future, will allow design research to be more significantly valued by the academy and established research bodies, and contribute to a new, ongoing, critical dialogue on design research.



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