

AGRICULTURE AND ENVIRONMENT

BIOINDUSTRIAL AND CIRCULAR INNOVATION

BIOINDUSTRIAL MATERIALS

Artificial Intelligence (AI) powered design and manufacturing for prefabricated wood buildings

The ongoing research addresses challenges in prefabricated wood building construction by integrating AI and robotics technologies. This project enhances productivity, sustainability, and efficiency by automating design processes and improving manufacturing methods. Key outputs include a deep learning-based method for extracting information from architectural drawings, generative design methodology with reinforcement learning to optimize design of light wood frame houses and mass timber post-and-beam building systems, and robotic manufacturing process for mass timber building components. By advancing prefabrication techniques, this research aims to revolutionize the wood building industry, particularly benefiting Alberta's construction sector.



FUNDING DETAILS



RECIPIENT:

Dr. Ying Hei Chui,
University of
Alberta



PARTNERS:

Landmark Group of
Companies,
Western Archrib, Timber
Engineering Inc.



TOTAL BUDGET:

\$1,999,500



AI FUNDING:

\$250,000



PROJECT DATES:

Mar 2022 –

Dec 2024



PROJECT TRL:

Start: 4

End: 7

APPLICATION

Advanced technologies such as Artificial Intelligence (AI) and robotics are reshaping industries, leveraging advancements in sensing technologies, IoT, GPUs, TPUs, and machine learning. In the building sector, which consumes a significant portion of global energy and emits greenhouse gases, AI and robotics offer transformative potential. Challenges posed by the unique nature of each building can be addressed through off-site and prefabricated construction, enhancing sustainability and efficiency. This approach also provides a controlled environment ideal for deploying AI and robotics, particularly in prefabricated home construction.

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PROJECT GOALS

The proposed research aims to enhance the productivity and sustainability of prefabricated buildings by integrating AI and robotics, focusing on light wood-frame and mass timber systems. The three key objectives are:

- **Automate Design:** Use AI and BIM to automate design, improving productivity and communication. This includes digitalizing design practices, developing generative design tools, creating AI-powered connection designs, and optimizing designs using reinforcement learning.
- **Enhance Design Value:** Support innovation and collaboration in the design phase with digital technologies, improving value generation and stakeholder satisfaction. This involves guiding team interactions and promoting digital platforms for collaboration.
- **Boost Manufacturing Flexibility:** Develop manufacturing techniques compatible with generative design systems. Integrate robotics and digital twin technologies for sustainable, intelligent manufacturing.

BENEFITS TO ALBERTA

- Enhanced productivity and sustainability in the construction sector, particularly in prefabricated wood buildings.
- Direct support for key industry players like Landmark Group of Companies and Western Archrib.
- Development of AI-driven design and manufacturing processes, leading to higher productivity.
- Reduced energy consumption and lower greenhouse gas emissions, supporting Alberta's environmental goals.
- Creation of a more automated and safer workplace, addressing labour shortage and boosting job opportunities.
- Contribution to Alberta's economic growth and sustainability goals.



2 review articles in progress, 2 conference papers submitted, 2 journal papers in preparation



4 PhDs, 2 MSc, 7 UGs, 1 PDF



1 Project manager
1 Technician

CURRENT STATUS

January 2025 – Complete

Two review papers are being prepared on AI in structural design and generative design for off-site construction. A deep learning-based method has been developed to extract information from architectural drawings, and a generative design methodology using reinforcement learning is in development. These methods aim to improve the design and manufacturing processes of prefabricated wood buildings. The research team is working with industry partners to ensure practical implementation.

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