



Active and Completed Projects

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July 2023



Australian Government
Department of Industry,
Science and Resources

AusIndustry
Cooperative Research
Centres Program



Active Projects

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3. Projects to Platforms: Investigating New Forms of Collaboration (Scoping Study)

Project Lead: Dr Duncan Maxwell | Monash University

Problem / thesis

Construction practice is rooted in project-based thinking as organisations utilise temporary teams, to create one-off products, in response to unique and changeable site conditions. In response, product platforms have begun to emerge in construction, but the introduction of broader, platform-based business models promises fundamental and holistic change to traditional construction.

Such business models leverage a combination of strategies in terms of product and process that require investigation, definition, critique, and adaptation for their potential use in construction.

Project 3 examines construction's disparate ecosystem to consolidate the broader network of actors through an examination of industry-wide business-level platforms.

List of partners:

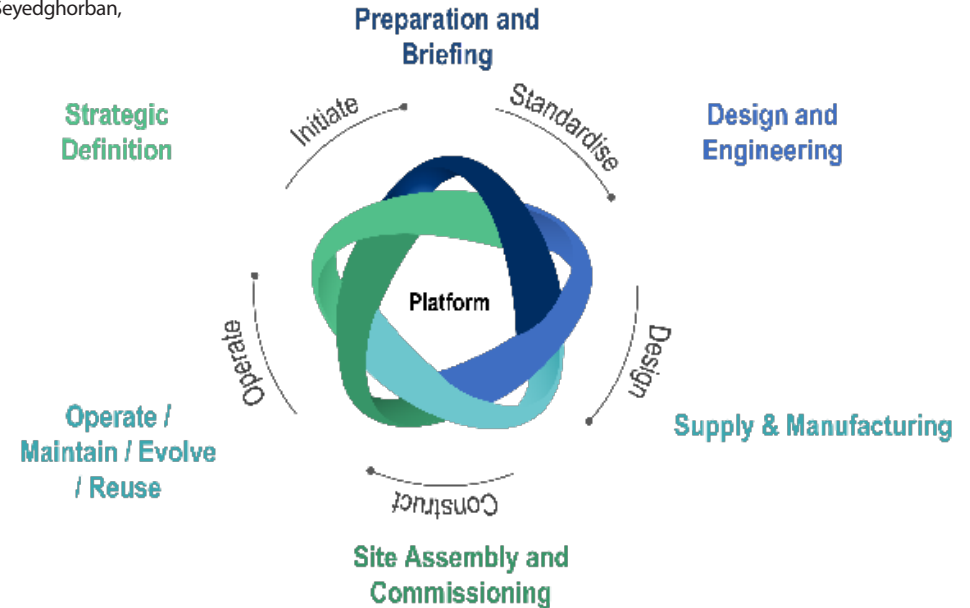
A.G. Coombs, BlueScope, Hyne & Son, Lendlease Digital, Monash University, Sumitomo Forestry, The University of Melbourne

List of researchers:

Duncan Maxwell, Amrik Sohal, Robert Moehler, Alka Nand, Daniel Samson, Prakash Singh, Zahra Seyedghorban, Liang Chen.

Date commenced and duration:

September 2021 - April 2023



11. Environmental Credentials for Building Technology Platforms

Project Lead: Dr Victor Bunster | Monash University



Problem / thesis

There is a growing need for environmental credentials to support B2B and B2C communication in the building industry. Solutions based on the Life Cycle Assessment (LCA) methodology are the most comprehensive, covering all the stages of the building's lifecycle – from extraction of raw materials to their end-of-life stages.

Despite the potential efficiencies of loosely-coupled supply chains, distributed decision making, and increased levels of digitalisation, there are no readily available methods to systematically assess the environmental impacts of building technology platforms.

This project is developing an ISO-compliant LCA framework to quantify and communicate these impacts using the uTecture and Airbuildr platforms as cases.

List of partners:

Uitecture Australia, Coresteel Buildings, Monash University

List of researchers:

Dr Victor Bunster, Dr Duncan Maxwell, Santiago Muñoz-Vela, Fernando Pavez, Yussra Rashed, Seongwon Seo, Edan Weis.

Date commenced and duration:

March 2021 - June 2023



Image credit: Airbuildr construction design platform (uTecture, 2022).

Supply Chain Impacts

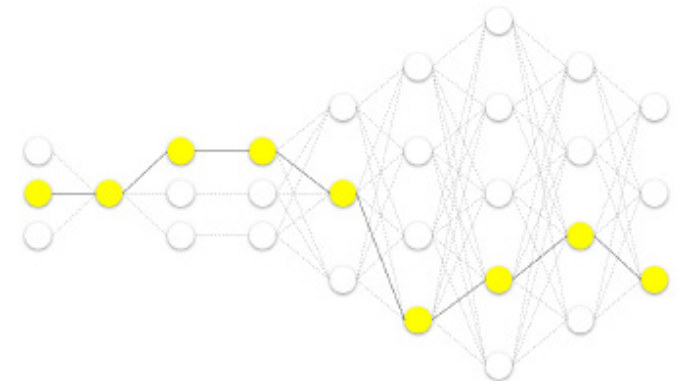


Image credit: Supply chain impacts of building technology platforms (Victor Bunster, 2022).

15. Using the Whole Tree for Future Timber-Based Construction Scoping Study

Project Lead: Dr Benoit Belleville | The University of Melbourne

Problem / thesis

This project aims to optimise parts of the Australian sawn timber processing sector, so it can adapt to changes in market demand and material characteristics in ways that align with the future timber-based construction.

The project is a review and scoping exercise to find ways of using the whole tree more effectively, while adding value to the built environment. The aim is to propose avenues of research that will address timber supply and provide manufacturing and structural design solutions to build a more resilient industry.

List of partners:

Hyne & Son, Sumitomo Forestry Australia,
The University of Melbourne

List of researchers:

Dr Benoit Belleville, Dr Wen Li, Dr Alireza A. Chiniforush,
Prof Tuan Ngo, Prof Barbara Ozarska, Prof Rod Keenan,
Mr Richard Nero, Mr Johannes Fehrmann

Date commenced and duration:

May 2022; 12 months

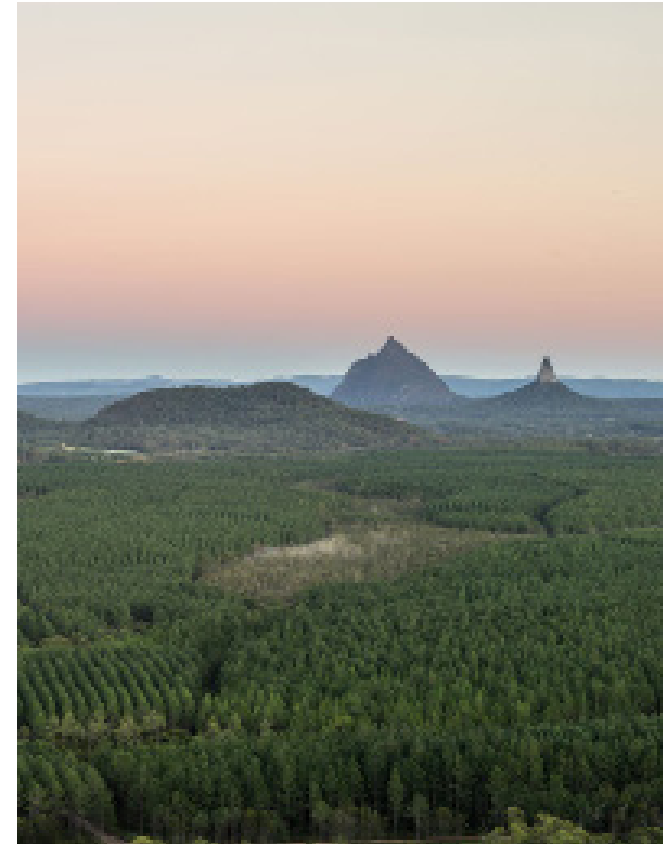


Image credit: Beerburum (Hyne Timber, 2022).

24. Next Generation of Robust and Fire-resilient Light Gauge Steel Systems for Mid-Rise Buildings

Project Leads: Prof Tuan Ngo & Dr Mahen Mahendran | UoM & QUT

Problem / thesis

Traditional construction practices in Australia have been criticised for their focus on the reduction of upfront construction costs at the expense of quality, performance and flexibility.

Current and emerging prefabrication processes could provide the efficiency and quality of construction to the traditional built-to-sell market, however by incorporating the possibilities to cater for the recently developing built-to-rent sector is considered to drive it even stronger.

This is because Build-to-rent shifts the housing profit model from capital gains to one based on ongoing rental income, with viability tied to minimising ongoing expenditure.

This scoping study seeks to examine the intersection of these assets and prefabrication processes, to identify opportunities for the housing and construction sector to reduce ongoing greenhouse gas emissions and increase the quality of stock.

List of partners:

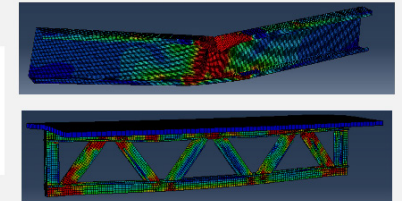
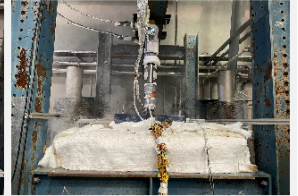
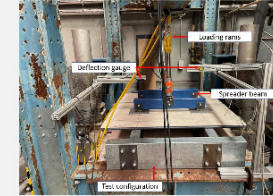
Bluescope Steel, Queensland University of Technology,
The University of Melbourne

List of researchers:

Prof. Mahen Mahendran, Dr Anthony Ariyanayagam,
Mr Fatheen Hisham, Mr Gihan Ranasinghe

Date commenced and duration:

March 2022; 36 Months



24. Next Generation of Robust and Fire-Resilient Light Gauge Steel Systems for Mid-Rise Buildings (Umbrella Project)

Project Leads: Prof Tuan Ngo & Dr Tai Thai | The University of Melbourne

Problem / thesis

Light gauge steel (LGS) offers significant advantages over other construction materials such as easy to install and resistant to rotting, shrinking and termite attack. However, the structural robustness to resist progressive collapse under localised damage due to accidental loads is a critical concern in LGS systems. This is particularly the case given the connections in LGS buildings are usually made via screws and rivets with low tying resistance.

This project will develop cost-effective structural solutions for robustness of LGS structures to promote their applications in mid-rise construction markets such as offices, apartments, hotels, hospitals, student accommodation and aged care facilities.

List of partners:

BlueScope, Queensland University of Technology,
The University of Melbourne

List of researchers:

Prof Tuan Ngo, Prof Nelson Lam, A/Prof Tai Thai,
Dr Tuan Nguyen, Mr Chris Mathwin, Mr Trac Nguyen

Date commenced and duration:

March 2022, 36 Months



29. Real-time EH&S Intervention to Improve Site Safety (Scoping Study)

Project Leads: Dr Barrett Ens & Dr Pari Delir Haghighi

Problem / thesis

Human error is the largest contributor to onsite accidents in the construction industry, but can be reduced through improvements to workplace design and procedures.

Through an examination of current practices, this project aims to identify existing relationships between variables such as worker behaviour and sentiment, site activities, and workplace incidents, from which we can uncover actionable insights to mitigate safety risks.

An inspection of practices from industries with a proven safety record and a survey of novel technologies will reveal potential opportunities for detection and intervention of risks, including the application of digital twins for evaluating proposed changes to design and procedures.

List of partners:

LendLease Digital, Monash University, The University of Melbourne

List of researchers:

Dr Pari Delir Haghighi, Dr Barrett Ens, Prof Tim Dwyer, Dr Hamid Rezatofighi, Dr Teresa Wang, Dr Benjamin Tag, Prof Tuan Ngo, Dr Tuan Nguyen, Prof Rajkumar Buyya.

Date commenced and duration:

February 2023; 24 Months



32. Acoustic flanking performance of mid-rise light gauge steel (LGS) structures

Project Lead: Dr Amin Heidarour | Monash University

Problem / thesis

The project aims to develop a robust method for predicting the acoustic flanking performance of floor and wall systems in mid-rise LGS buildings. The resulting design recommendations will give the building community confidence about how to reliably design and construct LGS buildings.

List of partners:

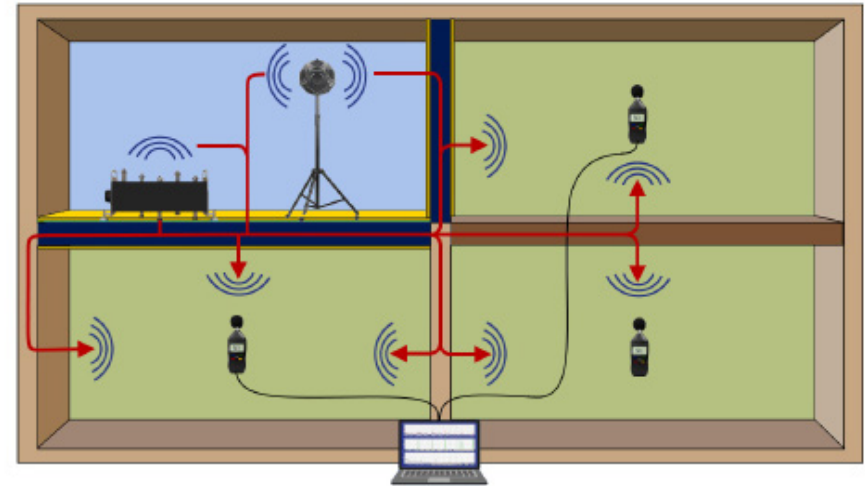
Bluescope, Monash University, The University of Melbourne

List of researchers:

Assoc Prof Amin Heidarpour, Prof. Tuan Ngo, Prof Lu Aye, Dr Bernard Gibson.

Date commenced and duration:

September 2022; 36 months



33. Remote Compliance Inspections

Project Lead: Dr Yihai Fang | Monash University

Problem / thesis

Remote (virtual) building inspections are expected to reduce the time and travel needs required by traditional in-person inspections while maintaining (or enhancing) the integrity and rigor of the inspection process and outcome. However, the effectiveness and suitability of technologies for remote building inspections are not fully understood and rigorously evaluated. This project aims to 1) review best remote inspection practices, 2) evaluate digital technologies for remote building inspections, and 3) develop a guideline for the effective implementation of suitable technologies for remote building inspections. Outcomes from this project are expected to guide the implementation of technologies and workflows for remote building inspection.

List of partners:

Victorian Building Authority, VMIA, Salesforce.com, Sumitomo Forestry Australia, University of Melbourne, Monash University,

List of researchers:

Dr Yihai Fang, Eric Windholz, Kourosh Khoshelham, Tuan Ngo, Tanghan Jiang, Jimmy Weng, Sajjad Einizinab

Date commenced and duration:

June 2022; 12 months



36. Academic validation of performance gap research in energy rating systems

Project Lead: Dr Victor Bunster | Monash University

Problem / thesis

The report "Closing the performance gap in Australia's commercial office sector (produced by Building 4.0 CRC and the Green Building Council of Australia (GBCA)) showed modelled energy performance of Green Star certified buildings is being achieved in operation, as demonstrated by NABERS energy ratings. The GBCA aims to further validate and extend this research through an academically peer-reviewed publication.

This project involves undertaking research to understand the outcomes of the Closing the performance gap report in the context of international contemporary academic studies and literature.

List of partners:

Green Building Council of Australia, Monash University

List of researchers:

Dr Victor Bunster, Dr Thais Gonçalves-Sartori,
Dr Duncan Maxwell.

Date commenced and duration:

September 2022; 6 months



38. Victorian Government Digital Build - Translating theory into practice

Project Leads: Dr Lee-Anne Khor & Prof Diego Ramirez-Lovering | Monash University

Problem / thesis

Project #38 is a cross-sector collaboration that aims to address the gap between theory and practice to facilitate greater uptake of digitally integrated building and offsite construction in Victoria.

Three tranches of research will be used to build Victoria-specific evidence about digital building projects, practices and environments: 1) off-site and modular construction hubs; 2) benefits of digital build; and 3) project applicability decision-making framework.

Building on our partners expertise and project data, this project will integrate spatial, economic and socio-technical research to align government and industry imperatives for establishing and sustaining a robust, digitally integrated building industry in Victoria.

List of partners:

AG Coombs, BlueScope, Fleetwood, Coresteel Australia, Donovan Group, Victoria State Government: Dept of Jobs, Precincts and Regions, Lendlease Digital, Monash University, SFDC Australia, Salesforce.com, Sumitomo Forestry Australia, Master Builders Association of Victoria,, The University of Melbourne, Ynomia.

List of researchers:

Prof Diego Ramirez-Lovering, Dr Lee-Anne Khor, Dr Duncan Maxwell, Dr Sahar Soltani, Dr Duncan Maxwell, Dr Laura Harper, Dr Ivana Kuzmanovska, A/Prof Lionel Frost, A/Prof Seamus O'Hanlon, Dr Claudio Labanca, A/Prof Gillian Oliver, Dr Abdallah Ghazlan, Dr Misita Anwar, Dr Caddie Gao, Prof Tuan Ngo, Dr Behzad Rismanchi, A/Prof Kourosh Khoshelham, A/Prof Tai Thai, Dr Lisa Kruesi, Dr Jocelyn Cranefield, Dr Siddhesh Godbole, Prof Tuan Ngo, Prof Nelson Lam, Dr Rackel San Nicolas, Dr Xuemei Liu

Date commenced and duration:

June 2022; 12 months



Image credit: Pavatex (Project Team, 2019)



Image credit: Monash Woodside Building for Technology and Design. Sectional Perspective. (Grimshaw)

41. New Materials for Windows of the Future - Phase 2

Project Lead: Prof Greg Qiao | The University of Melbourne

Problem / thesis

Double-glazed windows are a norm in many countries across Europe, Asia and North America due to their effective reduction of heat loss (-30%) compared to single-glazed windows.

However, in Australia, only 10% (approx.) of current window installations are double-glazed. This is in part owing to the temperate climate across many parts of Australia, but equally the high cost of double glazing. Material science has made rapid progress over the last two decades resulting in the development of many new advanced materials and coatings.

This project focussed on providing a critical assessment of the opportunities to apply new materials and coatings to reduce the cost, and improve the performance and ease of installation of double-glazed windows.

List of partners:

The University of Melbourne, Ultimate Windows

List of researchers:

Dr Greg Qiao, Tye Spierings, Daniel Lowden, Zak Ruitenber, Carl Neilson, Prof. Tuan Ngo, Joel Scofield

Date commenced and duration:

February 2023; 24 Months



Image credit: Ultimate Windows

44. Generative Architectural Design Engine

Project Lead: Dr Camilo Cruz Gambardella | Monash University

Problem / thesis

Advancements in machine learning (ML) and artificial intelligence (AI) models that produce graphics have dominated the discussion around computational creativity for the past 5 years. Generative neural networks, like DALL-E-2 and Midjourney, can render remarkably detailed, intricate and convincing images, to the point where they can be perceived as 'creative work'. This project aims to leverage these advancements to support creative processes in a more complex field: architectural design.

Using a combination of qualitative methods and advanced ML and AI models, our goal is to develop and implement prototypical digital tools, capable of 'proposing' multiple viable architectural design drafts, based on design value and performance. They will be used as a starting point for designers to build upon.

List of partners:

LendLease Digital, Monash University

List of researchers:

Dr Camilo Cruz Gambardella, Prof Jianfei Cai, Prof Shane Murray, Prof Dinh Phung,
Prof Jon McCormack, Prof Mel Dodd,
Dr Duncan Maxwell

Date commenced and duration:

July 2023; 36 Months



45. Prefab Wall Integrated System – Phase 2 Demonstration House and Market Study

Project Lead: Dr Phil Christopher | The University of Melbourne

Problem / thesis

There currently exists significant logistical and material shortage challenges in the residential home construction market. This coupled with a highly competitive environment has translated into most builders focusing on price of delivery, assuming this is the most important aspect to consumers. Builders are also subject to increasing risk with greater supply chain, labour and material shortages hindering the on time and on budget delivery of homes. This project tackles this problem through a two-prong approach (1) leveraging of existing work build a demonstration home that utilises a prefabricated wall system that delivers greater energy performance and lower supply chain risk with an integrated system and (2) to better understand the values of home buyers and the role that cost, energy performance and quality play in their decision making. This project will see the materialisation of the high-performance wall system in the construction of demonstration home in Melbourne, showcasing constructability, performance and the aesthetics of the system.

List of partners:

Bentley Homes, Ultimate Windows, University of Melbourne

List of researchers:

Dr Philip Christopher, Prof Tuan Ngo, A/Prof Felix Hui, Dr Tu Le, Dr Khuong Bui, Dr Lu Aye

Date commenced and duration:

July 2022; 24 months



48. Scoping Study for Building the Future – Circular Economy – Shared Interest Project

Project Lead: Prof Leonie Barber | Queensland University of Technology

Problem / thesis

With C&D materials accounting for 44% of all waste generated in Australia and the building sector's energy consumption and CO2 emissions at a record high, the move to a circular economy presents a significant opportunity for positive change. Given the complex socio-political and economic factors at play, and the potentially competing needs of key stakeholders, this scoping study will form a solid foundation on which to plan the necessary steps and actions to enable the transition to a circular economy. Study findings and the resulting roadmap will be widely disseminated to study participants, industry stakeholders and government to catalyse meaningful action.

Date commenced and duration:

June 2023; 12 months

List of partners:

A.G. Coombs, BlueScope, Fleetwood Australia, Donovan Group, Holmesglen Institute, Hyne & Son, Lendlease Digital, Monash University, Queensland University of Technology, Sumitomo Forestry Australia, Master Builders Association Victoria, The University of Melbourne, uTecture Australia, Victorian Building Authority, VIRIDI Group, Verton Ynomia

List of researchers:

Professor Leonie Barber (Project Lead), Dr Judith Herbst, Dr Melissa Teo, Senior Lecturer, Associate Professor Mirko Guaralda, Professor Tim Schork, Dr Sara Omrani, Associate Prof. Peter Graham, Dr Victor Bunster, Dr Duncan Maxwell, Prof. Amrik Sohal, Fernando Pavez Souper, Dr Phil Christopher, Prof Lu Aye & Prof Robert Crawford.



50. Development of Artificial Neural Network and Automated Life Cycle Assessments for Cloud Based Residential Energy Estimations

Project Lead: Dr Phil Christopher | The University of Melbourne

Problem / thesis

This project will see the development of a next generation cloud based artificial neural network for new home operational energy efficiency and embodied carbon. It is intended that designers, builders and clients in both Australia and New Zealand will be able to utilise this engine to gain near real time feedback on the estimated energy performance and embodied carbon of a new home empowering those in the industry to make better informed decisions when it comes to sustainability, cost and performance.

List of partners:

Monash University, University of Melbourne, uTecture Australia

Date commenced and duration:

April 2023; 30 months

List of researchers:

Dr Phil Christopher (Project Lead), Dr Khuong Bui, Dr Victor Bunster, Prof Tuan Ngo and Dr Lu Aye, Gavin Tonnet, Brett Donovan & Edward Massey



57. Wind Comfort Simulation and New Engineering Design Process

Project Lead: David Burton | Monash University

Problem / thesis

For a typical engineering project, Engineering design (upstream) and operation (downstream) commonly follow a linear process through multiple contracting parties. Such a process is inefficient and unsustainable for continuous improvement and IP retainment. To resolve such dilemmas in building wind comfort design, Lendlease Digital collaborates with Monash University to develop a new pathway by coupling cutting-edge multidisciplinary technologies, including wind tunnel experiments, numerical simulations, and field testing. The new pathway will improve efficiency by introducing a feedback loop to the system, to date an unprecedented approach to wind design for the built environment. Potentially, this pathway can also quickly transform comfort design within other engineering disciplines, for example, fire, water, and thermal.

List of partners:

Lendlease Digital, Monash University

List of researchers:

Mr David Burton, Prof Mark Thompson, Dr Daniel Tudball Smith, Dr Shibo Wang.

Date commenced and duration:

July 2022, 24 months

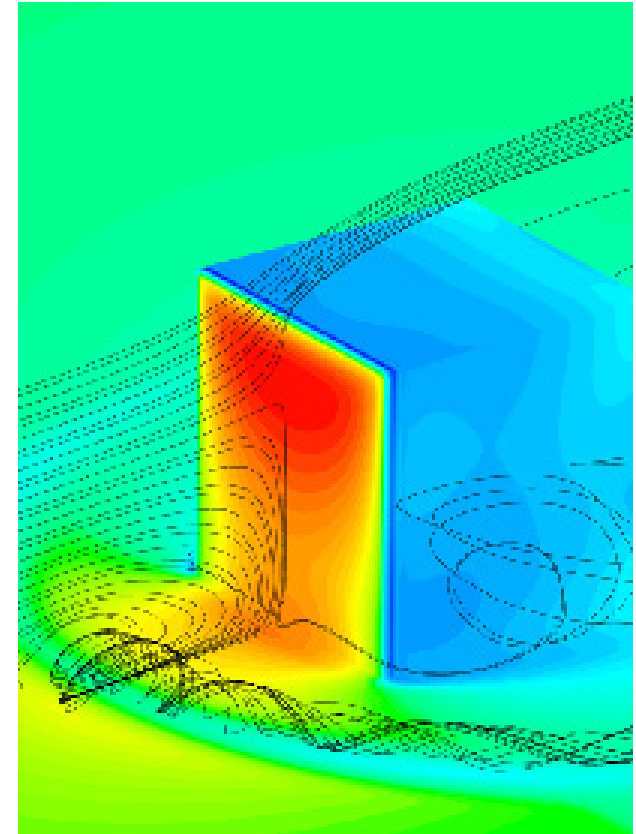


Image credit: CFD1 (Shibo Wang 2022)

59. Innovative Steel–Timber–Concrete Composite StrongFloor

Project Lead: Prof. Tuan Ngo | The University of Melbourne

Problem / thesis

This project aims to develop a novel structural flooring system covering mid- to long-spans that:

- * minimises material use
- * provides the possibility of fast and modular construction
- * reduces manufacturing and construction costs
- * improves space quality and aesthetic look
- * complies with the requirement of Australian standards and BCA.

The initial phases are an extension of existing experimental knowledge and the development of reliable numerical and analytical models. Later stages of the project will include optimising the floor components.

List of partners:

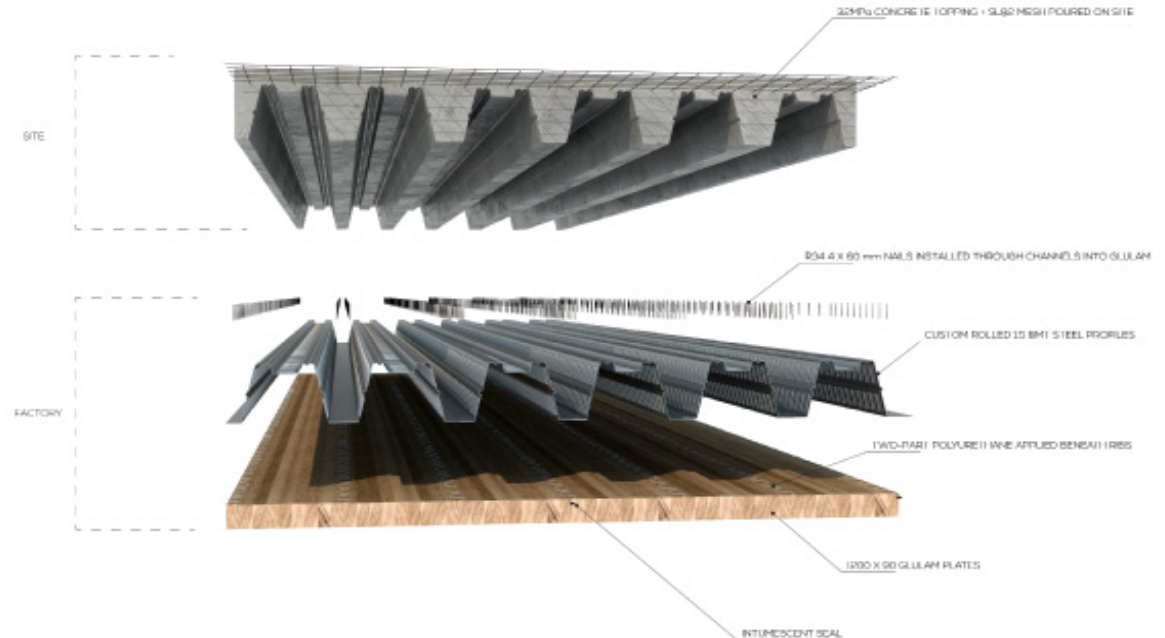
VIRIDI Group, The University of Melbourne

List of researchers:

Prof Tuan Ngo, Dr. Philip Christopher, Dr. Rachel San Nicolas, Dr. Alireza Chniforush, Khin Sheng Chin.

Date commenced and duration:

September 2022, 18 months



60. Mass Timber Wellness

Project Lead: Dr Stephen Whyte | Queensland University of Technology

Problem / thesis

Building 4.0 CRC proposes an intensive research project be undertaken to explore international academic literature and commercial material of mass timber buildings to investigate potential international case studies. The project will assess the long-term viability of a more comprehensive research project in terms of mass timbers impact on occupant health or market drivers, or potentially both.

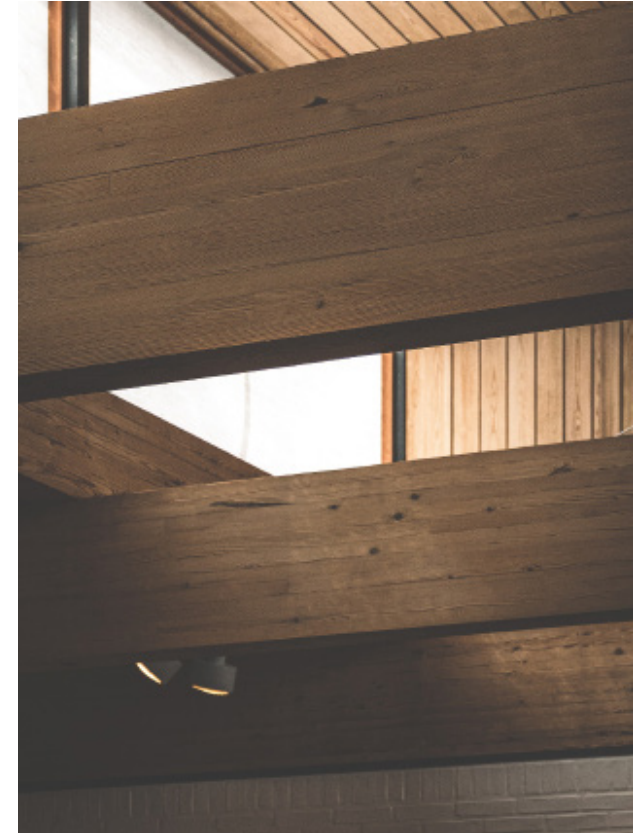
Initial research has found multiple physiological, psychological, and environmental benefits from wooden interiors that hold implications for stakeholders. These benefits include: improvements to a persons emotional state and level of self-expression; reduced blood pressure, heart rate and stress levels; improved air quality through humidity moderation; and its use as a long-term store of carbon, helping to fight climate change.

List of partners:

Monash University, Queensland University of Technology, Sumitomo Forestry, VIRIDI Group.

Date commenced and duration:

December 2022, 6 months



Light House Project #1: Monash Smart Manufacturing Hub (mSMH) – A Digital Twin Living Lab

Project Lead: Dr Yihai Fang | Monash University

Problem / thesis

Digital twins are an emerging technology with the potential to revolutionise the building industry by digitising the operation and maintenance of physical assets. However, several challenges need to be overcome before their widespread adoption in the built environment.

The Monash Smart Manufacturing Hub (mSMH) aims to tackle these challenges through the creation and utilisation of a digital twin for the hub. This endeavor will focus on assessing the performance of the digital twin by using the built environment's resilience and well-being as a case study.

The project entails enhancing the existing design and deployment of a multimodal sensing network, a data engineering and analytics platform, domain-specific data analytics and simulation applications, as well as a front-end portal for spatial visualisation and interaction with sensing data and simulation results.

List of partners:

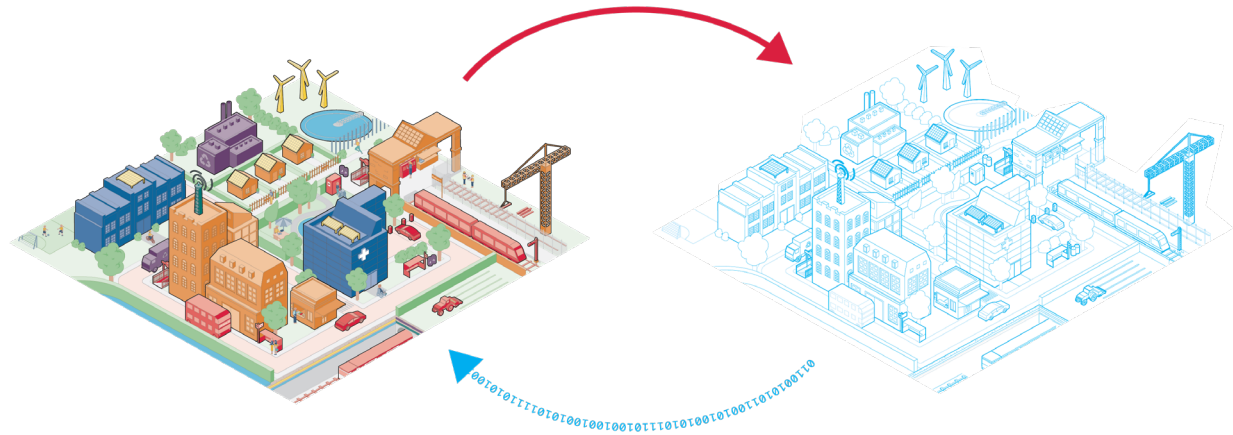
Amazon Web Services, Monash University

Date commenced and duration:

July 2023, 12 months

List of researchers:

Dr Yihai Fang, Dr Jenny Zhou, Dr Duncan Maxwell, Dr Sahar Soltani



Light House Project #3: NCHA Independent Living Lab

Project Lead: Dr Rachel Couper | Monash University



Problem / thesis

The NCHA Independent Living Lab is a piece of research infrastructure within the NCHA's Simulated Environments stream of work. The aim of this Living Lab is to support research and related activities to deliver the NCHA vision and aims, by providing a simulated home environment for multidisciplinary research, testing and demonstration of integrated spatial, assistive technology, and care models for healthy living and ageing.

To ensure the NCHA vision and aims are delivered from the outset, the B4.0CRC Lighthouse Project (LHP#03) has been developed over the last 9 months – to focus on the design and construction of the Independent Living Lab. It will take advantage of a rare opportunity to test research objectives of the NCHA through the procurement of the Living Lab itself. This aligns with key research questions about how modular and prefabricated production can create new innovations in living environments for ageing.

List of partners & Stakeholders:

Fleetwood Australia, Monash University: Urban Lab, Future Building Initiative, Design Health Collab School of Primary Allied Health Care (RAIL Lab), Monash University Buildings and Property Division, Peninsula Health Allied Health Team.

Date commenced and duration:

March 2023, 18 months

List of researchers:

Stream One: Associate Professor Leah Heiss, MADA Design Health Collab (Dr Troy McGee and Dr Myra Thiessen)/School of Primary and Allied Health Care RAIL Research Centre and Occupational Therapy Departments (Associate Professor Libby Callaway and Dr Linda Barclay)/Peninsula Health Allied Health Team (Ms Pip Veerman)

Stream Two: Professor Mel Dodd, MADA Urban Lab/Maryam Gusheh, School of Primary and Allied Health Care RAIL Research Centre and Occupational Therapy Department (Associate Professor Libby Callaway and Dr Eli Chu)/Peninsula Health Allied Health Team (Ms Pip Veerman)

Stream Three: Dr Rachel Couper, MADA FBI Team with Dr Duncan Maxwell.



Light House Project #6: Malvern East Apartment Development

Project Lead: Dr Sahar Soltani | Monash University



Problem / thesis

Although significant claims exist with regards to the benefits of utilising offsite construction, often, these are anecdotal, context-specific, and challenging to quantify in comparison to business-as-usual. Previous CRC project findings suggest that the benefits of offsite construction are often not realised because the design consultants, developers, and builders do not effectively collaborate to deliver integrated solutions.

This project will document, benchmark, and suggest improvements to realise the benefits in offsite construction using an offsite timber pilot project in Malvern East in order to quantify benefits and recommend improvements.

Research streams will focus on Integrated Design (Design for Manufacture and Assembly -DfMA) considerations, Life Cycle Analysis, Building Performance (Acoustic, Vibrations and Indoor Environmental Quality), Market Perceptions and Digital Project Management (10D-Building Information Modeling) to holistically demonstrate the value of the off-site timber approach in building construction.

List of partners:

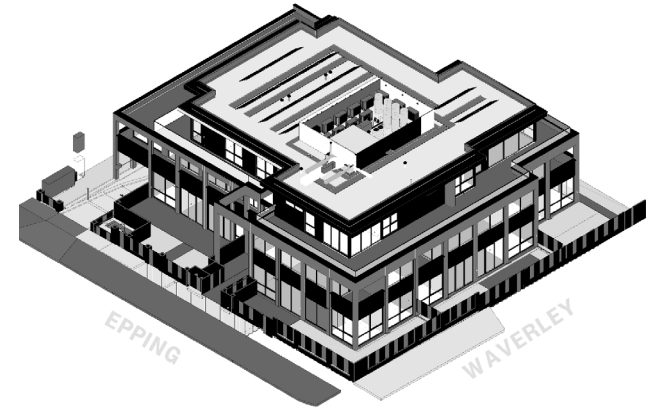
Monash University, Sumitomo Forestry, The University of Melbourne

Date commenced and duration:

December 2022, 24 months

List of researchers:

Ali Rashidi (Project Lead), Duncan Maxwell, Victor Bunster, Camilo Cruz Gambardella, Jean-Paul Rollo, Jenny Zhou, Victor Chang, Mohaimeen Islam, Miyami Sinhala Pathiranag, Dilshi Dharmarathna, Tuan Ngo, Lu Aye, Tuan Nguyen, Xuemei Liu, Bernard Gibson, Alireza Chiniforush, Richard Nero, Siddhesh Godbole.



Completed Projects

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1. ePlanning and eApprovals – Scoping Study

Project Lead: Dr Davood Shojaei | The University of Melbourne

Problem / thesis

Planning and building approval processes are still largely paper (PDF) based, which make them inefficient and time-consuming, imposing significant costs on both industry and government. Industry is effectively unable to test plan compliance against planning controls and building regulations, track progress of their applications, and efficiently track compliance through construction.

The longer-term objective of the CRC's work in this area is to embrace the opportunities that digital workflow and digital twin technology provide to design, develop and deliver an innovative digital platform to facilitate effective, efficient and timely planning, building permits, approvals, ongoing compliance with planning controls, building regulations and other regulatory requirements.

Outcome

In this project, a roadmap was developed for the phased design and implementation of an innovative digital platform to facilitate effective, efficient, and timely planning and building permits and approvals, thereby removing unnecessary delays and costs that impose substantial constraints on the building and construction sector. This objective must be viewed in the context of what industry perceives to be a broader problem, and the projects longer-term objective that extends beyond the planning and building permit process to the whole of the building lifecycle.

Project Outcomes: <https://building4pointzero.org/projects/eplanning-and-eapprovals-scoping-study/>

List of partners:

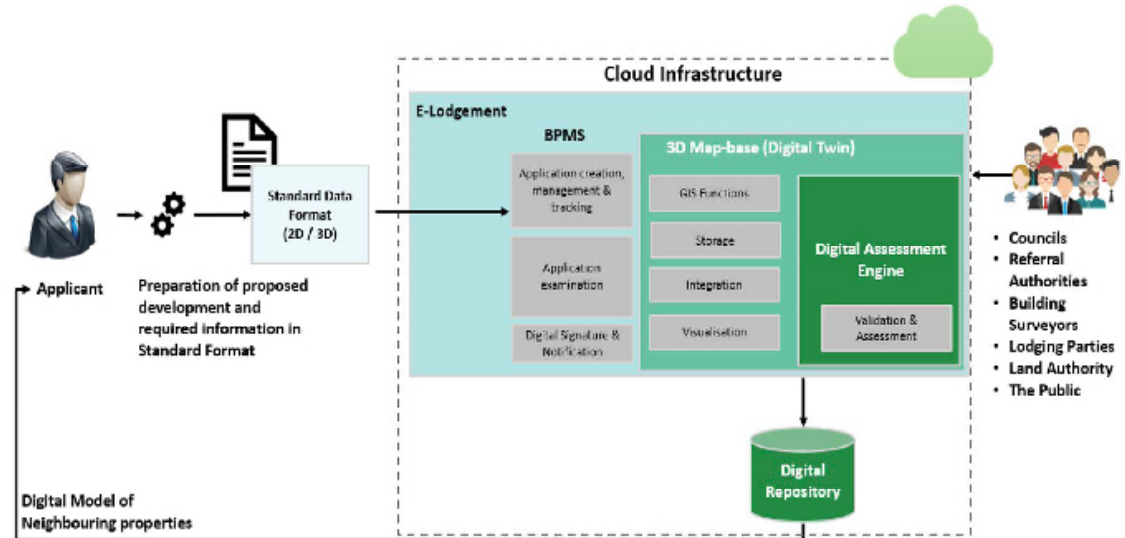
Lendlease Digital, uTecture, Sumitomo Forestry, A.G.Coombs Group, Salesforce.com, Inc., Master Builders Association of Victoria, Victorian Building Authority, Victorian Government, Department of Environment, Land, Water and Planning, Monash University, The University of Melbourne

Date commenced and duration:

March 2021 - September 2021

List of researchers:

Dr Davood Shojaei, Dr Soheil Sabri, Dr Eric Windholz, Dr Alexa Gower, Prof Tuan Ngo, Prof Abbas Rajabifard, Prof Colin Duffield, A/Prof Yee-Fui Ng, Dr Neda Malekzadeh, Dr Nilupa Herath, Ms Jihye Shin, Ms Susan Wright, Mr James Moutsias, Ms Cassandra Tremblay, Ms Vania Djunaidi, Ms Nellie Sheedy-Reinhard



2. Automated tracking of construction materials for improved supply chain logistics and provenance – Phase 1 Scoping Study

Project Lead: Dr Wen Li | The University of Melbourne

Problem / thesis

The construction supply chain poses challenges and risks mainly due to its unstable, highly fragmented, and geographically dispersed nature. The ability to track and trace (i.e., traceability), is becoming increasingly important as it contributes to and associates with building compliances, safety, project efficiency, and sustainability.

Outcome

Our researchers have used multiple research methods (e.g., interviews, literature review and case studies) to assess existing and emerging tracking technologies (e.g., sensors, information systems) for sectoral and issue appropriateness. This was to understand the state-of-the-art of traceability in the construction industry and key stakeholders, perspectives, as well as recommend future research.

Project Outcomes: <https://building4pointzero.org/projects/automated-tracking-of-construction-materials-for-improved-supply-chain-logistics-and-provenance-phase-1-scoping-study/>

List of partners:

BlueScope, Holmesglen Institute, Lendlease Digital, Monash University, Queensland University of Technology, Salesforce.com, Inc., Sumitomo Forestry, Master Builders Association of Victoria, The University of Melbourne, Victorian Building Authority, Ynomia

List of researchers:

Dr Wen Li, Dr Guilherme Luz Tortorella, Prof Robin Drogemuller, Dr Aravinda Sridhara Rao, A/Prof Joseph Liu, Dr Yihai Fang, A/Prof Tim Rose, Dr Sara Omrani, Prof Alistair Barros, Prof Tuan Ngo, Mr Declan Cox, Ms Negar Adeb, Mr Noor E Karishma Shaikh, Mr Siyu Chen, Mr Xin Ma, Mr Tendai Makasi

Date commenced and duration:

July 2021 - December 2021

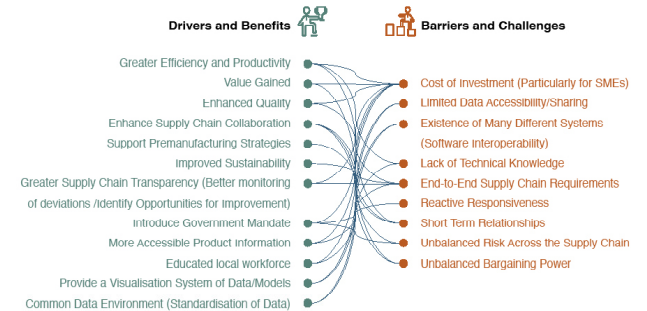


Image credit: Critical drivers, benefits, barriers and challenges for the construction traceability (Wen Li, 2022)

	QR Code	Barcode	Active RFID	Passive RFID	NFC	BLE	GPS
Cost-Effective	\$	\$	\$\$\$	\$	\$\$\$	\$\$\$	\$\$\$
Real-time tracking	✗	✗	✗	✗	✗	✓	✓
Power Consumption	✗	✗	✓	✗	✓	✗	✓
Scanning Range	High	High	High	Low	Low	Low	Unlimited
Storage capacity	3 KB	> 100 bytes	2 KB	4-8 KB	48 Bytes – 8 KB	NA	Unlimited
Continuous scanning	✓	✓	✓	✓	✓	At regular intervals	Real-time data
Two-way Communication	✗	✗	✗	✗	✓	✓	✓
Labour Intensive	✓	✓	✓	✗	✓	✓	✓
Popularity	Very high	Very high	High	High	Moderate	Moderate	Moderate

Image credit: Comparison of different product identification and tracking technologies (Aravinda Rao 2022)

4. Computational Design and Optimisation Tools for Prefabricated Building Systems

Project Lead: Dr Abdallah Ghazlan | The University of Melbourne

Problem / thesis

The objective of the project was to develop a computational framework for producing optimised design options for modular facade and floor systems, which are both structurally and thermally efficient, early in the conceptual design phase.

Outcome

Given the multi-objective criteria (both structural and energy), several designs were presented to the client in a format that allows engineers to make an informed decision on the option that meets project constraints. The time/cost efficiency of these building systems was ascertained by benchmarking them against existing case studies of building systems (facade and floor) designed using traditional manual techniques.

Project Outcomes: <https://building4pointzero.org/projects/computational-design-and-optimisation-tools-for-prefabricated-building-systems-phase-1-scoping-study-2/>

List of partners:

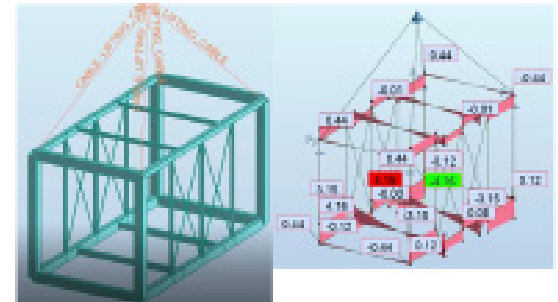
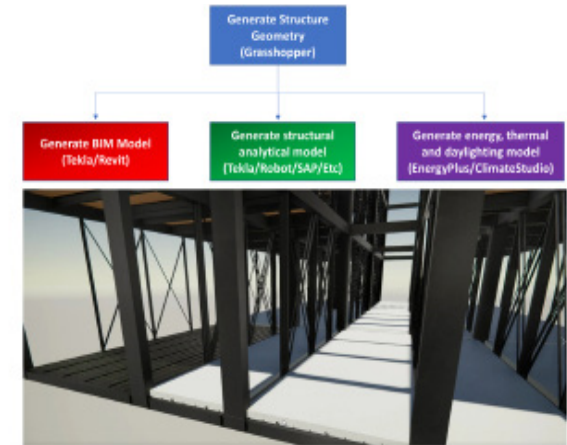
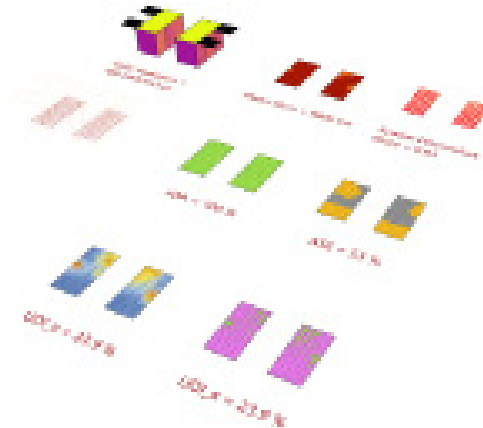
M-Modular, University of Melbourne, Queensland University of Technology

List of researchers:

Dr Tai Thai, Prof Tuan Ngo, Prof Robin Drogemuller, Dr Veronica Garcia Hansen, Dr Wendy Miller, Dr Abdallah Ghazlan, Dr Khuong Bui, Tu Le, Tay Son Le, Islam Mashaly

Date commenced and duration:

February 2021 - August 2021



5. Automatic compliance and energy rating system

Project Lead: Dr Phil Christopher | The University of Melbourne



Problem / thesis

This project transformed the current manual process of energy compliance checks for new residential homes by integrating existing rapid digital building software with Australia's building regulation and performance assessment requirements.

Outcome

This project developed a comprehensive workflow to take Utexture's existing home design and costing engine and propose subsequent compliance and NatHERS energy rating assessment procedures utilising CSIRO's Accurate engine.

The developed road map has paved the way for designers, builders, and clients to understand the energy performance and compliance of a home whilst also having an estimate of the capital and ongoing costs in near real time during design.

Project Outcomes: <https://building4pointzero.org/projects/automatic-compliance-and-energy-rating-system/>

List of partners:

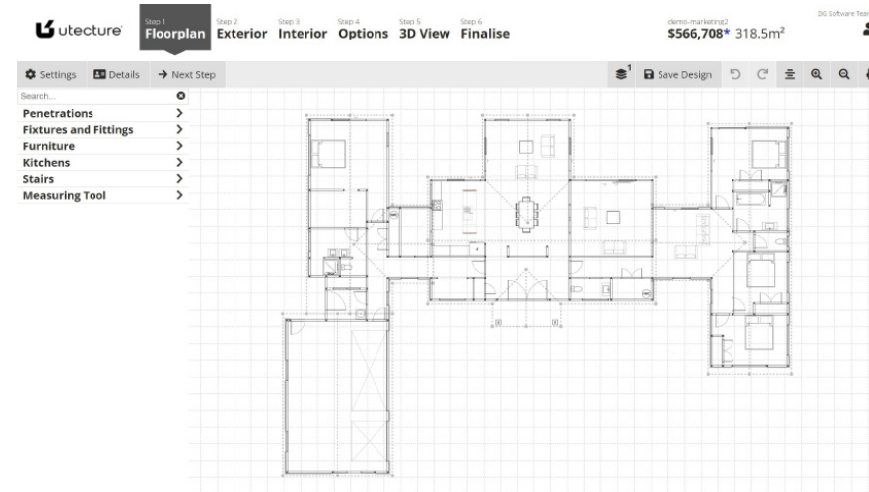
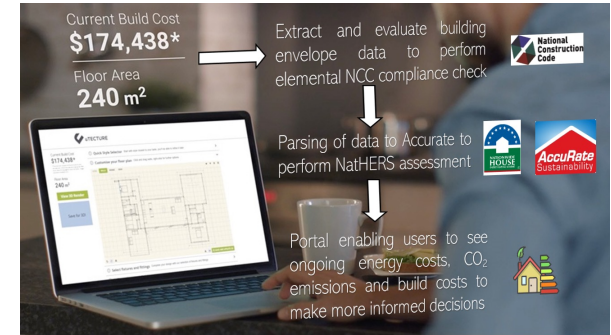
uTecture, Green Building Council of Australia, The University of Melbourne, Monash University, Queensland University of Technology

List of researchers:

Dr. Philip Christopher, Prof. Tuan Ngo, Prof. Lu Aye, Dr. Khuong, Dr. Victor Bunster, Prof. Robin Drogemuller, Dr. Sara Omrani

Date commenced and duration:

January 2021 - July 2021



6. Field Data Collation to Support Real-Time Operational Management

Project Lead: Dr Yihai Fang | Monash University

Problem / thesis

Accurate and timely information about construction processes is essential to provide greater visibility and understanding of project progress and therefore deliver the projects on time and on budget.

Outcome

This project has made significant advances in the knowledge and practice of acquiring and managing real-time operation data. More specific objectives include:

- 1) understanding how passive data collection can improve the management and coordination of on-site activities
- 2) analysing state-of-the-art in sensing and analytics technologies
- 3) conducting field tests to assess and validate the key assumptions underlying an implementation roadmap.

Project Outcomes: <https://building4pointzero.org/projects/field-data-collation-to-support-real-time-operational-management/>

List of partners:

Lendlease, Ynomia, Standards Australia, Monash University, University of Melbourne, Queensland University of Technology

List of researchers:

Dr Yihai Fang, A/Prof Mehrdad Arashpour, Dr Robert Moehler, Dr Duncan Maxwell, Dr Ivana Kuzmanovska, Dr Ali Rashidi, A/Prof Kourosh Khoshelham, Dr Aravinda S. Rao, Prof Tuan Ngo, Prof Robin Drogemuller

Date commenced and duration:

January 2021 - July 2021

Data types and technologies in passive data collation

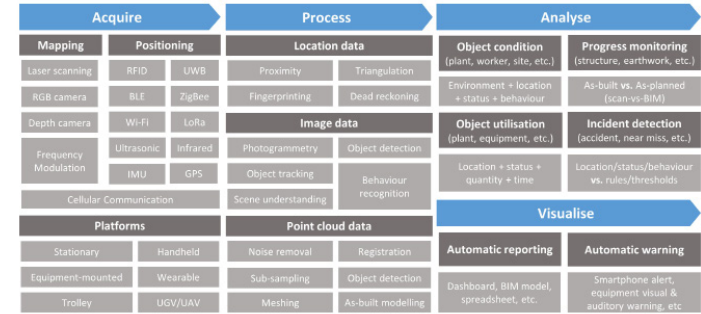


Image credit: Technological landscape of passive data collation on construction sites (Yihai Fang, 2022).

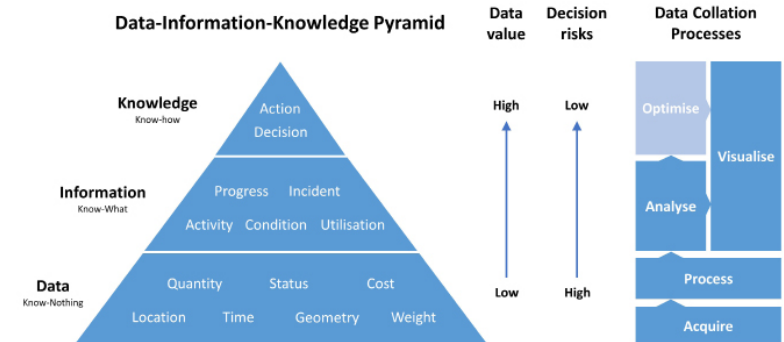


Image credit: DIK pyramid and data collation processes in site operational management (Yihai Fang, 2022).

8. Prefab, Integrated Wall Systems – Scoping Study

Project Lead: Dr Felix Hui | The University of Melbourne

Problem / thesis

This project sought to design a high-performance wall system exceeding the performance of a 7-star dwelling, with window systems that can be manufactured in two weeks and wall systems that can be assembled on-site (lockup stage) in four weeks, and can be manufactured, delivered and installed in a cost-effective manner.

Outcome

The initial phase consisted of a technology review and scoping exercise that lead a detailed design phase and a manufacturing systems design phase.

Project Outcomes : <https://building4pointzero.org/projects/prefab-integrated-wall-systems-scoping-study/>

List of partners:

Bentley Homes, Ultimate Windows
The University of Melbourne, Monash University

List of researchers:

A/Prof. Felix Kin Peng Hui, Prof. Tuan Ngo Prof. Lu Aye,
A/Prof. Tai Thai, Dr Philip Christopher, Dr Harry Khuong Bui,
Dr Wasim Muhammad, Dr Ivana Kuzmanovska, Dr Duncan Maxwell, Dr Victor Bunster, Dr Alexandra McRobert

Date commenced and duration:

November 2020 - May 2021



9. Guidelines for Implementing DfMA and Lean Construction Principles in Building Projects

Project Lead: Dr Ivana Kuzmanovska | Monash University

Problem / thesis

This 6-month research project aimed to understand: the current state of Lean and Design for Manufacture and Assembly (DFMA) knowledge within construction; their degree of implementation in both the local construction industry and abroad; and the implementation challenges that need to be addressed if we are to see broader uptake.

Outcome

To address these points, the project team conducted a literature review, a case study of a local construction project, and a survey of leading local and international companies who have adopted DfMA and/or Lean practices. The findings were synthesised into a self-assessment tool and implementation roadmap concept aimed at individual companies hoping to adopt Lean and DfMA practices.

Project Outcomes: <https://building4pointzero.org/projects/implementing-dfma-and-lean-in-construction-best-practice-guidelines-through-a-study-of-building-services-and-structure/>

List of partners:

A.G. Coombs, Lendlease Digital, Monash University, The University of Melbourne

List of researchers:

Dr Ivana Kuzmanovska, Dr Rachel Couper, Dr Tharaka De Vass, Dr Felix Hui, Dr Duncan Maxwell, Dr Robert Moehler, Prof Tuan Ngo, Achini Peiris, Dr Gao Shang, Prof Amrik Sohal, Rebecca Williams, Yiqin (Iris) Yu, Darcy Zelenko

Date commenced and duration:

June 2021 - February 2022

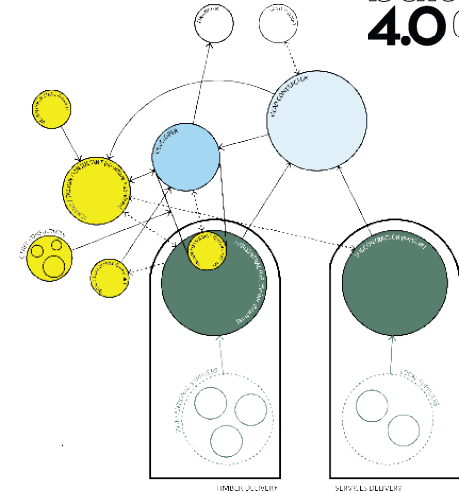


Image credit: Case Study Mapping of Project Stakeholders



Image credit: Case Study Construction Site

12. VR/AR Technologies in Vocational Education and Training

Project Lead: Dr Ali Rashidi | Monash University

Problem / thesis

Australia's Vocational Education Training sector has a critical role in preparing or updating current or future employees with job-related skills required in the workforce. The construction industry is highly regulated by VET programs that provide licensing requirements to many construction occupations. The number of VET-related occupations is expected to increase in the coming years, driven by a growing demand for skilled workers due to construction projects. These requirements imply significant pressures to update the training delivery approaches in the construction VET system.

Outcomes

Findings for this project were obtained from a literature review, market survey and a Delphi method as a research approach, which were selected to propose a decision making process to determine appropriate XR technology for specific skill training in the construction industry. This study proposes the most significant factors that VET educational providers should consider when selecting XR technologies to be implemented in VET training programs. Likewise, this study presents a workflow process for translating conventional vocational skill training into XR-based (VR/AR/MR) learning environments.

Project Outcomes: <https://building4pointzero.org/projects/vr-ar-technologies-in-vocational-education-and-training-scoping-study/>

List of partners:

Holmesglen Institute, Master Builders Association of Victoria, Monash University, Queensland University of Technology

List of researchers:

Dr Ali Rashidi (Project Lead), Dr Duncan Maxwell, Associate Prof Mehrdad Arashpour Dr Yihai Fang, Dr Barrett Ens, Prof Robin Drogemuller, Dr Leo Rezayan & Dr Fiona Lamari.

Date commenced and duration:

May 2021 - December 2021



Image credit: VR/AR demo workshop at Holmesglen Institute (Ali Rashidi, 2021).

17. The Implications and Opportunities from Industry 4.0 for the Building Industry: towards smart prefab

Project Lead: Dr Phil Christopher | The University of Melbourne

Problem / thesis

The Australian construction industry has faced severe challenges over the past few years. Spiralling costs of building materials and construction have made housing less affordable. Productivity, sustainability, health and well-being, and safety imperatives together with the market-wide expectation for high-quality design have further challenged traditional construction.

Outcome

This project developed a roadmap for Smart Prefab and Industry 4.0 for the Australian building industry. This was developed through a thorough review of world best practice and industry 4.0 principals coupled with a series of workshops with industry leaders in construction in Australia to better understand opportunities and barriers facing them.

Project Outcomes: <https://building4pointzero.org/projects/the-implication-of-industry-4-0-for-the-construction-industry-towards-smart-prefab/>

List of partners:

AMGC and Prefab Innovation Hub (Funding body), Various Building 4.0 CRC Industry Partners, Monash University, The University of Melbourne, Queensland University of Technology

List of researchers:

Dr Philip Christopher, Dr Siddhesh Godbole, Dr Aravinda Rao, Dr Francisca Rodriguez Leonard, Dr Sahar Soltani, Dr Ali Rashidi, Prof Tuan Ngo, Dr Duncan Maxwell

Date commenced and completed:

April 2021 - April 2022



Image Credit: Marketing Society (Project Team, 2022)

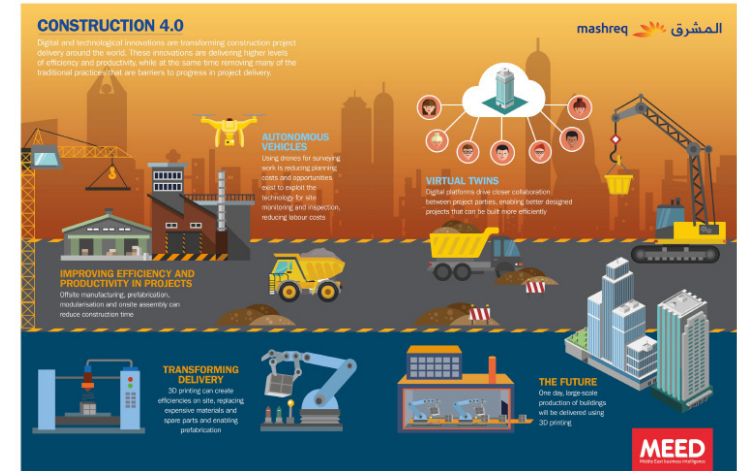


Image Credit: MEED (2021)

18. Long-Span Low-Carbon Floor Systems

Project Lead: Dr Ivana Kuzmanovska | Monash University

Problem / thesis

CRC#18 addresses the lack of data-informed product evaluation methods in construction, through the benchmarking of nine long-span, low carbon floor systems.

Outcomes

The key outcomes of the research point towards a logic and workflow that could be applied to any productised building element, involving:

- product mapping according to material and element type
- visualisation of high level benchmarking findings for use during early building design
- synthesis of detailed benchmarking findings to enable transparent discussion of decision priorities

This framework can be used as the basis for: further product benchmarking; evaluation and selection of most suitable products given an explicit set of selection priorities; and future product design development.

Project Outcomes: <https://building4pointzero.org/projects/long-span-low-carbon-floor-systems-scoping-study/>

List of partners:

Lendlease Digital, Sumitomo Forestry, Monash University, The University of Melbourne

List of researchers:

Ivana Kuzmanovska, Mizan Ahmed, Mehrdad Arashpour, Victor Bunster, Victor Chang, Lariza de Guzman, Tom Heath, Enzo Lara-Hamilton, Duncan Maxwell, Declan Murphy, Sejuti Saha, Angela Solarte, Jenny Zhou, Stephen Go, Felix Hui, Wen Li, Richard Nero, Tuan Ngo, Tuan Nguyen, Tai Thai, Muhammad Wasim

Date commenced and completed:

April 2020 - October 2020

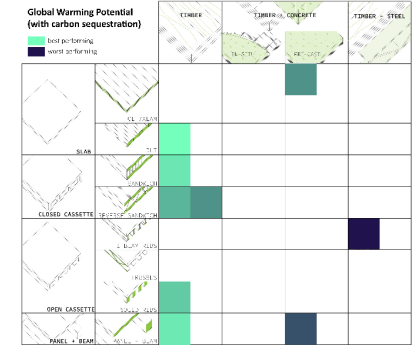


Image credit: Global Warming Potential (with carbon sequestration) (Ivana Kuzmanovska, 2022)

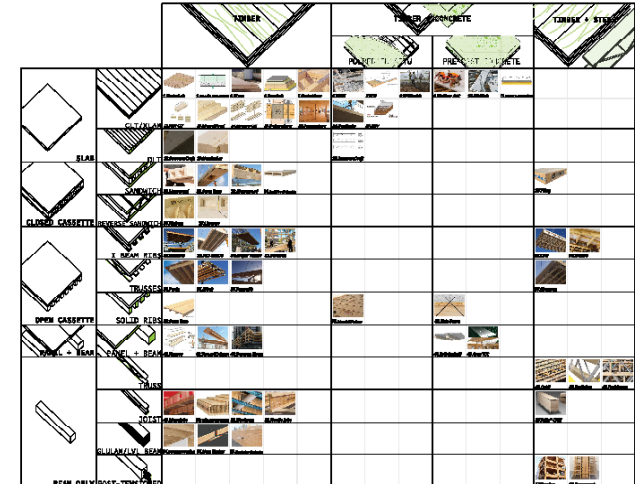


Image credit: Floor Systems Matrix (Ivana Kuzmanovska, 2022)

19. Hybrid Timber-Steel Structural Systems for Mid to High Rise Buildings – Phase 1 Scoping Study

Project Lead: Dr Amin Heidarour | Monash University

Problem / thesis

Mid-to-high-rise buildings in Australia are mainly constructed using reinforced concrete structures and have large carbon footprints.

Advanced manufacturing of engineered timber products, such as CLT and Glulam, as well as cold formed steel/high strength steel, with high strength-to-weight ratio, have paved the way for construction of those buildings, using hybrid timber-steel structural systems with a reduced carbon footprint.

Lightweight hybrid timber-steel systems may also enable a reduction in construction cost and time by allowing a DfMA approach to be taken to design and construction, and allowing the manufacturing of building components offsite. Despite the potential of hybrid structures, and unlike North America and Europe, the high-rise building market in Australia is still dominated by concrete structures, and the use of steel and timber has made few in-roads into this market.

Outcomes

This project reviewed developments in hybrid timber-steel buildings to identify the barriers to the take-up of this technology in Australia, with a focus on medium and high-rise buildings.

Project Outcomes: <https://building4pointzero.org/projects/hybrid-timber%e2%80%90steel-structural-systems-for-mid-to-high-rise-buildings-phase-1-scoping-study/>

List of partners:

BlueScope , Hyne & Son , Monash University
University of Melbourne
Queensland University of Technology

List of researchers:

Assoc. Prof Amin Heidarpour, Prof. Tuan Ngo,
Dr Craig Cowled, Dr Rackel San Nicolas,
Mohammad Amin Farmani, Ali Shahin,
Alireza Akbarzadeh Chiniforush

Date commenced and completed:

July 2021 - January 2022



Image credit: 547 Ann Street Fortitude Valley, QLD, Fulton Trotter Architects, Bligh Tanner and Kane Construction. CLT supplied by Xlam.

20. Systems and methods for robustness of mid-rise light gauge steel (LGS) buildings – Phase 1 Scoping Study

Project Lead: Dr Tai Thai | The University of Melbourne

Problem / thesis

Unlike hot-rolled steel buildings, where the robustness requirement can be easily met with the use of bolted or welded joining methods with high tensile resistance for connecting structural members, the connections in LGS buildings are made in the form of screws and rivets with low tensile resistance, and thus they are usually vulnerable to progressive failure.

Outcome

This project developed cost-effective systems and design methods to achieve suitable robustness in LGS buildings. The success of this study promotes the practical application of LGS to mid-rise construction markets.

Project Outcomes: <https://building4pointzero.org/projects/systems-and-methods-for-robustness-of-mid-rise-light-gauge-steel-lgs-buildings-phase-1-scoping-study/>

List of partners:

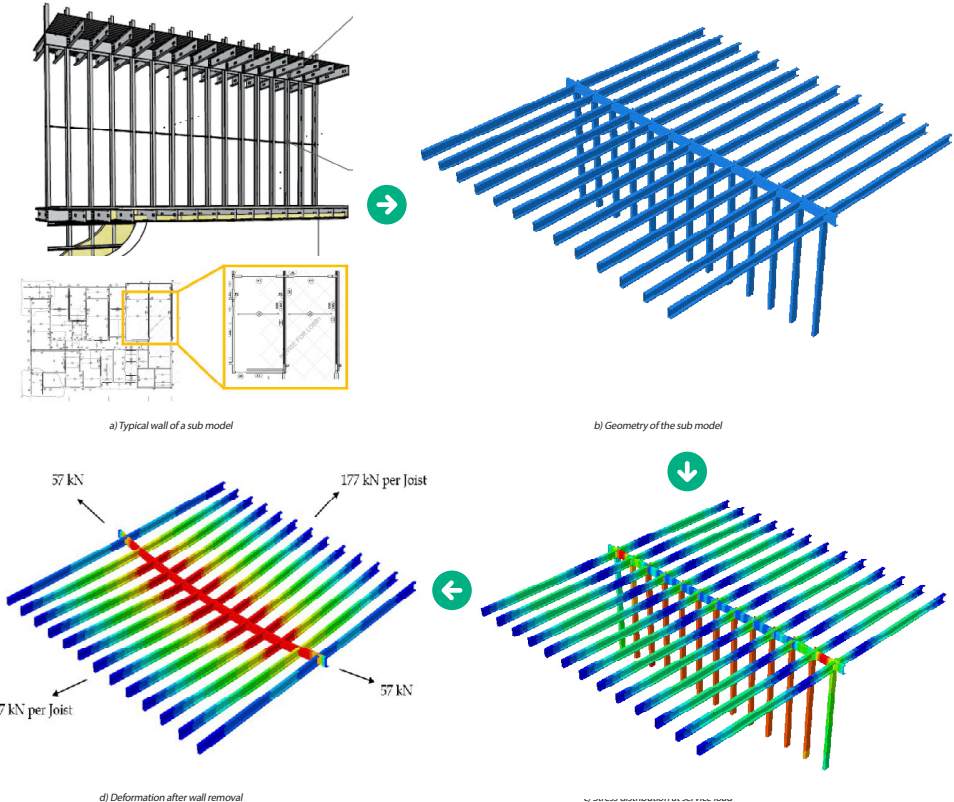
BlueScope, The University of Melbourne, Monash University

List of researchers:

Prof Tuan Ngo, Prof Nelson Lam, A/Prof Tai Thai, Dr Tuan Nguyen, Mr Chris Mathwin, A/Prof Amin Heidarpour, Dr Mizan Ahmed

Date commenced and completed:

July 2021 - December 2021



22. Generative design and BIM-based Design Automation methods for Steel Framed Buildings – Phase 1 Scoping Study

Project Lead: Dr Abdallah Ghazlan | The University of Melbourne

Problem / thesis

Light gauge steel (LGS) offers significant advantages over other materials including lightweight, quicker construction times, non-combustibility and resistance to rotting, shrinking, warping and termite attack.

Today, it is not clearly understood which tools and inputs should be considered at the early planning phase for a LGS solution to be a viable structural construction alternative to timber, steel and other structural systems, particularly in mid-rise building applications.

Outcome

The project developed computational design and optimisation tools for generating LGS building systems with excellent structural/fire performance that was benchmarked against an existing project that has employed traditional methods to quantify time and cost savings.



Project Outcomes: <https://building4pointzero.org/projects/generative-design-and-bim-based-design-automation-methods-for-steel-framed-buildings-phase-1-scoping-study/>

List of partners:

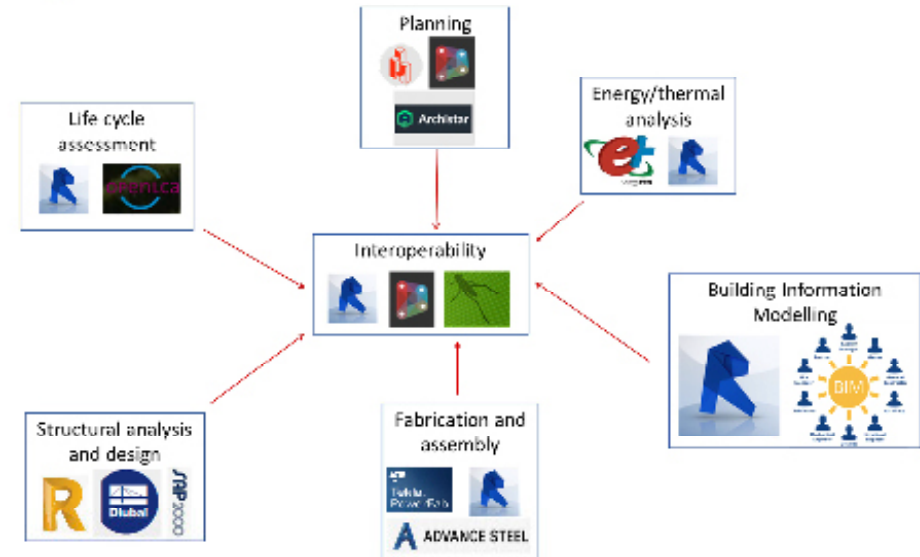
BlueScope , The University of Melbourne, Queensland University of Technology

List of researchers:

Dr Abdallah Ghazlan, Dr Tu Le, Dr Yousef Alqaryouti, Dr Muhammad Wasim, Dr Sara Omrani, Dr Tai Thai, A/ Prof Hafizah Ramli Sulong, Prof Tuan Ngo, Prof Nelson Lam, Prof Robin Drogemuller

Date commenced and completed:

June 2021 - December 2021



23. When prefab hits the ground: Barriers and opportunities in the Australian housing market



Program Lead: Dr Tanja Tyvimaa | Queensland University of Technology

Problem / thesis

Traditional construction practices in Australia have been criticised for their focus on the reduction of upfront construction costs at the expense of quality, performance and flexibility.

Current and emerging prefabrication processes could provide the efficiency and quality of construction to the traditional built-to-sell market, however by incorporating the possibilities to cater for the recently developing built-to-rent sector is considered to drive it even stronger.

This is because Build-to-rent shifts the housing profit model from capital gains to one based on ongoing rental income, with viability tied to minimising ongoing expenditure.

Outcome

This scoping study examined the intersection of these assets and prefabrication processes, to identify opportunities for the housing and construction sector to reduce ongoing greenhouse gas emissions and increase the quality of stock.

Project Outcomes: <https://building4pointzero.org/projects/when-prefab-hits-the-ground-barriers-and-opportunities-in-the-australian-housing-market/>

List of partners:

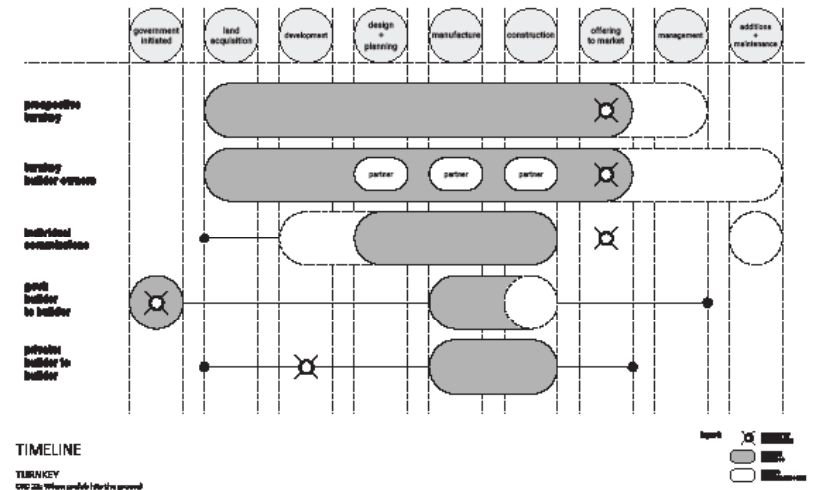
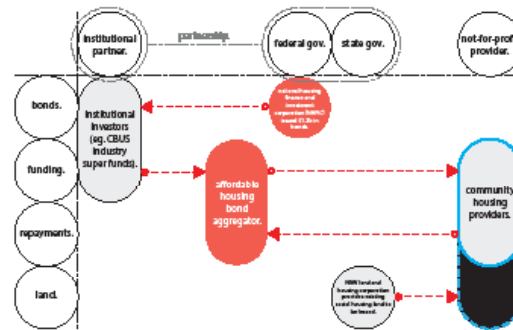
Fleetwood, Sumitomo Forestry,
Monash University, Queensland University of Technology

List of researchers:

Dr Alysia Bennett, Dr Judy Matthews, Dr Duncan Maxwell, Declan Murphy, Dr Francisca Rodriguez Leonard, Daniela Tinios, Dr Tanja Tyvimaa, Dr Kirsty Volz, Rebecca Williams..

Date commenced and completed:

May 2021 - November 2021



25. Operational Excellence framework of steel fabrication and processing in the OSM and prefabrication sector (Phase 1)

Project Lead: Dr Felix Hui | The University of Melbourne

Problem / thesis

In the manufacturing of modules off-site, steel fabrication often comes with many challenges, including supply chain reliability and clarity, the need for efficient production at both the steel producer and the modular builder end, and the flexibility for customisation.

This project looked for new methods of efficient production and new ways of collaborating in the steel fabrication supply chain from different perspectives such as monitoring, sustainability performance, efficient product platforms, innovative manufacturing techniques, transport and logistics and efficient communications.

Outcome

Phase 1 of this project was a scoping exercise to review the current state of the market and a comprehensive technology review.

Project Outcomes: <https://building4pointzero.org/projects/operational-excellence-framework-of-steel-fabrication-and-processing-in-the-osm-and-prefabrication-sector-phase-1/>

List of partners:

BlueScope, Fleetwood, Monash University,
The University of Melbourne, Ynomia

List of researchers:

A/Prof. Felix Kin Peng Hui, Prof. Daniel Samson, Prof. Prakash Singh,
A/Prof. Sherah Kurnia, Dr Guilherme Tortorella, Prof Tuan Ngo,
Dr Siddhesh Godbole, Mr Omar Castrejon , Dr Robert Moehler,
Dr Jenny Zhou, Dr Mizan Ahmed

Date commenced and completed:

November 2021 - May 2022



26. New materials for windows of the future

Project Lead: Prof. Prof Jacek Jasieniak | Monash University

Problem / thesis

Double-glazed windows are a norm in many countries across Europe, Asia and North America due to their effective reduction of heat loss (-30%) compared to single-glazed windows.

However, in Australia, only 10% (approx.) of current window installations are double-glazed. This is in part owing to the temperate climate across many parts of Australia, but equally the high cost of double glazing. Material science has made rapid progress over the last two decades resulting in the development of many new advanced materials and coatings.

Outcome

This project focused on providing a critical assessment of the opportunities to apply new materials and coatings to reduce the cost, and improve the performance and ease of installation of double-glazed windows.

Project Link: <https://building4pointzero.org/projects/new-materials-for-windows-of-the-future/>

List of partners:

Ultimate Windows , Monash University

List of researchers:

Prof Jacek Jasieniak, Dr Jing Gong

Date commenced and completed:

May 2021 - September 2021



27. Environmental Decision-support for Steel Structures

Project Lead: Dr Victor Bunster | Monash University

Problem / thesis

There is a growing demand for reliable methods to rapidly assess and compare the environmental impacts of alternative building solutions.

Approaches based on the Life Cycle Assessment (LCA) methodology are most commonly recognised by industry and academia; however, producing accurate results under this framework requires highly specialised skills and research effort that prevents their ready incorporation into the design of most buildings.

Outcome

This project generated a knowledge base to inform the development of decision-support systems, supporting environmentally efficient building design.

Project Link: <https://building4pointzero.org/projects/environmental-decision-support-for-structures/>

List of partners:

Bluescope, Monash University, The University of Melbourne

List of researchers:

Victor Bunster, Victor Chang, Maxwell Chng, Peter Graham, Santiago Muñoz-Vela, Safoura Salehi, Jenny Zhou, Lu Aye, Khuong Bui, Philip Christopher, Tuan Ngo, Thais Goncalves-Sartori

Date commenced and duration:

June 2021, 6 months



Image credit: Penguin Parade Visitor Centre, Phillip Island, VIC. © Peter Bennetts 2019.
Frame made from TRUECORE® steel.



Image credit: Smalls Road Public School, Ryde, NSW. © School Infrastructure NSW and Austruss. Frame made from TRUECORE® steel.

28. Componentised Internal Wall Systems for Multi-residential Applications

Project Leads: Dr Laura Harper & Dr Lee-Anne Khor | Monash University

Problem / thesis

Internal wall systems continue to rely on labour intensive and wasteful on-site processing despite advances in prefabrication and other aspects of multi-residential construction. Described performance requirements rely heavily on craftsmanship and supervision, when these fail, significant and costly legacy issues arise.

Outcome

Through a design-led, systems-thinking approach, this project explored componentised and connected internal wall alternatives, ranging from the improvement of BAU construction to the separation of performance core and surface, to plug-n-play installation.

The investigation revealed a series of design principles for costing legacy and life-time value, allowing services and performance-based criteria to be integrated in a controlled, off-site environment.

Project Outcomes: <https://building4pointzero.org/projects/componentised-internal-wall-systems-for-multi-residential-applications/>

List of partners:

Lendlease Digital, Monash University, The University of Melbourne

List of researchers:

Dr Laura Harper, Dr Lee-Anne Khor, Dr Duncan Maxwell, Dr Ivana Kuzmanovska, Dr Victor Bunster, Jean-Paul Rollo, Daniela Tinios, Prof. Tuan Ngo, Dr Yousef Alqaryouti, Dr Xuemei Liu

Date commenced and completed:

July 2021 - January 2022

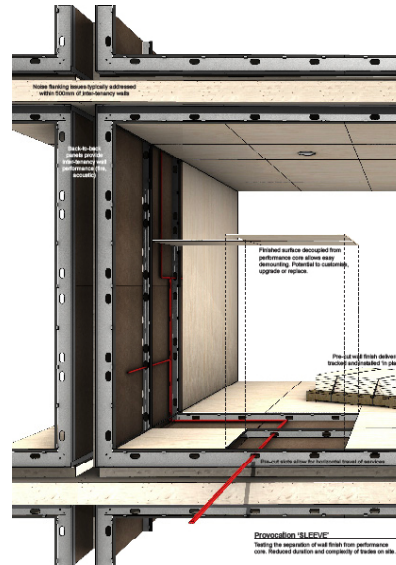


Image credit: Provocation SLEEVE: Testing the separation of wall finish from performance core. Reduced duration and complexity of trades on site. (Ayden Fiore 2022)

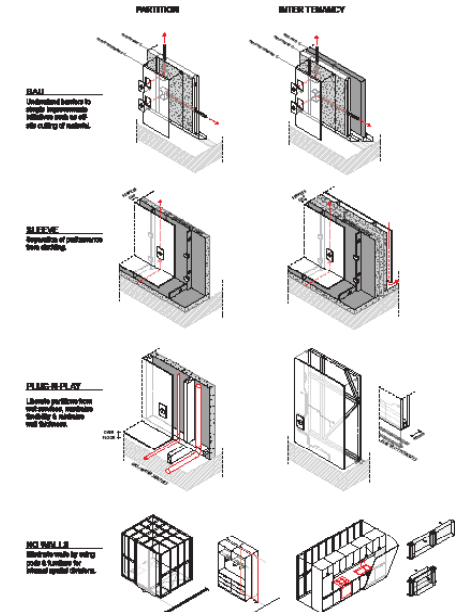


Image credit: Design principles for componentised and connected internal wall alternatives (Dani Tinios 2022)

30. Critical Path IMPACT through Productisation

Project Lead: Dr Robert Moehler | Monash University

Problem / thesis

The critical path coordinates and supports construction planning and execution, and defines the prioritisation and interdependence of tasks.

The resulting build program establishes a timeline, informed by the production modes, plans and management practices.

New building production systems and planning arrangements have only partially resulted in achieving the construction phase productivity gains and performance improvements promised by their introduction.

Outcomes

This project examined the roadblocks to effective impact on transforming construction programs, and established the context and conditions of future project timelines.

Project Outcomes: <https://building4pointzero.org/projects/critical-path-impact-through-productisation/>

List of partners:

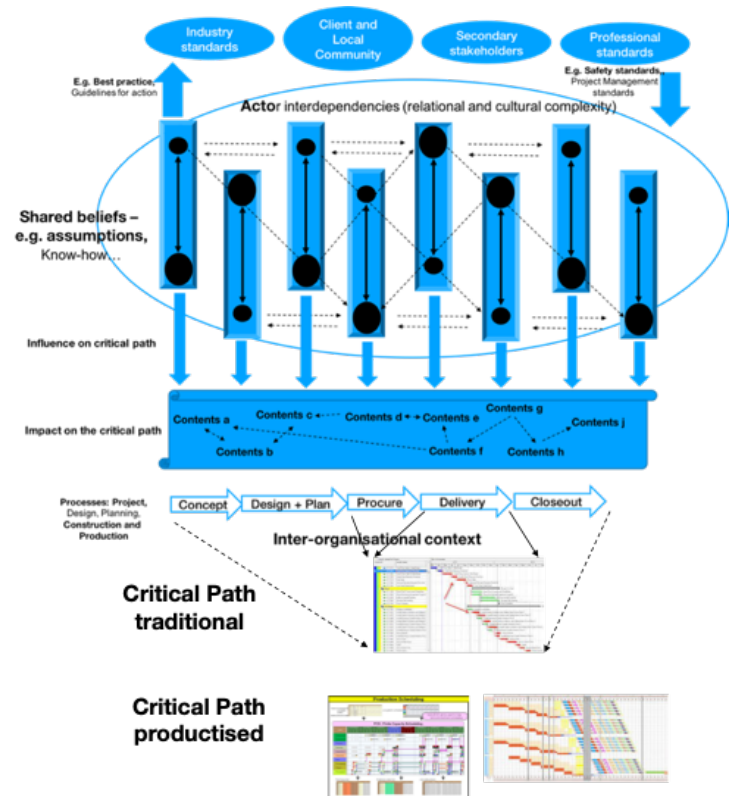
Lendlease Digital, Monash University, The University of Melbourne

List of researchers:

Dr Robert Moehler, Dr Felix Hui, Prof Tuan Ngo, A/Prof Lihai Zhang, Dr Siddhesh Godbole, Dr Nicolas Diban, Dr Duncan Maxwell, Dr Ivana Kuzmanovska, Dr Yihai Fang, Becky Williams, Osama Hussain, Songbo Hu, Yimin Li, Kaveh Mirzaei

Date commenced and completed:

July 2021 - August 2022



31. Demystifying Volumetric Construction: A Study of the Bathroom Pod

Project Lead: Dr Ivana Kuzmanovska | Monash University

Problem / thesis

The potential benefits of volumetric construction include faster builds, improved quality, and reduction in waste. However, increased transportation costs, structural redundancy, and increased overheads can dilute these benefits, limiting their uptake.

Within the Australian construction industry, the bathroom pod is one of the few volumetric assemblies that has become commonplace, and considered an acceptable method of delivering bathrooms in multi-storey buildings. However, the degree to which manufacturing methodologies have been adopted in the design and delivery of bathroom pods varies.

Problem / thesis

This project unpicks the complexities of a volumetric construction through the lens of the bathroom pod, examining business models, design approaches, and production strategies.

Project Outcomes: <https://building4pointzero.org/projects/demystifying-volumetric-construction-a-study-of-the-bathroom-pod/>

List of partners:

Lendlease Digital, Monash University, Queensland University of Technology, The University of Melbourne

List of researchers:

Dr Ivana Kuzmanovska, Dr Lu Aye, Marcel Gono, Dr Felix Hui, Mohaimeen Islam, Dr Lee-Anne Khor, Enzo Lara-Hamilton, Yimin Li, Dr Xuemei Liu, Dr Duncan Maxwell, Dr Robert Moehler, Prof Tuan Ngo, Mark Romei, Karen Tanfield, Dr Tanja Tyvimaa, Prof Clevo Wilson, Darcy Zelenko

Date commenced and completed:

July 2021 - September 2022

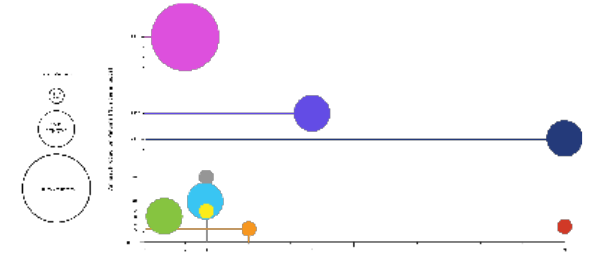


Image credit: Survey results: Age, size, and production volume of bathroom pod companies (Ivana Kuzmanovska, 2022)

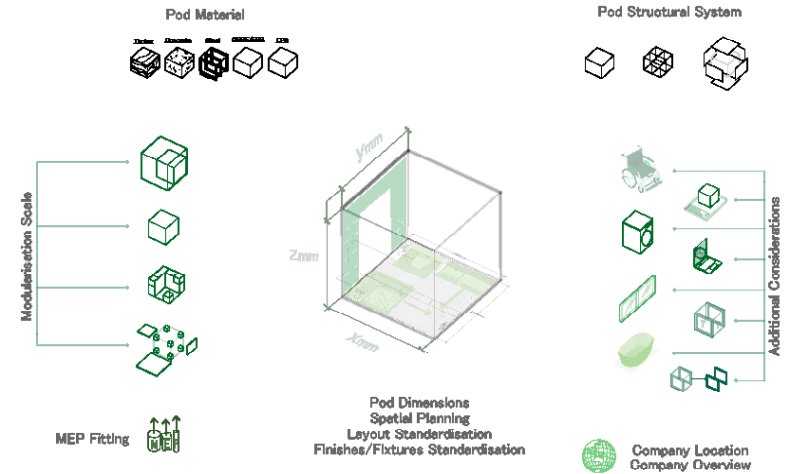


Image credit: Bathroom pod design considerations (Ivana Kuzmanovska, 2022)

34. Acoustic flanking performance of mid-rise Light Gauge Steel (LGS) structures – Phase 1 Scoping Study

Project Lead: Dr Amin Heidarour | Monash University

Problem / thesis

Light Gauge Steel (LGS) structures have great advantages in terms of lower weight, easier to transport, minimum construction wastes and shorter construction time.

Although the resistance of various light gauge systems, including floor and wall systems, under different loading cases has been widely recognised and tested, there is very limited information on the acoustic flanking performance of LGS structures.

Outcome

This scoping study lays the groundwork for developing a robust methodology for assessing the acoustic flanking performance of LGS buildings.

Project Outcomes: <https://building4pointzero.org/projects/acoustic-flanking-performance-of-mid-rise-light-gauge-steel-lgs-structures-phase-1-scoping-study/>

List of partners:

BlueScope, Monash University,
University of Melbourne

List of researchers:

Assoc Prof Amin Heidarpour, Prof. Tuan Ngo,
Prof Lu Aye, Dr Bernard Gibson.

Date commenced and completed:

July 2021 - January 2022



35. Prefab Housing Solutions for Bushfire and Disaster Relief

Project Lead: Prof Mel Dodd | Monash University

Problem / thesis

This study investigated the potential for prefabrication and advanced manufacture to be an alternative to traditional construction in providing both short-term and long-term housing solutions for those affected by bushfires and other disasters.

Outcomes

The research led to understanding the complexities and barriers to designing, manufacturing and installing prefabricated modular homes and units to bushfire impacted regions around the country.

Project Outcomes: <https://building4pointzero.org/projects/prefab-housing-solutions-for-bushfire-disaster-relief/>

List of partners:

AMGC and Prefab Innovation Hub (Funding body), University of Melbourne, Monash University, Queensland University of Technology

List of researchers:

Prof Mel Dodd, Prof Nigel Bertram, Dr Duncan Maxwell, Dr Rachel Couper, Dr Lee-Anne Khor, Dr Angela Solarte, Oscar Sainsbury, Prof Tuan Ngo, Dr Philip Christopher, Tu Le

Date commenced and completed:

July 2021 - October 2022.

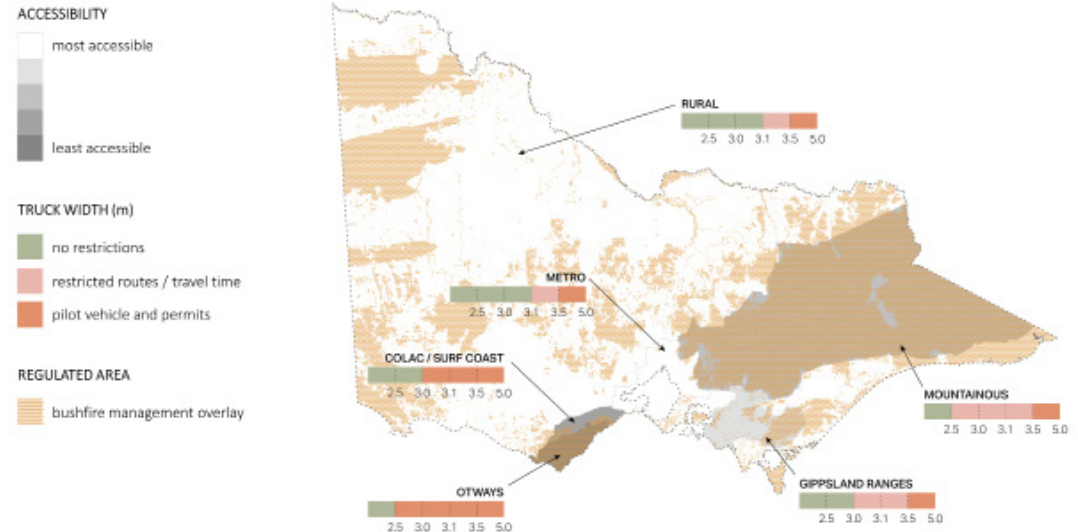


Image credit: Bushfire areas _ Transport access analysis (Tu Le, 2022)

37. Australian Timber Fibre Insulation Scoping Study

Project Lead: Dr Phil Christopher | The University of Melbourne

Problem / thesis

The Australian timber industry generates significant quantities of low grade by products in the form of chips and sawdust through the manufacturing of sawn and mass timber products. Most problematic among these are the H2 and H3 treated products that are not currently re-purposed into other products. Additional to this timber waste stream there are large amounts of other low to no value feedstock such as bark and single use timber pallets that have the potential to be manufactured into higher value fibre insulation products for the Australian market. This presents a potential opportunity to divert considerable quantities of waste from landfill and produce a high performance, locally made, low carbon, natural fibre insulation products for the building industry in Australia.

Outcome

This project was a scoping study that assessed the techno-economic feasibility and opportunities associated with the creation of a timber fibre insulation manufacturing facility in Australia.

Project Outcomes: <https://building4pointzero.org/projects/37-australian-timber-fibre-insulation-scoping-study/>

List of partners:

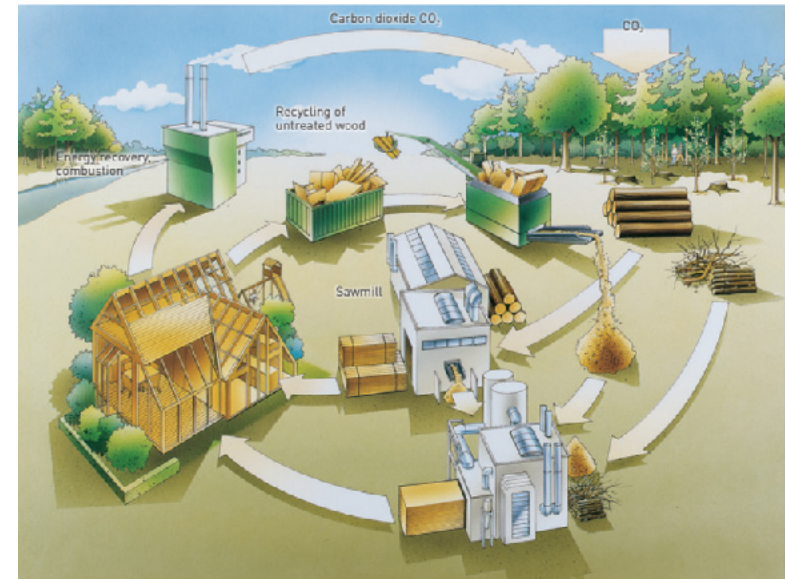
Hyne & Son, The University of Melbourne, Ultimate Windows

List of researchers:

Dr Philip Christopher, Dr Benoit Belleville, Dr Neda Nematollahi,
Dr Lu Aye, Prof Tuan Ngo

Date commenced and duration:

February 2022 - November 2022



40. Business Model Innovation: The Platform Ecosystem

Project Lead: Prof. Mathew Aitchison & Claire O'leary Building 4.0 CRC



Problem / thesis

Building 4.0 was commissioned by the AMGC in collaboration with prefabAUS to research, workshop and develop a report for the future of the building industry in Australia, with a primary focus on Business Model Innovation. Workshops were conducted in four Australian cities—Adelaide, Melbourne, Sydney, and Brisbane—with participation from all stakeholders in the building value chain, such as architects, engineers, consultants, contractors, governmental bodies, digital platform providers, and client body representatives. The cumulative participant count for the workshops was around 90. Through these one-of-a-kind workshops, concrete data was gathered for the first time on how participants in the industry value chain perceive such issues as business model innovation; changes to the structure of the building value chain; the positioning of their existing businesses within the value chain; operating models; and the adaptations required to embrace new ways of working.

Outcome

The final report is focused on presenting the platform ecosystem business model as an exemplar of business model innovation in the building industry and evaluating the desirability of such a business model. The report also outlines key recommendations for government, industry, peak industry bodies and academia.

Project outcomes:

<https://building4pointzero.org/projects/47-austrade-future-building-technologies-and-solutions/>

Researchers: Prof. Chris Knapp, Dr. Duncan Maxwell, Dr. Priya Das, Dr. Siddhesh Godbole.

List of Workshop Participant Companies:

A.G. Coombs, AECOM, Amazon Web Services, Apex Wiring Solutions, Archistar, Artibus Innovation, AssetsLogics, AterlierTen, Aurecon Australia Pty Ltd, Bentley Homes, Bliss & Reels, Bluescope Steel, Bond University, Bryden Wood, Case Meallin, CNC Design Pty Ltd, Computational Design Lead, CPO Architects, Cross Laminated Offsite Solutions, Daryl Patterson P/L, DAS Studio, DB Architects, DCCEEW Energy Division, Department of Jobs Skills Industry and Regions, Department of Jobs, Precincts and Regions, Department of Jobs, Skills, Industry and Regions, Donovan Group, DSDILGP (Department of State Development, Infrastructure, Local Government and Planning), Dynamic Steel Frame, Erilyan Pty Ltd, FAST FIX ARCHITECTURAL BUILDING SYSTEMS, Fleetwood, FormFlow, Future Map - Swinburne University, Gensler, Green Building Council of Australia, Grove Aust Pty. Ltd., Hansen Yucken, Hatch | Urban Solutions, Lendlease Digital, LIGHTWAVE Architecture, Mace, Master Builders, NSW Gov, Office of the Qld Government Architect, Populous, prefabAUS, Property Council of Australia, PT Blink, QUT, Simpel, SMEC, Taronga Ventures, Tech Central Alliance, The University of Queensland, Tribe Studio, University of Sydney, UTS - Design, Architecture and Building, Viridi Group, Weiss Insights, Xpede Pty Ltd

Date commenced and duration:

Oct 2022 - July 2023



42. Workflow Automation Tools for Residential Home Designs - Phase 1 Scoping Study

Project Lead: Dr Tu Le | The University of Melbourne

Problem / thesis

Volume builders are facing several challenges associated with the manual design of domestic homes where computational design automation can yield advantages, including many variations between house designs, regular design changes according to client requirements, time, resources and turnaround for each tender (cost estimation, drawings, material estimation and so on).

An integrated and automated process would bring all stakeholders together at the conceptual design phase to achieve a more integrated solution.

Outcome

The project reviewed currently available software and design workflows to propose a cutting-edge workflow for the automation of the residential home design process.

Project outcomes: <https://building4pointzero.org/projects/workflow-automation-tools-for-home-designs-phase-1-scoping-study/>

List of partners:

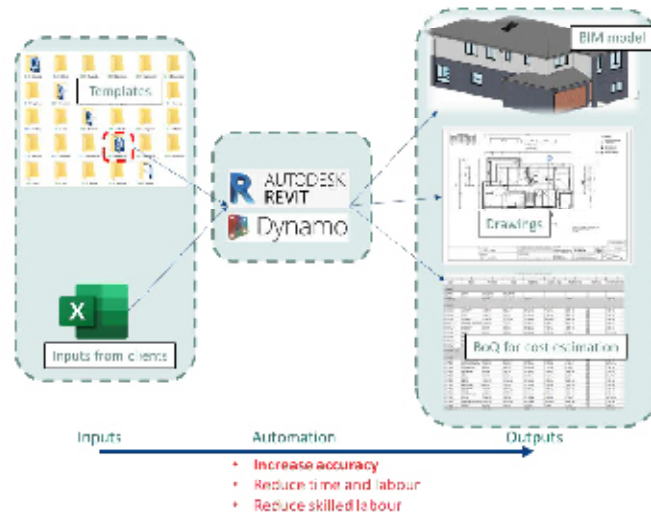
Bentley Homes, M-Modular, The University of Melbourne, Queensland University of Technology

List of researchers:

Dr Tu Le, Ben Huynh, Dr Khuong Bui (Harry), Dr Tuan Nguyen, Prof Tuan Ngo, Dr Sara Rashidian, Fereshteh Banakar, Prof Robin Drogemuller

Date commenced and completed:

August 2021 - August 2022.



This project aims to develop a new workflow to automate the home design process. The outcomes of this project will provide industry with a time and cost-efficient solution to quickly customise the design to meet the changes and variations requested by clients, reduce time spent on the iterative design process, and achieve faster and more efficient tendering outcomes. Phase 1 of the project is focusing on:

- Reviewing current available software on Australian market for quantity take-off and cost-estimation.
- Reviewing leading research on design workflows for automation design and quantity take-off using BIM.
- To propose a workflow for the automation of residential home design process for small to mid-size volume builders.

A demonstration of the workflow has been developed in this phase to investigate the workability and limitation of the workflow, opening a pathway to further development of the workflow.

Keywords: Automation Workflow; BIM; BIM-integrated detailing; Generative Design; Home Design;

46. Data analytics for structural fibre resources optimisation

Project Lead: Dr Steven Psaltis | Queensland University of Technology

Problem / thesis

The ongoing digitalisation of manufacturing companies enables new potential for optimisation of their processes. With a growing number of sensors implemented in manufacturing systems such as modern large sawmills, a huge volume of data is generated. This data is an important resource to maintain competitiveness.

Outcome

This project used data analytics approaches to investigate relationships in the production database provided by Hyne Timber. We considered data at 3 different stages of the sawmilling process: the log merchandiser, the green mill, and the dry mill. We also considered how to link data across the various stages. To develop predictive capabilities of key wood properties, we implemented 2 different machine learning models, and these approaches show promise. This scoping study uncovered a number of possible avenues for future investigations.

Project outcomes:

<https://building4pointzero.org/projects/data-analytics-for-structural-fibre-resources-optimisation/>

List of partners:

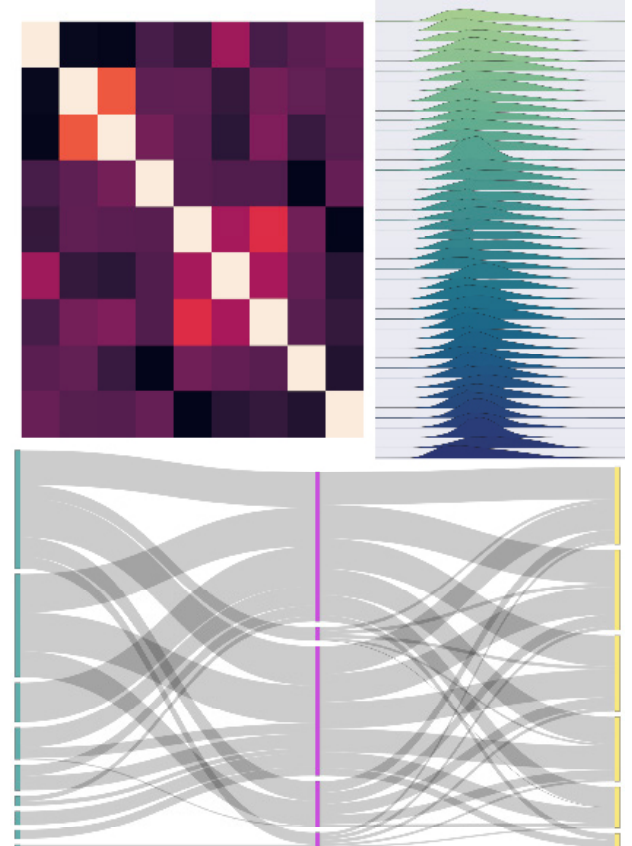
Hyne & Son, Queensland University of Technology

List of researchers:

Dr Steven Psaltis, Dr Xiaoyu Wang,
Prof Ian Turner, Rebecca Cherry

Date commenced and duration:

October 2021 - October 2022



47. Austrade: Future Building Technologies and Solutions

Project Lead: Isaac Coonan Building 4.0 CRC



Problem / thesis

The Australian Trade and Investment Commission (Austrade) commissioned Building 4.0 CRC to profile Australia's emerging building and construction technology capabilities, ecosystems and research strengths. As part of this research, Building 4.0 CRC conducted a mixture of desktop research, surveys and recorded interviews with 16 industry and ecosystem organisations, 11 research organisations, and 43 building and construction technology companies over a period of eight weeks.

Outcome

The final report contains a mixture of empirical data and bespoke insights to form a holistic overview of the national landscape. The 'Future Building Technologies and Solutions' report is now used as an internal tool for Austrade's international direct investment initiatives, highlighting Australia's national capabilities for the sector along with shaping their international direct investment campaigns.

Project outcomes:

<https://building4pointzero.org/projects/47-austrade-future-building-technologies-and-solutions/>

List of Contributors & Featured Organisations:

Austrade

3DB, Archistar, Build-Apps, Fologram, Hindsite, Immersiv, Mastt, Matrak, ProcurePro, SimPro, SPACECUBE, Trendspek, Verton, Veyor, Allume Energy, Boom!, Calumino, Cognian, Exergenics, Ground Floor, Outbound, PAM Wayfinding, Propella.ai, Space Platform, UbiPark, Valte, Happy Co, Inndox, Little Hinges, Spacetoco, Third Place, Work Club Global, Patch, Openn, AsBuilt, Bridgit, Prop App, QFlow, Uitecture, Forbury, Bond University, Holmesglen, University of Technology Queensland, University of Melbourne, Queensland University of Technology, Monash University, University of Queensland, Green Building Council of Australia, Bentley Homes, Bluescope Steel, Coresteel Buildings, Real Tech X, Fleetwood Australia, Greater Springfield, Hyne Timber, Lendlease, PieLab, Sumitomo Forestry, Proptech Association Australia, Ultimate Windows, Taronga Group, Viridi Group, The Australian Proptech Industry Map (APIM)

List of researchers:

Isaac Coonan & Claire O'leary Building 4.0 CRC

Date commenced and duration:

March 2022- September 2022



Active & Completed Projects Summary 1 of 2

BLACK TEXT = ACTIVE
GREY TEXT = COMPLETED

PEOPLE, PLACES & CULTURE

3	Projects to Platforms: Investigating New Forms of Collaboration – Scoping Study	A.G. Coombs, BlueScope, Hyne & Son, Lendlease Digital, Monash University, Sumitomo Forestry, The University of Melbourne
40	Business Model Innovation in the Building Industry: Better Buildings and Better Bottom Lines	AMGC, PrefabAUS, Monash University, University of Melbourne.
7	New Technologies, the Future of Work, Skills and Industrial Relations (IR)	AG Coombs, Holmesglen Institute, Master Builders Assoc, Lendlease Digital Delivery, Monash University, Queensland University of Technology, The Master Builders Assoc. The University of Melbourne.
17	The Implications and Opportunities from Industry 4.0 for the Building Industry: towards smart prefab	AMGC and Prefab Innovation Hub (Funding body), Various Building 4.0 CRC Industry Partners, Monash University, The University of Melbourne, Queensland University of Technology
23	When prefab hits the ground: Barriers and opportunities in the Australian housing market	Fleetwood, Sumitomo Forestry, Monash University, Queensland University of Technology
30	Critical Path IMPACT through Productisation	Lendlease Digital, Monash University, The University of Melbourne
35	Prefab Housing Solutions for Bushfire & Disaster Relief	AMGC and Prefab Innovation Hub (Funding body), University of Melbourne, Monash University, Queensland University of Technology
47	Promoting Capabilities and Opportunities for Future Building Technologies & Solutions	Austrade

INDUSTRIALISATION

24	Next Generation of Robust and Fire-resilient Light Gauge Steel Systems for Mid-Rise Buildings (Umbrella Project)	BlueScope Steel Limited , Queensland University of Technology, The University of Melbourne
32	Acoustic flanking performance of mid-rise light gauge steel (LGS) structures	BlueScope, Monash University & University of Melbourne
41	Advanced Windows - Phase 2 Development of Novel Hard Coat for Plastic Double Glazed Windows	The University of Melbourne, Ultimate Windows
59	Innovative Steel - Timber - Concrete Composite StongFloor	VIRIDI Group, The University of Melbourne
LHP3	Independent Living Lab	Fleetwood Australia, Monash University: Urban Lab, Future Building Initiative, Design Health Collab School of Primary Allied Health Care (RAIL Lab), Monash University Buildings and Property Division, Peninsula Health Allied Health Team.
LHP6	Malvern East Apartment Development	Monash University, Sumitomo Forestry, The University of Melbourne
4	Computational Design and Optimisation Tools for Prefabricated Building Systems – Phase 1	M-Modular, The University of Melbourne, Queensland University of Technology
8	Prefab, Integrated Wall Systems - Scoping Study	Bentley Homes, Ultimate Windows, The University of Melbourne, Monash University
9	Implementing DfMA and Lean in Construction: Best Practice Guidelines through a Study of Building Services and Structure	A.G. Coombs, Lendlease Digital, Monash University, The University of Melbourne
10	Product Platform for Volumetric Building (Scoping Study)	Fleetwood, Monash University
19	Hybrid Timber Steel Structural Systems for Mid to High Rise Buildings – Phase 1 Scoping Study	BlueScope, Hyne & Son, Monash University, The University of Melbourne, Queensland University of Technology
20	Systems and methods for robustness of mid-rise light gauge steel (LGS) buildings – Phase 1 Scoping Study	BlueScope, The University of Melbourne, Monash University
22	Generative design and BIM-based Design Automation methods for Steel Framed Buildings – Phase 1 Scoping Study	BlueScope, The University of Melbourne, Queensland University of Technology
25	Operational Excellence framework of steel fabrication and processing in the OSM and prefabrication sector (Phase 1)	BlueScope, Fleetwood, Monash University, The University of Melbourne, Ynomia
28	Componentised Internal Wall Systems for Multi-residential Applications	Lendlease Digital, Monash University, The University of Melbourne
34	Acoustic flanking performance of mid-rise Light Gauge Steel (LGS) structures – Phase 1 Scoping Study	BlueScope, Monash University, The University of Melbourne
42	Workflow Automation Tools for Home Designs Phase 1 Scoping Study	Bentley Homes, M-Modular, The University of Melbourne, Queensland University of Technology

SUSTAINABILITY

11	Environmental Credentials for Building Technology Platforms	utecture, Coresteel, Monash University
15	Using the Whole Tree for Future Timber-Based Construction – Scoping Study	Hyne & Son, Sumitomo Forestry, University of Melbourne
36	Academic validation of performance gap research in energy rating systems	Green Building Council of Australia, Monash University
45	Prefab Wall Integrated System – Phase 2	Bentley Homes, Ultimate Windows, The University of Melbourne
48	Scoping Study for Building the Future – Circular Economy	Shared Interest Project - All Building 4.0 CRC Partners
60	Mass Timber Wellness	VIRIDI Group, Sumitomo Forestry, Monash University Queensland University of Technology
5	Automatic compliance and energy rating system	uTecture, Green Building Council of Australia, The University of Melbourne, Monash University, Queensland University of Technology
18	Long-Span Low-Carbon Floor Systems	Lendlease Digital, Sumitomo Forestry, Monash University, The University of Melbourne
26	New materials for windows of the future	Ultimate Windows, Monash University
27	Environmental Decision-Support for Structures	BlueScope, Monash University, The University of Melbourne
37	Australian Timber Fibre Insulation Scoping Study	Hyne & Son, The University of Melbourne, Ultimate Windows

DIGITALISATION

29	Real-time EH&S Intervention to Improve Site Safety (Scoping Study)	Lendlease Digital Australia, Monash University, The University of Melbourne
33	Evaluation of Emerging Technologies for Remote (virtual) Inspections of Building Work	Victorian Building Authority, Victorian Managed Insurance Authority (VIMA), Salesforce, Sumitomo Forestry Australia, Monash University, The University of Melbourne
38	Victorian Government Digital Build - Translating Theory into Practice	A.G. Coombs, BlueScope, Fleetwood, Coresteel Australia, Donovan Group, Victoria State Government Department of Jobs, Precincts and Regions, Lendlease Digital, Monash University, SFDC Australia, Salesforce.com, Sumitomo Forestry Australia, The Master Builders Association of Victoria, The University of Melbourne, Ynomia
44	Generative Architectural Design Engine	Lendlease Digital Australia, Monash University
50	Development of Artificial Neural Network and Automated Life Cycle Assessments for Cloud Based Residential Energy Estimations	Monash University, The University of Melbourne, uTecture
57	Wind Comfort Simulation and New Engineering Design Process	Lendlease Digital, Monash University
LHP1	Monash Smart Manufacturing Hub (mSMH) – A Digital Twin Living Lab	AWS, Monash University
1	ePlanning and eApprovals – Scoping Study	Lendlease Digital, uTecture, Sumitomo Forestry, A.G.Coombs Group, salesforce.com, Inc., Master Builders Association of Victoria, Victorian Building Authority, Victorian Government, Department of Environment, Land, Water and Planning, Monash University, The University of Melbourne
2	Automated tracking of construction materials for improved supply chain logistics and provenance – Phase 1 Scoping Study	BlueScope, Holmesglen Institute, Lendlease Digital, Monash University, Queensland University of Technology, Salesforce.com, Inc., Sumitomo Forestry, Master Builders Association of Victoria, The University of Melbourne, Victorian Building Authority, Ynomia
6	Field data collation to support real-time operational management	Lendlease, Ynomia, Standards Australia, Monash University, University of Melbourne, Queensland University of Technology
12	VR/AR Technologies in Vocational Education and Training (Scoping Study)	Holmesglen Institute, Master Builders Association of Victoria, Monash University, Queensland University of Technology
31	Demystifying Volumetric Construction: A Study of the Bathroom Pod	Lendlease Digital, Monash University, Queensland University of Technology, The University of Melbourne
46	Data analytics for structural fibre resources optimisation	Hyne & Son Pty, Queensland University of Technology