

2024

ANNUAL REPORT

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building
4.0 crc

CONTENTS

MESSAGE FROM THE CEO	1
HIGHLIGHTS AND ACHIEVEMENTS	2
RESEARCH UPDATE	4
COLLABORATION AND ENGAGEMENT	14
ANNUAL SHOWCASE	16
ANNUAL CONFERENCE	18
EDUCATION AND TRAINING	24
GOVERNANCE	27

MESSAGE FROM THE CEO

2024 has been a year of action for Building 4.0 CRC as we move to focus on solutions. With the housing crisis and cost of living pressures escalating, our work to innovate across the building sector has never been more important.

We are advancing a proactive and ambitious agenda to tackle the root cause of the building industry's productivity decline over the past 50 years – namely the lack of investment into innovation.



This year, our focus was on tackling the big issues – increasing housing supply, improving sustainability and growing industry capacity through skills and education. We also continued to increase the reach and awareness of our research across industry and government.

We launched our most significant research project yet – a research and development program with Homes NSW that leverages Modern Methods of Construction (MMC) to build more quality social housing faster and more efficiently than traditional approaches (Project #95). This collaboration will include live proof-of-concept projects to facilitate industry adoption of innovative housing methods.

Our Housing Innovation Showcase in June 2024 shone the spotlight on the 'possible', highlighting new materials, designs, products, processes, platforms and technologies that accelerate construction timelines, enhance safety and improve sustainability outcomes. The event attracted over 23 exhibitors and 220 participants from industry, research and government sectors. The Hon. Ed Husic MP, Minister for Industry and Science, and Josh Burns MP, Member for Macnamara, previewed the event onsite the week prior.

Central to all discussions on building innovation is regulation and safety, ensuring we have the right policies to protect the community but at the same time not stymie innovation and supply through unnecessary red tape. Project #21 (Regulatory Reform for Industrialised Building) reviews current regulations and proposes reforms to 'future proof' regulation for MMC. We are also working closely with the Australian Building Codes Board (ABCB) on how to improve National Construction Code compliance and regulation for offsite construction, following a request from the Building Ministers' Meeting in March 2024.

Our team collaborated on Project #70 with the Commonwealth Government Circular Economy Ministerial Advisory Group (aka CE-MAG) to develop the Building Circularity 4.0 Tool. This tool suggests actions each player in the building can take now to embed circular economy principles in their operations. This focus on circularity continues with Project #48 (Scoping Study for Building the Future – Circular Economy). The final report – released in November 2024 – outlined a roadmap and recommendations on the next steps and actions for the building industry to transition to a circular economy.

Skills and the labour market are two critical and escalating issues, demanding a strong focus on building additional educational pathways. Two current projects focus on creating the building workforce of the future:

- Project #49 (Implications of Industry 4.0 Technologies on Work Practices) – aims to understand how new building and construction technologies affect work practices, workforce training and working conditions.
- Project #66 (Future of Construction Education) – is developing contemporary, forward-looking industrialised construction courses, by highlighting the skills and training required to meet the industry's changing landscape.

The Executive Team and researchers are increasing the reach and awareness of our research by presenting at high-profile international and national speaking engagements and conferences, including the Industrialized Construction Forum at Stanford University in February. We also hosted the third Building 4.0 CRC Annual Conference in September 2024, attracting eight international keynote speakers, 18 expert industry panellists and 230 attendees.

We recognise the best learnings come when we share challenges and solutions, globally and locally, and we facilitate opportunities for industry members to come together and build their knowledge. In February, 28 participants joined our research tour of industrialised construction companies and researchers in the San Francisco and Greater Bay area.

To facilitate deeper understanding and collaboration, we created a new initiative – monthly Building 4.0 CRC Knowledge Shares. These forums allow our partners to engage with and hear from business and government leaders and innovators on the key issues and trends facing the building and construction sector.

As Building 4.0 CRC enters year five of its seven-year life, we will continue to drive innovation in building. Our team will allocate the remainder of our funding towards the pipeline of outstanding projects we have developed until now.

We thank our partners from industry, government and research for another year of hard work. We are excited by the promise of what we can achieve together in 2025.

BUILDING 4.0 CRC MAJOR ACHIEVEMENTS

69 projects launched since CRC began:

14 projects launched in 2024

44 projects completed



International Research Tour of San Francisco and the Greater Bay Area



The inaugural Building 4.0 CRC Lifetime Achievement Award **presented to Dr Keith Hampson**

Annual Conference –
Making it Happen

230 attendees
8 international speakers
18 expert panellists



Annual Showcase –
Housing Innovation

220 attendees
27 exhibitors
4 expert panellists

147

Masters level researchers during FY23-24, bringing the total to 808 students to date

20

Elevator Initiative members

Prof. Mathew Aitchison awarded an **Honorary Fellowship** from the Australian Institute of Architects

28 industry, government and academic delegates
14 site visits (e.g. UC Berkeley, Stanford University, Autodesk, Factory OS, Google, Volumetric Building Companies)
3 tour delegates presented at the Industrialized Construction Forum at Stanford University

11

PhD students awarded their doctorates
4 employed in industry
7 continuing their academic careers

39

current partners– industry, project, research, government
46 partners altogether to date

400+

trainees impacted as an outcome of augmented reality/virtual reality simulation techniques from Project #12

Building 4.0 CRC profiled in Monash University report on mission-oriented initiatives that articulate bold problems, seek transformational change and combine research with societal impact.

RESEARCH UPDATE

As we shift our focus to the remaining three years our research ambitions are directed towards achieving maximum impact and world-class research outcomes.

With the 69 projects we have begun to date, Building 4.0 CRC has demonstrated leadership and advocacy. These projects are helping to address national strategic priorities including housing availability, decarbonisation, circularity and productivity.

We are building on these successful projects, creating lasting, durable evidence of our efforts in the form of significant lighthouse projects.

**PROF. CHRIS KNAPP, RESEARCH DIRECTOR,
BUILDING 4.0 CRC**

The CRC launched 14 projects during 2024. Cumulatively, we launched 69 projects in our first 4 years, 44 of which are now completed (see over). The project pipeline currently stands at 50 projects – 34 research projects, 15 Lighthouse projects and 1 shared interest project.

Project #95 (The Homes NSW MMC R&D Program) was launched, our largest and most substantial R&D research project to date. This \$4 million program with Homes NSW aims to build quality social housing faster than traditional approaches. See Case Study 1 for more information.

Several projects focused on embedding circular economy principles in the building industry.

- Project #70 (Building Circularity 4.0 Tool) was a collaboration with the Australian Government Circular Economy Ministerial Advisory Group. The tool promotes circularity and sustainability in building and construction, by suggesting actions each player in the supply chain can take to embed circular economy principles. See Case Study 3 for more information.
- Project #48 (Scoping Study for Building the Future – Circular Economy) – the first shared interest project – developed a circular economy roadmap for Australia's property and construction industry. The roadmap recommends actions to facilitate the genuine collaboration and partnership along the supply and value chain needed to create a circular economy in building – if stakeholders shift environmental or economic burdens to other stakeholders, the circle is in danger of breaking and the circular economy system will collapse. The study also highlights key gaps and future research areas.

Another Lighthouse Project began – real buildings that pair built or to-be-built projects with market leading industry partners. LHP#3: National Centre for Healthy Ageing (NCHA) Independent Living Lab. The Living Lab provides a simulated home environment for multidisciplinary research, testing and demonstration of integrated spatial, assistive technology and care models for healthy living and ageing. It aligns with key research questions about how modular and prefabricated production can create new innovations in living environments for ageing.

B4.0CRC PROJECTS BY RESEARCH THEME

Digitalisation (n=23)

- 01 - e-Planning / e-Approvals Phase 1
- 02 - Automated tracking of materials for improved supply chain logistics*
- 04 - Computational Design & Optimisation Tools for Prefab Building Systems
- 06 - Field data collation to support real-time operational management
- 11 - Environmental Credentials for Building Technology Platforms*
- 12 - VR/AR Technologies in Vocational Education / Training
- 22 - Design Automation methods for Steel Framed Buildings Phase 1
- 31 - Demystifying Volumetric Construction: A Study of the Bathroom Pod
- 33 - Remote Compliance Inspections*
- 38 - Victorian Govt Digital Build
- 42 - Workflow Automation Tools for Home Designs
- 46 - Data analytics for structural fiber resources optimization*
- 57 - Wind Comfort Simulation and New Engineering Design Process
- LHP 13 – Mixed Reality Construction Demonstration
- 29 - Real-time EH&S Intervention to Improve Site Safety
- 44 - Generative Architectural Design Engine
- 49 - Implications of Industry 4.0 Technologies on Work Practices
- 50 - Automated Cloud Based Residential Energy Estimations*
- 53 - Automated Design Optimisation and AI Tools for Prefab Systems (Ext to 4)
- 71 - Automated Decision-Making During Early-Stage Building Design
- 85 - From Digital Design to Human Robot Collaborative Masonry Construction
- 105 - Blockchain-powered peer-to-peer energy trading: Advancing sustainability and affordability in smart residential communities
- LHP 01 – Monash Smart Manufacturing Precinct
- LHP 28 – Computer vision to measure productivity and enhance safety

Industrialisation (n=21)

- 03 - Projects to Platforms
- 08 - Prefab, Integrated Wall Systems - Scoping Study
- 10 - Product Platform for Volumetric Building - Scoping Study
- 17 - Implication of Industry 4.0 for the construction industry: smart prefab
- 19 - Hybrid Timber-Steel Structural Systems for Mid to High Rise Buildings*
- 20 - Systems & methods for robustness of mid-rise Light Gauge Steel buildings
- 23 - Prefab: Barriers & opportunities in the Australian housing market
- 25 - Framework of steel fabrication & processing in the OSM & prefabrication
- 26 - New materials for windows of the future
- 28 - Componentised Internal Wall Systems for multi residential applications
- 34 - Acoustic flanking (Scoping Phase 1)
- 45 - Prefab Wall Integrated System Demonstration House & Market Study
- 47 - Future Building Technologies and Solutions
- 24 - Robust and Fire-resilient Light Gauge Steel Systems for Mid-Rise Buildings
- 32 - Acoustic Flanking performance of mid-rise Light Gauge Steel (LGS)
- 41 - New Materials for Windows of the Future
- 61 - Building Productivity – Product, Process, People
- 95 - The Homes NSW MMC R&D Program
- LHP 03 - Independent Living Lab (NCHA)
- LHP 06 - Malvern East Apartment Development
- LHP 07 - Platform Delivery of Affordable Housing

People, Practices & Culture (n=16)

- 02 - Auto tracking of materials for supply chain logistics and provenance*
- 09 - Implementing DfMA & Lean Construction Principles
- 15 - Resource optimisation Studies: Forest to Building
- 30 - Critical Path IMPACT through Productisation
- 33 - Remote Compliance Inspections*
- 40 - Business Model Innovation in the Building Industry
- 65 - European Research Tour
- 93 - US Research Tour
- 99 - Showcase 2024 Prototyping
- 21 - Regulatory Reform for Industrialised Building
- 29 - Applying Artificial Intelligence for Safety on Construction Sites
- 56 - Training and Optimising CRC Research in Construction
- 60 - Mass Timber Wellness
- 66 - Future of Construction Education
- 97 - SSAA Digital Platform Development
- 103 - ABCB Handbook for NCC compliance using MMC

Sustainability (n=16)

- 05 - Automatic compliance and energy rating system
- 11 - Environmental Credentials for Building Technology Platforms* 18 - Long-span Low-Carbon Floor Systems (Scoping Study)
- 19 - Hybrid Timber Steel Structural Systems for Mid to High Rise Buildings*
- 27 - Environmental Decision-Support for Structures
- 35 - Prefab Housing Solutions for Bushfire & Disaster Relief
- 36 - Academic validation of performance gap research in energy rating
- 37 - Aust Timber Fibre Insulation Scoping Study
- 46 - Data analytics for structural fibre resources optimisation*
- 68 - Post and Plate CLT Scoping, Optimisation, and Testing
- 48 - Shared Interest Project: Circular Economy
- 50 - Automated Cloud Based Residential Energy Estimations*
- 59 - Innovative Steel-Timber-Concrete Composite StrongFloor
- 84 - Feasibility study of recycling excavated clay materials in concrete
- 86 - Sustainable 3D printed concrete for bespoke infrastructure
- 100 - Aboriginal Housing Office 3D printed homes

White - completed projects

Black - active projects

*project is listed across multiple themes

PROJECT #95: THE HOMES NSW MMC R&D PROGRAM

PROGRAM #: 2 | **DATE COMMENCED AND DURATION:** May 2024, 12 months

PROJECT LEADS: Professor Mathew Aitchison, Belinda Ngo (Building 4.0 CRC)

PROJECT PARTIES: Homes NSW, Monash University, University of Melbourne

THE INDUSTRY PROBLEM

The shortage of affordable and quality housing in Australia is exacerbated by slow and costly traditional construction methods. Modern Methods of Construction (MMC) or Industrialised Construction is emerging as a viable solution to deliver high-quality buildings more efficiently and cost-effectively.

THE SOLUTION

The project aims to develop strategies and methods to utilise MMC in Homes NSW projects. The intent is to deliver more social housing faster with increased benefits for Homes NSW and their tenants.

The project addresses:

- Quality of housing solutions
- Speed and efficiency of housing delivery
- Cost and value for money
- Tenant satisfaction and experience
- Sustainability and resilience
- Operations and maintenance.

It comprises 3 interdependent research streams.

Stream 1: Land, Housing Types, Residents

This stream will identify priority sites and design criteria for a 4–6 storey apartment model to be developed and tested in Stream 2. It will also develop a framework for identifying replicable development opportunities for low- and medium-rise dwelling typologies that can support the longevity of the MMC Program. Recommendations for the MMC Program will be based on a survey of the existing Homes NSW portfolio of assets, an examination of future housing needs, opportunities for land use, dwelling design guidelines and relevant planning frameworks. This research will help to determine the location of the pilot projects to be delivered within the program.

Stream 2: Product, Supply Chain, Platform

This stream will focus on an MMC approach to delivering quality buildings efficiently. It will propose a kit-of-parts system that building designers can configure into a range of different project outcomes. Initially, the kit of parts will support one typology with the intent to expand to further typologies later. The primary goal is to achieve economic efficiencies while attaining the design standards and product requirements set by Homes NSW. This stream will also establish whether there is a viable supply chain to support future deployment of such a system and that this system can be eventually developed into a platform of processes, rules, tools, parts and supply options.

Stream 3: Change Management and Housing Delivery

This stream will deal with the anticipated difficulties that arise when implementing new solutions for housing delivery. The team will engage with all stakeholders to ensure they understand and share the purpose and strategies of the MMC Program. The MMC Program will require the building value chain to interact and transact differently, creating new roles and responsibilities for actors involved in housing delivery. This includes changes to risk management, procurement, contracts and commercial arrangements. The process and organisation of building delivery will also change, requiring new internal and/or external teams to manage housing delivery. Finally, educational initiatives will ensure the industry can understand how to grow and adapt, and skills and training initiatives will upskill the workforce who will deliver new housing.

Proposed Delivery Process

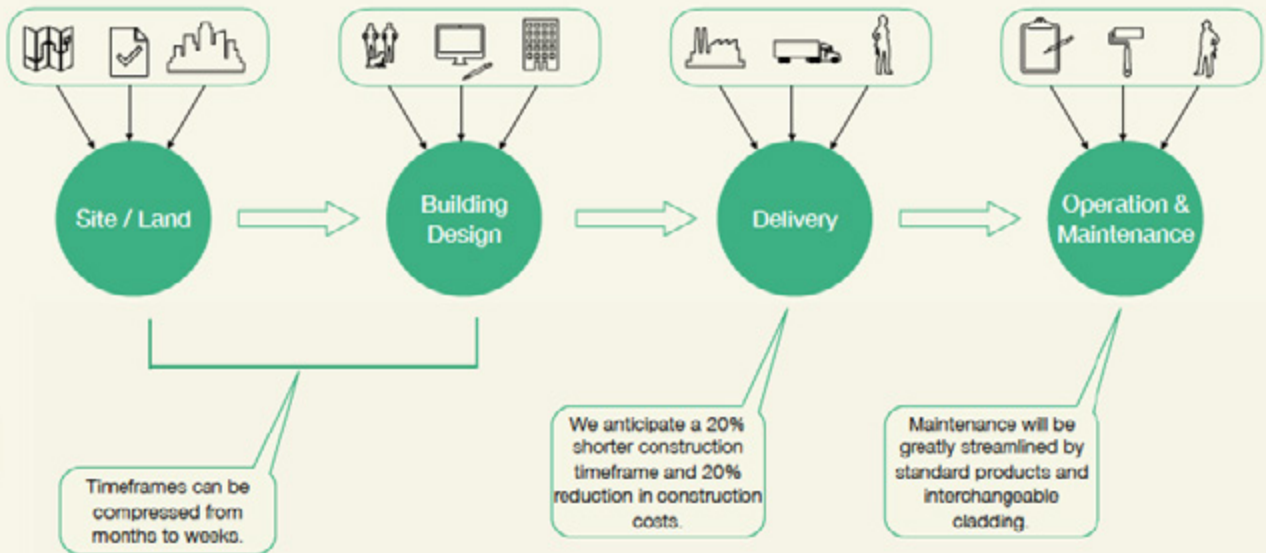


Figure 1: Kit-of-parts approach to delivering housing using MMC



By investing in innovative construction methods, we're not only increasing housing supply but also ensuring that our communities have access to safe and sustainable homes. Innovative initiatives like the MMC program are essential as we strive to meet the diverse housing needs of our residents, and by embracing cutting-edge technology and collaboration, we're building a stronger, more resilient housing sector for generations to come.

HON. ROSE JACKSON MLC, MINISTER FOR HOUSING AND HOMELESSNESS

Not One-Size-Fits-All Approach

Commonality of parts across different building typologies

Asset type	Location	Market diagnostic	Delivery methodology
 Secondary Dwelling	Inner urban Outer urban Regional Remote	Labour Materials Manufacturing Knowledge	Volumetric modular Flat-Deck Componentised
 Standard key worker housing	Inner urban Outer urban Regional Remote	Labour Materials Manufacturing Knowledge	Volumetric modular
 Urban duplex	Inner urban Outer urban Regional Remote	Labour Materials Manufacturing Knowledge	Volumetric modular Flat-packed
 Low-rise flats	Inner urban Outer urban Regional Remote	Labour Materials Manufacturing Knowledge	Flat-Deck Componentised

WHAT'S NEXT

In addition to this project focused on scoping, strategy and development, Homes NSW, in collaboration with Building 4.0 CRC, will demonstrate the application of the MMC Program on a series of live Proof-of-Concept projects to further facilitate and support industry adoption of innovative methods of housing delivery.

CASE STUDY

PROJECT #50: DEVELOPMENT OF ARTIFICIAL NEURAL NETWORK AND AUTOMATED LIFE CYCLE ASSESSMENT FOR CLOUD-BASED RESIDENTIAL ENERGY ESTIMATIONS

PROGRAM #: 1 | **DATE COMMENCED AND DURATION:** April 2023, 30 months

PROJECT LEAD: Dr Philip Christopher (University of Melbourne)

PROJECT PARTIES: Utecture Australia, University of Melbourne, Monash University

THE INDUSTRY PROBLEM

Current approaches to assessing the energy efficiency of homes in Australia and New Zealand have shortcomings:

- In Australia, accredited energy assessors manually assess the energy performance of residential buildings, based on building specifications and plans. This inefficient process is repeated every time the plans or specifications change.
- In New Zealand, building energy performance simulations are not typically required for compliance, leading to less efficient outcomes. Even if consumers desire a high-performance home, no easily deployable method exists to estimate or benchmark their new home's performance.
- Current methods of estimating embodied carbon in materials involves inputting a significant amount of data into external online tools. The time involved means this task is rarely done for new homes.

This tool has the potential to provide tangible benefits for the building industry and its clients – streamlined compliance processes (that save time and money) and more informed decisions about the trade-offs between energy efficiency and cost. But it can also provide tangible benefits for the environment and communities by reducing the amount of operational energy and embodied carbon in the built environment.

GAVIN TONNET, DIRECTOR AND CHIEF OPERATING OFFICER, UTECTURE AUSTRALIA

THE SOLUTION

This project aims to develop a cloud-based artificial neural network for new home operational energy efficiency and embodied carbon. Such a tool will provide near real-time feedback on the estimated energy performance and embodied carbon of a new home. Using this information, designers, builders and clients can make better informed decisions about sustainability, cost and performance.

- **Artificial neural networks (ANNs) that can estimate the energy demand of each home** – Housing models developed as part of this project will use NatHERS certified software to train artificial neural networks that can estimate the energy demand of each home. These models will extend existing models from The University of Melbourne using Utecture's common floor plans and publicly available plans.
- **Estimates of low embodied carbon building alternatives** – To provide real-time feedback on low embodied carbon building alternatives within Utecture, the project will identify and evaluate existing life cycle inventory databases for Australia and New Zealand. Gaps will be covered by extracting data from state-of-the-art databases adapted to reflect Australian and New Zealand production systems. Carbon emissions will be extracted from official country statistics and then applied to the extracted production systems, focusing on the product stage of the building.

PROPOSED WORKFLOW

1. New home is sketched in Utecture with key construction materials, orientation and location defined
2. Utecture calls API which runs Artificial Neural Network (ANN) and LCA
3. ANN Returns NAtHERS Star Rating in Australia and energy use in MJ/m² in New Zealand accurate to ~ 5% and LCA results
4. Annual emissions and costs to run the home are estimated and provided to the designer
5. Designers can iterate and optimise design to create cost effective, efficient and sustainable housing
6. When finalised the design is sent for final accredited certification and compliance

WHAT'S NEXT

The project team is currently expanding the model into other climate zones around Australia and New Zealand. There are two main opportunities for further extension:

- include other building uses, such as data centres or commercial offices
- explore implementation pathways in markets such as the United States and Japan.

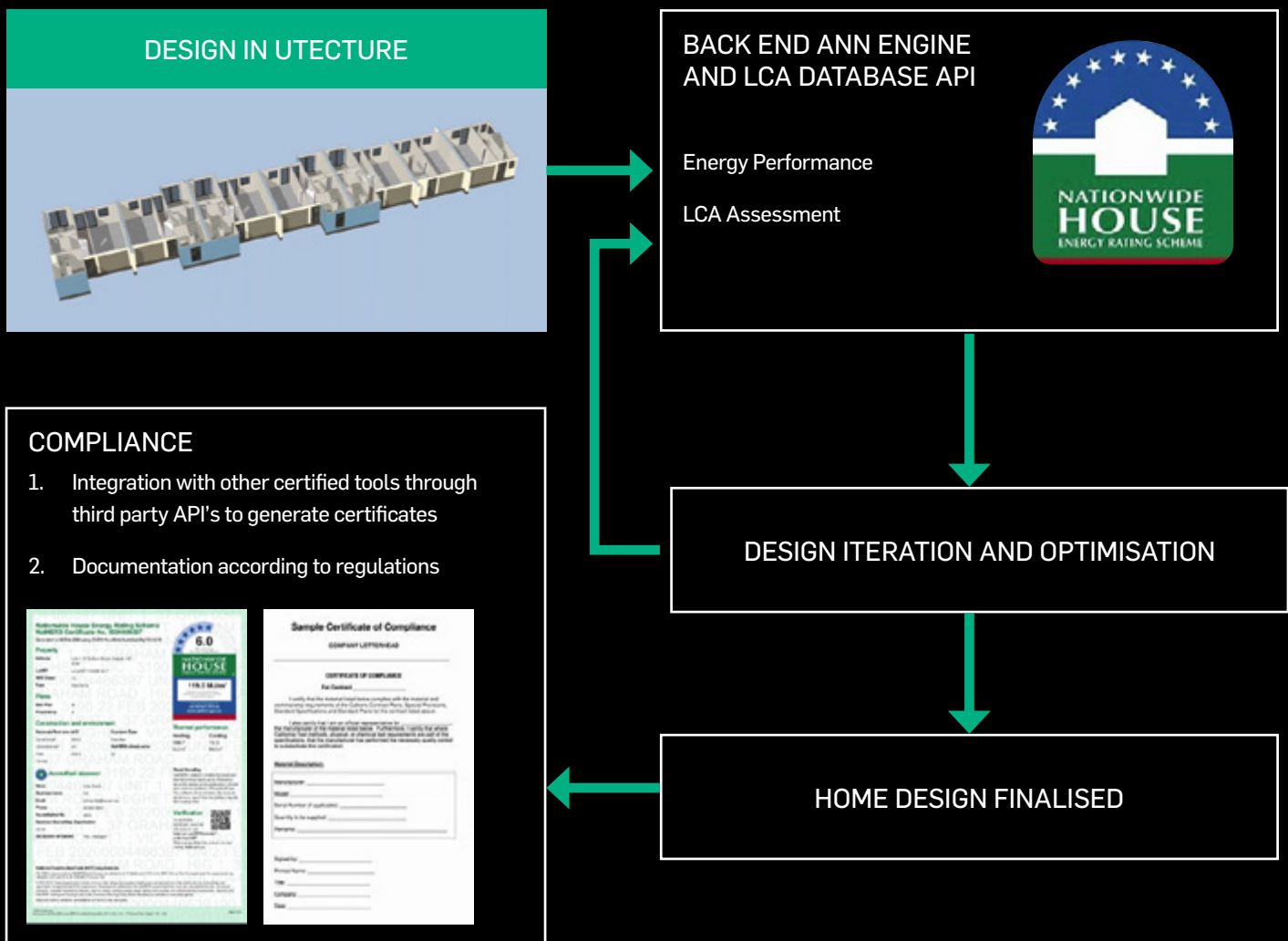


Figure 1: Proposed approach to applying the ANN and LCA tool.

PROJECT #66: FUTURE OF CONSTRUCTION EDUCATION

PROGRAM #: 3 | **DATE COMMENCED AND DURATION:** January 2024, 12 months

PROJECT LEADS: Professor Chris Knapp (Building 4.0 CRC), Dr Siddhesh Godbole (University of Melbourne), Jean-Paul Rollo (Monash University)

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

THE INDUSTRY PROBLEM

New materials, products, processes and paradigms can help deliver high-quality buildings at a lower cost. But, these new methods of designing and delivering buildings highlight the gap between current education and training approaches and the skills and competencies required in the future:

- **Skills gap:** Current education in construction management, building surveying, design and skilled trades lags behind emerging technologies and paradigms.
- **New skills:** Digital modeling, data analysis, automation, green building practices, energy efficiency and renewable resources require updated training.
- **Australian context:** Adoption of prefabrication, digitalisation and automation reveals gaps in training, certification, regulation, manufacturing and supply chain management and accreditation.

This project will provide valuable insights for higher education institutions – universities and vocational education providers – developing contemporary, forward-looking industrialised construction courses, by highlighting the skills and training required to meet the industry's changing landscape. It will have implications for construction education in Victoria and nationally.

DR HENRY POOK, DIRECTOR, CENTRE FOR APPLIED RESEARCH AND INNOVATION, HOLMESGLEN INSTITUTE

THE SOLUTION

This project aims to develop the new educational programs and approaches essential to address these issues and resolve the skills shortage in the construction sector.

It comprises three streams.

- **Stream 1: Context, Benchmarking and Content** – This stream will establish the gaps in knowledge and education for Australia, with benchmarking against global best practice. It involves engaging with stakeholders (building and construction businesses and education providers) to understand their needs and perspectives, conducting market research on broader Australian industry perspectives and exploring new educational approaches.
- **Stream 2: Degree Mechanics** – This stream will develop and gain approval for a new bachelor's degree program. It involves understanding current accreditation requirements and peak body competency frameworks.
- **Stream 3: Broader Program Development/Framework** – This stream will develop a framework for education that contextualises the bachelor's as a 'foundation' within a schema from diploma level through to post-professional masters.

The expected outcomes of the project are:

- a new degree program that aligns with the identified needs, forecasts and benchmarks, ensuring it is up to date and industry relevant
- subject matter modules that delve into specific subject matters, blending traditional and contemporary content to cater to a broad spectrum of learners
- a clear and actionable framework document and guidelines that cater to both industry professionals and educators, aligned with a roadmap for the broader education sector from trainees to PhDs.

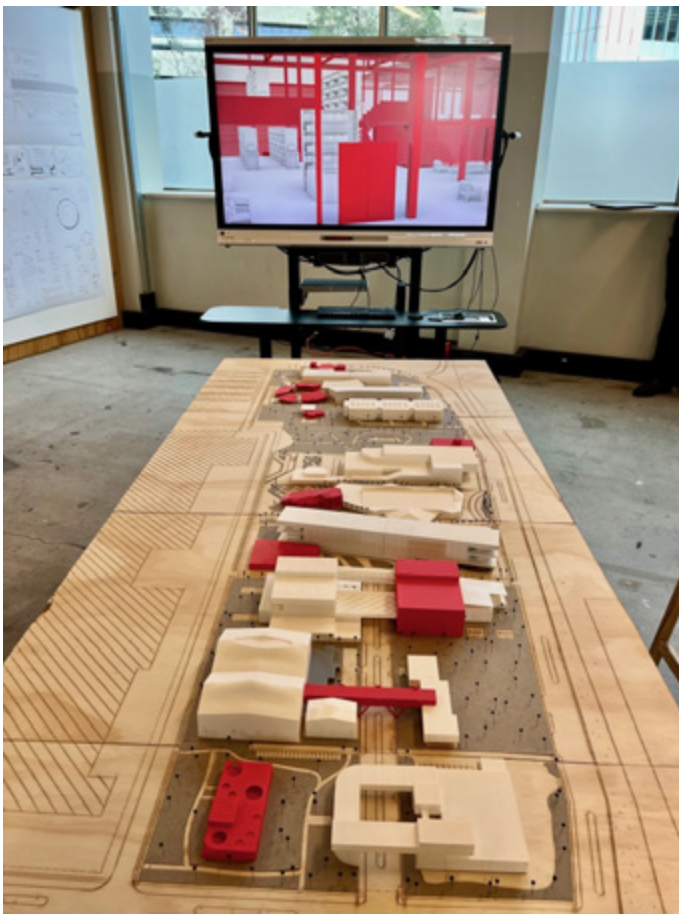


Figure 1: Exploring the future of the construction workplace and worker – Masters studio, Monash University

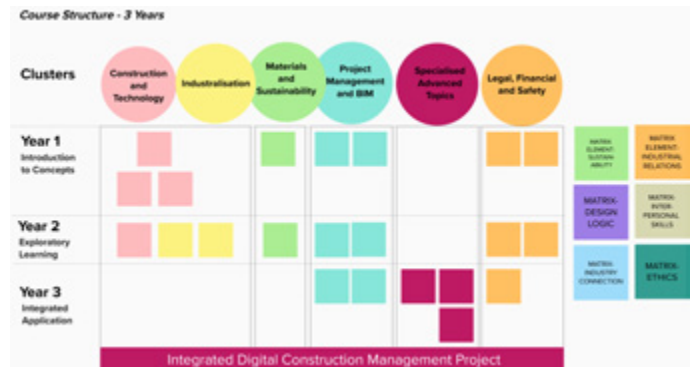


Figure 2: Matrix of content for proposed Bachelor's degree

WHAT'S NEXT
 Formal submission of the Bachelor of Digital Construction and Management to the Tertiary Education Quality and Standards Agency is slated for September 2024 with enrolments to follow in mid-2025. Final report planned for December 2024.

Digital Construction Specialist

This case study features an individual who entered the construction industry through a background in computer science. They specialised in Building Information Modelling (BIM) and digital construction tools.

This career path illustrates the increasing role of technology in construction and the opportunities available for tech-savvy professionals to lead innovation within the industry.

Educating Tomorrow's Workforce: The Future of Construction Careers

jean-paul.m@monash.edu | Switch accounts

Not shared

Career Journey

The following questions map out your career trajectory, highlighting pivotal moments and providing a chronological framework for the case study.

Can you describe your career path leading to your current position in construction, including any roles outside the construction industry?

Your answer

What key decisions or opportunities shaped your journey? (Select all that apply)

- Pursuing advanced education (e.g., Master's degree, certifications)
- Gaining experience through various roles
- Networking and building industry connections
- Taking on leadership roles
- Participating in industry-specific training programs
- Joining professional associations or organisations
- Relocating for better opportunities
- Engaging in innovative projects or technologies

Alternative Pathway: Construction Labourer to Digital Construction Manager

Starting as a construction labourer, this individual gained hands-on experience in the field, which provided a deep understanding of construction processes. Motivated by the growing impact of technology in the industry, they pursued further education in digital construction tools, such as 3D modelling and digital project management. This led to a new role as a Digital Construction Manager, where they now oversee the integration of advanced technologies, such as BIM and IoT, into construction projects.

This journey demonstrates how traditional construction roles can evolve with the adoption of digital skills, enabling professionals to lead in the era of Building 4.0.

Architects to Sustainability Specialist

This case study involves an architect who began their career focusing on traditional building design. Over time, they developed a keen interest in sustainability, particularly in environmentally sustainable design (ESD). They pursued additional training in sustainable materials and green building practices, eventually transitioning into a role as a Sustainability Specialist. In this position, they play a crucial part in ensuring that major construction projects meet high environmental standards, using their architectural background to integrate sustainable solutions seamlessly into design and construction processes.

This shift highlights the growing importance of sustainability in the industry and the opportunities for architects to specialise in this vital area.

Traditional Pathway: Project Management

A construction professional began their career as a graduate engineer, progressed through roles such as site engineer and project coordinator, and eventually became a project manager.

This journey highlights the importance of gaining experience in different roles within the construction industry, understanding the complexities of project management, and continuously building on technical and leadership skills.

Figure 3: Industry questionnaire on the future of construction careers

CASE STUDY

PROJECT #70: BUILDING CIRCULARITY 4.0: FIRST STEPS TO ADOPTION

PROGRAM #: 4 | **DATE COMMENCED AND DURATION:** August 2023, 9 months

PROJECT LEAD: Claire O'Leary (Building 4.0 CRC)

PROJECT PARTIES: Circular Economy Ministerial Advisory Group (CE-MAG)

THE INDUSTRY PROBLEM

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.

THE SOLUTION

The 'Building Circularity 4.0: First Steps to Adoption' tool aims to promote circularity and sustainability in buildings and construction, generating economic and social benefits for stakeholders and communities. It suggests actions each player in the 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.

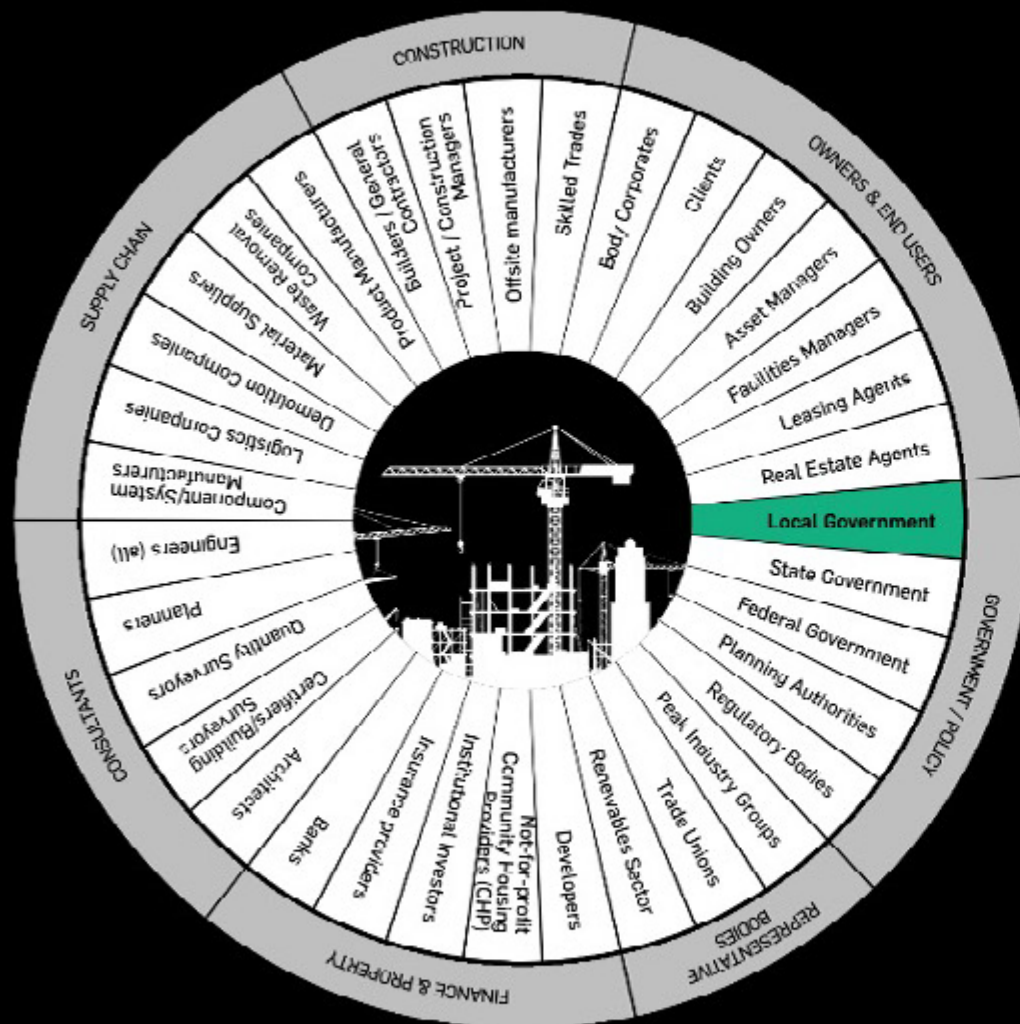
Users can access the tool via the Building 4.0 CRC [website](#). The wheel outlines all major key players in the building supply chain. Users select a chosen actor (e.g. Local Government) to see the suggested first step, and relevant references including industry reports, websites, books, online tools and research papers.

It is critical for everyone in the industry – whether they are planners, project managers, builders, investors or subbies – to know what are the first steps they need to take to participate in the Circular Economy. CE-MAG worked with Building 4.0 CRC to produce this tool as a start of a journey to provide the information needed by those who need it. Feedback from CE-MAG on presenting the tool was very positive.

DR DOMINIQUE HES, CIRCULAR ECONOMY MINISTERIAL ADVISORY GROUP MEMBER

WHAT'S NEXT

This tool is intended to be an ever-evolving resource for Industry. Users are encouraged to share feedback and submit additional references by selecting the feedback icon on the website.



BUILDING CIRCULARITY 4.0: WHAT ARE THE FIRST STEPS FOR YOUR INDUSTRY?

This Building Circularity 4.0: First Steps to Adoption framework aims to promote circularity and sustainability in buildings and construction. By integrating circularity in the building industry, stakeholders and communities can realise economic and social benefits. This framework suggests actions each player in the building supply chain can take to embed circular economy principles in their operations and links to further resources.

This tool was developed in collaboration with the Circular Economy Ministerial Advisory Group.

LOCAL GOVERNMENT

First Step

Establish requirements for waste and demolition plans that include screening, mapping and sorting valuable building products for further reuse, and provide guidelines and training for demolition companies.

References (5)

- 1 Pathways to circular construction: An integrated management of construction and demolition waste for resource recovery (Ghaff et al., 2020)
- 2 Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction (Hossain et al., 2020)
- 3 Circular economy in the Nordic construction sector: identification and assessment of potential policy instruments that can accelerate a transition toward a circular economy (2018)
- 4 World Business Council For Sustainable Development – Scaling the Circular Built Environment. Pathways for Business and Government
- 5 BRCA Green Star Buildings Fact Sheet for Government

COLLABORATION AND ENGAGEMENT

Productive collaboration and engagement with industry partners expands our research impact. During 2024, we welcomed new third party industry partners who contribute to specific projects:

- Cruxes Innovation – Project #56 (Accelerating B4.0CRC Translation and Impact)
- Homes NSW – Project #95 (The Homes NSW MMC R&D Program)
- M80 Ring Road Completion and Spark North East Link – Project #84 (Feasibility Study of Recycling Excavated Clay Materials in Full-Scale Concrete Applications)
- Brickworks – Project #85 (From Digital Design to Human Robot Collaborative Masonry Construction)
- Everhard Industries – Project #86 (Sustainable 3D Printed Concrete for Bespoke Infrastructure)
- Self Storage Association of Australasia – Project #97 (Self Storage Association of Australasia Digital Platform Development)
- NSW Aboriginal Housing Office – Project #100 (IEQ Monitoring of Aboriginal Housing Office 3D Printed Houses)
- Australian Building Codes Board, Brickworks – Project #103 (Prefabricated, modular and offsite construction – Handbook)

The Elevator Initiative continues to engage with SMEs that are passionate about transforming Australia's building sector. Members enjoy invitations to exclusive networking events and to collaborate on projects. To date, we have 20 members, representing a range of sectors.

Other key collaboration and engagement activities are described below.



We have a really diverse range of Industry Partners, covering the building supply chain – both large and small companies, as well as State Governments and peak bodies. Having a wide variety of perspectives and expertise in our consortium ensures our projects are high quality and make lasting transformational change. Industry-led research is what we do!

And without our Industry Partners, we wouldn't be where we are today, with so many innovative and influential projects that will impact the Australian building industry for the better.

CLAIRE O'LEARY, INDUSTRY LEAD, BUILDING 4.0 CRC



EXECUTIVE TEAM PRESENTATIONS AT CONFERENCES AND OTHER EVENTS

- February 2024: **Industrialized Construction Forum**, Stanford University, Stanford, Dr Duncan Maxwell (Presenter)
- February 2024: **Master Builders National Committee Meeting**, Melbourne, Prof. Mathew Aitchison (Presenter)
- March 2024: **Urban Development Institute of Australia (UDIA) National Congress**, Melbourne, Prof. Mathew Aitchison (Presenter)
- March 2024: **NetZero Construction Summit**, Sydney, Prof. Tuan Ngo (Round Table Host)
- May 2024: **Sydney Build Expo**, Sydney, NSW Housing Minister, Hon Rose Jackson MP and Prof. Mathew Aitchison (Panelist)
- May 2024: **Sydney Build Expo**, Sydney, Prof. Mathew Aitchison (Panel Co-host)
- May 2024: **Building Ministers Roundtable**, Canberra, Prof. Mathew Aitchison (Invited Participant)
- May 2024: **Homes VIC 'Learning Spotlight Series'**, Melbourne, Prof. Mathew Aitchison (Presenter)
- May 2024: **The Brisbane Dialogue 'Housing – What do we want to achieve'**, Brisbane, Kathy Mac Dermott (MC)
- June 2024: **Western Sydney Leadership Dialogue East London study tour**, London, Prof. Mathew Aitchison (Participant)
- June 2024: **Building Ministers Roundtable hosted by Hon Ed Husic MP**, Melbourne, Prof. Mathew Aitchison (Invited Participant)
- June 2024: **NSW Government MMC Taskforce**, Sydney, Prof. Mathew Aitchison (Presenter)
- August 2024: **QShelter webinar 'The Now Proposition: Exploring Growth and Availability of Housing Supply'**, Brisbane, Prof. Mathew Aitchison (Panellist)
- August 2024: **Senior Officials Workshop on Advancing Prefabricated and Modular Construction**, Prof. Mathew Aitchison (Presenter)
- August 2024, **Victorian Parliamentary Library: Modern Methods of Construction and Industrialised Technologies**, Melbourne, Prof. Tuan Ngo (Presenter)
- September 2024: **Housing Now! Conference**, Sydney, Prof. Mathew Aitchison (Panellist)
- October 2024: **Australian British Infrastructure Catalyst UK research tour**, Prof. Mathew Aitchison (Presenter)
- October 2024: **SXSW Sydney, Sydney**, Prof Mathew Aitchison (Panellist)
- October 2024: **New Beginnings Australia-Japan, 61st Annual Conference**, Nagoya, Dr Bronwyn Evans AM and Prof. Mathew Aitchison (Presenters)
- November 2024: **International Conference for Decarbonising the Building Industry (DBI)**, Melbourne, Prof. Chris Knapp (Presenter)

HOUSING INNOVATION

In June we brought together significant demonstration projects for industry, government and the community to experience first-hand the building innovations created and share insights.

PROF. MATHEW AITCHISON, CEO, BUILDING 4.0 CRC

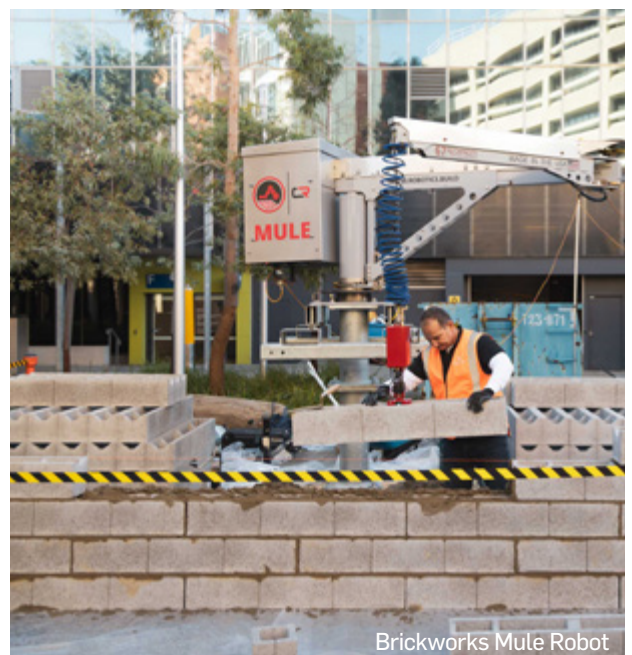
A bricklaying robot, a prefabricated demonstrator pod, a modular retrofit façade to reduce energy consumption and a two-bedroom rapid deployment home – these were just some of the housing innovations on display at our Annual Showcase and Forum 2024 (Wednesday 19 June 2024 at Monash University Caulfield Campus). This year, the event focused on housing innovation, showcasing prototypes, products and processes that will help resolve our national housing crisis.

The Hon. Ed Husic MP (Min. for Industry and Science) and Josh Burns MP (Member for Macnamara) visited on Thursday 13 June for a preview.

A highlight of the showcase were modular housing solutions that can provide housing solutions quickly and new building components that deliver lower cost, improved performance and better environmental outcomes:

- Candour's prefab platform is a suite of customisable prefabricated building components that make the core of a building – the floor, walls, roof and façade.
- Monash University's 'kit-of-parts' offers temporary housing in disaster-affected areas that can be expanded and extended to become permanent.
- SPACECUBE's 45m² 2-bedroom Rapid Deployment Accommodation module is customisable and configurable, yet requires minimal fit out.
- Finding Infinity's Carbon Positive Mass Timber Construction combines cost-effective, pragmatic, practical initiatives that are commercially viable and scalable.
- Monash University's new approach to improving the acoustic performance of light gauge steel frames reduces noise in multi-residential buildings
- MASSLAM's and Sumitomo Forestry's mass timber bearing connection makes timber mass construction fast, strong, safe and sustainable.

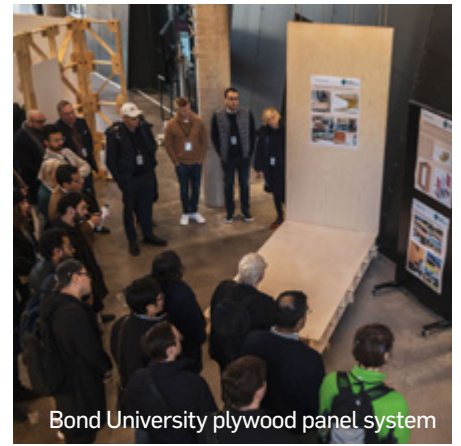
- Earth building materials need less energy for heating and cooling (developed by the University of Newcastle, University of New South Wales, Earth Building Association of Australia, Earth Building Solutions, MudTech and Integrated Biotechure).
- The Brickworks Mule Robot can pick and lay bricks with precision, increasing the efficiency of building brick walls.
- The Verton SpinPod 7.5 is a hands-off approach to lifting and orienting loads on construction sites that is both safer and more efficient.
- PT Blink's construction software and marketplace allow flexible, offsite manufacture and onsite integration of buildings, to deliver faster, safer, better, less waste construction solutions.
- Bond University's plywood panel system uses a glue-only fixing system that eliminates the need for conventional fasteners.



Brickworks Mule Robot



SPACECUBE



Bond University plywood panel system



Project #35



Candour Pavilion



Earth building



Verton SpinPod 7.5



The Hon. Ed Husic MP (Min. for Industry and Science), Prof. Mathew Aitchison, Prof. Mel Dodd (Monash University) and Will Young (Finding Infinity)

MAKING IT HAPPEN

Our theme of 'Making it Happen' captures Building 4.0 CRC's fierce focus on bringing together solutions to unlock the future of building. And our proactive and ambitious agenda has never been more important, as our housing crisis and building insolvencies continue to escalate and our commitment to emissions reduction must be unstintingly pursued.

DR BRONWYN EVANS AM, CHAIR, BUILDING 4.0 CRC

Building 4.0 CRC's third annual conference (Tuesday 3 September 2024) delivered a compelling vision for the future of the building industry. With a clear focus on actionable solutions, the event explored the industry's most pressing challenges and opportunities:

- Making modern methods of construction (MMC) a reality, with Dr Jerker Lessing (Stanford University and Linköping University), Arlan Collins (Sustainable Living Innovations) and Daryl Patterson (West Island Workshop)
- Housing retrofit and MMC, with Justine Prain (Energiesprong UK) and Emanuel Heisenberg (ecoworks)
- Ensuring equal access to affordable housing with Ash Livingston (NSW Aboriginal Housing Office)
- Creating the industry of the future, with Dr Robert Sobrya (BuildSkills Australia), Dr Corrie Williams (Master Builders Association of Victoria) and Chad Gladovic (Holmesglen Institute)
- New ways to deliver social housing, with Tyler Pullen (Turner Labs), Michael Wheatley (Homes NSW) and Andrew McKenzie (Kainga Ora)
- Regulatory reform and the industrialisation of building, with Gary Rake (Australian Building Codes Board), Alexandra Waldren (Master Builders Australia) and Prof. Perry Forsythe (UTS)
- New ideas and policy to improve building sustainability, with Dr Dominique Hes (Circular Economy Ministerial Advisory Group) and Giulia Scagliotti (Stanford University)
- Bold ideas for a better future, with Dr Sarah Breen-Lovett (University of Newcastle), Jeremy McLeod (Breathe), Daniel Fink (Republica), Murray Ellen (PT Blink), Tyler Pullen (Turner Labs), Giulia Scagliotti (Stanford University), Justine Prain (Energiesprong UK).

Special guest the Hon. Sonya Kilkenny (Victorian Minister for Planning and Minister for the Suburbs) shared her vision for a planning system that fosters building innovation.





INAUGURAL BUILDING 4.0 CRC LIFETIME ACHIEVEMENT AWARD

At the Speakers' Dinner before this year's conference, Dr Keith Hampson received the inaugural Building 4.0 CRC Lifetime Achievement Award.

This Award recognises outstanding achievement in research and innovation in the Australian building industry. Keith's bold vision and outstanding commitment as CEO and Professor of the CRC for Construction Innovation from 2001 to 2009 created new partnerships between industry, government and research partners, with a shared goal to achieve exemplar community and commercial outcomes together.

A registered civil engineer and project manager, Keith's career has spanned more than three decades.



OTHER CONFERENCE ACTIVITIES

Before and after the conference, our international and national speakers conducted adjacent forums and workshops in Melbourne, Sydney and Brisbane.

This included a 1.5 day Masterclass on Modern Methods of Construction by Dr Jerker Lessing for Homes NSW and industry participants.

Following the conference, international and national thought leaders Dr Jerker Lessing, Justine Prain, Giulia Scagliotti, Daryl Patterson, Dr Bronwyn Evans AM, Clinton Ostwald and Ben Slack presented at events in Sydney and Brisbane to build MMC knowledge and showcase global best practice across the industry. Continuing the conference themes, these events explored the potential of Modern Methods of Construction to address Australia's global housing supply and affordability crisis. Hosted by Urbis, the events attracted 36 participants in Sydney and 33 in Brisbane.

Conference speakers also presented at a workshop that explored how Modern Methods of Construction could be applied in New Zealand.



SAN FRANCISCO AND THE GREATER BAY AREA

Building 4.0 CRC led a delegation to San Francisco and the Greater Bay area to provide delegates with firsthand experience of cutting edge technology and innovative building techniques, including large-scale industry implementation, international academic research, solutions to the housing crisis and decarbonisation efforts in building.

Delegates had the opportunity to engage with industry experts and researchers, exchange ideas and insights with peers and collaborate on research projects, leveraging the knowledge and expertise of several organisations to drive innovation and change within the industry.

The tour highlighted that the challenges within Australia's building industry are global. The US construction industry faces remarkably similar issues: a lack of productivity; resistance to change; building chain fragmentation; high carbon emissions and construction waste; long-term leadership, regulatory and capacity issues; housing affordability and shortages; and labour and material issues.

Other key lessons include the following:

- Australia's size, institutional structure and system of government are not barriers. Australia has an advantage with a consistent building code and fewer jurisdictions and variations in building codes.
- Investment plays a key role in researching and developing innovation solutions, and compared with Australia, US organisations have access to more funds, although recent spectacular failures have deterred investment in building innovation.
- Decarbonisation of the building sector has not attracted the same level of interest and action in the US as it has in Europe and Australia.



New in 2024, Knowledge Shares allowed industry partners to engage with and hear from business and government leaders and innovators on key issues and trends facing building and construction.

The five events delivered in 2024 demonstrated the breadth of issues the CRC covers:

Daryl Patterson (West Island Workshop) identified the keys to making modern methods of construction a success:

- Consistent solutions
- A distributed supply chain
- Designs that leverage standardised parts.

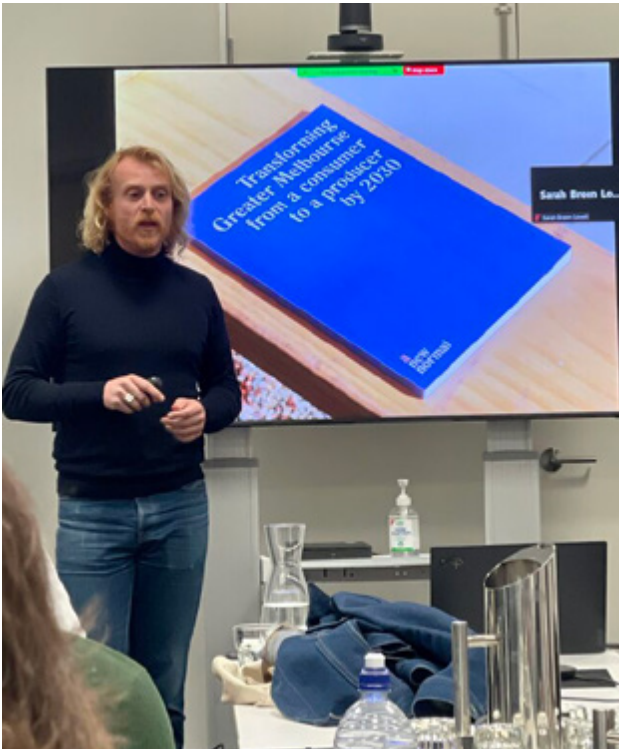
Ross Harding (Finding Infinity) shared how to make sustainable development a reality:

- Work with the private sector – make it profitable
- Engage the public – build support
- Inform policy – de-risk it for politicians.

Jeremy McLeod (Breathe/Grounded) outlined his plans for a community of beautiful terrace homes – 100% electric, 100% solar and featuring 20% affordable homes.

Daiman Otto (DK Otto) demonstrated how a kit-of-parts approach in multi-residential buildings is far from a one-size-fits-all. Instead, it involves a strategic blend of standardisation, flexibility and creates freedom.

Prof. Shane Murray (Monash University, and B4.0CRC Board member) and **Dr Lee-Anne Khor** (Monash University) shared their perspectives on how architects can influence urban development and housing, particularly in residential suburbia where most of us live.



INTERNATIONAL WOMEN'S DAY

Jennifer Cunich (Chairperson, AHURI; Chair, ACT Suburban Land Agency) and Julie Saunders (Director, Urbis; Chair, Bric Housing Board) shared their insights on this year's theme – 'Count Her In: Invest In Women And Accelerate Progress'.

Drawing on their own personal career experiences and achievements, they discussed how we can remove barriers and build systems that enable all women and girls to thrive and realise their full potential.

They shed light on what has changed and what still needs to change to foster innovation, inclusion and gender equality.



Julie Saunders

Director, Urbis; Chair, Bric Housing Board



Jennifer Cunich

Chairperson, AHURI; Chair, ACT Suburban Land Agency

COMMUNICATIONS AND MEDIA

43
publications
finalised by
Building 4.0 CRC
in 2024

Publications

- 14** conference papers
- 11** journal articles
- 4** media releases/news articles
- 3** newsletters
- 3** podcasts
- 7** project reports
- 1** video.

LinkedIn followers

4469 (compared with 2803 in 2023).

Media mentions

74 (compared with 58 in 2023)

Highlights include:

- May 2024: realestate.com.au 'Real Talk' Podcast Pre-fab homes: would you live in one?, Prof. Mathew Aitchison (Presenter)
- June 2024: SBS Digital, Prof. Mathew Aitchison (Interview)
- July 2024: ABC Radio, Prof. Mathew Aitchison (Interview)

EDUCATION AND TRAINING

Fostering the future leaders of the building and construction industry is a core responsibility of Building 4.0 CRC. We have 45 students across our three university partners – Monash University, the Queensland University of Technology (QUT) and the University of Melbourne.



Brandon Johns was a student at Monash University. For his PhD, he explored automating high-rise curtain wall installation and understanding the interface between humans and construction cranes. He completed his PhD in 2023 and is a research fellow at Monash University.



Fereshteh Banakar studied at QUT, developing an extended Building Information Model (BIM) for road infrastructure design, construction and operation. Her research focused on creating a data specification that can be used for asset management of linear infrastructure such as roads. She completed her PhD in 2023 and is Digital Coordinator at DBM Vircon.



Kaveh Mirzaei was a student at Monash University. His research focused on automatically inspecting quality measures of construction projects using point clouds achieved from depth-sensing devices. He completed his PhD in 2023 and is a lecturer at the Central Queensland University.



Marko Radanovic was a student in the School of Engineering at the University of Melbourne. As part of his research, he developed a real-world Building Information Model – an application for automated registration of digital building models to real-life buildings in Augmented Reality. He completed his PhD in 2023 and is working as a graduate researcher at the University of Melbourne.



Mohammad Aslanpour was a student at Monash University. As part of his research, he proposed self-adaptive software systems that achieve energy awareness through resource scheduling algorithms. He completed his PhD in 2023 and is working as a development operations engineer at Sky Ledge.

Eleven have completed their studies and have now graduated with their doctorates.



Rajendra Prasad Bohara was a student at the University of Melbourne. His research involved developing and implementing auxetic composites to protect infrastructures from blast load. His research interests included auxetic metamaterials, computational modelling, protective structures, 3D printing and earthquake resistant structures. He completed his PhD in 2023 and is an engineer at Karagozian & Case.



Richard Nero was a student in the Infrastructure Engineering department at the University of Melbourne. His research focused on developing environmentally sustainable building materials and systems, to help designers create better buildings with superior sustainability credentials. He completed his PhD in 2023 and is working as a graduate researcher at the University of Melbourne. He is part of the research team on Project #95 (The Homes NSW MMC R&D Program).



Sara Rashidian was in the School of Architecture and Built Environment at QUT, focusing on implementing new construction approaches to enhance collaboration and integration among construction stakeholders. Her research explored adoption of Building Information Model (BIM), Integrated Project Delivery and Lean Construction principles. She completed her PhD in 2023, and works as a research assistant at QUT. She is part of the research team on Project #21 (Regulatory Reform for Industrialised Building).



Son Tung Vy studied at QUT, his research aiming to provide comprehensive knowledge and understanding on the structural and fire behaviour of innovative light gauge steel framed wall systems made of built-up cold-formed steel studs. He completed his PhD in 2022 and is working at QUT as a research associate.



Thais Goncalves Sartori was a student in the School of Architecture and Built Environment. Her research sought to evaluate the environmental impact of buildings throughout the design process. She completed her PhD in 2022 and now works as Sustainability Consultant at Cundall.



Tobias Kramer studied at QUT, investigating the impact of climate change on indoor thermal comfort, and exploring the potential use of emerging technologies like data science and AI for thermal comfort prediction in future buildings. He completed his PhD in 2023 and is now a post-doctoral researcher at the Center for the Built Environment at UC Berkeley.

MASTERS STUDENTS

As part of Project #66 (The Future of Construction Education), a design studio was run in Semester 1 at Monash University, involving 18 Master of Architecture students in research-led design of an 'off-site construction hub'. This work was exhibited at the Annual Showcase in June 2024.



Building 4.0 CRC PhD students at the Annual Conference.

GOVERNANCE

Building 4.0 CRC has now completed its fourth year and the Board has begun to consider future transition arrangements. At a half-day workshop in July 2024, they discussed wind up administrative procedures and a range of transition opportunities. This process will continue until the CRC's term ends in 2027.

THE BOARD



Dr Bronwyn Evans AM
Chair



Prof. Mathew Aitchison
CEO



Prof. Shane Murray
Nominee Director



Theodora Elia-Adams
Independent Director



Dr Steve Gower
Independent Director



Jan Bingley
Independent Director



George Konstandakos
Tier 1 Director (2023-24)

The Executive Team

We welcomed the following new faces to the Executive Team in 2024:

- Smaro Exelby (Engagement Lead)
- Michelle Smith (Executive Assistant).

We farewelled the following people, and thank them for their contribution:

- Dr Sarah Breen-Lovett (Engagement and Education Lead)
- Clare Blizzard (Executive Assistant).

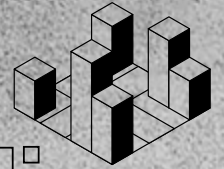


PARTNERS

The CRC's collaborative structure enables our partners to understand the value of new thinking and to integrate innovative practices in their work.

We currently have 39 partners across Industry, Projects, Research and Government.

For a full list of partners, visit the Building 4.0 CRC website.



building
4.0 crc

2024

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