Paul Loh
Mond Qu
David Leggett
editors

catalogue

architecture, art, engineering, culture, fashion

FUTURE PROTOTYPING

Future Prototyping Exhibition Catalogue

Held at the Melbourne School of Design,
The University of Melbourne
24th February – 27th March 2020

This event is part of Melbourne Design Week 2020, an initiative of the Victorian Government in collaboration with the NGV, 12th – 22th March. Call for projects was held between the 19th September - 4th November 2019.

Edited by Paul Loh, Mond Qu and David Leggett

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All the research statement of significance associated with each project is written by the individual authors and is copy-edit by the curatorial team. All authors' information, detail and biography are provided by the authors. Any omissions are entirely unintentional, and the details should be addressed to the editors.

Book cover designed by United Make.

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture on whose unceded lands we conduct the research gathered in this book. We pay our respects to their Elders past, present and emerging.

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FOREWORD

JANE BURRY

The Future Prototyping exhibition comes to us in 2020, the year for 20-20 vision. The focus of the exhibition selection criteria were first, ideas (non-commercial), second, novelty and third, the potential for future impact of prototyping in architectural design.

The curators of this exhibition are uniquely qualified to assemble this collection of current, but future-focused, Australasian prototyping practice and academic work. Paul Loh and David Leggett are partners in the dual Melbourne architecture and advanced fabrication practices LLDS and Power to Make. Mond Qu, is Founder and Director at United Make. They marry design and making in every breath they draw, and share an Architectural Association (AA) background and an ongoing Melbourne University studio teaching present. Their publications, including Dr Loh's short essay in this catalogue, tease out the way in which making and prototyping can be the force generating design, not merely a testing ground for abstract design propositions. Their own research in the exhibition speaks as highly as words of these agendas. The works exhibited were selected from a very exciting and challenging field of entries, the panel adhering closely to the criteria to ease deliberations. The result is an eloquent and enquiring collection, an inspiration for future prototyping.

Suddenly, but not serendipitously, in 2020 in Australasia, the sense of urgency for paradigm change is at a new pitch; nowhere more so that in the built environment. In numerology, the number 20 signifies diplomacy and the ability to bring a project to conclusion and is 'the perfect biblical waiting period'. The post millennium wait for decisive action on climate change in Australia must now be over.

The need for not just incremental but radical paradigm shifts means a new heightening of experimentation to find workable solutions. "Workable" means rapid iterative prototyping, working across disciplines and at every level from material testing and bio investigation to investment in carbon neutral and negative buildings. Prototyping is core to architecture, as never before.

In exploring, in the most recent decade, the prototyping practice of 50 leading global architecture practices for the book Prototyping for Architects, Mark Burry and I discovered that, digital practice had not only fostered a singular Bauhaus-like revival of physical prototyping, but a diverse field of prototyping practice understood differently by every architect or engineer of whom we asked "what is a prototype". We found out that architectural and design prototypes were tools for: thinking and feeling, experimental verification/falsification, testing processes or performance, manifestations of data, progenitors, and often the built project itself. This exhibition aptly reflects this diversity across a broad palette of materiality, used as the primary organisational strategy for the catalogue. But the curatorial taxonomy also captures other qualities; from biological to biodegradable, earthen to mineralogical, light-weighting to waste-eliminating, visually-affective to reactively-sculpted, temporal to textile, pneumatic to auditory, paper to metal, interactively artistic to robotically prosthetic, self-organising to tele-present, artificially intelligent to mixed reality, and timber: steam-bent, elastically-curved, carved, recycled, actuated, irregular, deep-structured and data-inventoried.

Future Prototyping is a collection rich and rare.

INTRODUCTION

This book is published alongside the Future Prototyping exhibition held at the Dulux Gallery at the Melbourne School of Design, the University of Melbourne from the 24th of February to 27th of March 2020. The exhibition is part of Melbourne Design Week 2020. The exhibition aims to survey the current state of design innovation within the Australia and New Zealand context. Through artefacts as a design prototype, the curatorial team aims to generate debates around the nature of innovation through design and making (as co-dependent activities) and its role in our neo-liberal, post-industrial, and post-digital society.

The exhibition brings together 36 projects from significant institutions and design practices across Australia and New Zealand together with a global network of research partners. Curated through an open call for projects and each project is double-blind reviewed. This is the first time all of the projects have been presented together in a curated exhibition in Australia.

The first round of blind review is where each project is discussed by the curatorial team in terms of the relevance of the prototype to its design intention. The curatorial team then re-organises the projects into categories of material and presents the projects to an expert panel for the second round of review. The panel consists of Professor Jane Burry (Dean of the School of Design in the Faculty of Health, Arts and Design at Swinburne University of Technology), Professor Donald Bates (Chair of Architectural Design at the Melbourne School of Design and Director of LAB Architecture Studio) and Jon Yeo (Curator of TEDxMelbourne). Each reviewer is assigned several categories of materials and asked to rank the projects based on the three criteria set by the curatorial team and listed below.

- The project must not be commercially available.
- The project must be novel or have an innovative aspect.
- The project must provide a glimpse of the future (that is relevant to today's societal needs).

Once each reviewer has ranked their assigned group of projects, it is then tabled, and the curatorial team facilitates a discussion with the other reviewers. Here, projects are re-ranked, and the highest-ranked projects are accepted. During the process, the reviewers provide recommendations as to whether some or all the artefacts submitted by each author should be accepted for the exhibition.

This catalogue documents the 36 projects selected for the exhibition; each project is accompanied by an image and a research statement by its author(s). The research statement highlights the significance of the project and its design relevance.

The rigorous review process generated discussion and debate around the nature of prototypes. Several research questions emerged: What makes an artefact a prototype? What is the role of technology in contemporary prototyping processes? How do prototypes provide us with glimpses of the future?

What is a prototype?

Making a prototype provides a means to experiment, design and test a concept. While most prototypes are physical artefacts, they can also be virtual and come in a multitude of media that challenge our senses in the form of sound, touch, smell, sight and taste. A prototype may or may not be functional. It may be incomplete, sometimes rough and ready with areas that demand further development. A

Future Prototyping exhibition in the Dulux Gallery, Melbourne School of Design

prototype helps the designer to encapsulate and translate abstract design ideas and intentions into physical form, shapes and material effects.

Prototyping is the process of testing design ideas. As Mark Burry and Jane Burry (2016, p.12) eloquently describe, prototyping is the revelatory process through which a designer gains insight into how well their experiment is proceeding, and it is an essential part of every designer's repertoire. While prototyping is often synonymous with experimentation, the outcome of an experiment may not necessarily be a prototype. We encounter this assumption during the curatorial process of the exhibition. The questions we ask: What makes an artefact a prototype? When is the artefact an experiment and not a prototype?

Indeed, there is a fine line between experimentation and prototyping. While both rely on a pre-determined set of hypotheses and yield a set of unknown outcomes, what differentiates prototyping from experiments is a sense of design intention. It is this intention that enables a prototype to transform an abstract idea into the physical or virtual in order to project new potential at the same time. In other words, it is orientated towards both the future and the past.

Prototyping the Future

What prototype does is to make the future visible. As Fred Turner (2019) proclaims, prototyping has long foretold brighter futures. More critically, it challenges our current views of our world and the ideals of our future society. In this exhibition, we see prototypes that push forward in time to question the way we construct our built environment, consume fashion, produce products, and provide humanitarian shelter. Others show us a glimpse of future gardens, arts, artificial intelligence, and strategies to deal with waste and by-products – an optimistic and brighter future as designers from multiple disciplines tackle issues stemming from the inevitable climate changes and the shifting of economic power in our neoliberal society.

Future Technology and Techniques

Technology has played a crucial role in the current state of prototyping practice. Almost all the prototypes utilise (in some form or another) advanced computer numeric controlled (CNC) devices or electronics to facilitate the making process – from the industrial robotic arm to using Arduino™ microprocessor for open-source prototyping. Some projects are only made possible through custom code that either mimics material behaviour (Inconsistencies v0.6 by Stojanovic & Katic, p. 75), or constructs machine learning algorithms (Sketches of Thoughts by

Mirra & Pugnale, p. 101). 3D printing has already made a significant impact on the way we design and make an object. Its proliferation in everyday homes and educational institutions have uncovered new potentials. The question for designers is how to deploy it to overcome convention, restriction and constraints in manufacturing. Here, we see new methods in 3D printing soft robotic hand (Mohammadi et al., p. 65) coupled with 3d-scanning (Mayer et al., p. 67) facilitated a lower-cost and more accessible prosthetic device for amputees. The Parametric Adjustable Mould (Loh et al., p.41), Cast Bodies (Bao, Snooks & Xie, p. 63) Tailored Flexibility (Engholt & Pilgrim, p. 43), Cloops (Little, p. 39) and Knitted Architecture (Zilka & Underwood, p. 51) are a handful of the selected projects that point towards new means of construction combining CNC technology with the traditional crafts of casting and knitting.

Future of Sustainable Design

The future of sustainable design seems to lie with the biological materials. In this exhibition, more than half of the selected projects explore timber, fibres, grounded coffee, mycelium and kelp. Three trajectories of research in the use of biological material are emerging. First, the re-use of timber off-cut in construction with the aid of advanced technology from robotic milling to mixed reality assembly: Crooked Lamella (Aagaard et al., p. 93), Suspended Remnants (Baber et al., p. 97) and Augmented Assemblies (Guy, p. 87). Second, the exploration of new material possibilities through bending, reciprocal arrangement, lamination and repair: Steampunk (Jahn et al., p. 81), House #05 (Loh & Leggett, p. 95), SuperSuccah (Pilgrim & Maxwell, p. 83), Dark Craft Pavilion (Maxwell et al., p. 53) and Coat of Theseus (Pesaran & Edwards, p. 49). Third, the growing, manipulation and re-use of biological material towards a designed form or structure: Scoby Bear (Hindrum, p. 19), Mycelium Structure Prototype #3 (Chen et al., p. 29), Bio-Fabrication with Mycelium and Kelp (Power et al., p. 23), Latte (Qu et al., p. 27), and Synesthesia (Copland, p. 25).

Future Society

Behind the form, material, technology and techniques of the prototypes showcased in the exhibition are more significant ideas about the future of our society. We dare not claim that some of these prototypes will bring about a paradigm shift in their field or radical social order, but what we are certain of is that, if proliferated, some of these prototypes will affect our lifestyle and the way we construct, view and inhabit our environment. Just like how code and algorithms are structuring our lifestyle from Instagram to Uber and Airbnb, each prototype promises a new means of engaging with the way we will live in the future. A single prototype can unveil new housing typology (House #05), potential to reduce waste (Re.Bean, p. 21) or provide humanitarian aid (SheltAir by Quinn, p. 59). We encourage the visitors to the exhibition and readers of this catalogue to reflect on the prototypes and come up with your vision of a future society.

A Note on Curatorial Taxonomy

In order for us to make sense of the 36 prototypes showcased in the exhibition, we have organised each of the artefacts based on its material outcome. There is, of course, more than one means to taxonomise the projects via scale, disciplines, techniques, and senses. Each project is indexed with these taxonomies to allow the reader to formulate new relationships between projects, see page 15.

The exhibition itself consists of several prototyping aspects. The exhibition structure is a 'supergrid' held together with a CNC-milled cross joint detail (image on the front cover). The structure is designed so it can be assembled and disassembled to avoid waste in exhibition design. The structure may well pop up as fragments in other exhibitions. To accompany the exhibition, Mond Qu has designed and curated a dining experience tailored to the exhibition space. The experience promises to dilate your senses and tease the taste buds with ingredients such as Impossible meat, and miracle berry. We also put remote fabrication to the test – the foyer of the exhibition is dominated by a prototype 2.0 of SuperSuccah by Supermanoeuvre. Instead of shipping the existing prototype from Sydney, we saw an opportunity to clone the work remotely as an act of future prototyping. Supermanoeuvre used this opportunity to refine the piece, reducing all elements to 4mm plywood and making the assembly more accessible, see page 113.

Last, we run a one-day symposium where selected authors present their projects and round table discussions are conducted around the thematic of Learning through Making, Prototyping across Disciplines, and Prototyping with Technology.

Paul Loh, Mond Qu + David Leggett

References:

Burry, M & Burry, J 2016, Prototyping for Architects, Thames and Hudson (London, United Kingdom).

Turner, F 2016, 'Prototype', in B Peters (ed), Digital Keywords : A Vocabulary of Information Society and Culture, Princeton University Press, Princeton, New Jersey, pp. 256-268.

Future Prototyping Exhibition


FUTURE PR

CATEGORISATION

YEAR+
TECHNIQUE+
SENSE+
DISCIPLINE+
MATERIAL+
SCALE+

Technique+

Milling
Printing
Mixing
Growing
Coding
Sensing
Casting
Stitching
Carving
Inflating
Knitting
Recirocal
Folding
Sawing
Bending
Aggregating

Sense+

Sound
Smell
Touch
Sight

Discipline+

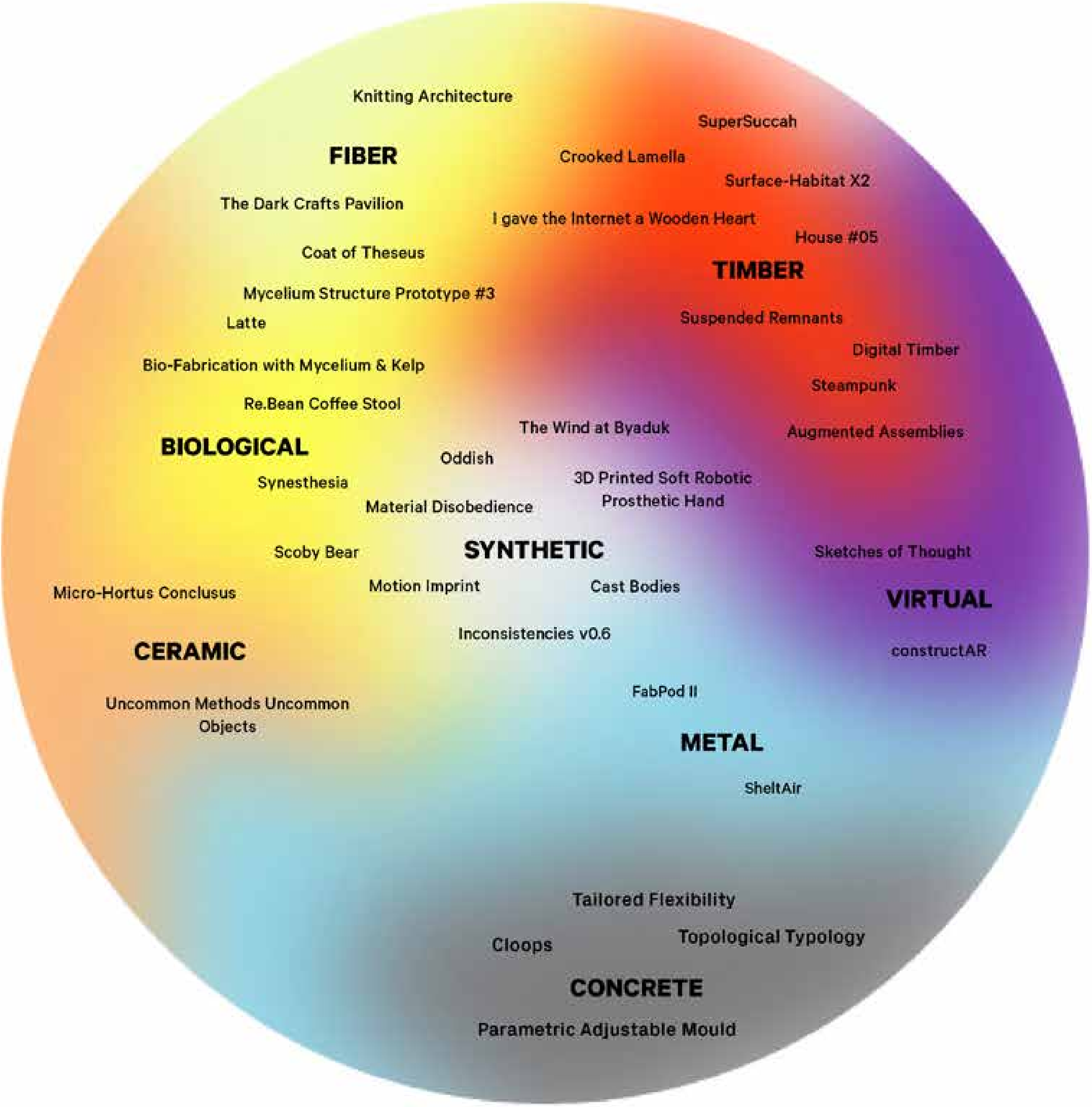
Art
Furniture
Product
Aromachology
Engineering
Landscape
Architecture

Material+

Biological
Ceramic
Concrete
Fiber
Metal
Synthetic
Timber
Virtual

Scale+

Human
Room
Infinite
Digitial



Biological+Ceramic+Concrete+Fiber+
Metal+Synthetic+Timber+Virtual+

biological

Projects

Scoby Bear, Re.Bean Coffee Stool,
Bio-Fabrication with Mycelium and Kelp,
Synesthesia, Latte,
Mycelium Structure Prototype #3

2019+
Growing+
Touch+
Product+
Biological+
Human ——

SCOBY bear

Bacterial cellulose is currently being investigated by various industries due to its potential ability to literally grow the final product and eliminate various stages of production (Jang et al., 2017). The Symbiotic Colony of Bacteria and Yeast (SCOBY), better known as the mother used for brewing kombucha tea is grown from readily-available domestic materials, like sugar and tea and is an easily accessible form of bacterial cellulose.

SCOBY bear aligns the material with a familiar and non-threatening object – a child's teddy bear. At the time of photographing the work, the SCOBY material used for making the bear was still alive and in a state of hibernation. All it would take to reactivate the material used for the bear's skin would be to add a cup of cooled sweet tea. This reactivation process would allow the material to once again begin growing. The bear is made from bacterial cellulose, in this case, the SCOBY (Symbiotic Colony of bacterial and Yeast) produced when fermenting tea.

The significance of the final prototype is not readily apparent without first understanding the growing process implemented. This prototype involved the innovative method of literally growing the pattern pieces to size, with no cutting of material required. As a result, zero material waste was produced to create the SCOBY bear pattern pieces. This design process required the negative space of the pattern pieces to float on the surface of the fermenting tea, restricting the available growing surface to the required pattern. Once the SCOBY grew to the desired thickness, the pieces were washed and dried. This process produced the required pattern pieces that could be stitched to form the 3-dimensional bear.

Reference:
Jang, WD, Hwang, JH, Kim, HU, Ryu, JY and Lee, SY. 2017, 'Bacterial cellulose as an example product for sustainable production and consumption', Microbial Biotechnology, vol. 10, no. 5, pp. 1181–1185.

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Sonja Hindrum,
University of Tasmania

SCOBY Bear: Bacterial cellulose and cotton. Image by Sonja Hindrum

2018+
Casting+
Touch+
Furniture+
Biological+
Room ———

Re.Bean Coffee Stool

Re.Bean Coffee Stool explores a brand-new sustainable material for furniture pieces from locally collected coffee ground waste and other coffee industry waste. The project features a unique smell and tactility of coffee, as well as 100% biodegradable – generating no waste to our natural environment.

Coffee ground waste has become one of the significant organic wastes globally. However, the issue is mostly unaware of by the public. Re.Bean Coffee Stool aims to develop innovative design solutions to reutilise this waste material and transform it into a sustainable and more importantly, biodegradable piece of functional furniture. Throughout the development process, a strong emphasis has been placed on the materiality and fabrication techniques. While most other sustainable furniture products in the market conventionally incorporate timber or other material for structural purpose, this binary approach is challenged by creating a sense of design using a singular material to create a unique design and fabrication method.

In addition, Re.Bean Coffee Stool seeks to make a manifesto of a creative design solution that how designers can help to cope with waste problems; it also tries to raise public's awareness towards the environmental issues of coffee industry waste. Through its coffee smell, unique tactility and fabrication process, Re.Bean Coffee Stool is revealing how our daily waste from coffee, one of the most globally consumed beverages, can be transformed into a useful furniture object.

-
Kristen Wang,
University of Melbourne

2019+ Growing+ Touch+ Architecture+ Biological+ Room ———

Bio-Fabrication with Mycelium and Kelp

Bio-design is an emergent and rapidly growing design paradigm that extends beyond biomimicry. Instead of simply being inspired by nature and its processes, bio-design incorporates living materials and processes into the design. As a result, the materials and the final design itself may be quite literally grown. Bio-design offers a process to harness biological organisms such as yeast, bacteria, fungi and algae. In this new way of designing and manufacturing, "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" (Catts and Zurr, 2013, p. 72). This presents opportunities for architects and designers to employ an extended palette of materials and engage in collaborations across disciplinary spheres.

The work on display has been produced by final-year 2019 Master of Architecture advanced design research students. In a unit that partners budding research students with research studio leaders, the research question and scope are developed in a team-based context. This work extends previous multi-disciplinary and collaborative research in bio-design by the academic leads that began with exploration of Symbiotic Colony of Bacteria and Yeast (SCOBY). The extended suite of materials has shifted in this iteration to focus on mycelium (mushroom) and kelp (an important local resource).

Mycelium and kelp have multiple benefits for the designer in terms of aesthetics, cost, sustainability, and various material performance capacities. Many examples of bio-fabrication in architecture focus on the finished output – the hero shot image of a completed design or artefact. The significance of this research and prototyping is the focus on de-mystifying the growing processes and the sampling needed to reach an end goal. The instruction manual outlines the steps for growing and testing the materials, in an attempt to share and allow others to join the burgeoning bio-fabrication community. The magnified photographs of the mycelium and kelp provide an insight into what takes place at a microscopic level.

The work on display is a small portion of what was produced during the year-long material sampling and design ideation. Other outputs (not on display here) included physical samples, to enable the haptic qualities of the materials to be experienced; an Instagram account, with workshop photographs and videos of the process; and, a set of design guidelines to provide advice for use of the materials for producing a temporary biomaterial pavilion.

Reference:
Catts, O. and Zurr, I. 2013, 'The vitality of matter and the instrumentalisation of life,' Architectural Design, vol. 83, no. 1, pp. 70–75.

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Michael Hornblow, Jacqueline Power,
Jingwen Huo, Jie Jun Low, Hao Ouyang, Jared Pan, Wan Ping Tay + Eric Yong,
University of Tasmania

Mycelium-composite growth tests, various substrates


PLAYGROUND™
PERFUME PLAYGROUND™
PERFUME PLAYGROUND™

2018+
Mixing+
Smell+
Aromachology+
Biological+
Human ——

Synesthesia

Synesthesia is a prototype with scent re-imagined for beauty, performance and well-being — a diffusion of evidence-based aroma within an art installation - a Perfume Playground.

Inspired by the 'The Secret Lives of Colour' which tells the unusual stories of the 75 most fascinating shades, dyes and hues we carefully selected sensory worlds with an unforgettable story, some seductive, startling and thought-provoking. From shocking pink to absinthe green, our goal was a deep emotional engagement to connect urban dwellers with nature; awakening shared feelings of euphoria, transcendence and joy.

With above in mind, the final scents were designed from the latest cannabis-science, three years of direct olfaction research within an international Perfume Playground Club, artisan fragrance training, and working with global trends and techniques mixing fragrance, technology and art. To create a consistent and memorable experience, Perfume Playground selected three colour stories; pink, green and yellow alongside three moods and motivations; euphoria, transcendence and joy.

A range of Cannabis-terpenes was explored in Synesthesia, considering the strain, variety, smell, strain effect, and when to use. Terpenes are aromatic metabolites found in the oils of plants. There are more than 20,000 terpenes in existence and at least 100 produced by the cannabis plant; the fragrant essential oils are secreted alongside cannabinoids like THC and CBD. Terpene combinations often distinguish one cannabis strain from another. Each terpene blend provides a unique sensory experience.

Fine Fragrances were then created with a clear evolution using raw materials from whole essential oils, absolutes, resins and isolated from parts of roots, grasses, leaves, barks, woods, spices, fruits and flowers.

As Emile Durkheim suggests, "each new generation is reared by its predecessor; the latter must, therefore, improve in order to improve its successor. The movement is circular." Experience natural fragrance re-imagined.

-
Samantha Copland,
Perfume Playground

2016+
Casting+
Sight+
Product+
Biological+
Human ——

Latte: Coffee Lampshade

Every year, over 3000 tonnes of coffee waste is produced. Less than 10% is recycled while the rest goes to landfill. What are we able to do with this byproduct from our thirst for more coffee? This prototype coffee lampshade is hand-made from recycled coffee grounds that are usually discarded.

The waste grounds are collected from local Melbourne cafes and sun-dried for 96 hours before being mixed with a resin. This mixture is poured into moulds and allowed to grow and cure into their final forms which only takes minutes. The growth of each lampshade is different, although they have the same mould the growth reactions are organic which creates remarkable translucency and uniqueness.

As the world starts to run out of virgin materials, we need to look at different ways of reuse, recycle and upkeep.

Latte is a prototype that tackles these issues of discarded materials in the 21st century and aims to help show different approaches where craftsmanship, design and reuse can be not only useful but also beautiful.

-
Mond Qu,
United Make

Photo of lampshade

2018+
Growing+
Touch+
Architecture+
Biological+
Infinite ——

Mycelium Structure Prototype #3

Can grown materials replace manufactured materials? Can the products of natural processes lead us to more ecological cities? Can biological processes be harnessed to improve our built environments?

In collaboration with the Institute for Advanced Architecture of Catalonia (IaaC), Swinburne University runs an annual Global Summer Studio. This studio seeks to explore alternative processes to mitigate the environmental impact of a world of unprecedented urbanisation. Our existing built environment and manufacturing models exploit and deplete our physical and biological natural resources, and produce byproducts which we now understand to have harmful consequences. At the same time, we recognise that natural processes involve closed-loop processes, in which pollutants are fuel for further processes. Ecologies of organisms ensure that what might be toxic for one species is sequestered by another, ensuring the quality of air, soil and water. How can designers and architects employ natural processes to create the material fabric of tomorrow's world? How can designers and architects harness natural processes to improve the quality of the environments we design? How can designers and architects embrace the variability of the natural world to enrich our surroundings?

This project takes a multidisciplinary approach that draws inspiration, technology and knowledge from biological science, algorithmic design and digital fabrication. Through building and making, participants collaborate with biologists, engineers, designers and architects to probe, experiment with, and test bio-materials and explore their fabrication potential and performance qualities.

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Canhui Chen, John Sadar + Linus Tan,
Swinburne University of Technology

Mycelium prototype prepared by IAAC GSS participants ceramic

Projects

Micro-Hortus Conclusus - Ceramic 3D printed micro-garden lattices, Uncommon Methods Uncommon Objects

2019+
Printing+
Touch+
Landscape Architecture+
Ceramic+
Room ———

Micro-Hortus Conclusus -
Ceramic 3d printed micro-garden lattices

This proposed future prototype scales down our conventional focus and association with what constitutes a 'garden'. Riffing off the tradition of the enclosed garden (hortus conclusus), the miniature or micro-world of small plants is deliberately framed and given authority by keeping things small and delicate.

The current prevailing approach towards the cultivation of our environments, whether it be in urban ecologies or agriculture is rapidly tending towards the monocultural. An attentiveness to the micro-world, often unseen at our feet, affords us an awareness of the greater diversity that may constitute a wider environment or ecology, spanning across the full spectrum of sizes and scales.

The mini-horticultural world has been coming into focus as a valuable biological resource that has the potential to realign our relationship to our wider ecology. The ignored world of bryophytes are an untapped new sensing network that has the capacity to act as indicators or monitoring agents of the air quality and pollution in our cities. More recently, the burgeoning trend of microgreens has been found to offer a highly concentrated source of nutrition which can be cultivated with a smaller environmental impact and allowing for the diversification of food systems in urban areas.

Pairing fourth industrial revolution manufacturing advances with associative design and modelling, this prototype offers a process that allows for the generation of larger ceramic micro-garden lattice systems that have the capacity for customisable differentiation. The ancient material world of ceramics and its characteristic properties offers a logical framework as well as growing medium for the miniature world of micro-plants.

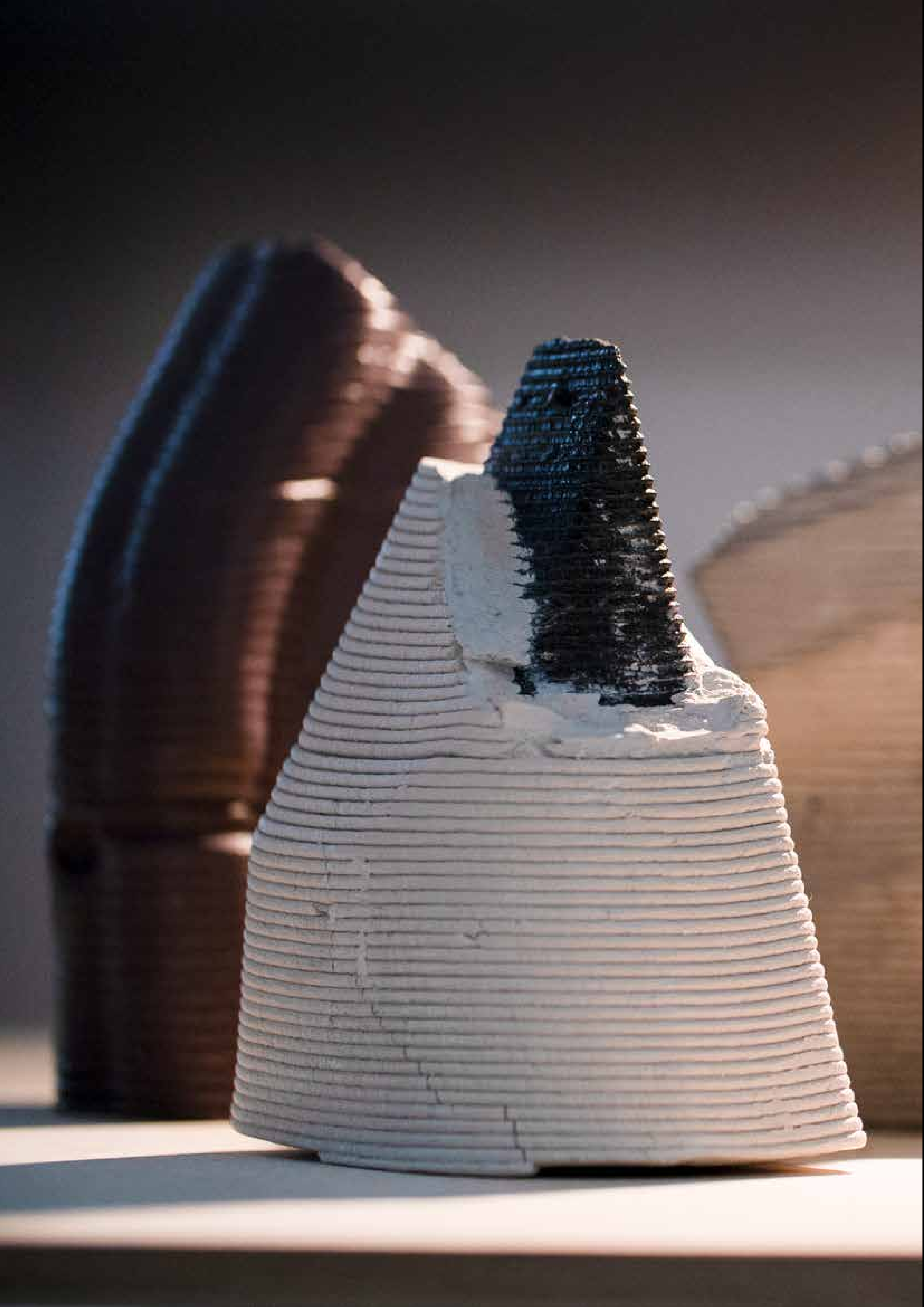
The base associative model leverages the natural structural and space filling capacities of the circle which is scaled up to form an intricate lattice. Variables in circle size, thickness, tapering (to produce cylindrical or conical profiles) and depth afford the capacity for the lattice to take on an opaque thickened section or a lighter, delicate lace-like quality. This translates to a wide gradient of qualities of exposures, shading, protection, moisture and sizing or in other words; a diversified range of synthetic habitats and micro-climates.

The research aim of this prototype is an exploration of the capacities for novel fabrication technologies to construct cultivated synthetic micro-ecologies.

-

Leire Asensio Villoria + David Syn Chee Mah,
University of Melbourne
Project Assistant: Candela de Bortoli
Flower and plant advice: Warren Worboys, Royal Botanic Gardens of Victoria
Floral Design: Azumi Ishikawa, Azumi

A 3d printed porcelain framework of varying sizes and extrusion profiles provide a synthetic range of micro-climates for cultivating a micro-gardens.



2019+
Casting+
Sight+
Product+
Metal+
Human ——

Uncommon Methods Uncommon Objects

Uncommon Methods Uncommon Objects is a material and process exploration that considers fabrication and materiality in regard to the modern designer/maker. By drawing on the visible connections between method and object, the works are a reflection on contemporary manufacturing, reproduction and the pursuit of individuality in design.

The digital to physical workflow for casting and mould making aims to create a connection between the process and product by designing objects that promote the method's unique physical characteristics. With a focus on developing forms for sculptural furniture and lighting design, these prototypes explore the possibilities of the unique production method and how objects can create visible references to how they were made.

The method utilises a self-built clay extruder to 3D print ceramic moulds for casting in metal and other materials.

-
Danny Triebert

Pewter casting sample

concrete

Projects

Cloops, Parametric Adjustable Mould,
Tailored Flexibility, Topological Typology

2019+
Printing+
Touch+
Furniture+
Concrete+
Human ——

Cloops

The Cloops project explores the ability of robotic clay extruders to create reusable formwork for the casting of complex sculptural objects.

As a material often modified by the hand, clay acquires new agency through its marriage with 3D printing technology. Objects substantiated using the Cloops prototyping method are distinguished by a geometric complexity hewn by optimisation processes exclusive to the digital canvas. The highly precise hand of the computerised 'craftsman' wields form-finding techniques unbounded by the physical boundaries exerted upon traditional sculpting processes, extending the suppleness of clay beyond its understood limits. By introducing virtual geometries into the physical world via 3D printing, their abstract carapaces are tectonically tested: tolerances, layer heights and draft angles represent some of the variables that focalise to produce prototypes anchored in a distinctively layered aesthetic. An additional trait of the transition from numerical to physical is the unplanned moments of failure: the ability for clay to slump, fold and deform under its own weight.

The clay vessels that come as a result of the Cloops process are then able to assume the role of formwork for a variety of casting materials. By applying an impermeable silicon layer between the 3D printed clay moulds and the casting material, the clay formwork is temporarily unable to reabsorb water and hence retains its structural rigidity while allowing the interior substance to remain uncontaminated during the curing period. The magnanimity of clay allows for its continuous reuse: once the 'positive' is set, the clay encasement can be rehydrated, removed, then reprinted.

Future avenues for prototyping in this way include the development of clay support structures, the employment of diverse casting materials and the creation of larger-scale objects where the relationship between the stratified formal language of the 'positive' object is shifted. A parallel channel of investigation lies in moments of controlled failure - seductive instances of collapse and unforeseen detail occurring within an otherwise regulated language. Such a methodology has the potential to be scaled beyond the currently tested sizes to produce geometries limited only by the scale of the robotic extruders involved.

Cloops represents a newly afforded dexterity in fabricating complex geometries with a material that offers reuse and malleability as its most compelling virtues. The consequences of importing of a traditional material into the digital process present indeterminable opportunities for the synthesis of manual and computerised practices.

-
Gaby Miegeville-Little,
University of Melbourne

Early Cloops prototype, glass fibre reinforced concrete cast in 3D printed clay, 2019.

2018+
Casting+
Sight+
Architecture+
Concrete+
Infinite ——

Parametric Adjustable Mould

Parametric Adjustable Mould (PAM) is a novel fabrication machine that uses an adjustable mould frame for casting doubly-curved concrete panels. The design and fabrication of the project are undertaken by a team of researchers at the Melbourne School of Design led by Dr Paul Loh. The project aims to eliminate the wasteful practice of concrete casting in the industry. 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 technology has the potential to reduce approximately 225,000 tonnes of landfill waste annually in Victoria, equivalent to the household waste created by the entire population of Ballarat. The impact of the research provides a sustainable mean of constructing complex form and geometry.

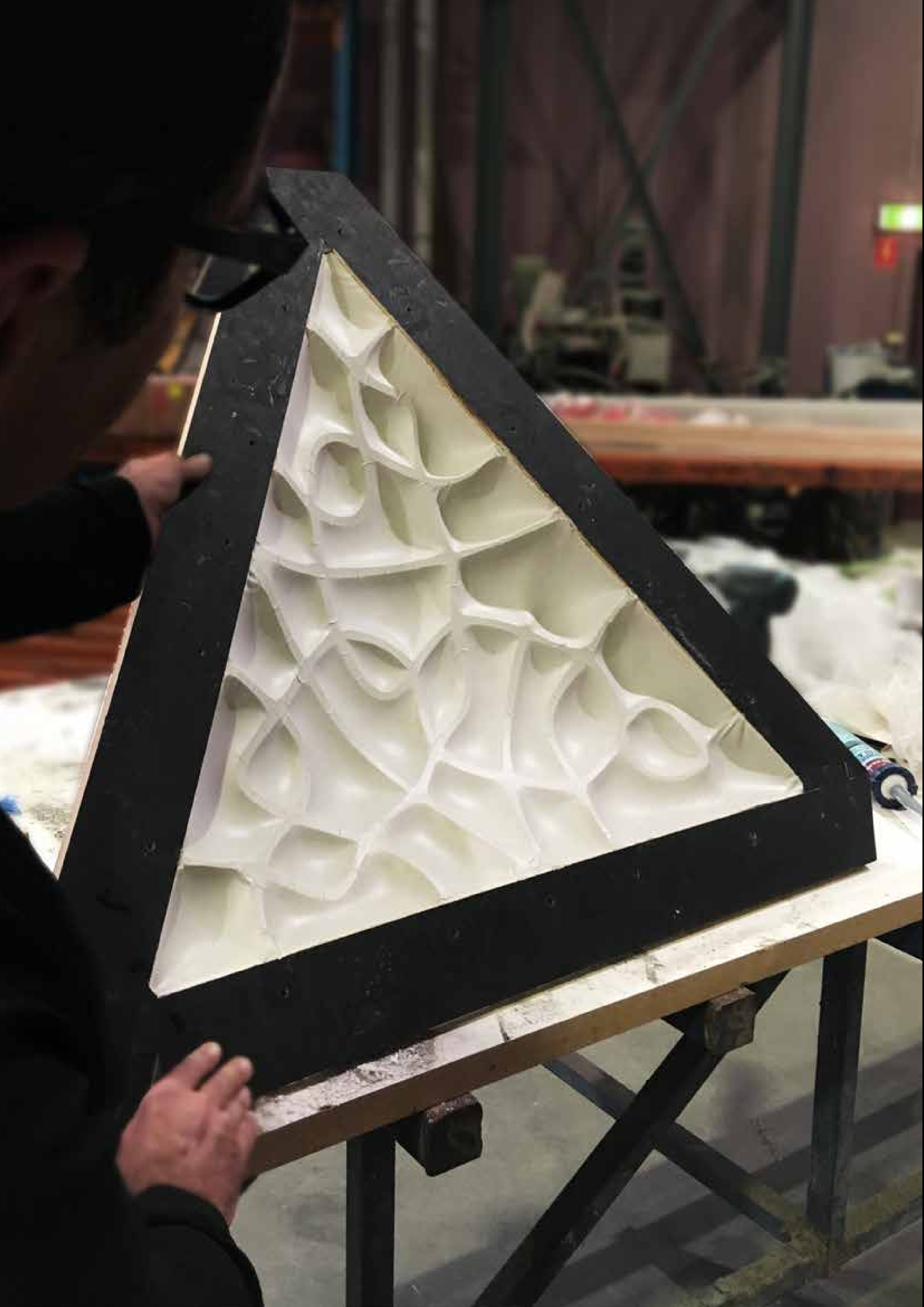
The bespoke computer numerically controlled (CNC) machine consists of a single adjustable mould which receives translated digital information from a panelised surface using a custom script to actuate the mould into desired positions for concrete casting. The translated data of the virtual surface is 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. To make a geometrically useful panel, the panel is robotically trimmed to suit the desired shape. Through smart optimisation of the design geometry and the PAM machine, the waste produce from the robotic trimming process is minimal.

This project contributes to design research through firstly aligning construction problems faced in practice with advanced fabrication technology. The novel CNC machine can make designing with complex geometry more viable and economically feasible through innovative fabrication methodology. The robotic workflow developed is novel and demonstrated research for design that moves beyond standard digital fabrication techniques and solutions. 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.

A 1:1 cladding prototype and the machine prototype is exhibited. Accompanying the artefact is a video that demonstrates the fabrication procedure of the panel using PAM technology in conjunction with the robotic trimming procedure developed by Dr Paul Loh and David Leggett of LLDS | Power to Make.

-
Paul Loh,
University of Melbourne
David Leggett,
LLDS | Power to Make
Daniel Prohasky,
Swinburne University of Technology

Cladding prototype using PAM technology with robotic milling developed by LLDS | Power to Make.



2019+
Casting+
Sight+
Architecture+
Concrete+
Infinite ——

Tailored Flexibility

Tailored Flexibility is a research project that combines large-scale robotic 3d-printing, flexible-formwork, inverted pressure casting and Glass-Fibre Reinforced Concrete (GFRC) to produce highly differentiated lightweight facade panels with minimal waste. The research project 'Material imagination: Reconnecting with the matter of architecture' studies how digital design and fabrication tools might engage a penetrating imagination of material manipulation. This PhD sub-project focusing on concrete and carried out by co-author Jon Engholt investigates how the material characteristics of liquid concrete manifest emergent aesthetic qualities when confronted by digital means of control. Carried out as successions of physical experimentation, this study includes a notion of digital craft, in which matter, mind and manipulation are intimately connected. Such intimate involvement with physical matter suggests not only a method of study but also invites an attitude of material research. Initially driven by curiosity rather than demand, the successions of prototypes offer an example of how fertile such inquisitive experimental studies might be.

The material experiments initially studied the combination of fabric formwork and large-scale fused deposition modelling (FDM). By printing patterns of thermoplastics onto a two-way stretch fabric, the deposited material acts to locally reinforce the fabric and thus restrain the liquid concrete. The physical form thus arises from the gravitational negotiation between liquid concrete and the tailored variable elasticity of thermoplastic-reinforced fabric formwork. The development process studied: fabric/thermoplastic adhesion; pattern topology and toolpath generation; reuse of rigid casting rig parts; horizontal and vertical casting in one- and two-sided moulds; thermoplastic blends and performance; formwork material reuse; inverse pressure casting and bespoke panel design.

The exhibited artefacts demonstrate a prototypical iteration towards lightweight concrete panels that involves fixing the reinforced fabric membrane in a rigid frame, weighing it down with sand, sealing the sand inside the formwork, inverting the assembly and spraying GFRC onto the smooth fabric, that now bulges from the sand pressure. This method produces a high-quality lightweight panel with a pattern of concave cavities throughout the exposed surface thus inverting the familiar bulging aesthetic of fabric formwork in architecture (Fisac, Unno, West, Kudless etc.) Intended for a larger facade element assembly, each triangular panel is cast against individually printed fabric membranes while the rigid frame can be repeatedly re-used and adjusted to define the size and edges of each panel.

Embracing the second meaning of prototype – primitive – the project demonstrates how iterative successions of prototypical studies might transform something fundamentally artistic (or architecturally primitive) into a functional architectural element.

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Jon Krähling Engholt,
Aarhus School of Architecture
Dave Pigram,
University of Technology Sydney
Iain [Max] Maxwell,
University of Canberra

The panel during formwork disassembling.

2019+
Casting+
Sight+
Architecture+
Concrete+
Infinite ——

Topological Typology

Topological Typology investigates the transformation of typological information identified within existing built environments and its subsequent implementation through digital fabrication. Prototyping in this project served as a means of testing and evaluation, but also discovery in identifying unexpected material properties that added additional detail and richness to the project.

Early work for a small house in North Melbourne identified that in the historic buildings surrounding the site, articulation of facade surfaces typically clustered around openings within a single material, rather than surface articulation corresponding with material articulation as is common in many contemporary buildings. Several experiments were undertaken to explore how to translate this observed typological trait into a new configuration for the proposed pre-cast concrete panel skin of the building.

Through this experimentation, a procedural system was developed where a simulation of overlapping magnetic fields located at the centres of a nominal facade design produced complex interference patterns of field lines radiating out from the perimeter of these openings. A square-blade profile with a stepped chiselling action was applied to these radiating paths, producing zones of intense topological articulation around the openings. This surface effect produces visual and haptic registers where the increased surface articulation signals where to enter or engage with the building. These visual and haptic qualities are like those operating in different materials and configuration in the historic references identified around the site.

Subsequent tests of robotically carved polystyrene, CNC milled XPS foam, and CNC milled plywood prototypes explored the implementation of these surface effects through different material and fabrication approaches. These tests revealed that not only was the realisation of the surface effects possible, but that the material properties of the plywood added an additional layer of detail and visual complexity to the form-liners and in the finished precast panels, revealing the agency of prototyping in enriching design processes.

Explorations of the potential of procedural tools and digital fabrication in architectural practice often focus on either material/process optimisation or the development of novel tectonics in the pursuit of the radically new. This work seeks to apply these techniques in the transformation of the know or familiar, rather than the novel. Emerging technologies change how we make our buildings, however, the cultural information embedded within our built environments can and should be sustained and transformed through this transition.

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Ben Milbourne,
RMIT University

Pre-cast concrete prototype using CNC milled plywood form-liner.

fibres

Projects

Coat of Theseus, Knitting Architecture, The Dark Crafts Pavilion

2020+
Stitching+
Touch+
Fashion+
Fiber+
Human ——

Coat of Theseus

This project asks where and when the value in a garment is produced—is it located in the materials, or in the branding? As a garment ages, changes, is repaired and parts of it replaced, does it increase or decrease in value?

This project considers the mass-production of fashion apparel products. The surplus of garments resulting from this system is affected by a common practice in garment design which enables the consumer to ignore the product lifecycle and focus attention on constantly-regenerating aesthetic expressions. This aesthetic regeneration is a kind of game of archival cultural references in which some key elements of design (fit, materiality, colour, silhouette) take turns becoming prominent and receding.

Constant newness, with no regard for where materials are extracted or processed, and where the disused garments travel to after ownership is ceded, is a core mechanism of the fashion industry. The consumer's desire for newness in recent times has been satisfied by brands offering new products at a regular frequency. Lifelong ownership and repair are not readily available options for consumers. However, this project proposes a speculative system for garment design and use that enables consumers to disrupt the regeneration of garments—not only aesthetically, but materially.

The idea for this system is based on a thought experiment proposed in antiquity called The Ship of Theseus, which is very useful for cracking open the possibilities for this proposition to be critical and engaging with timely and important notions of sustainability and individual identity expressed through fashion.

The Ship of Theseus is a thought experiment explored by Greek philosopher Heraclitus around 400-500 b.c. In this experiment, the ship that carried Theseus to the battlefield is preserved in a museum and the planks of the ship start to rot. The rotting planks are replaced with new, yet identical planks. If this process continued for another hundred years and at some point all of the original planks had been replaced, would the ship still be the one that carried Theseus? The proposition is to produce a wardrobe for Theseus. What stays the same in a coat that has been repaired so many times that it no longer retains any of its original fabric or thread? The silhouette, the size, the length of its sleeves and hems? What about the archetype, colour, texture, or print? If the garment survives for a hundred years, are the lapels narrowed and widened, are there trims or lace or feathers added to reflect the fashions of the day?

This prototype series could open lines of enquiry into how fashion consumers engage with authenticity, identity, value and long time. Can we design a garment for a hundred years?

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Daphne Mohajer va Pesaran + Jake Nakashima-Edwards
RMIT University

A new Theseus Coat. Japanese washi paper made in Kurotani, Kyoto, silk, and rayon.


SES-SWG

2019+
Knitting+
Touch+
Architecture+
Fiber+
Room ———

Knitting Architecture

The exploration between Dr Leanne Zilka (architect) and Dr Jenny Underwood (textile designer) focuses on the dynamic nature of fabrics and textiles, and applies these qualities to the scale of architecture.

The ability of whole garment knitting technologies to fabricate 3-dimensional forms, and connections between these forms is beneficial to the fabrication of digitally generated architecture that contains complex curvature. Knitting by its very nature is a parametric material system, simultaneously producing surface and form. A garment emerges stitch by stitch (pixel by pixel) made up of a set of connected 3-dimensional extruded tubes. Complexity can be added into the system through changes in the surface pattern (stitch structure) and in fibre and yarn selection.

This research explores the territory between architecture and textiles to develop a way of working with soft, non-rigid, floppy materials. The exploration works in the narrow territory between the digital realm and the physical reality, such that the digital can be realised without the need for a separate phase of fabrication investigation. We are designing and visualising with embedded knowledge of the knitting machines variables, limitations and possibilities to produce complex curvature through knitted structures. The resultant material system creates lightweight, strong, yet malleable curvature structures at scale.

The prototypes exhibited are ones that work on the idea of an undulating ceiling that can be used for acoustic attenuation. The ceiling pattern varies depending on the ‘hotspots’ of where acoustic attenuation is needed most, larger ceiling pods are needed where conversation pits are located in the architecture. The soft fabric forms are stuffed with acoustic baffling to reduce reverberation in interior space, creating more surface area than typical sheet material allows. The textile is not tensioned between structure but rather the weight, form and material work with gravity to articulate the forms. What emerges are material strategies for new spatial qualities that are soft, fluid and flexible in form, behaviour and expression.

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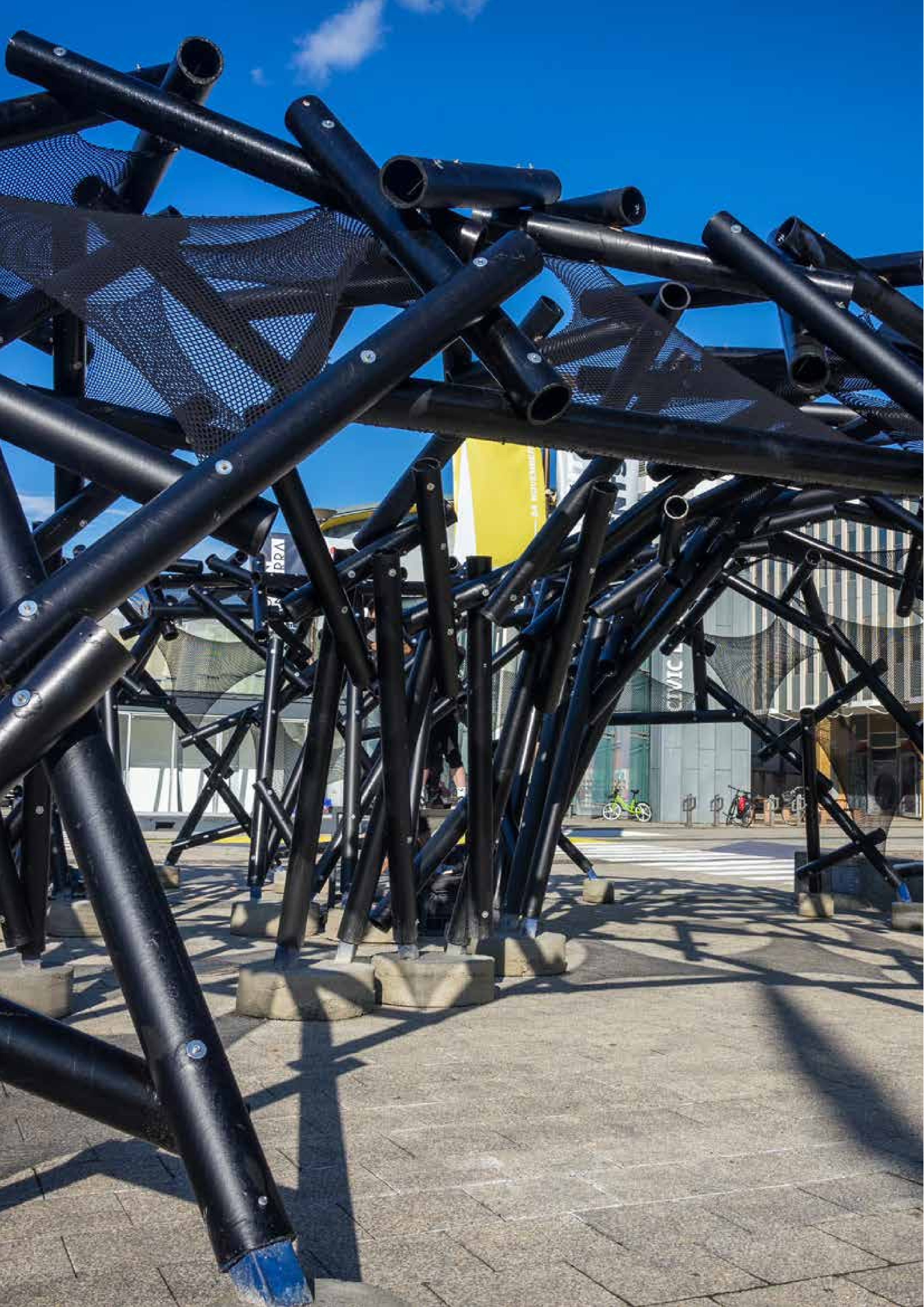
Leanne Zilka,
School of Architecture, RMIT University
Jenny Underwood,
School of Fashion and Textiles, RMIT University

Prototyping knitted architecture – full-scale prototype prior to installation. Knitted material as constructed by the Shima Seki whole garment knitting machine. Resulting forms are 3-dimensional – meaning material is inserted to create volume.



2019+
Recirocal+
Sight+
Architecture+
Fiber+
Infinite ——

The Dark Crafts Pavilion

The Dark Crafts Pavilion was commissioned by Craft ACT for the 2019 Design Canberra Festival, It responded conceptually and technically to the festival's celebration of the influential links between the Bauhaus and the development of city's urban fabric in the 1960s. The pavilion is positioned within an existing water fountain located on the city's most prominent plaza: reclaiming its publicness through the creation of a large urban room for hosting events throughout the festival. The design's hexagon-dominant figuration reflects the persistent use of this geometric order within the city's urban plan. The project expands upon the traditions of German modernism - notably the furniture of Breuer et al. - through the skilled authorship of contemporary systems of (robotic) production towards new design expression. In coupling a computational approach to design with robotic fabrication techniques, the project establishes creative feedback relationships between material, tectonic strategy, tool design and fabrication protocol; a conceptual and technical bridge that sets the basis for a new definition of craft and artisanal production and one that subverts the historical claim of craft as an exercise of workmanship related to the human hand.

The design features a 12-metre diameter reciprocal frame gridshell and leverages rotational symmetry to manage the logistics of non-standard part production. Thus, while the pavilion consists of nearly 500 linear metres of cardboard tubing for a total of 348 individual members, these can be traced to one of 58 unique yet repeatable (6-fold) types ranging from 800 - 2050 mm in length. Each part features 4 pin-connections where the translation and rotation of each pin is highly specific, zero tolerance and can only be assembled one-way. A two-step design-to-factory workflow was developed: The first stage consists of a generalised framework for the creation of reciprocal frame structures; The second, processes the resultant configuration for robotic fabrication. Each workflow was developed in the Python programming language within Rhinceros 3D's Grasshopper (RGH) environment. The precise nature of the tectonic strategy outlined, allowed for a relatively fast and self-aligning spatial assembly without the need for propping or falsework. Critically, no construction drawings of the project were necessary. Instead, all information pertaining to part identification, location, orientation and adjacent member verification was visualised at the moment-of-production with the RGH and physically embedded (written) on the parts.

Design, fabrication and construction of the pavilion were undertaken by faculty and students in their first year of architecture at the University of Canberra.

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Iain Maxwell, Sam Tomkins, Ben Claase + Erin Hinton,
University of Canberra
David Pigram,
University of Technology Sydney

The Dark Crafts Pavilion expresses a hexagon-dominant reciprocal frame structure. (Credit: Nicholas Borner @ Sellicks Consultants) metal

Projects

FabPod II, SheltAir


SPECTION & TESTING

2017+
Milling+
Sound+
Architecture+
Metal+
Infinite ——

FabPod II

FabPod II is a project that investigates the need for privacy and speech optimisation in open work areas. In this design, an intricate and customised variation of geometry and material combinations are achieved through novel approaches to digital fabrication.

FabPod ll geometry features a combination of sound absorption and reflection and the scattering of sound-waves, which contribute to even distribution of sound, and speech clarity within its interior. The exterior faces cut sound transmission to the outside, despite the semi-open architecture. The construction system was developed as a lightweight thin modular steel metal structure. Individual cells were custom cut out of sheet metal and folded in a cellular arrangement for increased structural strength. and the cells are stacked together to provide the framework that could be covered later with acoustic panels. A double-layered 'skin' was developed with a diverging exterior structure and a converging interior shape. The double skin geometry was simulated in ODEON™ software to verify the sound performance of the system and to rank various tested iterations for improved speech privacy.

The result was an improvement in the speech privacy of an open interior from the initial design with 100% of the space having full speech intelligibility to the final iteration, where almost 55% of the space had Speech Transmission Index below 0.6. This research applied acoustics as a design driver at early stages of design, interweaving auditory analysis and other design imperatives such as fabrication constraints to play key roles in shaping the architecture.

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Jane Burry, Canhui Chen, Pantea Alambeigi + Daniel Prohasky,
Swinburne University of Technology
Nicholas Williams,
Aurecon

Assembled metal frame modules and oculi.

2019+
Inflating+
Sight+
Architecture+
Metal+
Infinite ——

SheltAir

Elastic gridshells are celebrated for their striking biomimetic curves, long spans and efficient material usage. Constructed from a grid mechanism of slender beams, an elastic gridshell is assembled on a flat surface then repositioned into its final curved shape - after which stabilising elements are added, and the structure becomes a stiff load-bearing shell.

While elastic gridshells are efficient in their built-state, the established methods with which to erect them ('lift up', 'push up' and 'ease down') are associated with substantial complexity, cost and time which inhibit their adoption. The central research question of SheltAir asks whether elastic gridshells can be erected using pneumatic falsework (i.e. 'inflate'), if so, how and what would be the implications of doing so?

This project takes this simple and novel idea of pneumatically erecting elastic gridshells and develops it to fruition in a concise, logical and innovative way in which the narrative recounts a successful example of design through research.

The work presented here proves that the pneumatic erection of elastic gridshells is not only feasible but offers many advantages (such as the speed of erection, structural robustness and architectural qualities) over existing shelters for humanitarian, event and architectural applications.

The first of two demonstrators spanned 14m and was designed as a summer event shelter whereas the second 10m span demonstrator was designed as a multi-family disaster-relief shelter specifically for the extreme weather conditions and usage requirements of the Azraq refugee camp in Jordan. The novel design in this project takes inspiration from Bedouin dwellings and insists that disaster-relief shelters need not be, in fact must not be, overly utilitarian in their design as they provide not only environmental shelter but crucially are places where the emotional healing of suffering people can begin. Feedback from residents of the Azraq camp reveal that there is significant attraction to this biomimetic design, particularly from women.

The importance of large shelters for medical treatment, social convalescence and religious gatherings in refugee or disaster-stricken areas is largely neglected due to the necessary and immediate focus on smaller family dwellings but also due to the cost, time, complexity and energy demands associated with the construction of larger shelters. The system presented here offers an exciting solution to these challenges and its application in the future.

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Gregory Quinn,
Swinburne University of Technology

SheltAir prototype in disaster-relief context taking inspiration from Bedouin architecture.

synthetic

Projects

Cast Bodies, 3D Printed Soft Robotic Prosthetic Hand, Repeatability of 3D Scanned Transradial Stump-Sockets, Material Disobedience, Motion Imprint - Interpolating Polynomial CurveRobotic Hot Wire Cutter, Oddish, Inconsistencies v0.6, The wind at Byaduk

2019+
Printing+
Sight+
Architecture+
Synthetic+
Infinite ——

Cast Bodies

The Cast Bodies prototypes explore the design and fabrication of intricate lattice structures through the application of 3D printed formwork strategies. The two prototypes each use a different 3D printed material to act as either sacrificial or temporary formwork for fibre-reinforced cast concrete. The various printing constraints and opportunities will be encoded with a generative design process to create a family of similar forms, each exhibiting unique characteristics created by the bias of their fabrication approach.

The prototypes will utilise the following fabrication approaches:
1. Printed polymer sacrificial formwork, 2. Printed flexible polymer temporary formwork.

The lattice structures are designed through the interaction of generative multi-agent algorithms, which are conditioned by fabrication constraints, and BESO structural topology optimisation. The focus of this research is a design methodology that establishes a complementary relationship between topological optimisation, behavioural algorithms, robotic 3D printing and materiality. This methodology will be tested through the generative design and additive manufacture of architectural component prototypes to be exhibited at Future Prototyping Exhibition at the University of Melbourne. The methodological innovation of this research is the integration of topological optimisation method with multi-agent generative design algorithms. This approach attempts to negotiate between concerns of architectural design and structural engineering. This research demonstrates the process of integrating two algorithms which will establish a real-time feedback loop in the process of designing a complex form. This process of encoding rules of topological structural optimisation into multi-agent systems is developed to create complex geometry that embeds the necessary constraints of a 3D printing fabrication process.
The Architectural components presented in the exhibition is for a facade design. The prototype is used to test the new approach for a large-scale spatial structure. It describes a hybrid of architectural and structural behaviours through integrating topological optimisation and multi-agent algorithms and the closeness of their interaction.

Conceptually this strategy develops a relationship between structural-based form-finding methods and swarm systems, respectively for evaluation in algorithmic design and robotic fabrication.

These prototypes, while small in scale, attempt to explore the architectonic implications of the interaction of emerging computational design and robotic fabrication processes, and speculate on their future application to architecture.

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Dingwen 'Nic' Bao, Roland Snooks + Yimin 'Mike' Xie,
RMIT University

This prototype explores the design and fabrication of intricate lattice structures through the application of 3D printed formwork strategies.

2018+
Printing+
Touch+
Engineering+
Synthetic+
Human ——

3D Printed Soft Robotic Prosthetic Hand

The loss of an upper limb severely affects the ability to execute daily tasks and it occurs to people of any age, including those in the prime of their lives and some even from birth. Replacement of an upper limb with a functional prosthetic hand has the potential to return some of the limb functionality. Design of prosthetic hand for children is challenging due to small size and constant growth of their hand. We have designed an anthropomorphic light-weight soft robotic prosthetic hand for adults using 3D printing of compliant materials. The objective of this research is to develop this design to accommodate children with upper limb loss.

The design of the prosthetic hand is conducted with a focus on low complexity and user-friendly interface, to allow intuitive, robust, and reliable controlin in addition to its lightweight quality. This is done by first focusing on providing only the most common grasps for the activities in daily living and second, using 3D printing techniques to manufacture the overall hand with low infill in the structure to reduce the weight. We have realised the two most commonly used grasps: pinch grasp and power grasp. Combined, these grasps will cover more than 70% of the daily activities. For fabrication of the whole hand, we used a commercially available 3D printer to fabricate the parts. The hand for children has one motor which pulls five cables, each corresponding to a finger. Using the different size of spools for pulling tendon cables of each finger, the hand can provide pinch and power grasp.

The overall weight of the hand, including the controller and actuator is less than 200 gram. Due to the parametrised CAD of the hand, the dimensions of the hand can be readily customised for different hand sizes. The hand is controlled using two electromyography (EMG) electrodes for opening and closing of the hand. Compliance of the hand enables users to grasp a wide range of objects in one specific pre-shape hand - eliminating the need for switching between different grasps.

The designed hand is ultra-light, durable, cheap and easy to manufacture. It is readily customisable for different hand size due to parameterised CAD design and using 3D printing techniques. The proposed design addressed the challenges in the design of prosthetic hand for children due to their small size and constant growth.

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Alireza Mohammadi, Jim Lavranos, Peter Choong + Denny Oetomo,
School of Electrical, Mechanical and Infrastructure Engineering, University of Melbourne

3d-printed paediatric soft bionic hand.

2018+
Printing+
Touch+
Engineering+
Synthetic+
Human ——

Repeatability of 3D Scanned Transradial Stump-Sockets

3D scanning and printing is an agile manufacturing process explored in the last decades. Creating 3D scanned and printed upper limb stump sockets can reduce the costs of such devices due to reduced labour, increasing the quality due to otherwise inexperience/unfamiliar prosthetists as there are small numbers of individuals with upper limb amputation (1:30 compared to lower limb). This allows the production of multiple sockets to account for volume fluctuations in post-operative times (Lake, 2016). Multiple 3D scanning and printing socket attempts have been reported (Rosicky et al., 2016) though none of them has shown the validity of scanning a residual limb in comparison to the current practice (casting process). This research shows the repeatability of 3D scanned transradial stump-sockets. The experiment was conducted with one subject (transradial amputation; male; 21 years) under the ethics granted by Ethics Committee Melbourne University (1853087.1).

An Artec Eva 3D scanner was chosen, and an armrest to keep the subjects arm stable (Rosicky, 2016). Markers are drawn on the subjects' arms for better auto alignment via Artec Studio®. One trained operator scanned the subject's arm three times. The comparison is based on the volume error, bounding box error and the root mean square error (RMSE).

A volume error of 2.76 ± 1.77cm3, a bounding box error of [0.18±0.05,0.14±0.03,0.08±0.05] mm as well as an RMSE measured between three consecutive scans and three operators, was found. The obtained RMSE and bounding box error are within the range of the specified 3D resolution of 0.5 mm of the scanner. Further experiments on the repeatability of state-of-the-art socket manufacturing are necessary.

References:
Lake, C. (2016) 'The Evolution of Upper Limb Prosthetics Socket Desing', JPO, 20, pp. 1-7.
Rosicky, J. et al. (2016) 'Application of 3D Scanning in Prosthetic and Orthotic Clinical Practice', Proceedings of the 7th International Conference on 3D Body Scanning Technologies, Lugano, Switzerland, pp. 88-97.

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Raphael Maria Mayer, Yi Rong, Alireza Mohammadi + Jim Lavranos,
School of Electrical, Mechanical and Infrastructure Engineering, University of Melbourne
Gursel Alici,
School of Mechanical, Materials, Mechatronic and Biomedical Engineering, University of Wollongong,
Peter Choong,
Department of Surgery, University of Melbourne
Denny Oetomo,
School of Electrical, Mechanical and Infrastructure Engineering,
University of Melbourne

3d-printed stump.

2016+
Printing+
Sight+
Architecture+
Synthetic+
Infinite ——

Material Disobedience:

Generating architectural design through embedded intelligence in material compositions

Historically materiality within architecture has been determined retrospectively from the initial conception of architectural form. This has lead to a homogenisation of material use within architecture and the way it is constructed. This project seeks to explore material behaviour and its relationship with additive manufacturing techniques such as robotic 3D printing. Through a material-driven approach to architectural design, this project considers material behaviour as a way of generating new complex geometries and alternative methods of architectural conception. Showcased are two prototype case study of exploration in material behaviour using plastic and clay. Each prototype explores a different embedded logic within the material to derive new architectural textures, aesthetics and objects based on the material composition.

Prototype 1 - 3D printed self healing columns
The first prototype of the project showcases an exploration of the healing properties of plastic in conjunction with an industrial KUKA robotic plastic extruder. The material behaviour is given an initial simple geometry of a square column to operate within. This was chosen to challenge how much architectural texture, patterns and aesthetics could be derived from the material behaviour itself rather than the input geometry of the column. Through manipulation of the robotic tool path, the speed of the robot and rate of extrusion the project showcases the plastics ability to self heal during the fabrication process. The prototype shows a glimpse into the potential of using material behaviour to articulate textural and aesthetic qualities in architectural elements such as a column at a finer resolution.

Prototype 2 - Clay qualities
Extending on the lineage of prototype 1, prototype 2 explores clay 3d printing and how its material behaviour can inform the design process. Clay is used for its increased volatile qualities embedded in its material behaviour. These prototypes engage in balancing a controlled approach of the robotic extruder with the volatility and disobedience of clay. Through understanding how to control the complex material behaviour and its navigation through the robotic extruding fabrication technique, this allows for the development of architectural elements that have emergent textural qualities from the design and fabrication process. Ultimately, clay is used in this prototype as a mechanism to transition into the future of 3d printing with concrete and its potential to embed the aesthetics textures achieved in the clay with the structural strength of concrete and fibres in the future.

Fundamentally this research proposes the synthesis of material science and advanced fabrication techniques through a fusion of the physical with computational processes. It is allowing for a new singular operating system of new material compositions, optimisation of material, structural performance and alternatives that offer less production of material waste. These prototypes provide a glimpse into the possible futures of material and technology and its application.

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Prototype 1: Mary Spyropoulos, Joshua Lye, Joel Lok + David Fitoussi,
RMIT University
Prototype 2: Mary Spyropoulos + Joshua Lye,
RMIT University

Prototype 1: Self Healing Column - Elevations. Material: PLA, Dimensions: H1500 X W400 X D400mm.

2019+
Carving+
Sight+
Architecture+
Synthetic+
Infinite ——

Motion Imprint:
Interpolating Polynomial Curve Robotic Hot Wire Cutter

Motion Imprint discusses the design and fabrication of a novel hot wire cutter used as an end effector for a robotic arm. Typically, hot wire cutters used a linear cutting element which results in single-ruled surfaces geometry. Rust et al. (2016) have explored using cooperative robotic arms to develop non-ruled surface geometry with linear hot wire cutting element. This research furthers the enquiry within the field by exploring non-linear cutting element for a hot wire cutter and thereby achieving non-ruled surface geometry with a single robotic arm.

The machine utilises a curved hot wire cutting element with up to three controlled nodal points that is used to shape Expanded Polystyrene (EPS). Unlike conventional hot wire cutter, the actuated Interpolating Polynomial Curve (IP-C) hot wire cutter is numerically controlled and can perform variable cut sections with a single robotic movement to produce non-ruled surface. In this research, the tool is used to cut EPS which is then coated with resin-infused fibreglass to create a durable surface for architecture or sculpture application such as facade cladding.

IP-C robotic hot wire cutter is the result of a master-level design Studio 15 at the Melbourne School of Design under the agenda Machining Aesthetics, led by Dr Paul Loh and David Leggett. The research is conducted through physical prototyping of the end-effector resulting in a series of furniture scale prototypes. The design team observed the potential of the fabrication techniques and tested it through a design project: an urban performance stage design titled Motion Imprint. Critical to the design process is the integration of knowledge from the tooling to the design workflow.

Using the Kuka KR120 working envelope as a design constraint, the team speculate on how the design can be fabricated based on the constraints and opportunities of the tool. The IP-C hot wire cutter is further developed for an on-site fabrication scenario. A 1:1 scale prototype is produced as a proof-of-concept.

Through an understanding of the mathematics of an interpolating polynomial curve, the design team aligns both the material system necessary to construct the device with the methodology to extract data from the parametric curve. In this research, the parametric curve is used to drive the time-based transformation of curvature to form a complex network surface. Critically, the IP-C robotic hot wire cutter questions how machine can make architecture in the future.

Reference:
Rust, R., Jenny, D., Gramazio, F. and Kohler, M., 2016. Spatial Wire Cutting: Cooperative robotic cutting of non-ruled surface geometries for bespoke building components.

-
Yuhan Hou, Jiaqi Mo + Chun Tung Tse,
University of Melbourne

Interpolating Polynomial Curve (IP-C) Robotic Hot Wire Cutter.

2017+
Folding+
Sight+
Architecture+
Synthetic+
Infinite ——

Oddish: Tectonic Grounds

An Interactive Forest of Flowers.

What if your environment could speak to you? What will it say? What stories will it tell?

Oddish is a blooming interactive installation that is light responsive and looks at a new future of interactive environments. Using light sensors, highly intricate lasercut perspex and coding in logic within the structure the prototype starts to have a conversation with people, spaces and lights.

To get a reaction from Oddish wave your phone light across the face of a flower and see it blossom. Be gentle and don't poke it, this is a sensitive species. This interactive installation is a prototype to future responsive environments that will respond and react to different inputs.

The project is a collaboration with Cube Zero and the elective subject Tectonic Grounds at the Melbourne School of Design.

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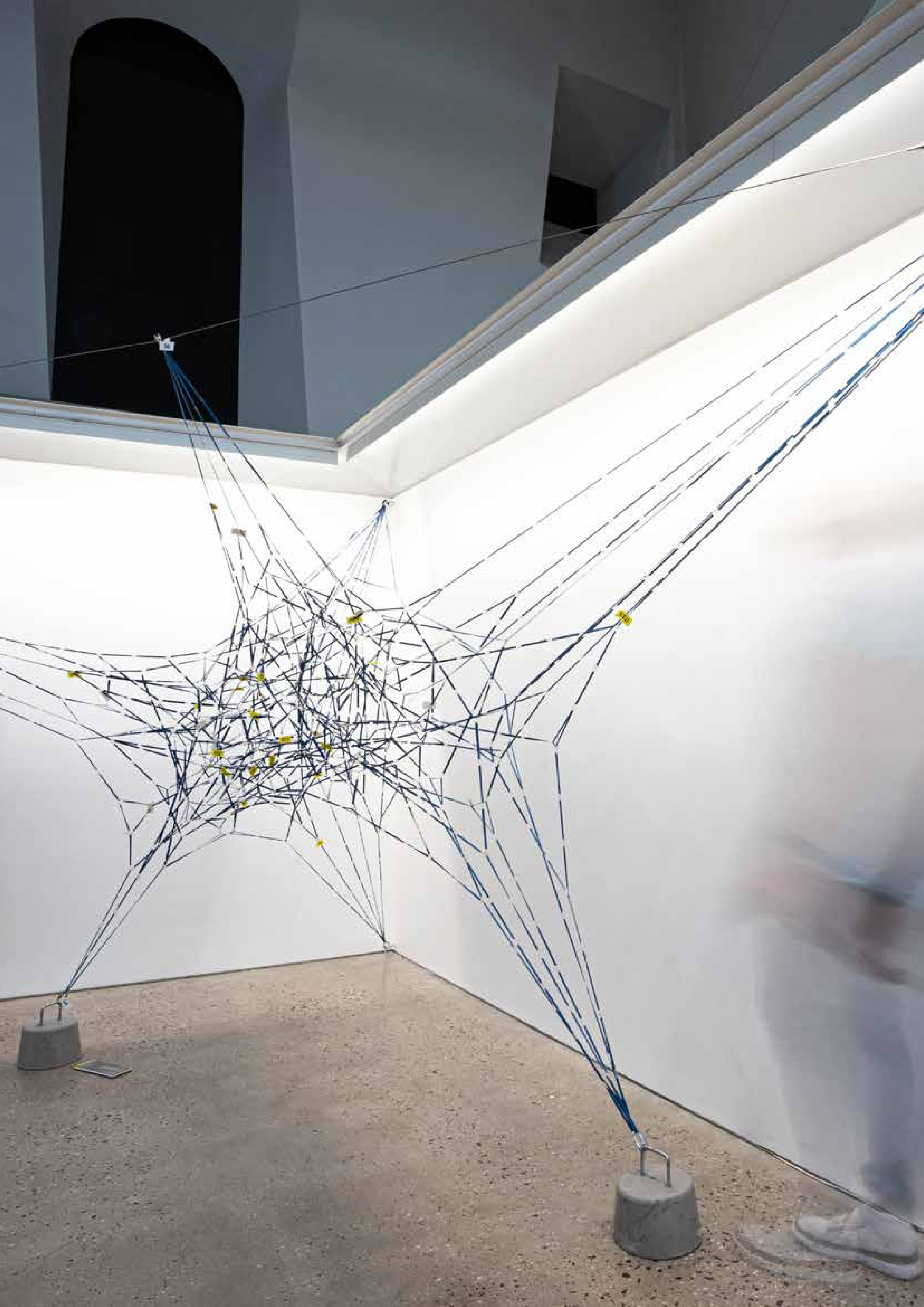
Melbourne School of Design
Tectonic Grounds
United Make
Cube Zero

Tectonic Grounds Exhibition.



2020+
Knitting+
Sight+
Architecture+
Synthetic+
Room ———

Inconsistencies v0.6

Irregular and wild in appearance, this experimental structure is a result of a rule-based assembly method and a precise digital modelling technique involving both geometric and material properties. It is a part of the study that investigates the role of algorithms in the creation of complex spatial systems, characterised by the ability to self-organise, grow and readjust. These and other properties of complex systems often found in nature amongst living things are continually attracting interest from architects and urban designers. Their understanding, at both practical and theoretical level, may hold significance for the creation of the built environment of the future.

The impact of this study is in the domain of design experimentation and the development of innovative workflows. The significance of this study is in understanding the behaviour of complex spatial systems as something physical, based on material performance and production of tangible prototypes. The complexity, i.e. the ability of the spatial system to readjust itself, is generated by the high number of components involved and reinforced further with their ability to change. Throughout the construction process, elastic material behaviour is essential as it allows initially identical construction components to change and thus enable the overall form to readjust itself and gain structural stability. Therefore, the experimentation is focusing on the parallel application of two algorithmic protocols to capture the correlation between geometric properties and material performance.

The investigation is based on a sequence of prototypes, with several iterations produced up to date. The prototype Inconsistencies v0.6 is custom built for the Future Prototyping Exhibition, with the application of knowledge, computational tools and assembly techniques developed through the sequence past experiments.

-
Djordje Stojanovic,
University of Melbourne
Milan Katic,
4of7 Architecture
Student assistants: Ananya Khujneri, Zhexing Huang,
Samantha Yu-Hsuan Tseng, Chandavinel Ath + James Urlini

Inconsistencies v0.6 - photography by James Rafferty.

2018+
Sensing+
Sight+
Art+
Synthetic+
Human ——

The Wind at Byaduk

The Finding Byaduk creative residency is located in the town of Byaduk, in the Western District of Victoria, Australia. The creative brief centres around a thought experiment with 'affective telepresence' – finding means to remotely convey the qualities of a place using found objects, environmental sensors, digitally connected technologies, and the design of embodied expressions and interactions. The experimentation generates speculations about the phenomenology of digital data representations of landscapes removed from one's home, and the design of interfaces and expressions to embody said representation. Part of this process is also inspired by design ethnography, and the consideration of its methodologies to articulate a remote picture of the site in question. In this sense, the crafted artefacts, imbued with digital connectivity, explore the possibility of technological objects serving as soft focal points for an almost casual, autoethnographic reflection. As a prototype for affective telepresence, it poses the question: how might we conjure gentle connections of wonder, to faraway places?

The Wind at Byaduk, the first artefacts to emerge from the residency, are works of kinetic sculpture combining custom electronics and found objects – using two discarded glass bottles found in Byaduk. An electric fan articulates quietly on its stem, modulating its fan speed according to the readings of the wind sensors mounted on the wall at the Old Byaduk Church. The resulting soft, resonant howls created by the interactions between the fan and the mouth of the bottles recreate the near real-time sonic presence and intensity of wind in Byaduk.

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Chuan Khoo,
RMIT University

The Wind at Byaduk.

timber

Projects

Steampunk, SuperSuccah, Surface-Habitat X2 - Synthetic Ecological Fields, Augmented Assemblies, I gave the Internet a Wooden Heart, Digital Timber: Interactive Design Environments for the Design for Manufacturing and Assembly of Complex Spatial Timber Structures, Crooked Lamella, House #05, Suspended Remnants

2019+
Bending+
Sight+
Architecture+
Timber+
Infinite ——

Steampunk

Steampunk is a pavilion constructed from steam-bent hardwood timber using primitive hand tools augmented with the precision of intelligent holographic guides. Rendering digital models as holographic overlays directly within construction environments enables fabricators to use their expertise and inventiveness to produce highly intricate and complex objects. The timber elements in the structure are steam-bent over an adaptable, moldless formwork using a holographic model as a reference to the desired result. Fabricators can intuitively adapt bending techniques or formwork positions until physical parts match digital models within accepted tolerances. This approach removes the necessity of anticipating every aspect of material behaviour in digital models and in so doing leaves open a certain degree of indeterminacy as material affects are discovered, desired and amplified during construction. It is this liberation of digital expression from the constraints of digital fabrication, together with the opportunity for nuance and material affects derived from material craft, that drives the architectural effects of the pavilion.

The plan of the pavilion is a cross that divides the grassy mound of the Biennial site into four distinct spaces that frame views towards the old city of Tallinn and the Architecture Museum. The variable surface effects in the pavilion are a product of expediency, as bending three-dimensional curves from straight 100x10mm boards forces the timber profile to twist along its length. This attempt to produce an architecture from standardised lengths of material is more akin to weaving than assembling, and twisting timber sections contribute stiffness and compression strength to a composite timber and steel shell. Tracing the lines of the woven timber leads from conventional orthogonal surfaces to the complete break down of familiar topology, toying with the ambiguity of the form of the knot, inside and outside or surface and volume. By demonstrating that complex digital models can be fabricated by hand without traditional drawings or CNC machine code, the pavilion aims to democratize the production of more performative, expressive and bespoke architectural designs and serve as a deliberate polemic in the context of widespread robotic fabrication and automation.

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Gwyllim Jahn + Cameron Newnham,
Fologram
Soomeen Hahm + Igor Pantic,
Bartlett UCL

Steampunk Pavilion – Photographer Peter Bennetts.

2019+
Milling+
Sight+
Architecture+
Timber+
Infinite ——

SuperSuccah

SuperSuccah is a lightweight, elastically curved and twisted plywood pavilion that evidences a fabrication-aware approach to the design of topologically complex architectural forms. In establishing creative feedback relationships between algorithmic design strategies, material testing and prototyping, the pavilion exemplifies how the known constraints of a designated fabrication process can serve as a productive basis for the innovation of architectural form.

SuperSuccah demonstrates increasingly complex speculation of the architectural object as a differentiated field-condition that constantly shifts its character depending on the relative motion of the inhabitant and the weather. Rapid shifts in strip alignment ensure that at any time the observer will be presented with both extremely transparent (4mm on edge) and entirely opaque aspects. The strong twisting of each element presents surfaces of all angles to register, reflect and redirect the sun, wind and rain such that small changes in the external environment trigger amplified effects in the micro-climate within.

The design comprises six prefabricated shells that harness mirror- and rotational-symmetry to resolve the complex overall geometric expression. The use of symmetry delivered significant benefits across multiple project demands spanning fabrication, transportation and most importantly structural analysis. Together, these ensured that the complex formal ambitions of the work could be balanced against the tight timeline and budget; need to establish a design-for-disassembly logic, and; the extremely demanding engineering requirements of such an unprecedented structure. The most notable being the very high wind-loads resulting from the exposed coastal site.

The project's complex surfaces are constructed from a matrix of 4mm and 6.5mm twisted and bent plywood ribs. The orientation of the ribs is derived via computation of quasi-asymptotic lines found upon a quad-dominant isothermic minimal-surface (zero-gaussian-curvature). The description and application of asymptotic gridshells has been offered by Pottman (2016), Schling (2018) and others. Like traditional gridshells, highly performative structural shapes that utilise very little material are possible. Unlike traditional gridshells however, asymptotic grids possess further geometric properties relevant to construction: Firstly, asymptotic lines give rise to normal constant strips that are entirely developable and therefore easily produced using standard sheet material and 3-axis CNC technologies; secondly, these strips unroll parallel offering part nesting efficiency; finally, the resulting lattice of strip elements all meet perpendicular to one another ensuring a friction-fit joint capable of serial assembly.

SuperSuccah was commissioned by Shalom for 'Succah by the Sea' as part of 'Sculpture by the Sea', 2019 in Sydney. TTW engineers provided structural and wind engineering. Fabrication facilities were provided by the University of Technology, Sydney.

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Dave Pigram,
University of Technology Sydney
Iain [Max] Maxwell,
University of Canberra

Photo by Hamish McIntosh, Courtesy of Office Feuerman.

2019+
Milling+
Sight+
Architecture+
Timber+
Infinite ———

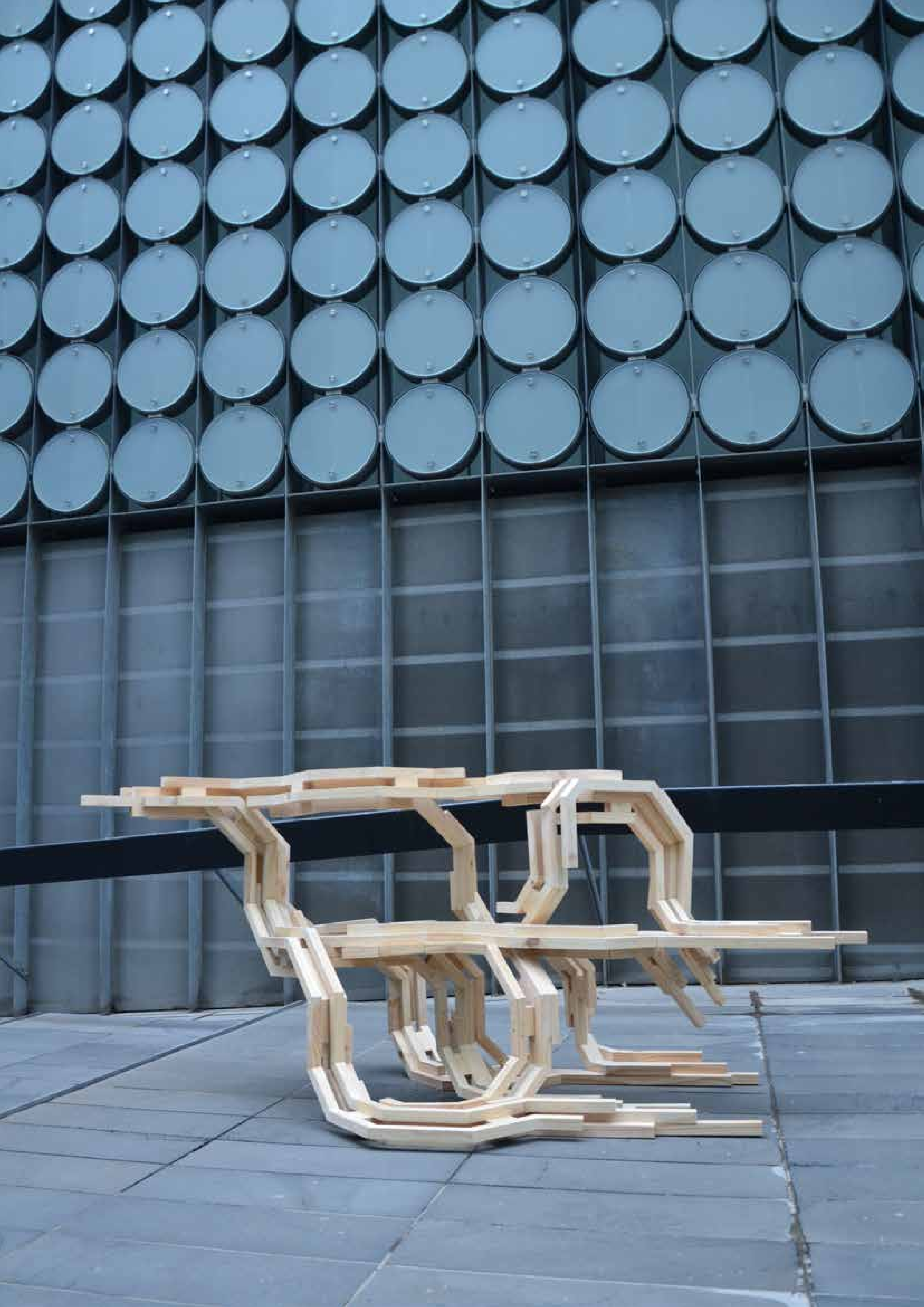
Surface-Habitat X2 - Synthetic Ecological Fields

Surface-Habitat X2 provides a tangible, didactic and functioning illustration of the links between the ways in which we shape our environments and their associated capacities to cultivate and sustain living environments. More and more, we need to be reminded of the ways in which we can materialise built environments which operate as vital new supports for novel ecologies and habitats that also provide engaging public artefacts which solicit many ways in which the public may engage with the themes and experiences offered by the prototype.

The prototype is a micro-habitat system that unwraps and twists a field of surfaces to create larger garden pockets while simultaneously providing an undulating substrate that embeds a micro garden within its thickness. The surface itself achieves many tasks, defining and framing protected planter spaces, creating multiple orientations and forming a twisted surface that undulates while structurally stabilising itself. The digitally designed, simulated and fabricated surfaces unfold at different angles to provide varying scales of pocket gardens as well as a wide gradient of shade, producing a variety of microclimates on the moss surface (from slopes directly exposed to sunlight to shaded overhangs) and within the garden pockets. The prototype was developed with biologists, horticulturalists and structural engineers. Digital design and fabrication were paired with advanced horticultural techniques which integrated moss into a prefabricated system.

-
David Syn Chee Mah + Leire Asensio Villoria
University of Melbourne
Structure: Adams Kara Taylor Engineering
Moss: Suzanne Campeau,
Bryophyta Technologies
Harvard GSD Student assistants: Arthur Liu, Mark Rukamuthu,
Haemee Han, Bosuk Hur + Michael J. Smith

Overall view of prototype Version 2.0.



2019+
Aggregating+
Sight+
Architecture+
Timber+
Infinite ——

Augmented Assemblies

Augmented Assemblies encapsulates series of projects exploring the potentials of mass-customized timber structures made entirely from recycled material scraps and offcuts. The work includes two built case studies exploring these ideas: one for the AA Visiting School Melbourne (July 2019), and the other in the Augmented Assemblies studio at RMIT University (September 2019). The projects aim to create a more circular construction cycle, whereby the potential to re-use discarded construction materials prolongs the lifespan of a building's use, rather than the typical linear path leading to high levels of waste and scrap material.

Augmented Assemblies makes use of holographic fabrication methodologies that enable bespoke, hand crafted timber assemblies proposing new structural and material potentials. Mixed reality fabrication techniques remove the problem of recycled scrap materials being odd shapes and sizes, and instead allows for an easily fabricate-able, mass-customized construction system, without the need for any drawings or complex tools and machinery.

The building and construction industry is one of the most inefficient in terms of material disposal, building redundancy and lifecycle turnover, with a toxic tear down, trash and rebuild culture. Typically, the reason scrap material is difficult to reuse is because of the unique and awkward shapes and sizes, especially with modern construction techniques relying so heavily on repeatability and standardization. Use of robotic automation and CNC machinery in architecture and design have attempted to shift the paradigm towards material mass-customization, however these types of equipment are often expensive at face value, un-intuitive in their operation, and inefficient in their file preparation. Augmented Assemblies instead explores mixed reality fabrication and construction of mass-customized parts with the Microsoft HoloLens™ as a low-cost alternative.

The construction was staged in two parts: the first involved the marking, matching and cutting of each mass-customized piece in the structure, and the second involved the in-situ assembly of the overall structure. Using the HoloLens, assistants to the project were able to accurately measure, mark and match the timber pieces against a holographic guide of each individual piece in the digital model without the use of any drawings. These pieces were then fixed together with surprising accuracy using a domino joint system. A holographic digital model of the overall structure was then used as a series of assembly instructions. The tools and methodologies enabled the creation of an intricate and structural mass-customized timber assembly system, made entirely out of scrap offcut timber materials.

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Sean Guy,
The Different Design

Augmented Assemblies Prototype at RMIT University - Photographed by Michael Liu and Xinghang Fu.

2019+
Sawing+
Touch+
Product+
Timber+
Human ——

I gave the Internet a Wooden Heart

If we have a wooden heart for communicating data – and if the Internet is given said heart – what might we read of the rhythms expressed through it?

I gave the Internet a Wooden Heart is a semiotic experiment into data-driven haptics. It is a heartbeat generator of online data streams, manifesting familiar palpitations that are felt by clasping one's hands around it, its heartrate changing in step with the datasets being expressed. The underlying mechanics of the project blend two key aspects for prototyping affect: working with tangible interactions as a semiotic device and using a custom software platform IoTa (the Internet of Things Affective) to analyse online data.

Affirmative design-oriented practices in product design offer efficient solutions to identified challenges. However, inefficient speculations relating to affect and the ever-present pursuit of socially redeeming technologies grant us curious lenses to help scrutinise the way we understand the world and design opportunities for dialogue and engagement. The Wooden Heart is built on a flexible technological framework that affords the crafting of wonder and reflection, a pivot towards prototyping poetic engagements using the same technologies adopted by the Internet of Things.

Ironically, this is both a finished and incomplete prototype. In its exhibited form, it comes pre-set with selected datasets through which it draws an electronic pulse. Just as the title suggests a material artificiality to an otherwise genuine expression, performing data mapping configurations manufacture aspirations of hope and wonder towards the data being translated. For example, it can switch between the sombre pulse of suicide rates in Melbourne, or binge on asinine narratives such as a sentiment analysis of Reddit comments on r/oddlysatisfying.

The intimate experience of the wooden heart suggests an extended period of co-existence. The Wooden Heart is incomplete insofar as what the Near Future Laboratory suggests as a theory object, an open work (Eco & Cancogni, 1989), an artefact of critical making (Ratto, 2011), a speculative design (Dunne & Raby, 2013), and a manifestation of performative research (Haseman, 2006) that acknowledges the agency of the 'end-user' in shaping the 'use' of the artefact. This extension takes critical reflection and knowing beyond design practice into the hands of the end-users, and rewards nurturing, autoethnographic dispositions when experiencing the wooden hearts. They underscore the importance of prototypes affording a degree of conscious criticality, reflection and creative iteration.

References:
Eco, U., & Cancogni, A. (1989). The Open Work. Cambridge, Mass.: Harvard University Press.
Dunne, A., & Raby, F. (2013). Speculative everything: design, fiction, and social dreaming. MIT Press.
Ratto, M. (2011). Critical Making: Conceptual and Material Studies in Technology and Social Life. The Information Society, 27(4), 252-260.
Haseman, B. (2006). A Manifesto for Performative Research. Media International Australia incorporating Culture and Policy, 118, 98-106.

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Chuan Khoo,
RMIT University

I gave the Internet a Wooden Heart.

2019+
Milling+
Sight+
Architecture+
Timber+
Infinite ——

Digital Timber: Interactive Design Environments for the Design for Manufacturing and Assembly of Complex Spatial Timber Structures

Digital Timber demonstrates the closed-loop design cycle of a recent design-build experiment in the Design for Manufacturing and Assembly (DfMA) of complex timber structures using novel robotic fabrication and augmented-reality-aided assembly processes. The experiment is part of an ongoing research project at the Aarhus School of Architecture in collaboration with Zaha Hadid Architects Computational Design and Arup Engineers.

The premise of the project is that a knowledge and communication gap exists between design teams, digital manufacturers and construction professionals that discourage the uptake of advanced robotic manufacturing and digital assembly techniques in the building industry. Through demonstrators such as the one exhibited, the project aims to demonstrate the potential impact of solutions applied in a practice-based setting and at an industrial scale.

The project focuses specifically on the development of Interactive Design Environments (IDEs) for the Design for Manufacturing and Assembly (DfMA) of spatial timber structures using advanced digital manufacturing and assembly methods. The environments build upon state-of-the-art research in User Experience Design (UXD), Computational Geometry (CG) and Artificial Intelligence (AI) to enable real-time interactivity and feedback on key DfMA metrics in the early-stage design process of complex structures.

The specific experiment shown focused on the computational design, robotic fabrication and AR-aided assembly of a complex self-supporting timber structure based on the Zollinger reciprocal frame structural principle. Two earlier versions of the experiment had been undertaken in collaboration with Niels Martin Larsen from Aarhus School of Architecture and Toni Oesterlund from Geometria Architecture. In both cases, the assembly of the precisely manufactured elements proved challenging due to a reliance on traditional construction documentation, inevitably leading to miscommunication, inaccuracies, and ultimately, the painstaking process of iteratively checking the structure against the digital model.

The ambition of the exhibited experiment was to establish a fully digital chain from design and manufacturing through to documentation and assembly - a move toward next-generation construction. The connection between digital manufacturing and assembly was made possible through our partnership with Fologram, the developers of software that connects common CAD packages with the Microsoft Hololens™, permitting the AR-aided construction of complex structures directly from the digital model.

The established workflow was demonstrated as a prototype fabricated as part of the Paramateria digital workshop series in collaboration with Ligas at the Eberswalde University for Sustainable Development.

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Ryan Hughes,
Aarhus School of Architecture

View of the structure, robotically fabricated and assembled using an augmented-reality-aided process.

2019+
Milling+
Sight+
Architecture+
Timber+
Infinite ——

Crooked Lamella

Crooked Lamella challenges today's linear processing methods for wood and proposes customised machining processes informed by individual material properties. Through an investigative approach, material capacities and fabrication methods are explored and combined towards new workflows and architectural expressions, where material, fabrication and design are closely interlinked.

The current industry tries to reduce irregularly grown wood into standardised straight timber. During such processes, internal fibres of the wood are repeatedly cut, which leads to the sacrifice of structural strength (Bianconi and Filippucci, 2019; Hoadley, 2000). At the same time, even though the timber industry is using highly advanced geometrical analysis technologies to reduce wastage, a large amount of high-quality timber still ends up to be discarded as firewood or pulp.

Inspired by traditional naval and architectural construction methods (Neerso and Schantz, 1986), this research investigates how we could bring material properties and design closer together. It examines and leverages the grown material qualities and develops customised evaluation, design and fabrication approaches, based on the naturally occurring geometries. This method not only enhances such geometrical qualities but deploys the wood's anisotropic and structural properties into the design.

The current focus of the research entails robotic machining of crooked oak logs which have been discarded by the timber industry due to their unusual shapes. Oak is a hardwood with excellent structural properties but tends to grow in irregular geometries. Through analysis and evaluation methods deploying 3D scanning tools, an informed digital workflow for individualised machining of each unique log is applied. The point clouds, describing a highly precise representation of the physical geometries of the oak logs, are simplified towards NURBS geometries to allow lightweight data-handling. Through a target-based computational approach, each sawlog matching to a particular curvature is designated to a given position in space, belonging to a larger whole as a structure. The method involves a discretisation process of a predefined target surface. It provides an interface between the design, structural qualities of the wood and the naturally grown properties of the material, altogether forming the architectural expression. According to the calculated centre curve of every individual log and their connecting neighbour-pieces, bespoke milling toolpaths are generated.

Through the rethinking of machining processes for sawlogs and custom-made methods for non-standard material, this research tries to identify approaches that can contribute to the reduction of waste products in the current industry. The process, at the same time, discovers unique aesthetic qualities and expressions of non-standardised wood directly explored through the 1:1 prototyping workflow.

References:
Bianconi, F., Filippucci, M., 2019. Digital wood design: innovative techniques of representation in architectural design.
Hoadley, R.B., 2000. Understanding Wood: A Craftsman's Guide to Wood Technology, 1st edition. ed. The Taunton Press, Newtown, CT : Emeryville, CA.
Neerso, N., Schantz, G., 1986. A viking ship: "Roar Ege" a reconstruction of a trading vessel from the Viking Age. Breakwater, S.L.

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Anders Kruse Aagaard, Niels Martin Larsen + Lynn Hyun Kieffer,
Aarhus School of Architecture

Lamella sub-element describes a part of a larger construction generated through a dialogue between designed geometry and naturally found shapes.

2018+
Milling+
Sight+
Architecture+
Timber+
Infinite ——

House #05

House #05 is a prototypical design for a new form of urban terrace typology. The design contributes to current discourse of increasing urban density, especially within an Australian context. The project currently under construction is sited on a 4-metre-wide plot, formerly a carpark space for a commercial unit. Like many inner suburbia plots that are under-used in Melbourne, the site is accessible via a laneway only. However, unlike traditional terrace typology where the boundary wall leads to a linear arrangement of rooms and light-stricken interiors, House #05 deploys a thick roof structure to modulate natural light to the interior; it also functions as a roof garden, terrace and shading from the harsh summer sun.

Responding to the lack of garden space for the dwelling, the roof of the house is conceived as an elevated timber 'plant pot', which is raised 8 meters above the ground so that it receives natural daylight and is not overshadowed by neighbouring buildings. The void below the roof becomes the dwelling. The roof is supported by two concrete boundary walls that springs up from a 3-metre high plinth. The plinth contains the most private spaces of the dwelling: the snug, bedrooms, utilities and bathrooms.

The form of the roof is driven by multiple criteria ranging from maximum solar gain to shading of the interior through the deep timber structure. An innovative aspect of the roof is the use of laminated structural grade birch plywood to form the primary structure, a material mainly used for interior lining. Here, it will be used for the first time in Australia as a certified structural material in a domestic dwelling. The roof structure is entirely milled using a combination of flat-bed CNC machine and robotic arm.

The significance of the project is in the use of digital fabrication and robotics in Australian domestic building. The roof design modulates the interior quality of the dwelling; its geometry is scripted so it can be shaped to suit different site orientations, creating variation of the terrace form. A 1:1 prototype of the roof forms part of the exhibit. It is accompanied by a video that illustrating the proliferation of the new urban housing typology driven by multi-criteria algorithm that better utilises the unique laneway urban morphology of Melbourne. The design furthers the search for an appropriate and sustainable response to cope with the ever-increasing urban population of our city.

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Paul Loh,
University of Melbourne
David Leggett,
LLDS | Power to Make

Laminated plywood roof with green roof composition around a roof light opening.


FUTURE PROTOTYPING

2019+
Milling+
Sight+
Architecture+
Timber+
Room ———

Suspended Remnants

The Suspended remnants Pavilion was designed and fabricated using a digital form-finding model that combines the generation of funicular geometry with a material inventory constraint. The form-finding model is a design tool that allows the exploration of structural form while simultaneously satisfying two rationalisation criteria. It maintains an equilibrated structure derived from funicular geometry, and optimally assigns an inventory of parts containing naturally occurring dimensional variation. The combined goal for the design outcome is to achieve material efficiency through both structurally rational form and minimisation of material waste.

The material chosen for the inventory was utility-grade sawn timber, being lightweight but with naturally occurring structural defects. An otherwise non-structural material, it will readily yield usable short lengths of structural members once the defects are removed, and in doing so, generate a unique inventory of random short members. These are well suited to articulated structures, which, by employing an inverted funicular geometry, only incur axial stresses and can employ simple (non-moment resisting) timber connections.

This research was undertaken for the design of the pavilion for the "Working Group 21 – Advanced Manufacturing and Materials" exhibition at the IASS (International Association for Shell and Spatial structures) Symposium 2019.

The project acknowledged the following sponsors: The University of Queensland, Swinburne University of Technology, ARC Future Timber Hub and Hyne Timber.

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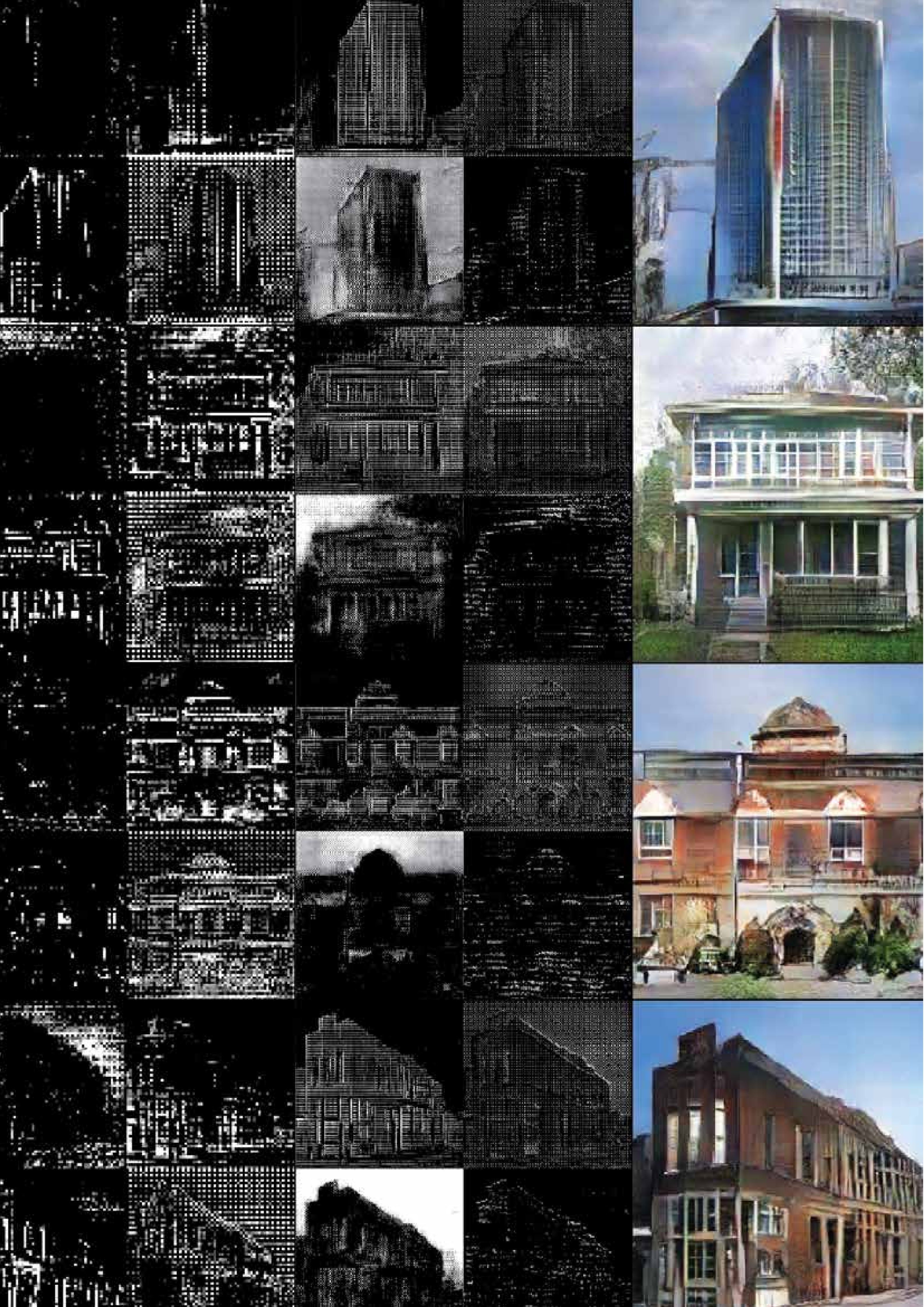
Kim Baber,
University of Queensland
Jane Burry + Canhui Chen,
Swinburne University of Technology
Joe Gattas,
University of Queensland
Aurimas Bukauskas,
University of Bath

Suspended Remnants pavilion

virtual

Projects

Sketches of Thought: Inside the Black Box of AI, constructAR



2020+
Coding+
Touch+
Engineering+
Virtual+
Digital ——

Sketches of Thought:
Inside the Black Box of AI

‘Sketches of Thought’ is a human-machine collaborative design system based on Artificial Intelligence (AI).

The first aim of ‘Sketches of Thought’ is illustrating an approach to AI-integration within the designer’s creative workflow. The system translates a hand-drawn architecture sketch into a photorealistic image that suggests a possible evolution of the design idea. The dialogue with the system happens through a visual interface whereby the designer communicates by sketching directly on a drawing monitor, while the system responds by showing the results of the image translation process on a second monitor. Interaction with the system does not end after a first iteration. Instead, the designer is encouraged to adjust the initial sketch – or even make new sketches – for several times to explore, with the aid of the machine’s feedback, different elaborations of an idea. This system does not require particular drawing skills, and therefore anyone can experience a proficient ‘exchange of ideas’ with the AI model.

The second aim of ‘Sketches of Thought’ is helping the designer familiarise with AI technology. This is achieved by unveiling the black box of the AI model functioning, that is, through a representation of its internal processes. Moreover, as the AI model simulates some aspects of human cognition, a look inside the black box of AI also means visualising a simplified version of the human mental processes. Therefore, learning about AI is an opportunity for humans to learn more about themselves.

The relevance of this virtual prototype is twofold. First, it promotes the view of AI as a means to augment rather than replace the human cognitive capabilities. Second, it challenges the current beliefs and prejudices on AI-technology by making the AI internal processes explicit through a visual representation.

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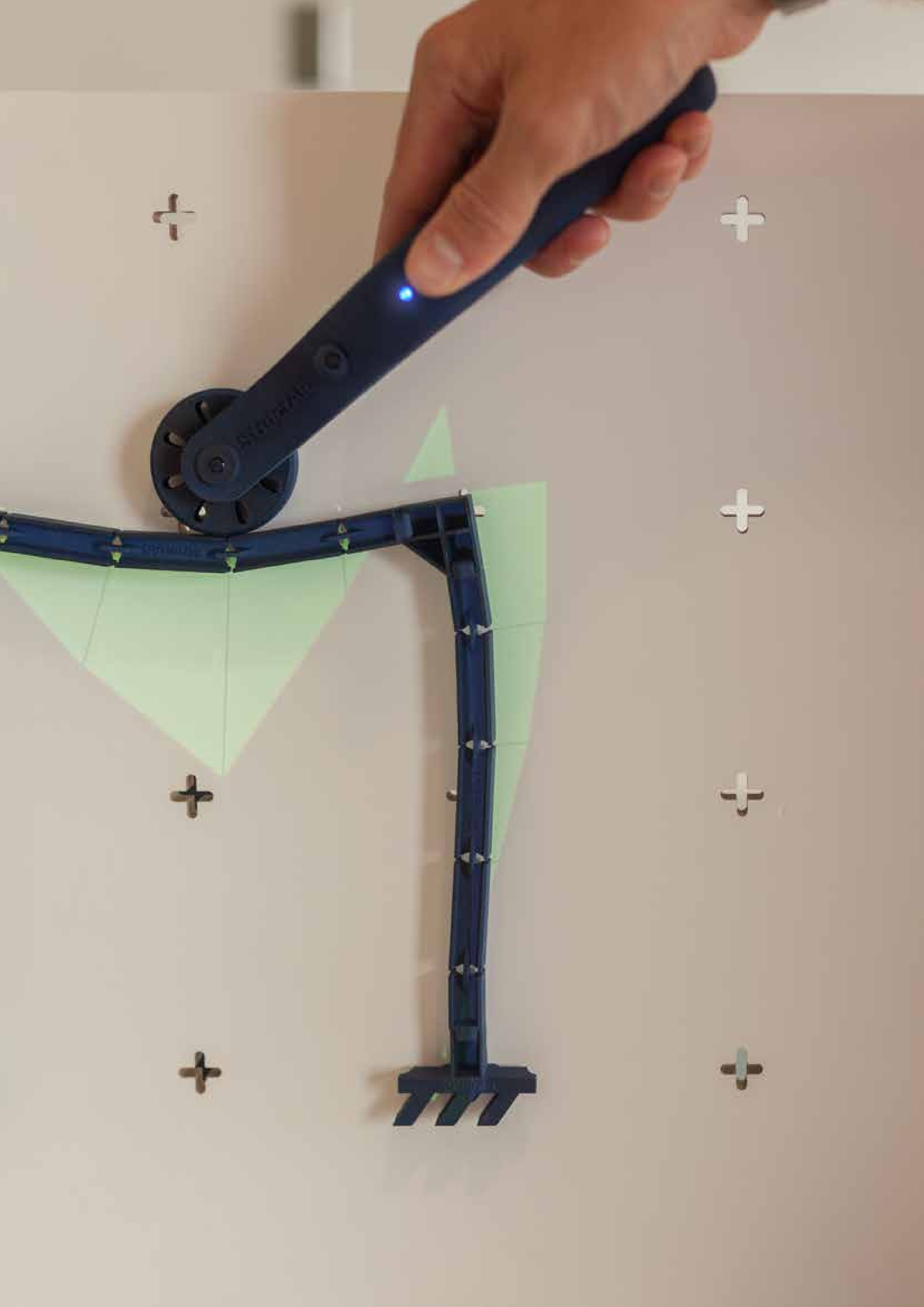
Gabriele Mirra + Alberto Pugnale,
University of Melbourne

Diagram explaining the architecture of the AI model, as well as the human-machine collaborative system.



2019+
Sensing+
Touch+
Engineering+
Virtual+
Digital ——

constructAR

This project is focussed on the benefits of learning by doing. Touching something physically is not only more stimulating and rewarding than just visualising new concepts abstractly, but haptics actually triggers our brains to make more effective connections. Put simply: by touching, we learn better!

ConstructAR presents an entirely novel proof-of-concept technology which allows users to physically interact with hand-sized building components (e.g. springs, pulleys, beams), engage in explorative design thereof and, crucially, gain insights from projected visual content of pedagogical value which the physical objects cannot convey on their own (such as forces, acceleration or electrical current). Such augmentation of physical objects under user-imposed manipulations is wholly novel and promises to transform active learning in STEM education and has implications for a new age of analogue-digital hybrid learning. The importance of STEM education is a policy focus of governments worldwide meaning that it must become more accessible, more effective and more fun if its broader dissemination is to succeed, particularly underprivileged communities.

This novel technology is effectively a 'classroom in a box'. It is a physical kit of consisting of a board and parts which also grants its users access to a digital platform of learning, content and sharing. These kits will assist educators in delivering syllabus to their students and enable students to learn complex themes in an engaging, colourful and gamified manner. Expansion packs and lesson plans will be purchasable to the end-user via an online marketplace. However, the core innovations are as follows:

1) facilitating active learning and explorative design which have well-established benefits (but remain overwhelmingly underexploited in most classroom settings),
2) exploiting the benefits of the "haptic bond" between visual and auditory stimuli which has academically demonstrable cognitive and pedagogical value,
3) digitally augmenting the physical components with projected images powered by advanced simulations making the 'invisible become visible',
4) strategic implementation of gamification techniques as have shown to be effective in education and other fields.

Novel technology has been developed by the design team to make learning more effective, engaging, and fun. This technology offers a glimpse of a new form of haptics-digital hybrid learning.

-
Gregory Quinn + Fabian Schneider,
Swinburne University of Technology

An early prototype of constructAR.

SHORT ESSAY ON THINKING THROUGH MAKING

PAUL LOH
University of Melbourne

When we are making 'things', we are doing more than merely reproducing an abstract idea or an image in our mind. Whether it's coding using a high-level language or physically putting material together with tools or using robotics, making activities allow the mind to be in a constant state of learning throughout the experience. For the makers, the sometimes unconscious act of correcting one's own errors while making is a usual practice. For others, making allows one to realise emerging mistakes, tinker with configuration, or construct new possibility in the artefact (Charny, 2011). It may even lead to a re-evaluation of aesthetics, and, at times, it may question the original design intent, goals and objectives.

Making is an evolving process that feeds back into the conceptualisation of the design work. When a maker implements these feedback strategies of abstraction, experimentation, experience, and reflection, what the maker is doing is more than reproducing an artefact. He or she is, in fact, prototyping[1].

The emerging nature of prototyping implies that there may not be an end or a final artefact or product per se. What prototyping prompts is a search process for a state of equilibrium or stasis between the abstract idea, the intention of the design and its execution. As the architect-turned-furniture maker David Pye (1995, p.49-50) suggests, 'the intended design of any particular thing is what the designer has seen in his (her) mind's eye: the ideally perfect and therefore unattainable embodiment of his (her) intention'. To make the intent even more unattainable, design intention is often coupled with an associated framework of judgement, in the form of performance criteria or aesthetics that act as a means to qualify or satisfy such intention. In design, the intention is often subject to change, influence and negotiation; these are sometimes within the control of the maker and designer, but often they are not.

In other words, the 'end' of design is merely a negotiated outcome of all the factors associated with the intention and the making process; it is not perfect, but it will do. All the artefacts showcased in this exhibition document this state of flux – the in-between status where ideas are still formulated or emerging – in its most exciting state of multiplicity in terms of the multiple trajectories of possibilities and potentials the artefact embodies.

Thinking Through Making

Thinking through making is a well-established pedagogical model, especially in design education. This mode of teaching places emphasis on learning experiences rather than on the 'banking' concepts of education (Paulo & Ramos 1972). As designers are form-givers, bringing ideas into the material world is part of their business (Dunnigan, 2013). The process of learning and working through design as an open-ended 'wicked' problem (Rittel & Webber 1973) requires the integration of both mind and hand, where designers construct individual learning experiences through embodied interactions with reality.

Seymour Papert (1988) discusses the need for 'messing about' with materials to construct active learning through the incremental building of knowledge. 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

1. The term 'prototyping' emerged from software engineering in the late 1980s when engineers adopted rapid prototyping as a methodology to design and test their software design. The concept is, of course, not new, as engineers, architects and designers develop physical mock-ups to test their ideas.

construction of artefacts and capable of solving real-life problems, just like wood or metal.

As David Kolb points out, in an experiential and integrated model, learning is based on the conflict between concrete experiences and abstract concepts as well as the conflict between observation and action. He outlines three historical models of experiential learning proposed by Lewin, Dewey and Piaget, noting that all models share a baseline relationship between 'concrete experience', 'reflections and observations', 'abstract conceptualisation', and 'active experimentation' or 'testing' (Kolb, 1984). These four categories are set up as feedback to enable a continuous learning experience (see figure 1). Kolb identifies the process of learning as 'the resolution of the conflict between didactically opposed modes of adaptation to the world' – those of 'observation' and 'testing of active experiments', 'concrete experience', and 'abstract conceptualisation'. Both Constructionism and

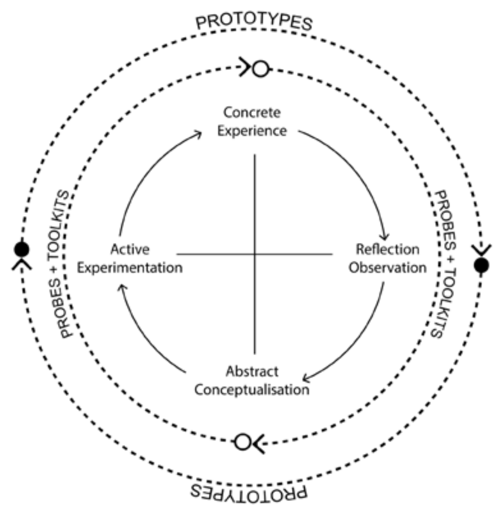


Figure 1. Prototypes as one of the "doing devices" overlaying the experiential learning model of Kolb

Critical Making have experiential learning as part of the thinking.

Constructionism in education advocates the construction of knowledge through real-life or real life-like experiments that foster learning. It emphasises the importance of actively making things and pairing abstract concepts with concrete experiences to make sense of knowledge. Schank points out that the key to enhancing learning is 'doing'. It allows one to experience and formulate judgement – the more you 'do', the more experience one accumulates to inform the next set of 'doing'.

While Critical Making builds on constructionist theory (Boytchev, 2015), it looks at the implication of making on the societal level where technology is seen as an agent in the design process. Matt Ratto (2014) makes a distinction between Critical Making and Constructionism, 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 crucial aspect of Critical Making, as demonstrated by almost all the prototypes in this exhibition. In design education, this aspect of learning is often excluded from the teaching of technology for several reasons. Typically, technology is seen as a separate silo to social engagement. As Ratto (2014, p.229) observes, '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' As educators, we have more work to do here.


Future Prototyping exhibition in the Dulux Gallery

Making as Incremental Discovery

In archaeology, Lambros Malafouris utilised actor-network theory to discuss making activities as a form of material engagement. His theory proposed that making consists of a complex set of agents at work: the mind, the sensorimotor, the tool used and the material.

The agency of making is both a fluid and an open concept (Loh, 2019). Malafouris illustrates this through the making of an axe head, using the knapping technique on flint. The act of knapping, he argues, is an exercise of multiple agents at work; for example, the hand of the maker, the knapping stone, and the stone being knapped. Each subsequent strike of the flint determines the angle of the next strike. This incremental method of form discovery is contrary to the traditional understanding that the axe head is a preconceived image within the flint. It is closer to an iterative negotiation of materials. Hence, 'there are no fixed agentive roles in this process; instead, there is a constant struggle towards a "maximum grip"'(Malafouris, 2016).

Making as Research Methodology

How and why is this relevant for us? For most of us, we have always seen thinking and making as separate exercises in which making is a secondary activity – the execution of a thought process. The theories that I have highlighted in this short essay, however, all point towards making as a complex thinking process. Whether we are learning through making, forming new social engagement or understanding the relationship between material and our mind, all these frameworks are useful in helping us to understand how making can be a way of thinking through materials.

As Malafouris (2020, p.3) suggests, 'we think with and through things, not simply about things'. In this sense, object and artefact is not just an encapsulation of thought but is the very vehicle for thought. Here, we question the need to separate what the mind thinks of the object and the object itself. Rather, the object should be seen as an extension of the mind. The iterative process of prototyping begins to remove the hierarchy between our mind and the designed environment we lived in. With this awareness, I suggest we view the prototypes in the exhibition with a different light. Aside from containing useful information for the designer, they are evidence of design research through making. In other words, making can be seen as a form of research methodology: a valid means to test a hypothesis, a method of information gathering and testing, a thinking process through materiality and critical reflection on design intention and objectives. All of these could lead to innovation and discovery.

References:

Boytchev, P 2015, 'Constructionism and Deconstructionism', Constructivist Foundations: An Interdisciplinary Journal, vol. 10, no. 3, pp. 355–363.

Charny, D 2011, Power of making : the importance of being skilled D Charny (ed), V&A Publishing, London.

Dunnigan, J 2013, 'ThinKing', in R Somerson, M Hermano, & J Maeda (eds), The Art of Critical Making, Wiley ; John Wiley.

Freire Paulo, 1921-1997 & Ramos, MB 1972, Pedagogy of the oppressed, Sheed and Ward, London.

Kolb David A 1984, Experiential learning : Experience as the source of learning and development, Prentice-Hall, Englewood Cliffs, N.J.

Loh, P 2019, 'Digital Material Practice: the agency of making', RMIT University.

Malafouris, L 2016, How Things Shape the Mind, The MIT Press.

Malafouris, L 2020, 'Thinking as "Thinging": Psychology With Things', Current Directions in Psychological Science, vol. 29, no. 1, pp. 3–8.

Papert, S 1988, 'Computer as material: Messing about with time', Teachers College Record, vol. 89, no. 3, pp. 408–417.

Pye, D 1995, The Nature & Art of Workmanship, A & C Black, Chippenham, England.

Ratto, M 2014, 'Textual Doppelgangers: Critical Issues in the Study of Technology', in M Ratto & M Boler (eds), DIY Citizenship, Critical Making and Social Media, MIT Press, pp. 227–236.

Rittel, HWJ & Webber, MM 1973, 'Dilemmas in a general theory of planning', Policy Sciences, vol. 4, no. 2, pp. 155–169.

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Future Prototyping is the long-awaited effort to critically review and survey the current state of design innovation within the Australia and New Zealand context as we moved into a new decade.

With foreword by Professor Jane Burry, authors of numerous books including Prototyping for Architects (Burry & Burry 2016, Thames & Hudson), the catalogue is edited and introduced by the curatorial teams consisting of architecture educators and design practitioners.

This catalogue accompanied the Future Prototyping exhibition held at the Dulux Gallery, the Melbourne School of Design, from 24th of Feb – 27th of March 2020. The exhibition gathered for the first time 36 unique projects spanning multiple disciplines from art to engineering, architecture, fashion and computing to examine the status of prototype and how it acts as a pivotal moment for designers to articulate novel ideas and speculate on the future of our society.

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