building 4.0 crc

Active and Completed Projects

July 2025

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program

Active Projects

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

Image credit: LGS truss and joist floor systems (Mahen Mahendran, 2022).

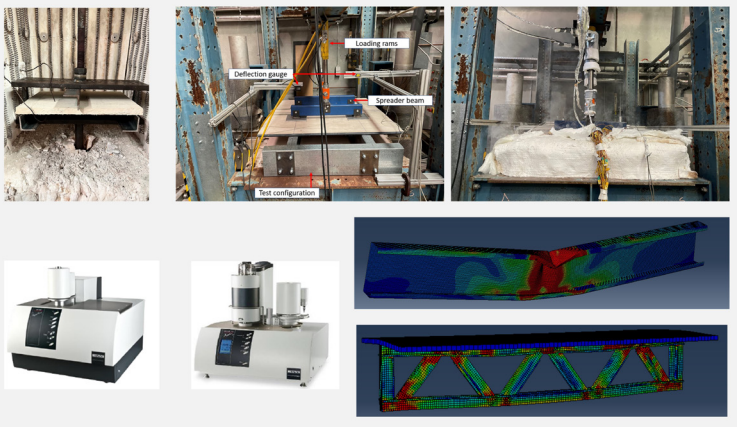


Image credit: Testing and Modelling (Mahen Mahendran, 2022).

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

Project Lead: Dr Pari Delir Haghighi | Monash University

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:

Feburary 2023; 24 Months

Image credit: Project Team

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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:

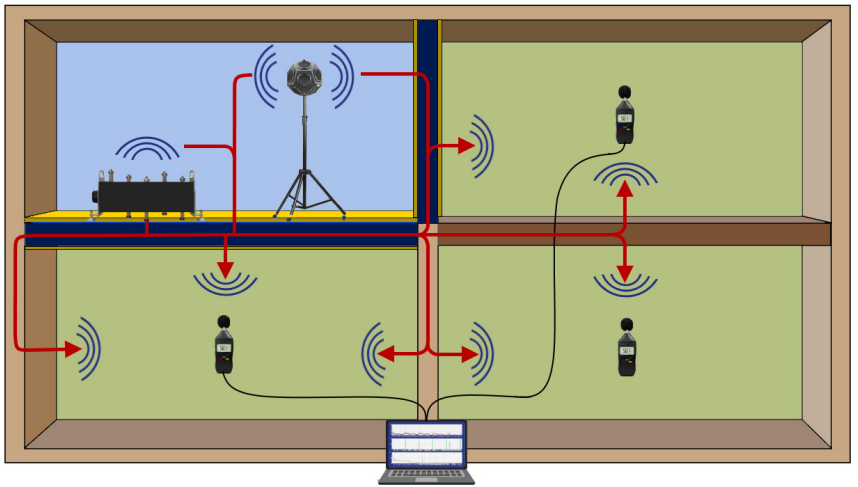
Bluescope, Monash University, The University of Melbourne

List of researchers:

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

Date commenced and duration:

September 2022; 36 months



Australian Government
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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 Ruitenberg, Carl Neilson, Prof. Tuan Ngo, Joel Scofield

Date commenced and duration:

February 2023; 24 Months

Image credit: Ultimate Windows

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 DALLE-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

Image credit: An example of the use of AI for Generative Design (Camilo Cruz Gambardella, 2022).

Australian Government
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Cooperative Research Centres Program

49. Implications of Industry 4.0 technologies on work practice

Project Lead: Prof. Frank Vetere | The University of Melbourne

Problem / thesis

New technologies in the building and construction industry will have a major impact on workplace processes, skills, infrastructure and working conditions. This project aims to understand the implications of emerging technologies on work practices, workforce training and working conditions in the building and construction industry.

The project identifies the challenges and opportunities of emerging technologies, their impacts on workplace practices and working conditions, and the requirements for future workforce training. The project outcomes will include recommendations to:

* support the transition in work practices (especially in moving from onsite to offsite work)

* guide the scope and focus of an effective skills training program

* identify the issues and opportunities for employee working conditions posed by new technologies.

Together, these recommendations will contribute to the choice, design and integration of new technologies to create safe, satisfying and productive workplaces in building and construction.

List of partners:

Holmesglen Institute, LendLease Digital, A.G. Coombs, Master Builders Association Victoria, Building and Plumbing Commission, University of Melbourne

List of researchers:

Prof. Frank Vetere, Dr Wafa Johal, Prof. John Howe, Prof. Eduardo Velloso, Dr Andrew Irlitti, Dr Jens Emil Grønbæk, Emily Wong

Date commenced and duration:

July 2024; 18 Months

Image credit: Adobe Stock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

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

Date commenced and duration:

April 2023; 30 months

Image credit: uTecture

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

53. Process Engineering, and Design and Estimating Automation of Fleetwood's Product Platform

Project Lead: Dr Abdallah Ghazlan | The University of Melbourne

Problem / thesis

This project aims to improve Fleetwood's business by digitising the physical components and assets of their product platform, and automating their design and estimating processes, procedures and workflows.

Expected operational benefits for Fleetwood include more efficient material use and production time, competitive market bidding and ease of installation while also minimising cost.

List of partners:

Fleetwood Australia, Monash University, The University of Melbourne

List of researchers:

Dr Siddesh Godbole, Dr Camilo Cruz, Associate Professor Tai Thai, Dr Victor Bunster, Professor Tuan Ngo, Professor Nelson Lam, Dr Duncan Maxwell, Dr Yousef Alqaryouti

Date commenced and duration:

October 2023; 18 months

Image credit: Shutterstock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

55. Towards smart contracts and smart finance in construction – Phase 1

Project Lead: Dr Lachlan Robb | Queensland University of Technology

Problem / thesis

Smart contracts and blockchain may be a technology that can provide certainty and clarity to the construction industry. Contracting and finance issues are an acute problem this industry, often creating delays and uncertainties that can lead to insolvency or other issues.

This project explores case studies in the construction industry to determine the future of smart contracts and blockchain technology to address concerns about finance and supply chain transparency. In particular, it investigates using smart contracts to facilitate faster and more reliable payments and how a digital twin of the supply chain can allow for more transparent and trustworthy systems.

The project team will develop a blueprint that can be used in a future phase to build the proposed technological solution.

List of partners:

Fleetwood Australia, Monash University, The University of Melbourne

List of researchers:

Dr Lachlan Robb, Prof. Felicity Dean, A/Prof. Tim Rose, Dr Bikalpa Rajbhandari

Date commenced and duration:

December 2024; 12 months

Image credit: Shutterstock

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Department of Industry, Science and Resources
Cooperative Research Centres Program

56. Accelerating B4.0CRC Translation and Impact

Project Lead: Associate Professor Niharika Garud | The University of Melbourne

Problem / thesis

Building is one of the largest sectors of today's global economy, so it is essential that the building industry benefits from the latest research findings and new knowledge created through rigorous research initiatives.

The capability gaps for researchers and industry professionals increase the difficulties of adopting and translating research into industry impact and industry outcomes. This research project aims to support the CRC's vision of developing a thriving Australian advanced manufacturing sector by enabling industry to direct and draw on Australian research through a scalable methodology that upskills researchers and industry professionals in collaboration, engagement and adoption of innovations.

List of partners:

A.G Coombs, BlueScope Steel, Cruxes Innovation, Sumitomo Forestry Australia, The Master Builders Association of Victoria, Victorian Building Authority

List of researchers:

Professor Daniel Samson, Professor Tuan Ngo, Research Assistants (TBC), Jonathan Lacey, Emily Chang

Date commenced and duration:

December 2023, 12 months

Image credit: Stock image.

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

58. The Retrofit Housing Atlas

Project Lead: A/Prof. Maryam Gusheh | Monash University

Problem / thesis

This project will document the typology, frequency and concentration of common Australian housing stock (1940–2010s) and demonstrate systematic and scalar retrofit strategies for their densification, diversification and adptation to 21st century social and environmental priorities:

The Atlas will include:

* Descriptions of common Australian house types in 8 Australian capital cities – Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth and Sydney – with potential for retrofitting and adaptation for measured densification and better social and environmental performance. These will be illustrated through representative case studies of each common housing type. Urban mapping of the identified house types will illustrate their concentration and frequency through maps at precinct, suburb and metropolitan scale.

* Strategies for adaptations and retrofitting of the identified house types. These will be illustrated through design concepts.

List of partners:

A.G. Coombs, Donovan Group, Fleetwood Australia, Holmesglen Institute, Hyne &Son, Master Builders Association Victoria, Sumitomo Forestry Australia, Building and Plumbing Commission, Monash University, Standards Australia, Green Building Council Australia

List of researchers:

A/Prof. Maryam Gusheh, Prof. Nigel Bertram, Dr Tom Morgan, A/Prof. Catherine Murphy

Date commenced and duration:

April 2025, 12 months

Image credit: Project Team

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 Rackel San Nicolas, Dr Alireza Chniforush, Khin Sheng Chin

Date commenced and duration:

September 2022, 18 months

Image credit: Viridi Group Strong Floor

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

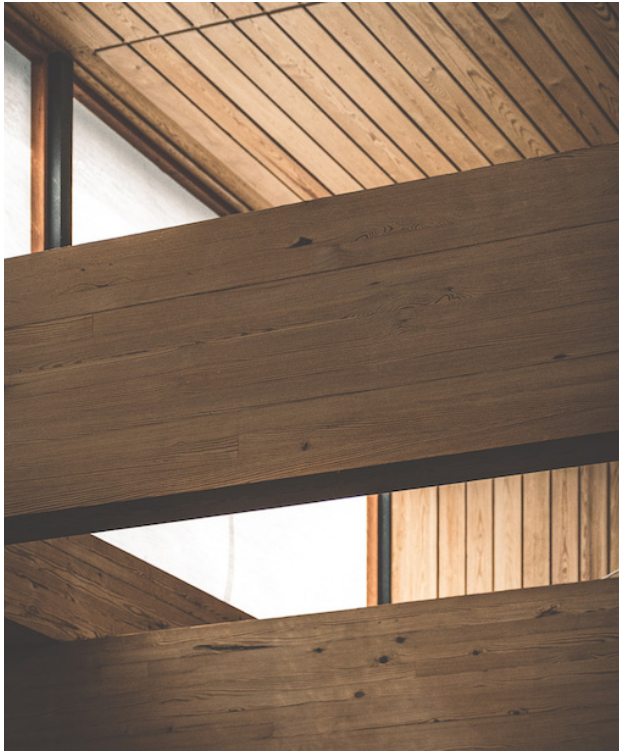

Image Credit: Stock Image (Daniel Lorentzen)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

61. Building Productivity: Product, Process, People

Project Leaders: Dr Duncan Maxwell & Dr Rachel Couper | Monash University

Problem / thesis

The common adage "If you can't measure it, you can't manage it" can be applied to building products, processes and projects. Current data capture in construction practice is typically scarce, inaccurate, lagging and non-standardised. Through the lenses of product, process and people,

Project #61 investigates how the capture, analysis and use of data can contribute to waste reduction, quality assurance and improvement of efficiency and effectiveness in the building industry.

The project aims to understand:

(1) What is impact of people (human factors/aspects) on the process and product efficiency?

(2) What kind of data is needed?

(3) When is it to be collected and by whom?

(4) Which methodologies, tools and technologies would be best suited?

List of partners:

Lendlease Digital Delivery, Monash University

List of researchers:

Project leads: Dr Duncan Maxwell, Dr Rachel Couper

Project team: Dr Victor Bunster, Dr Lee-Anne Khor, Dr Laura Harper, Dr Camilo Cruz Gambardella, Dr Sahar Soltani, Dr Yihai Fang, Prof. Amrik Sohal, Mohaimeen Islam, Fernando Pavez Souper, Miyami Pathiranage

Date commenced and duration:

September 2023; 3 years

Image credit: Shutterstock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

66. Future of construction education

Project Leads: Prof. Chris Knapp, Dr Siddhesh Godbole, Jean-Paul Rollo, Dr Priya Das | Monash University and The University of Melbourne

Problem / thesis

TThis research will contribute to the body of knowledge on the future skills required for the building and construction industry and the role of technology and automation in meeting those skills demands.

The research will provide valuable insights for higher education institutions in the development of contemporary, forward-looking industrialised construction degrees. It will also have broader implications for workforce development in the building and construction industry, highlighting the skills and training required to meet the industry's changing landscape.

The project will have implications for construction education in Victoria and nationally.

List of partners:

Holmesglen Institute, A.G. Coombs, Lendlease Digital, Victorian Building Authority, Nexans, Master Builders Association Victoria, Sumitomo Forestry Australia, Fleetwood Australia, Monash University, The University of Melbourne

List of researchers:

Dr Henry Pook, Dr Sam Duncan, Cedomir Gladovic, Dr Duncan Maxwell, Dr Laura Harper, A/Prof. Ari Seligmann, Prof. Mel Dodd, A/Prof. Maryam Gusheh, Prof. Tuan Ngo, A/Prof. Felix Hui, Dr Robert Moehler, Jane Dash

Date commenced and duration:

January 2024, 12 months

Image credit: Building 4.0 CRC

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

71. Automated decision making for interdisciplinary coordination during early-stage building design

Project Lead: Dr Pierre Le Bodic | Monash University

Problem / thesis

This project aims to develop algorithms and techniques to facilitate and streamline the spatial negotiation that originates from coordinating building systems throughout the different stages of the building design process. The hope is that building design teams can use these techniques to make informed decisions when developing a building design, which in turn should improve performance and reduce time and cost.

List of partners:

Lendlease Digital, A.G. Coombs, Monash University

List of researchers:

Dr Victor Bunster, Dr Camillo Cruz Gambardella, A/Prof. Duncan Maxwell, Prof. Peter Stuckey, A/Prof. Guido Tack, Dr Allen Zhong, Dr Amin Karimi, Dr Victor Calixto, Tim Butler, Vidish Iyer, Bryon Price and Paul Carey

Date commenced and duration:

October 2024, 24 months

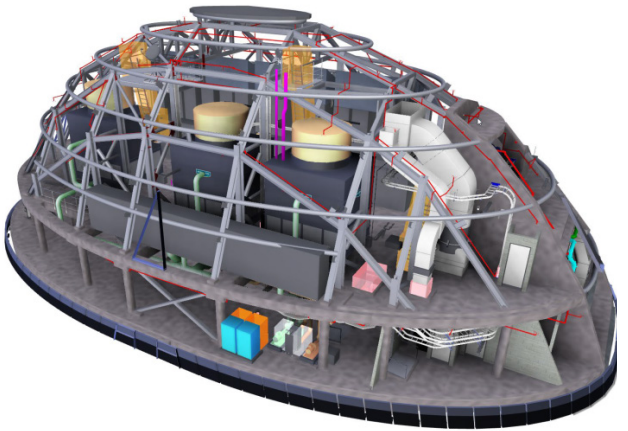

Image Credit: Shutterstock

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76. Thermally active floor panels for cost effective space cooling

Project Leads: Dr Behzad Rismanchi | The University of Melbourne

Problem / thesis

This project addresses the challenge of reducing energy consumption and greenhouse gas emissions from space cooling in buildings by using Phase Change Material (PCM) technology. The project team will design and install a PCM radiant cooling system in a purpose-built full-scale testing facility, and then monitor performance.

The expected outcome is a validated, market-ready PCM radiant cooling system that lowers cooling costs and improves energy efficiency.

List of partners:

Taphcore®, University of Melbourne

List of researchers:

Stefan Brey (Industry Lead), Bryon Price, Prof. Tuan Ngo, Prof. Lue Aye

Date commenced and duration:

February 2025, 24 months

Image credit: Taphcore®

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Department of Industry, Science and Resources
Cooperative Research Centres Program

80. Why are insolvencies so high in the Construction industry and what can be done about it?

Project Lead: Dr Lyndall Bryant | Queensland University of Technology

Problem / thesis

This project explores the causes of high insolvency rates in the residential construction sector, addressing concerns about financial risk management as well as policy and regulation impacts. It focuses on reducing the broader economic and other impacts of residential building company failures, by triangulating insolvency data, industry systems and educational environment to identify key focal points for reform.

The final report's insights and recommendations will provide regulators and educators evidence-based guidance in designing reforms, preventative measures and educational supports to enhance the robustness of the industry and bolster its role in housing affordability.

List of partners:

Building and Plumbing Commission, Master Builders Association Victoria, Holmesglen Institute, Queensland University of Technology

List of researchers:

Dr Fiona Cheung, Dr Elisabeth Streten

Date commenced and duration:

February 2025, 7 months

Image Credit: Shutterstock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

84. Feasibility study of recycling excavated clay materials in full-scale concrete applications

Project Lead: Dr Rackel San Nicolas | The University of Melbourne

Problem / thesis

Objectives

The study aims to explore the potential reuse of excavated clay-based materials for concrete applications as both cement and aggregate replacements. This project addresses two concurrent challenges: the disposal of excavated soil, often unused and sent to landfills, and the high carbon footprint associated with concrete applications.

Overview

In Australia, traditional low-carbon cement substitutes, such as fly ash (a coal industry by-product) and blast furnace slag (a steel industry by-product), face constraints due to ongoing changes. Cleaner energy production, leading to the closure of coal-fired power stations in the next decade, and modifications in steel manufacturing processes contribute to shortages of fly ash and blast furnace slag respectively. With a forecasted 70% growth in concrete demand, Australia must establish alternative cementitious materials that are eco-friendly, locally sourced and abundant to avoid dependence on imported cement alternatives.

Project description

Through sampling and characterising by-product clays sourced from two major Victorian construction projects – the M80 Ring Road Completion and the North East Link project – the trial aims to showcase the feasibility of incorporating heated spoil into concrete constituents. The study will progress to full-scale trials, paving the way for innovative and environmentally friendly concrete solutions. This study will demonstrate and confirm the use of calcined clay derived from clay/spoil excavated from project sites as a viable Supplementary Cementitious Material (SCM) and aggregate in concrete production. This will redefine the criteria for calcined clay in concrete, pushing the boundaries of sustainable construction practices.

Due to commercial calcinators not being available in the market, the study is proposing to use a heat treatment process normally used to treat contaminated soil to develop calcined clay and validate the feasibility of using alternative heat treatment facilities for the calcination of clay.

The project unfolds in 5 distinct stages:

Phase 1 – A preselection process involves nalysing soil through borehole assessments across the M80 Ring Road Completion project site and the North East Link project site. Characteristic soil is preselected based on predefined criteria from literature and site capacity. A full characertisation of these samples narrows down the highly promising soil samples.

Phase 2 – This phase is conducted at a mortar scale and involves testing the preselected samples from Phase 1 in 3 different cement and mortar systems. Performance and long-term behaviour are thoroughly analysed.

Phase 3 – The 2 most promising clay samples will be calcined/heated in larger quantities, transitioning from mortar-scale experiments to concrete-scale assessments in Phase 4.

Phase 4 – This phase involves the concrete mix design development and testing, evaluating both mechanical and durability performance.

Phase 5 – The most successful laboratory concrete mix is subjected to a full-scale trial, encompassing both in-situ and precast scenarios. This trial is conducted with the support of a concrete mixing plant and precast facility.

List of partners:

M80 Rig Road Completion, Spark – North East Link, University of Melbourne

List of researchers:

Dr Echo Wang, Laura Jukes, Sasika Perera, Miles Dacre, Ross Brookshaw, Lexie Walter, Julia Rogerson, Lucy Whalen, Rachel Lee, Adrian Pagnoccolo

Date commenced and duration:

June 2024, 12 months

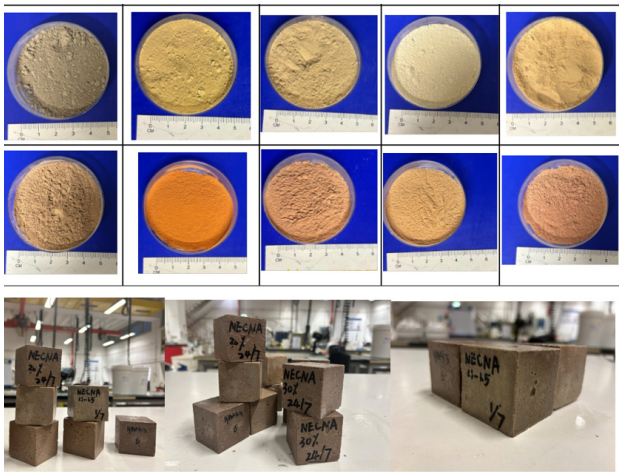

Image Credit: Project team.

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Cooperative Research Centres Program

85. From digital design to human robot collaborative masonry construction

Project Lead: Dr Müge Belek Fialho Teixeira | Queensland University of Technology

Problem / thesis

Imagine humans working alongside collaborative robots (cobots), laying bricks to build urgently needed homes for the growing Australian population. This human robot collaboration project will develop a digital design to physical construction workflow for masonry construction using cobots to be employed alongside labourers.

Using masonry bricks, the project elevates the efficiency of building brick walls which are essential building elements in the housing industry. Based on observational studies of masonry construction of highly skilled labourers, the project aims to train cobots working alongside human workers to pick and place masonry bricks with precision.

List of partners:

Brickworks, Queensland University of Technology

List of researchers:

Dr Tatheer Zahra, Prof. Glenda Caldwell, Prof. Tim Schork, Lloyd Gainey, Maja Caballero, Hamidreza Rafizadeh

Date commenced and duration:

February 2024, 36 months

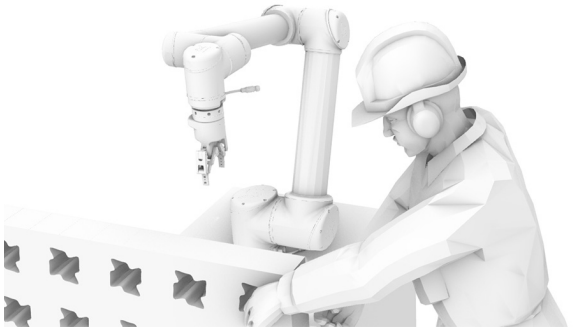

Image Credit: Project team.

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86. Sustainable 3D printed concrete for bespoke infrastructure

Project Lead: A/Prof. Hafizah Binti Ramli | Queensland University of Technology

Problem / thesis

Robotic 3D printing has the potential to revolutionise the concrete industry and contribute to more sustainable concrete construction through material optimisation, carbon emission and waste reduction, design freedom and greater precision.

This study aims to develop a prototype of bespoke infrastructure elements using Robotic 3D printing technology. Optimised mix design for low carbon 3D printed concrete with enhanced fresh and hardened properties will be proposed. The structural performance will be enhanced by incorporating short fibres and embedding textile meshes. The outcomes will give positive impact to precast drainage, sewerage and civil infrastructure industries.

List of partners:

Everhard Industries, Queensland University of Technology

List of researchers:

Dr Muge Belek Fialho Teixeira, Dr Tatheer Zahra, Dr Sabrina Fawzia, Adam Turner, Daniel Sweatman, Dr Mohammad Kangavar, Ahmed Sakr, AHM Javed Hossain Talukdar, Shabnam Lotfian

Date commenced and duration:

June 2024, 18 months

Image Credit:

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

90. Evaluating the effectiveness of roofing work inspection using remotely piloted aircraft systems

Project Leads: Dr Kourosh Khoshelham | The University of Melbourne

Problem / thesis

This project aims to evaluate the effectiveness of remotely piloted aircraft systems (RPAS) and 3D mapping techniques to inspect roofing work to support or enhance conventional in-person inspections. The project will also explore methods to automate and scale up technology-assisted roofing work inspection for broader implementation at a state or national level.

It builds on Project #33, which identified the potential to use RPAS to inspect roofing work remotely.

The project outcomes will enhance on-site quality assurance of roofing work and regulatory oversight of roofing work by detecting and rectifying non-compliant roofing work early. Expected benefits include a lower building repair costs and improved health and wellbeing of occupants.

The expected outcome is a validated, market-ready PCM radiant cooling system that lowers cooling costs and improves energy efficiency.

List of partners:

Building and Plumbing Commission, Holmesglen Institute, Master Builders Association Victoria, Sumitomo Forestry Australia, University of Melbourne, Monash University

List of researchers:

Dr Desmond Zhang, Dr Yihai Fang, Dr Eric Windholz, Dr Robert Moehler, Victor Arowoiya, Senuri Siriwardhana, Tanghan Jiang

Date commenced and duration:

January 2025, 12 months

Image credit: Project team.

Australian Government
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Cooperative Research Centres Program

95. Homes NSW MMC Program: Solving the Housing Crisis

Project Lead: Prof. Mathew Aitchison | Building 4.0 CRC

Problem / thesis

Background

The traditional method of housing construction, largely unchanged for a century, is too slow and costly to meet this growing demand.

In response, the NSW Government has committed a historic $6.6 billion investment aimed at constructing 8,400 new homes and repairing 30,000 existing dwellings. To maximise the impact of this investment, Homes NSW and Building 4.0 CRC have developed the Modern Methods of Construction (MMC) Program.

What is the MMC Program?

The MMC Program is a revolutionary approach to delivering social housing. By leveraging modern manufacturing techniques and digitally enabled processes, we create standardised building components offsite. These components are then assembled rapidly onsite, fundamentally shifting the traditional 80% onsite, 20% offsite construction model.

The MMC Program is not just about building faster, but also about improving tenant outcomes, reducing lifecycle costs, stimulating local manufacturing, and building homes that are durable, liveable, and future-ready. The project commenced in May 2024, with Homes NSW and Building 4.0 CRC each contributing $2 million, in addition to in-kind contributions. We have also partnered with universities such as Monash University and the University of Melbourne for this research.

Rather than think about building site by site or project by project, our research primarily aims to develop a systematic program for housing delivery. This approach encompasses a 360° view of housing: from design and development, through to construction, maintenance, and repair.

Starting with medium-density homes (4-6-storey buildings) and using the standardised kit-of-parts manufactured offsite (i.e., bathrooms, kitchens, balconies), these parts will be assembled onsite, employing systems and processes to meet tenant needs, speed up delivery, and unlock economic efficiencies.

The 'Kit-of-Parts' Approach

The Homes NSW MMC Program uses a Kit-of-Parts methodology: a pre-defined suite of movable building components (e.g., bathrooms, kitchens, balconies, etc.) manufactured offsite and assembled onsite. This system allows for flexibility in design while improving build speed, quality, and cost-efficiency. Not every part is made offsite; the system provides for around 20% of building works to enable every building to be 'fitted' to the specifics of its location. In the other 80%, every part is designed to fit together within a standardised assembly framework, forming homes that are adaptable yet easily repeatable.

Core objectives of the MMC Program

Speed and Efficiency: Rapid construction timelines to urgently address housing shortages.

Cost-Effectiveness: Reducing overall housing costs through scalable, efficient production.

Quality Assurance: Higher quality control through offsite manufacturing.

Sustainability: Environmentally responsible construction and durable housing designs.

Tenant Satisfaction: Improved liveability, adaptability, and long-term maintenance.

List of partners:

Homes NSW

Date commenced and duration:

May 2024, 24 months

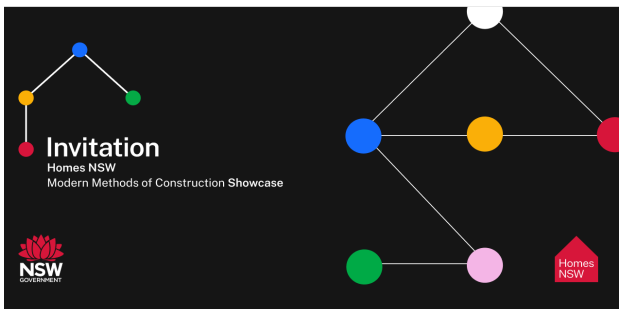

Image Credit: Project team.

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97. Self Storage Association of Australasia Digital Platform Development

Project Leads: Prof. Robin Drogemuller | Queensland University of Technology

Problem / thesis

This project provides an online interface into the current state of the self storage industry by mapping and benchmarking self storage facilities. It will also support demand forecasting and planning for new facilities. It uses demographic, financial, regulatory and geospatial data to assist in optimising the current and future self storage industry.

The platform will be a comprehensive digital solution that enables members and suppliers to:

1. Map the existing state of and provision for self storage facilities in a geographical context
2. Support benchmarking of the performance of facilities using a range of standard industry operational metrics
3. Understand current supply pipeline
4. Assist authorised users to assess the potential of new locations for self storage facilities
5. Forecast future demand
6. Assess zoning, site feasibility and unit mix potential
7. Understand the economic impact and benefits of the sector.

List of partners:

Self Storage Association of Australasia, Queensland University of Technology

List of researchers:

Makala Ffrench Castelli, Prof. Alistair Barros, Dr Lyndall Bryant, Jason Gray, Dr Mark Limb, Dr Sara Omrani, Dr Umberto Baresi, Dr Fereshteh Banakar, Andres Arteta Molina, Nazli Soltanmohammadlou

Image credit: Project team.

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100. IEQ monitoring of Aboriginal Housing Office 3D printed houses

Project Leads: Dr Sara Omrani | Queensland University of Technology

Problem / thesis

The shortage of affordable and quality housing in Australia, particularly in regional, rural and remote communities, is exacerbated by slow and costly traditional construction methods. In response, the NSW Aboriginal Housing Office (AHO) is piloting 3D printing technology to construct 2 townhouse units in Dubbo, NSW. This project aims to test the effectiveness of 3D-printed houses in providing comfortable indoor environments. The research will evaluate Indoor Environmental Quality (IEQ) through objective sensor data and subjective tenant feedback. The findings will provide the AHO with insights into the suitability of 3D-printed houses for larger-scale deployment, with the aim to provide improved housing options for Aboriginal communities across NSW.

List of partners:

NSW Aboriginal Housing Office, Blue IoT, Queensland University of Technology

List of researchers:

A/Prof. Veronica Garcia-Hansen (Co-Lead), Dr Francisca Rodriguez, Dr Kirsty Volz, Kieu Pham, Mahdi Valitabar

Image credit: Project team.

Date commenced and duration:

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Department of Industry, Science and Resources
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102. Skills and training implications of modern methods of construction: Across design, manufacture and assembly

Project Lead: Dr Laura Gutierrez-Bucheli | Monash University

Problem / thesis

The global construction industry has faced a persistent productivity crisis. To address this challenge, the industry is moving towards Industrialised Construction (IC), also known as Modern Methods of Construction (MMC).

While the technical and commercial aspects of MMC have been well studied, there is still a significant gap in understanding the required workforce transformation to effectively implement these methods.

Project #102 aims to address this gap by analysing the workforce implications, training needs and skill development essential for widespread MMC adoption across the Australian built environment value chain.

List of partners:

BuildSkills Australia, Monash University

List of researchers:

A/Prof. Duncan Maxwell, Dr Savinidi Perera, Dr Sahar Soltani, Jean-Paul Rollo, A/Prof. Gillian Kidman

Date commenced and duration:

April 2025, 12 months

Image Credit: Project team.

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Department of Industry, Science and Resources
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104. Development of a solution for high-rise mass timber residences through a Post & Plate system – Phase 2 Numerical and experimental investigation

Project Lead: Dr Richard Nero | The University of Melbourne

Problem / thesis

This project builds on Project #68, which explored the feasibility of introducing the Post & Plate timber structural system to Australia's multi-residential sector.

This Phase 2 project comprises 7 elements:

1. Employing finite element numerical modelling approaches to establish the structural impact of the conventional conservative design assumptions
2. Developing a practical 2-way hand-calculation design check method
3. Conducting a targeted literature review of experimental Post & Plate tests and data from international engineering and research institutions
4. Undertaking full-scale testing of the Post & Plate flooring configuration for the Australian context informed through numerical modelling
5. Assessing acoustic performance
6. Developing a Post & Plate connector
7. Assessing fire performance.

List of partners:

Sumitomo Forestry Australia, Hyne and Son, Cedar Pacific, University of Melbourne

List of researchers:

Dr Philip Christopher, Dr Alireza Chiniforush, Dr Bernard Gibson, Karl-Heinz Weiss, Prof. Tuan Ngo

Date commenced and duration:

December 2024, 24 months

Image Credit: Rothoblaas

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Department of Industry, Science and Resources
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105. Blockchain-powered peer-to-peer energy trading: Advancing sustainability and affordability in smart residential communities

Project Lead: Dr Hui Cui | Monash University

Problem / thesis

This project explores how blockchain technology can enable direct energy trading between households and buildings, aligning with the Industry 4.0 vision of creating smart, interconnected and sustainable living environments. By leveraging blockchain's decentralised and transparent features, the project aims to enhance housing affordability and optimise energy usage.

This innovative approach will help reduce energy costs, ensure transparent transactions, and promote the adoption of renewable energy sources, ultimately contributing to more sustainable and efficient communities.

List of partners:

Web3in Tech-Lab, Monash University

List of researchers:

A/Prof. Aamir Cheema

Date commenced and duration:

November 2024, 12 months

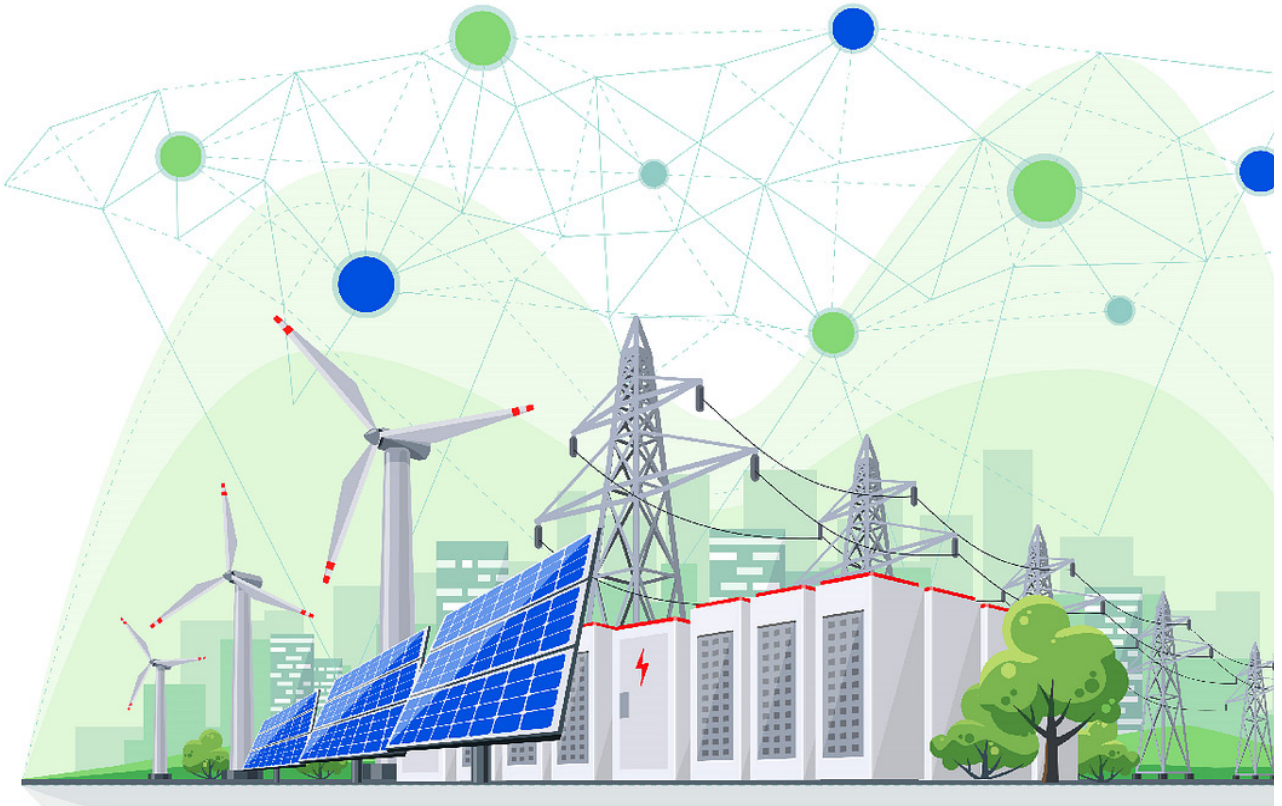

Image credit: Shutterstock

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108. Project Circle Design Phase 1

Project Lead: Prof. Dan Hill | The University of Melbourne

Problem / thesis

Project Circle is an exploratory applied research collaboration between industry, academia and government. It will explore how circular systems design can be applied to building and service design. The aim is to build a working circular systems demonstrator – specifically a pair of small pavilions – that focuses on the building and construction sector's biggest challenge: the embodied energy, material resource use and biodiversity degradation associated with construction.

The design for each pavilion will demonstrate how they fit within climate science-derived emissions limits for Australian housing, and each design will exemplify different approaches to circularity:

First, via circular biomaterials from regenerative sources 'grown' as building materials

Second, through reclaimed, reconditioned and reused materials salvaged from demolition.

Each building will embody a particular 'useful archetype' e.g. free-standing single-storey house versus apartment/ townhouse.

Via new and existing research, the project will:

1. Identify systemic blockers and enablers, and challenges and opportunities

2. Explore the authorising environment for building, such as regulations, policy, business models, investment and value models, public perceptions

3. Consider international comparators that contrast and complement Australian approaches.

The final report will inform the pavilions' concept and system design, including approaches to material sourcing, fabrication, construction, program, portability and operations. It will address issues such as material stocks, resources and infrastructures, agricultural/manufacturing capacity, environmental constraints and opportunities, skills and capabilities, financing and value models, technologies, business models, policy and governance. It will also explore how to communicate and mobilise change.

List of partners:

Lendlease Development, University of Melbourne

Date commenced and duration:

April 2025, 30 months

List of project steering group:

Dr Chris Jensen, Andrew Chappell, Kevin Brake

List of researchers:

Bohemia Hookham, Tim Butler, Prof. Rob Crawford, Dr James Helal, Katie Skillington, Dr Djordje Stojanovic, A/ Prof. Christhina Candido, Prof. Tuan Ngo, Dr Alice Kesminas, Brendon McNiven, Dr Andre Stephan, Dr Xavier Cadorel, Dr Reza Hosseini

Circle

Australian Government
Department of Industry, Science and Resources
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111. VET Qualifications System and Training Framework for Modern Methods of Construction

Project Lead: Dr Laura Gutierrez-Bucheli | Monash University

Problem / thesis

The imperative to transform the construction industry through digitalisation and modern methods of construction (MMC) is widely acknowledged in industry and policy discourse, aiming to achieve higher productivity. However, their adoption remains limited, with 'traditional' site-built construction practices still prevalent. Current industry practices often lack the integrated and collaborative approaches vital for effective MMC implementation.

This challenge mirrors the situation within the Vocational Education and Training (VET) sector. Current VET programs often provide generic training, lacking specific content related to MMC and its application across the value chain. This project will explore the suitability of current VET training programs in relation to MMC and ascertain whether new training directions are needed to bridge gaps in skills and training at the trades and para-professional levels. Ultimately, the goal of this project is to create a purpose-driven VET qualification framework focused on MMC.

List of partners:

Holmesglen Institute, Master Builders Association Victoria, Monash University

List of researchers:

A/Prof. Duncan Maxwell, Dr Sahar Soltani, Jean-Paul Rollo, Prof. Chris Knapp, Dr Yihai Fang, A/Prof. Gillian Kidman, Dr Henry Pook, Dr Sam Duncan, Chad Gladovic, Liz Jansz, Warren Guest, Maxine Courtier

Date commenced and duration:

April 2025, 30 months

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Department of Industry, Science and Resources
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112. Flexible wet cores for volumetric housing construction

Project Lead: Dr Lee-Anne Khor | Monash University

Problem / thesis

This design research investigation tests the efficacy and feasibility of developing a suite of standardised wet cores that can be reconfigured for a range of medium and low-density residential building typologies delivered through volumetric construction.

The research aims to identify key spatial relationships between wet cores and typical dwelling arrangements that can maximise manufacturing efficiencies while responding to the imperatives of Fleetwood's existing and emerging housing markets.

The design strategies will inform "rule sets" for aggregating wet elements in different dwelling typologies to be codified (by others) for use in generative design processes being undertaken by Fleetwood.

List of partners:

Fleetwood Australia, Monash University

List of researchers:

A/Prof. Duncan Maxwell, Dr Camillo Cruz Gambardella, Dr Laura Harper, Research Assistant

Date commenced and duration:

April 2025, 12 months

Room and core assembly possibilities to form a variety of household types

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Image credit: Project Team

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.

Image Credit: Thomson Adsett

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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.

Image Credit: Sumitomo Forestry

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Completed Projects

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 completed:

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

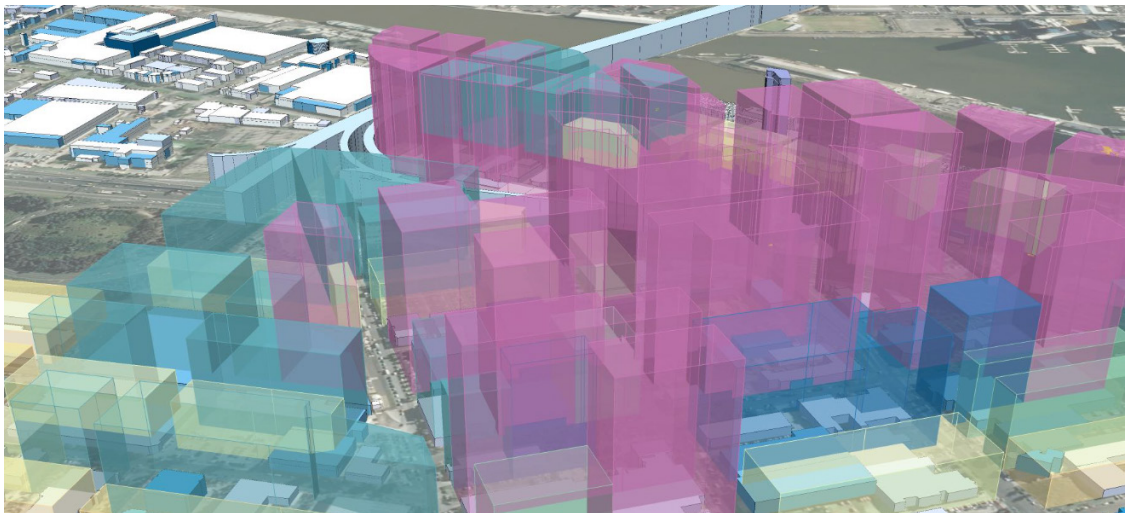

Image Credit: Architecture (Davood Shojaei, 2021)

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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 Adebi, Mr Noor E Karishma Shaik, Mr Siyu Chen, Mr Xin Ma, Mr Tendai Makasi

Date commenced and completed:

July 2021 - December 2021

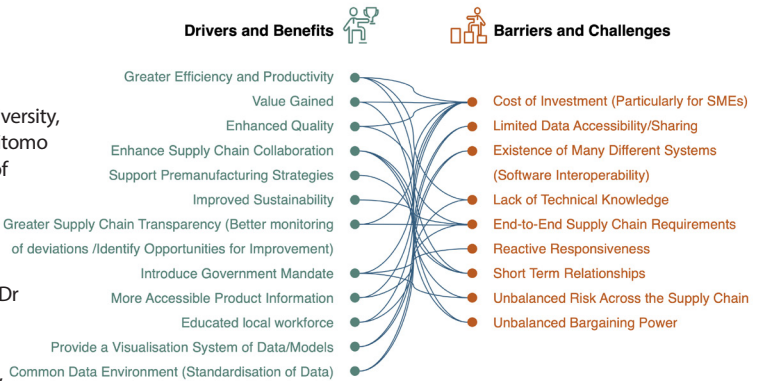

Image credit: Critical drivers, benefits, barriers and challenges for the construction traceability (Wen Li, 2022)

	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)

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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.

Outcome

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

Project Outcomes: https://building4pointzero.org/projects/project-title-projects-to-platforms-investigating-new-forms-of-collaboration-scoping-study/

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 completed:

September 2021 - April 2023

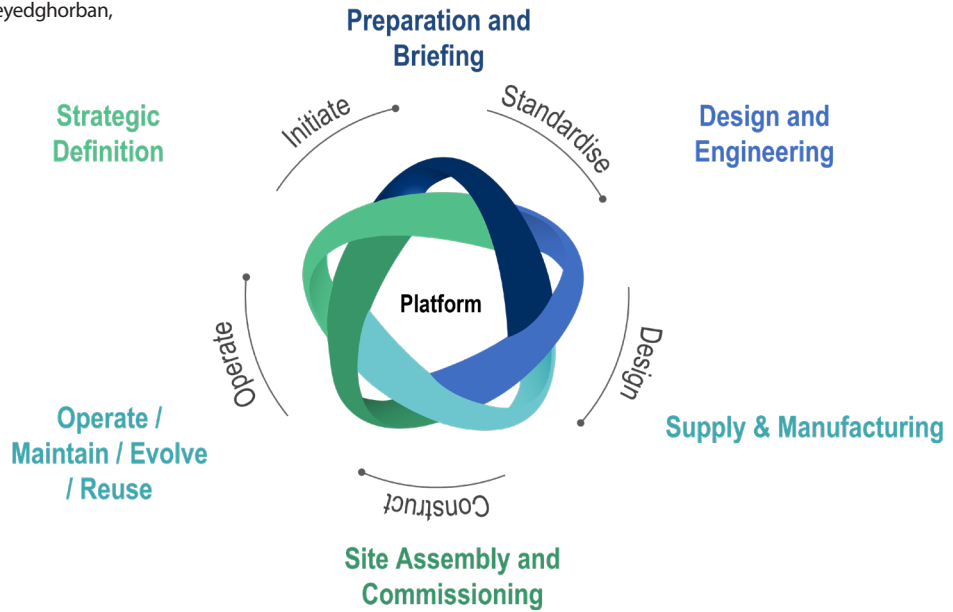

Image credit: Value Chain (Project 3 Team 2022)

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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:

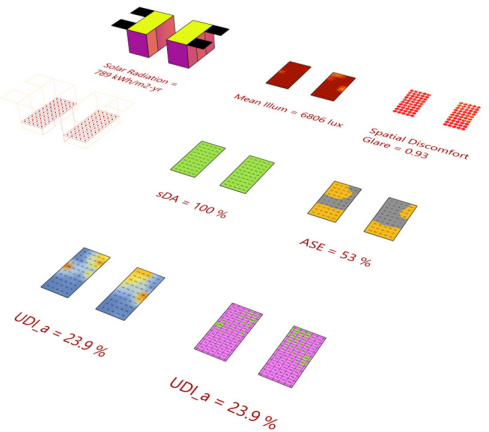
M-Modular, University of Melbourne, Queensland University of Technology

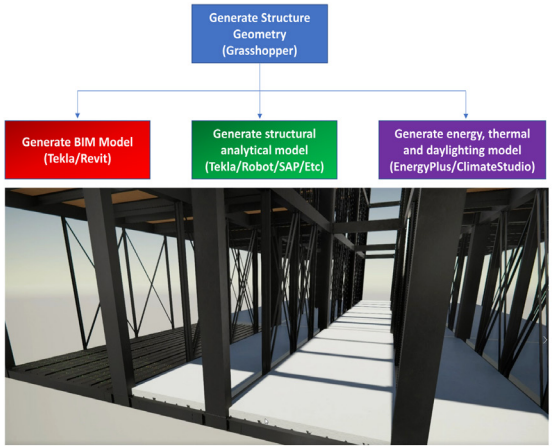
List of researchers:

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 completed:

February 2021 - August 2021





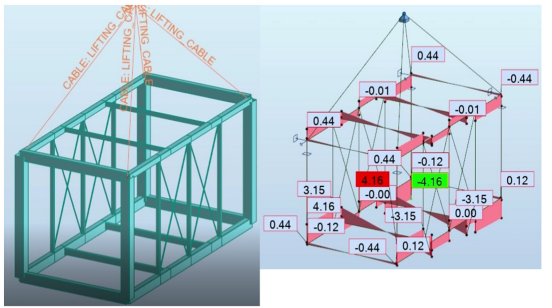


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Image credit: Computational Design and Optimisation Tools for Prefabricated Building Systems (Abdallah Ghazlan, 2022).

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 Utecture'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:

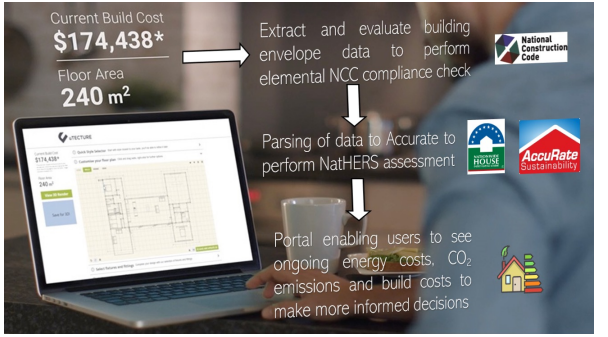
uTecture, Green Building Council of Australia, The University of Melbourne, Monash University, Queensland University of Technology

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 completed:

January 2021 - July 2021



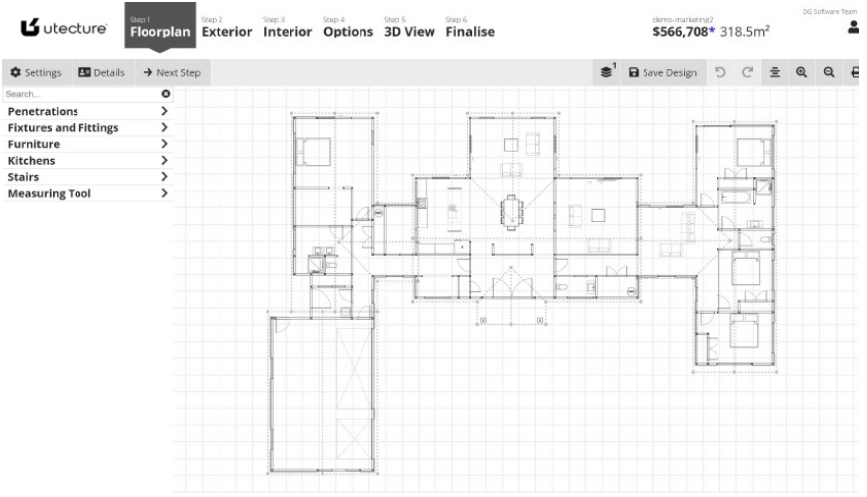


Image credit: Icon designs by Flaticon.com

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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 completed:

January 2021 - July 2021

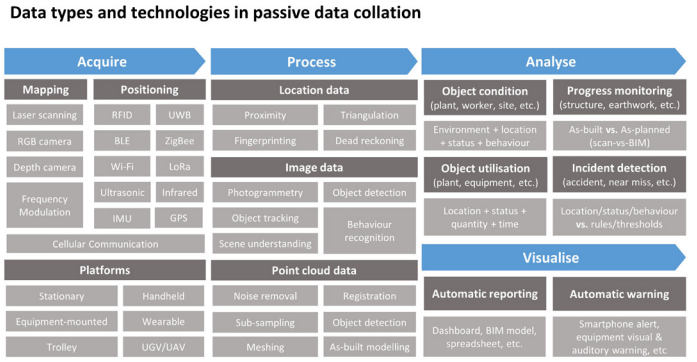

Image credit: Technological landscape of passive data collation on construction sites (Yihai Fang, 2022).

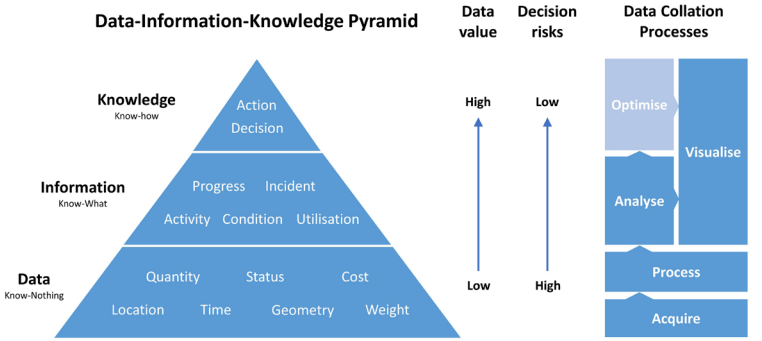

Image credit: DIK pyramid and data collation processes in site operational management (Yihai Fang, 2022).

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

8. Prefab, Integrated Wall Systems – Scoping Study

Project Lead: Dr Felix Hui | The University of Melbourne

Problem / thesis

This project seeked 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 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 completed:

November 2020 - May 2021

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 completed:

June 2021 - February 2022

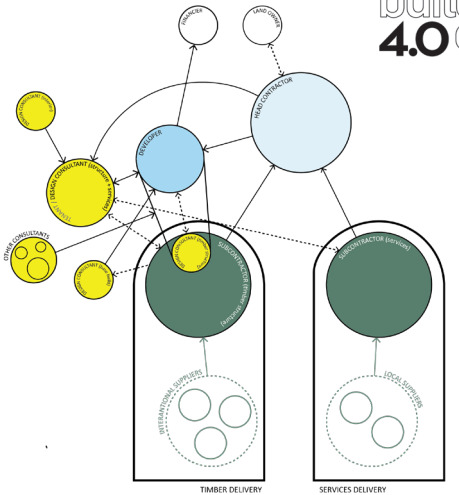

Image credit: Case Study Mapping of Project Stakeholders

Image credit: Case Study Construction Site

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

10. Product Platform for Volumetric Building (Scoping Study)

Project Lead: Dr Duncan Maxwell | Monash University

Problem / thesis

Product platforms seek to standardise products, processes, company knowledge, and supply chain to drive efficiency, unlock design variability, and enable continual improvement in response to market conditions.

This project sought to define a framework and roadmap for the future development of a product platform specific to the context and the needs of our industry partner: a large Australian volumetric construction company.

Outcome

The research involved: the investigation of best practice case studies; value stream mapping of our industry partner, existing design, manufacture, and assembly systems; and identification of, pain points, in the value stream and opportunities for commonality of parts and processes.

Project Outcomes: https://building4pointzero.org/projects/product-platform-for-volumetric-building-scoping-study/

List of partners:

Fleetwood Building Solutions, Monash University

List of researchers:

Dr Duncan Maxwell, Dr Ivana Kuzmanovska

Date commenced and completed:

November 2020 - November 2021

Image credit: Steel framed volumetric module assembly

Image credit: Design flexibility enabled by the General Motors product platform (General Motors, 1956)

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Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

Outcome

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

Project Outcomes: https://building4pointzero.org/projects/environmental-credentials-for-building-technology-platforms/

List of partners:

Utecture 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 - May 2024

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

Supply Chain Impacts

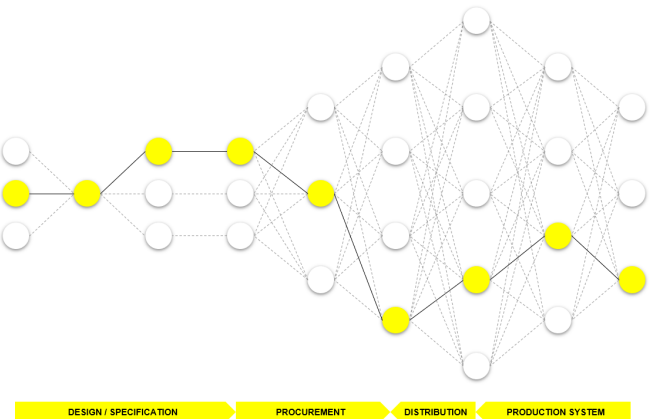

Image credit: Supply chain impacts of building technology platforms (Victor Bunster, 2022).

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 completed:

May 2021 - December 2021

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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 aimed 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.

Outcome

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

Project Outcomes: https://building4pointzero.org/projects/15-using-the-whole-tree-for-future-timber-based-construction-scoping-study/

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 completed:

May 2022 – April 2024

Image credit: Beerburrum (Hyne Timber, 2022).

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 - December 2023

Image Credit: Marketing Society (Project Team, 2022)

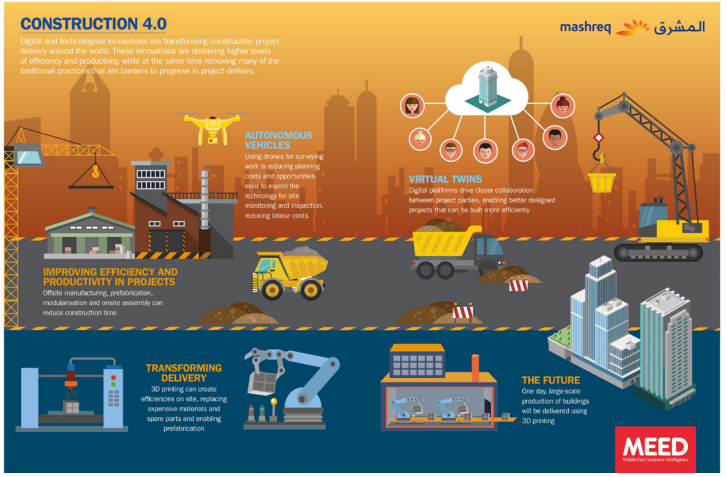

Image Credit: MEED (2021)

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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

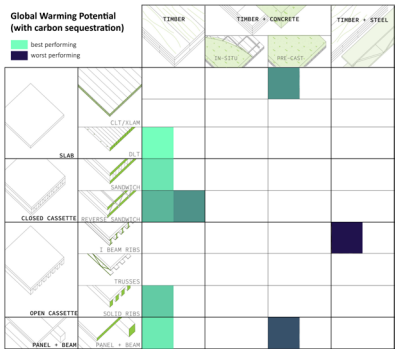


Image credit: Global Warming Potential (with carbon sequestration) (Ivana Kuzmanovska, 2022)

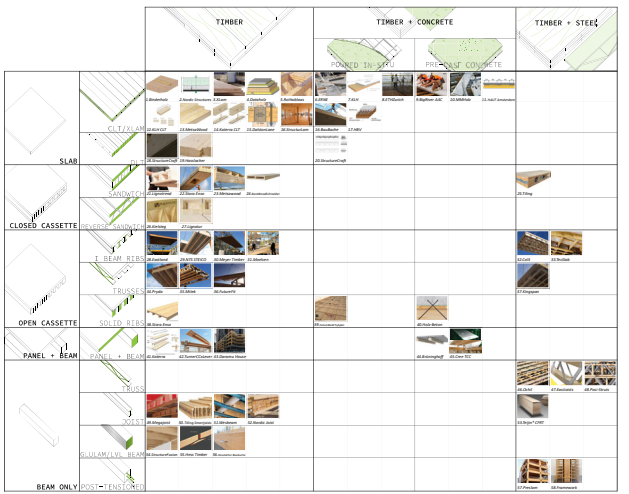


Image credit: Floor Systems Matrix (Ivana Kuzmanovska, 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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:

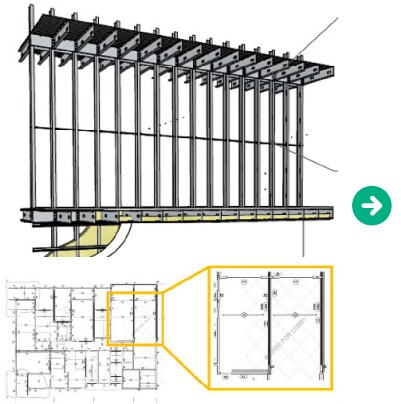
BlueScope, The University of Melbourne, Monash University

List of researchers:

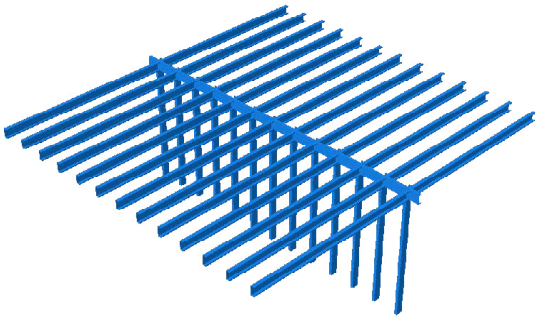
Prof Tuan Ngo, Prof Nelson Lam, A/Prof Tai Thai, Dr Tuan Nguyen, Mr Chris Mathwin, A/Prof Amin Heidarpour, Dr Mizan Ahmed

Date commenced and completed:

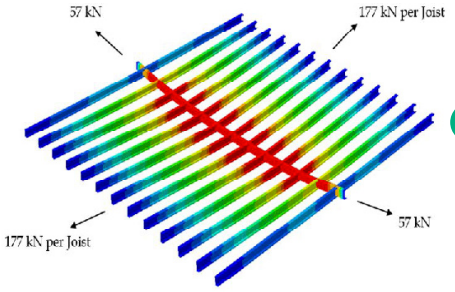
July 2021 - December 2021



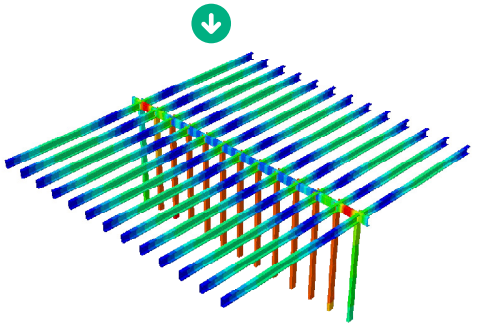
a) Typical wall of a sub model



b) Geometry of the sub model



d) Deformation after wall removal



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Cooperative Research Centres Program

Image credit: Catenary action of a sub model of LGS buildings

21. Regulatory Reform for Industralised Building

Project Lead: Prof. Perry Forsythe & Dr Sara Omrani | University of Technology Sydney & Queensland University of Technology

Problem / thesis

The construction industry is moving towards more industrialised practices, including offsite manufacturing of building components. However, current regulatory practices are not well suited to accommodate these industrialised practices.

This project aims to build on previous work and propose reform to recognise industrialised building practices. It seeks to address two main questions: how to improve current regulations to accommodate various industrialised practices and how to "future proof" the reform for upcoming innovations.

Outcome

This project recommended a coordinated national approach to regulatory reform, involving streamlined certification, harmonised state regulations and modernised compliance pathways.

Project Outcomes: https://building4pointzero.org/projects/21-regulatory-reform-for-industrialised-building/

List of partners:

A.G Coombs, Fleetwood Australia, Lendlease Digital, Queensland University of Technology, Standards Australia, Sumitomo Forestry Australia, Master Builders Association Victoria, Victorian Building Authority

List of researchers:

Sara Rashidian, Dr Brydon Wang, Prof. Robin Drogemuller, Assoc. Prof. Timothy Rose, Selnina Mayer

Date commenced and completed:

November 2023 – December 2024

Image credit: Shutterstock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

List of partners:

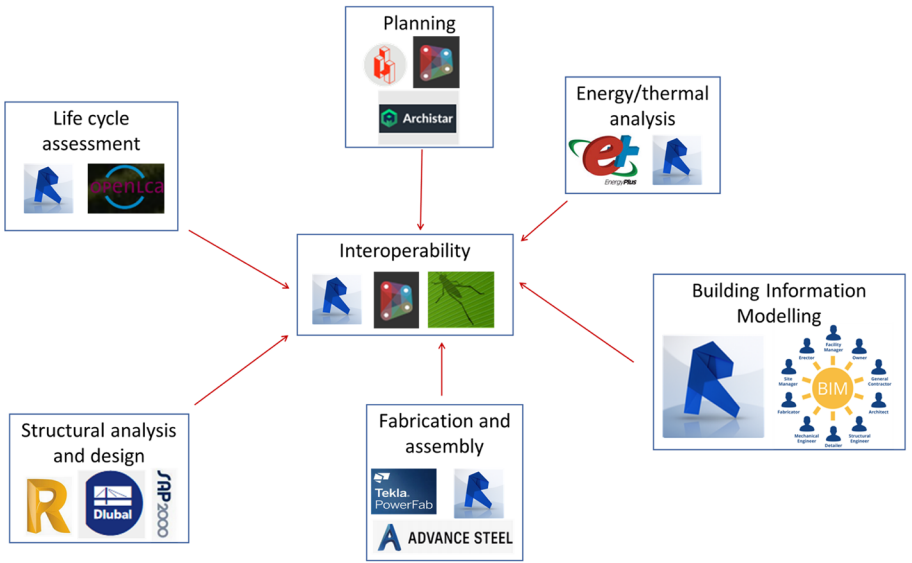
BlueScope , The University of Melbourne, Queensland University of Technology

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



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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

Image credit: Project 22 Poster (Abdallah 2022)

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:

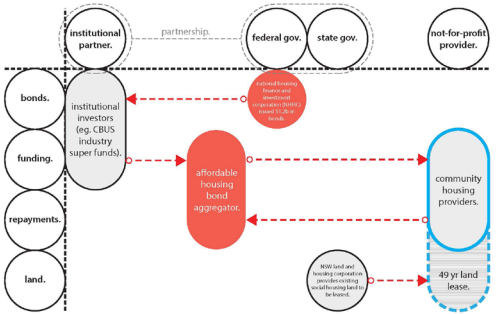
Fleetwood, Sumitomo Forestry,
Monash University, Queensland University of Technology

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



super PPP model (public private partnerships).

Image credit: Case study 1: BTR Cbus t Australian Housing Models

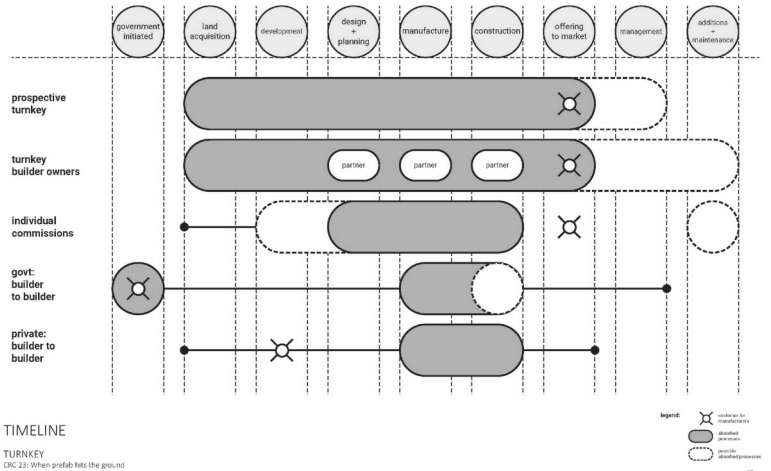


Image credit: Timeline Turnkey

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Cooperative Research Centres Program

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

Image credit: Stock Image (Tony McDonough)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 Outcomes: 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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 Outcomes: 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 completed:

June 2021– December 2022

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.

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

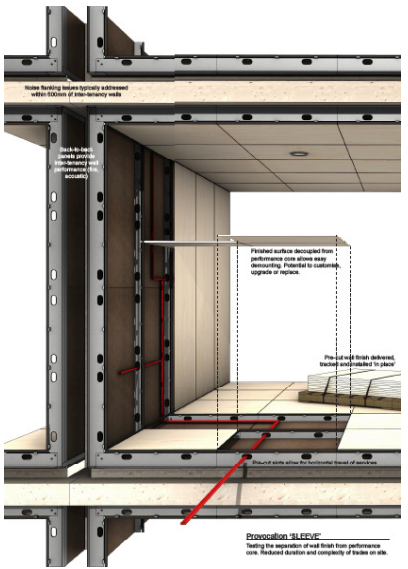

Image credit: Provocation SLEEVE: Testing the separation of wall finish from performance core. Reduced duration and complexity of trades on site.(Ayden Fiore 2022)

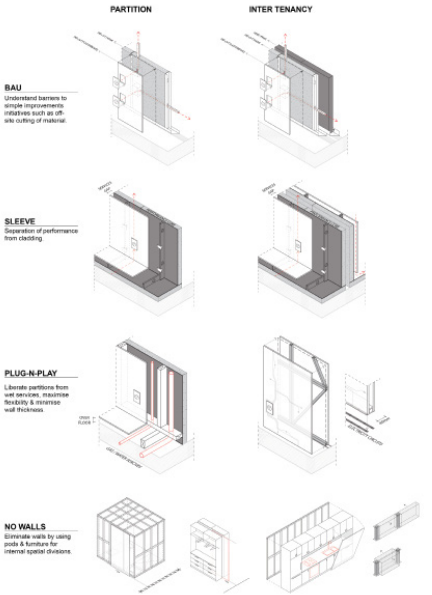

Image credit: Design principles for componentised and connected internal wall alternatives (Dani Tinios 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

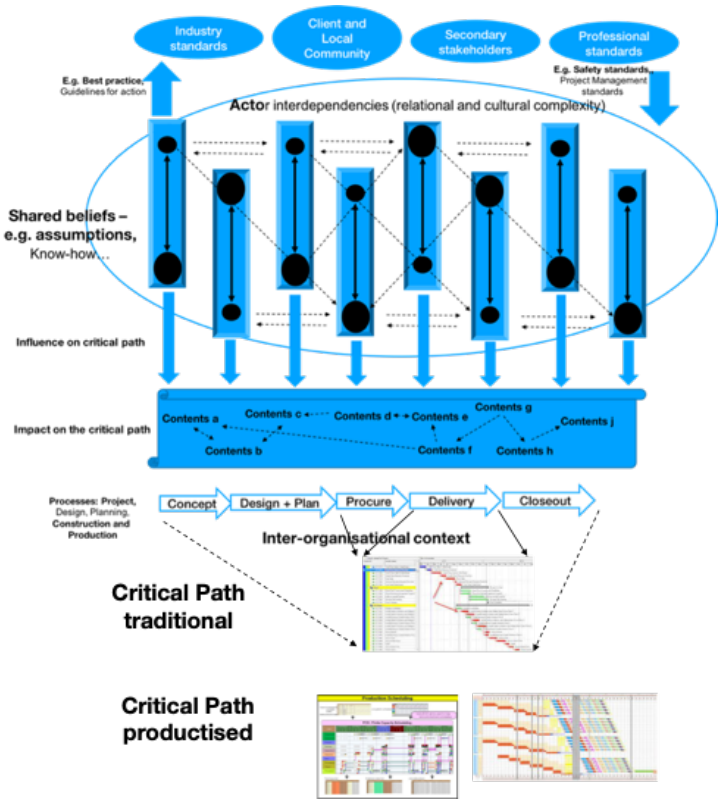

Image credit: Project visual abstract (Robert Moehler, 2022).

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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:

Lendllease 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

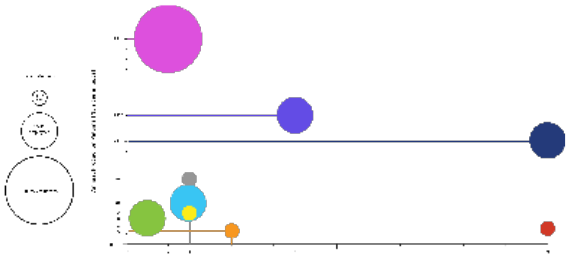

Image credit: Survey results: Age, size, and production volume of bathroom pod companies (Ivana Kuzmanovska, 2022)

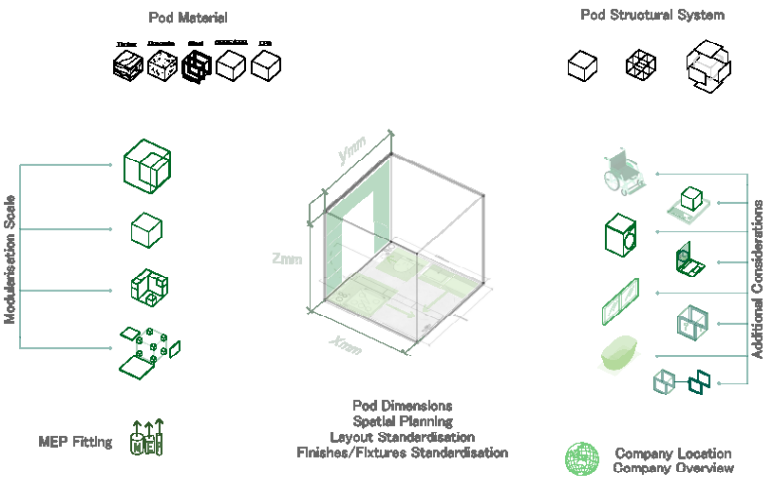

Image credit: Bathroom pod design considerations (Ivana Kuzmanovska, 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

3. Develop a guideline for the effective implementation of suitable technologies for remote building inspections.

Outcome

Outcomes from this project are expected to guide the implementation of technologies and workflows for remote building inspection. The potential to use remotely piloted aircraft systems (RPAS) is being explored in Project #90 (Evaluating the effectiveness of roofing work inspection using remotely piloted aircraft systems).

Project Outcomes: https://building4pointzero.org/projects/33-evaluation-of-emerging-technologies-for-remote-inspections-of-building-work/

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 completed:

June 2022 – July 2023

Image credit: Stock image (Alexander Andrews)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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%e2%80%90rise-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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

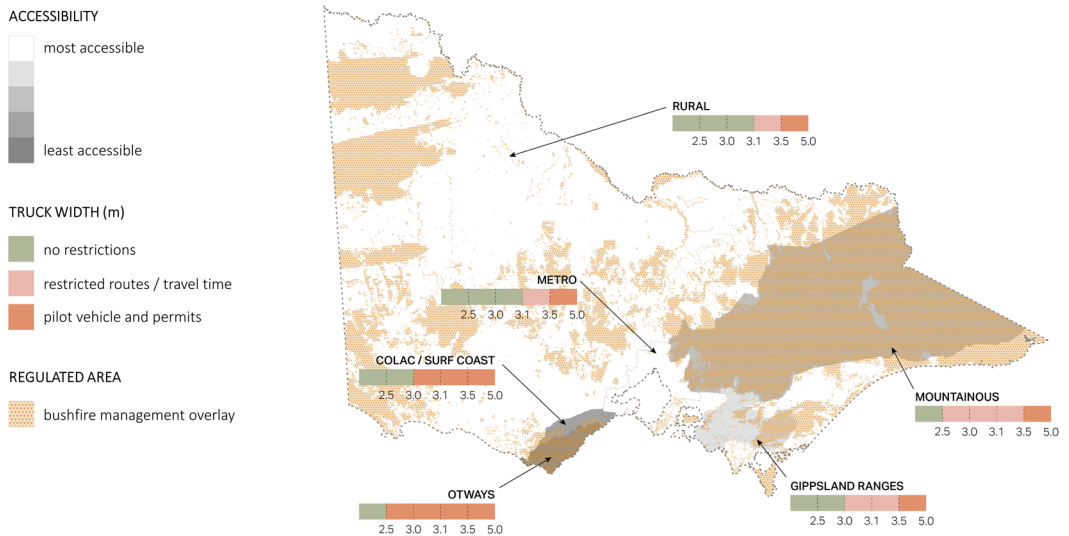

Image credit: Bushfire areas _ Transport access analysis (Tu Le, 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

Outcome

A journal article explored the effectiveness of the National Australian Built Environment Rating System (NABERS) and Green Star, initiatives to help the construction industry to meet energy targets. The article found that using certification systems can help close the energy performance gap by setting buildings up for high-energy performance through design and operation.

Project Outcomes: https://building4pointzero.org/projects/36-academic-validation-of-performance-gap-research-in-energy-rating-systems/

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 completed:

September 2022 – June 2024

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 completed:

February 2022 - November 2022

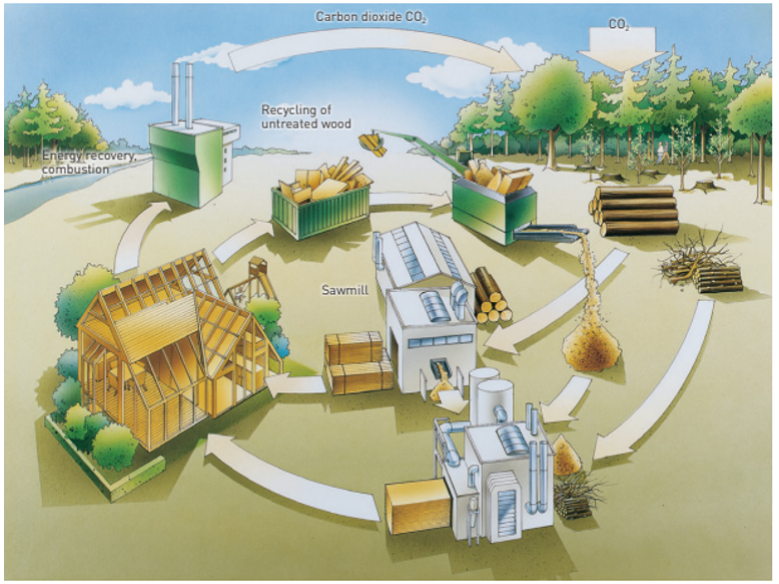

Image credit: CEI (Bois, 2009)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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. Offsite and modular construction hubs
2. Benefits of digital build
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.

Outcome

The project identified opportunities and challenges to establishing offsite construction hubs in Victoria.

Project Outcomes: https://building4pointzero.org/projects/38-victorian-government-digital-build-translating-theory-into-practice/

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 OHanlon, 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 completed:

June 2022 – August 2023

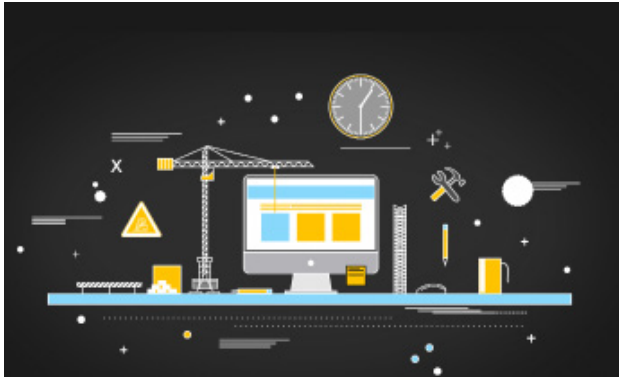

Image credit: Pavatex (Project Team, 2019)

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

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

40. Business Model Innovation: The Platform Ecosystem

Project Lead: Porf. 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 completed:

October 2022 – July 2023

Image credit: Stock Image by: Redd F

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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

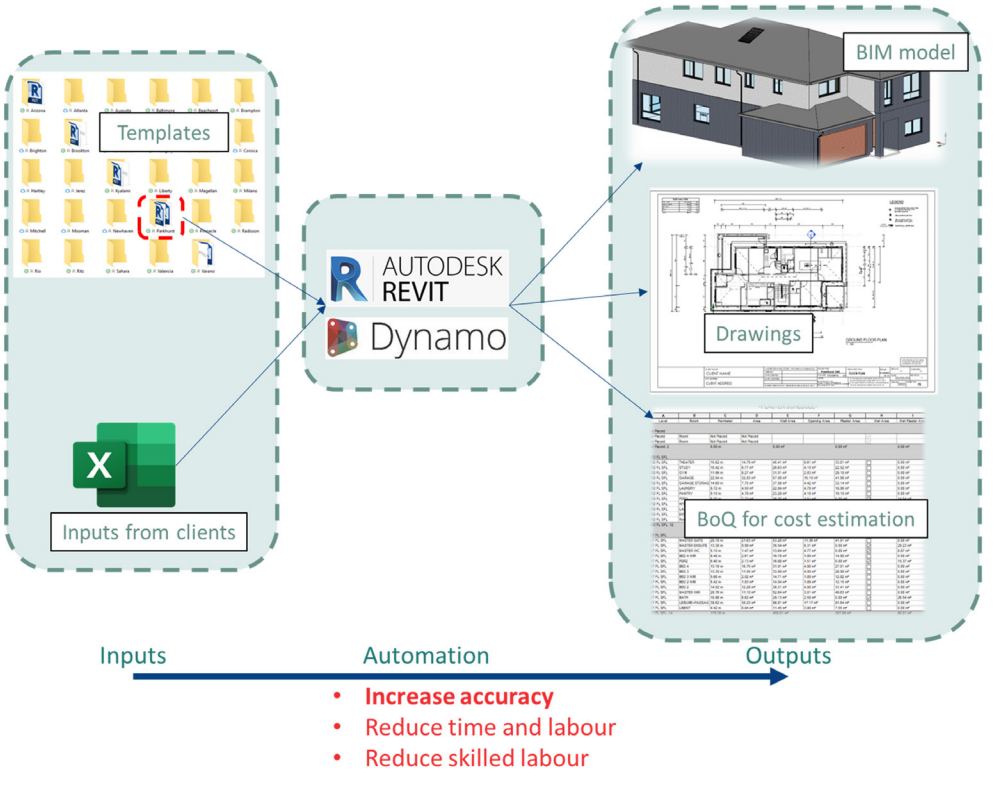

Image credit: Workplace Automation Tools for Residential Home Designs (Tu Le, 2022).

Australian Government Department of Industry, Science and Resources
Cooperative Research Centres Program

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 existing work to build a demonstration home that utilises a prefabricated wall system that delivers greater energy performance and lower supply chain risk with an integrated system

2. Better understanding the values of home buyers and the role that cost, energy performance and quality play in their decision making.

Outcome

This project applied a high-performance wall system to construct a demonstration home in Melbourne, showcasing constructability, performance and the aesthetics of the system.

Project outcomes: https://building4pointzero.org/projects/45-prefab-integrated-wall-system-phase-2-demonstration-house-and-market-study/

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 completed:

July 2022 – July 2024

Image credit: BuildSMART (BuildSMART 2016)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 completed:

October 2021 - October 2022

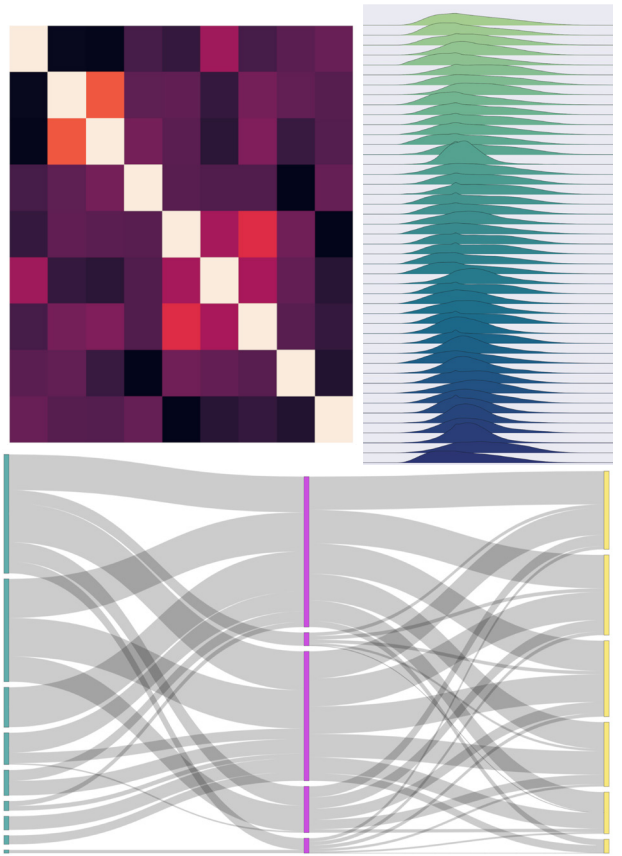

Image credit: Data Analytics (Steven Psaltis 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

47. Austrade: Future Building Technologies and Solutions

Project Lead: Isaac Coonan & Claire O'Leary 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, Utecture, 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 completed:

March 2022 - September2022

Image credit: Stock Image by: Redd F

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

Outcome

The final report sets out a roadmap and recommendations on the next stesp and actions for transitioning the building sector from a traditional linear economy — which follows a 'take, make, use, dispose' model — to a circular economy.

Project outcomes:
https://building4pointzero.org/projects/48-scoping-study-for-building-the-future-circular-economy-shared-interest-project/

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 Barner (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.

Date commenced and completed:

June 2023 – August 2024

Image credit: Stock Image: Volodymyrh Ryshchenko

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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 collaborated 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.

Outcome

The project proposed an iterative, feedback-driven process, where design decisions are continuously evaluated and refined based on feedback. It means designs can be adjusted and improved throughout the project's development.

Project outcomes:
https://building4pointzero.org/projects/57-wind-comfort-simulation-and-new-engineering-design-process/

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 completed:

July 2022 – December 2023

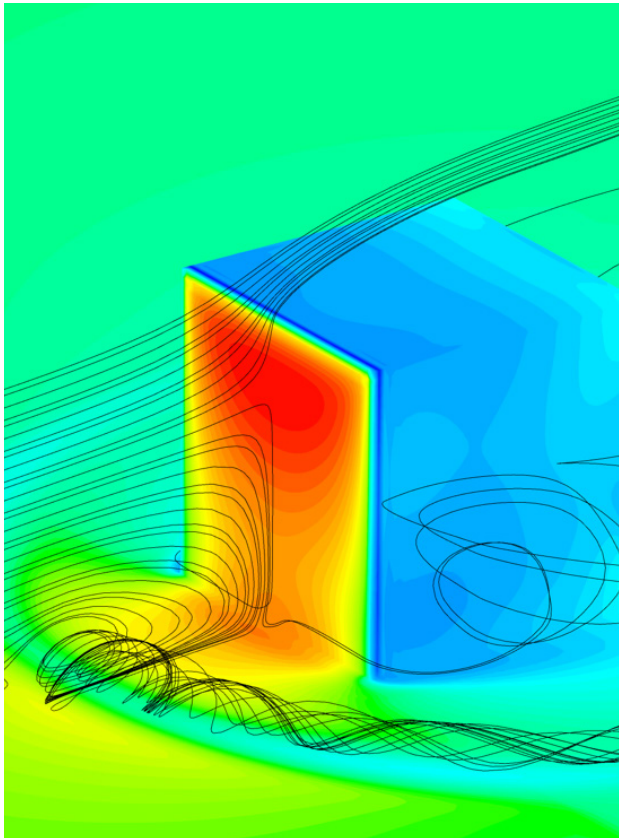

Image credit: CFD1 (Shibo Wang 2022)

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

68. Development of a solution for high-rise mass timber residences through a Post & Plate system – Phase 1 feasibility study

Project Leads: Dr Philip Christopher, Prof. Tuan Ngo | The University of Melbourne

Problem / thesis

This research centres on an innovative project to bring the Post & Plate timber structural system to Australia's multi-residential sector. The project comprises 4 elements:

- Reviewing in-depth precedent studies from around the world to extract critical engineering, compliance and construction insights
- Understanding Australian building typologies
- Conducting a targeted engineering and compliance review
- Making data-driven recommendations to adapt the Post & Plate system to Australia's unique architectural, regulatory and sustainability needs.

The research is designed for rapid deployment and aims to revolutionise high-density, sustainable living in Australia.

List of partners:

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

List of researchers:

Dr Alireza Chiniforush, Richard Nero, Karl-Heinz Weiss

Date commenced and duration:

January 2024, 3 months

Image Credit: Rothoblaas

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

70. Building Circularity 4.0: First Steps to Adoption

Project Lead: Claire O'Leary | Building 4.0 CRC

Problem / thesis

The Circular Economy Ministerial Advisory Group (CE-MAG) industry feedback workshop held on 25 May 2023 highlighted the gap in awareness and understanding about what circular economy really means, and how the industry can get involved. A key question from the session became:

'What practical things can the different actors in the industry do as a first step?'

To address this issue, Building 4.0 CRC proposed a project to develop a tool in collaboration with CE-MAG that the industry could turn to.

Outcome

The 'Building Circularity 4.0: First Stepts to Adoption' tool aims to promote circularity and sustainability in buildings and construction, generating economic and social benefits for stkaeholders and communities. It suggests actions each player int he building supply chain can take to embed circular economy principles in their operations and it provides links to further resources that could help grow understanding and awareness.

The wheel outlines all major key players in the building supply chain. Users select a chosen actor (e.g. Local Government) to see the suggested first step, and relevant references including industry reports, websites, books, online tools and research papers.

Project outcomes:
https://building4pointzero.org/projects/70-building-circularity-4-0-first-steps-to-adoption/

Date commenced and completed:

August 2023 – May 2024

Project party:

Circular Economy Ministerial Advisory Group (CE-MAG)

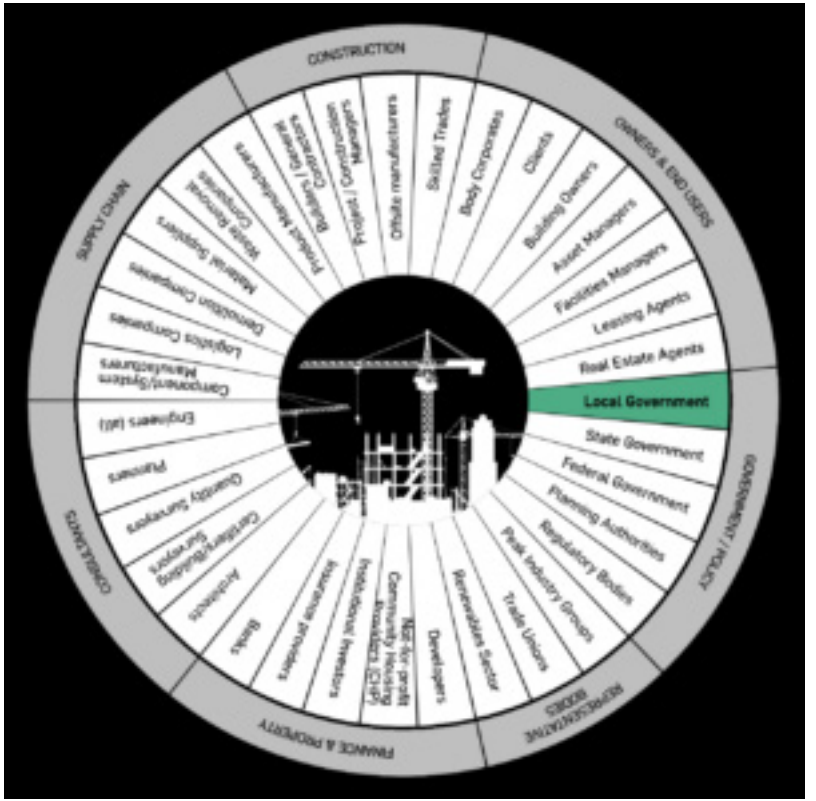

Image credit: Project team.

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103: Prefabricated, modular and offsite construction – Handbook

Project Lead: Fraser Paxton | Building 4.0 CRC

Problem / thesis

The current method of recording productivity on construction sites relies heavily on manual inputs limiting both accuracy and efficiency. This project will explore more automated and technologically advanced solutions that can provide real-time, accurate and unbiased data on on-site performance. Such innovations can not only streamline the data collection process but also free up labour resources to focus on essential construction activities, ultimately leading to more efficient and reliable project outcomes.

Outcome

The handbook provides guidance on achieving National Construction Code (NCC) compliance in buildings that use modern methods of construction (MMC). In particular, it clarifies the existing NCC compliance pathways available when using MMC in permanent buildings, structures and plumbing installations.

Project outcomes: https://building4pointzero.org/projects/103-abcb-handbook-for-ncc-compliance-using-modern-methods-of-construction/

Date commenced and completed:

August 2024 – October 2024

List of partners:

Australian Building Codes Board

Image Credit: Shutterstock

Australian Government
Department of Industry, Science and Resources
Cooperative Research Centres Program

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.

Outcome

The proje explored the benefits of developing a digital twin for the Monash Innovation Labs, focusing on energy-efficient heating, ventilation and air conditioning control and individual thermal comfort.

The final report outlines key lessons, suggests a digital twin design and development framework, and identifies future research directions.

Project outcomes: https://building4pointzero.org/projects/light-house-project-1-monash-smart-manufacturing-hub-msmh-a-digital-twin-living-lab/

List of partners:

Amazon Web Services, Monash University

Date commenced and completed:

July 2023 – July 2024

List of researchers:

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

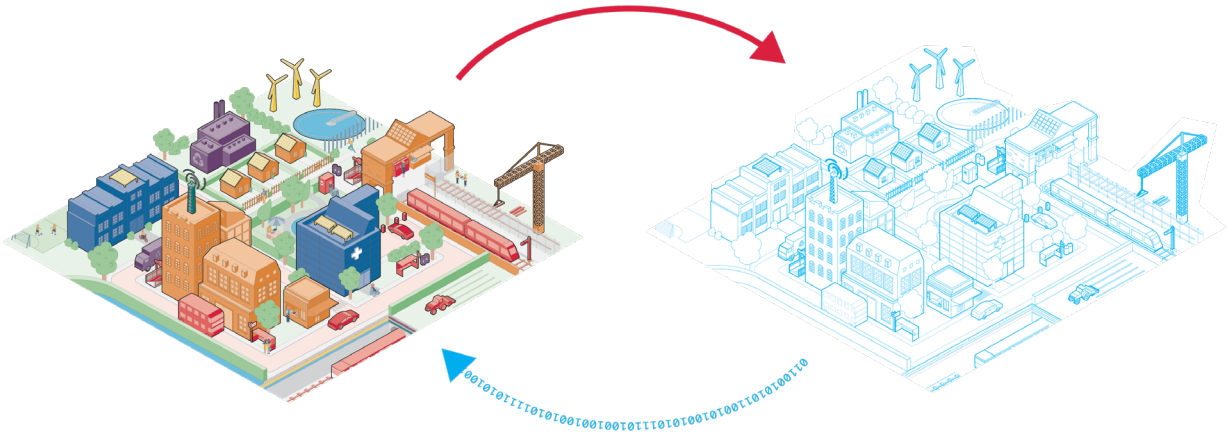

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Image Credit: Adapted from Burgess G, Enzer M, Schooling J et al. 'Flourishing systems' © 2020 Centre for Digital Built Britain and Centre for Smart Infrastructure & Construction, Cambridge. p. 11

Light House Project #13: Mixed Reality Carpentry

Project Lead: Dr Sahar Soltani & Dr Duncan Maxwell | Monash University

Problem / thesis

This project harnesses Augmented Reality (AR) and Virtual Reality (VR) to enhance prefabricated component assembly in carpentry and construction.

By integrating AR/VR tools like Twinbuild by Fologram, the project aims to improve training and upskilling process, assembly instructions, spatial awareness, quality control, and collaboration.

A real-time assembly of a complex timber pavilion at the Building 4.0 CRC Annual Conference will showcase these technologies' efficacy in addressing construction challenges.

Outcome

Using these technologies meant construction components could be effectively tracked and visualised. Students could start constructing the timber pavilion in less than 2 hours – a task that would typically take up to 3 days. These technologies also increased engagement, and allowed students to rapidly develop skills and undestand complex carpentry techniques.

Project outcomes: https://building4pointzero.org/projects/light-house-project-13-mixed-reality-carpentry-demonstration/

Date commenced and completed:

September 2023 – January 2024

List of researchers:

Project leads: Dr Sahar Soltani, Dr Duncan Maxwell

Researchers: Lisa Giusti Gestri, Darcy Zelenko

List of partners:

Ynomia, Holmesglen Institute, Monash University & Fologram

Image Credit: Fologram

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Light House Project #28: The application of computer vision to measure productivity and enhance safety on construction sites

Project Lead: Dr Philip Christopher | The University of Melbourne

Problem / thesis

The current method of recording productivity on construction sites relies heavily on manual inputs limiting both accuracy and efficiency. This project will explore more automated and technologically advanced solutions that can provide real-time, accurate and unbiased data on on-site performance. Such innovations can not only streamline the data collection process but also free up labour resources to focus on essential construction activities, ultimately leading to more efficient and reliable project outcomes.

Outcome

This project involved AI-powered monitoring of earth removal volumes, equipment utilisation, labour deployment and overall site activity. The final report identified recommendations to address challenges such as environmentla factors on site (e.g. glare, lighting conditions), omplex interactions between equipment and machinery types, and privacy concerns.

Project outcomes: https://building4pointzero.org/projects/light-house-project-28-the-application-of-computer-vision-to-measure-productivity-and-enhance-safety-on-construction-sites/

Date commenced and completed:

December 2023 – December 2024

List of partners:

Level Crossing Removal Project, Sightdata, University of Melbourne

List of researchers:

Prof. Tuan Ngo, Dr Paul Reichl, Dr Amir Soroush, Ed Muthiah, Jay Humble, Research Assistants

Image Credit: Sightdata

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Department of Industry, Science and Resources
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Active & Completed Projects Summary 1 of 4

BLACK TEXT = ACTIVE
GREY TEXT = COMPLETED

PEOPLE, PRACTICES & CULTURE

49	Implications of Industry 4.0 technologies on work practices	Holmesglen Institute, Lendlease Digital, A.G. Coombs, Master Builders Association of Victoria, Building and Plumbing Commission, The University of Melbourne
55	Towards smart contracts and smat finance in construction - Phase 1	Building and Plumbing Commission, Master Builders Association of Victoria, Holmesglen Institute, PT Blink, Queensland University of Technology
56	Accelerating B4.0CRC Translation and Impact	A.G Coombs, BlueScope Steel, Cruxes Innovation, Sumitomo Forestry Australia, The Master Builders Association of Victoria, Victorian Building Authority
66	Future of construction education	Holmesglen Institute, A.G. Coombs, Lendlease Digital, Victorian Building Authority, Nexans, Master Builders Association of Victoria, Sumitomo Forestry Australia, Fleetwood Australia, Monash University, The University of Melbourne
80	Why are insolvencies so high in the Construction industry and what can be done about it?	Building and Plumbing Commission, Master Builders Association of Victoria, Holmesglen Institute, Queensland University of Technology
97	Self Storage Association of Australasia Digital Platform Development	Self Storage Association of Australasia, Queensland University of Technology
102	SKills and training implications of modern methods of construction: Across design, manufacture and assembly	BuildSkills Australia, Monash University
111	VET Qualifications System and Training Framewok for modern methods of construction	Holmesglen Institute, Master Builders Association of Victoria, Monash University
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
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
21	Regulatory Reform for Industrialised Building	A.G Coombs, Fleetwood Australia, Lendlease Digital, Queensland University of Technology. Standards Australia, Sumitomo Forestry Australia, Master Builders Association Victoria, Victorian Building Authority
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
40	Business Model Innovation in the Building Industry: Better Buildings and Better Bottom Lines	AMGC, PrefabAUS, Monash University, University of Melbourne.
47	Promoting Capabilities and Opportunities for Future Building Technologies & Solutions	Austrade

Active & Completed Projects Summary 2 of 4

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SUSTAINABILITY

60	Mass Timber Wellness	VIRIDI Group, Sumitomo Forestry, Monash University Queensland University of Technology
84	Feasibility study of recycling excavated clay materials in full-scale concrete applications	M80 Ring Road Completion, Spark - North East Link, University of Melbourne
100	IEQ monitoring of Aboriginal Housing Office 3D printed houses	NSW Aboriginal Housing Office, Blue IoT, Queensland University of Technology
108	Project Circle Design Phase 1	Lendlease Development, University of Melbourne
5	Automatic compliance and energy rating system	uTecture, Green Building Council of Australia, The University of Melbourne, Monash University, Queensland University of Technology
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
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
36	Academic validation of performance gap research in energy rating systems	Green Building Council of Australia, Monash University
37	Australian Timber Fibre Insulation Scoping Study	Hyne & Son, The University of Melbourne, Ultimate Windows
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
70	Building Circularity 4.0: First Steps to Adoption	Circular Economy Ministerial Advisory Group (CE-MAG)

Active & Completed Projects Summary 3 of 4

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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
58	The Retrofit Housing Atlas	A.G. Coombs, Donovan Group, Fleetwood Australia, Holmesglen Institute, Hyne & Son, Master Builders Association of Victoria, Sumitomo Forestry Australia, Building and Plumbing Commission, Monash University, Standards Australia, Green Building Council of Australia
59	Innovative Steel - Timber - Concrete Composite StongFloor	VIRIDI Group, University of Melbourne
76	Thermally active floor panels for cost effective space cooling	Taphcore®, University of Melbourne
85	From digital design to human robot collaborative masonry construction	Brickworks, Queensland University of Technology
86	Sustainable 3D printed concrete for bespoke infrastructure	Everhard Industries, Queensland University of Technology
95	Homes NSW MMC Program	Homes NSW, Monash University, University of Melbourne, Queensland University of Technology
104	Development of a solution for high-rise mass timber residences through a Post & Plate system - Phase 2 numerical and experimental investigation	Sumitomo Forestry Australia, Hyne & Son, Cedar Pacific, 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
68	Development of a solution for high-rise mass timber residences through a Post & Plate system - Phase 1 feasibility study	Sumitomo Forestry Australia, Hyne & Son, University of Melbourne
103	Prefabricated, modular and offsite construction - Handbook	Australian Building Codes Board

Active & Completed Projects Summary 3 of 3

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DIGITALISATION

29	Real-time EH&S Intervention to Improve Site Safety (Scoping Study)	Lendlease Digital Australia, Monash University, The University of Melbourne
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
53	Process Engineering, and Design and Estimating Automation of Fleetwood's Product Platform	Fleetwood, Monash University, The University of Melbourne
61	Building Productvity: Product Proecess People	Lendlease Digital Australia, Monash University
71	Automated decision making for interdisciplinary coordination during early-stage building design	Lendlease Digital, A.G. Coombs, Monash University
90	Evaluating the effectiveness of roofing work inspection using remotely piloted aircraft systems	Building and Plumbing Commission, Holmesglen Institute, Master Builders Association Victoria, Sumitomo Forestry Australia, Univesity of Melbourne, Monash University
105	Blockchain-powered peer-to-peer energy trading: Advancing sustainability and affordability in smart residential communities	Web3in Tech-Lab, Monash University
112	Flexible wet cores for volumetric housing construction	Fleetwood Australia, 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
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
46	Data analytics for structural fibre resources optimisation	Hyne & Son Pty, Queensland University of Technology
57	Wind Comfort Simulation and New Engineering Design Process	Lendlease Digital Australia, Monash University
LHP1	Monash Smart Manufacturing Hub (mSMH) – A Digital Twin Living Lab	AWS, Monash University
LHP13	Mixed Reality Carperntry Demonstration	Ynomia, Holmesglen Intitute, Monash University & Fologram
LHP28	The Application of Computer Vision (Powered by Artificial Intelligence and Machine Learning) to Measure Productivity and Enhance Safety on Construction Sites	Sightdata, Level Crossing Removal Project, University of Melbourne