CONSTRUCTION
INNOVATION CENTRE
Research Driving Change

ANNUAL REPORT

2024

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INTRODUCTION

WHAT IS THE CIC?

The University of Alberta's Faculty of Engineering established the Construction Innovation Centre (CIC) in May of 2019. Its mission is "to provide breakthrough research, education and training that directly benefit Canada's construction industry and lead to the sustainable and economic development of our built environment and a competitive advantage for the Canadian construction industry."

The CIC brings together more than 30 established faculty members in construction engineering, building science, masonry, steel and water by uniting under one umbrella the Hole School of Construction Engineering, Nasseri School of Building Science and Engineering, Masonry Group, and Steel Centre. The CIC is supported by more than 50 partners in industry, professional associations, and funding bodies.

With the help of its partners, the CIC seeks to identify strategic directions for innovation and education and provide the united platform required to coordinate the activities and resources of the wide range of University of Alberta research groups in a manner that maximizes impact for the construction industry, Albertans, and Canada as a whole.

The CIC seeks to become an internationally recognized center for research, teaching, and training in engineering, construction, and servicing the built environment—the focal point around which academia, industry and government can come together to meet the grand challenges facing construction industries and create high-impact innovations across the construction engineering spectrum. We believe in research and innovation that drives change.

CIC Goals

- Accelerate and support **innovation**, **productivity**, and **competitiveness** in Alberta's and Canada's construction industry, including off-site industries materially impacting construction, through **high-impact research projects**
- Identify **industry needs** and align CIC research programs to meet these needs
- Provide a unified platform for **solutions to construction industry problems** through multi-disciplinary research
- Train the **next generation** of construction engineers and workforce with leading-edge knowledge and skills
- Enhance engagement with all stakeholders including government to **grow and sustain investment in Canada's construction industry**

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"The CIC aims to provide breakthrough research, education and training that directly benefit Canada's construction industry and lead to the sustainable and economic development of our built environment and a competitive advantage for the Canadian construction industry."

Research Driving Change
CONSTRUCTION INNOVATION CENTRE

Top Research Methods

Systems and Data Integration
Simulation Modeling
Automation and Technology
Visualization
Decision Support Systems
Artificial Intelligence
BIM

Top Research Problems

Sustainability and the Environment
Off-site Construction and Modularization
Design and Planning
Health and Safety
Productivity and Performance
Energy

CURRENT

CIC RESEARCH PROJECTS

Ongoing Research Projects (NSERC/MITACS Approved)

01 A Robust and Low-cost Technology for Risk Mitigation of Pathogenic Infection in HVAC Systems

02 Artificial Intelligence (AI) Powered Design and Manufacturing for Prefabricated Wood Buildings

03 BIM-Integrated Robotics for Intelligent Mass Timber Manufacturing and Operations

04 Construction-oriented Digital Twins for Multi-dimensional Production Planning and Control

05 Enhanced Perception for Autonomous Truck Mounted Attenuator (ATMA) to Increase Work Zone Safety

06 Enhancing Safety Management Systems on Construction Projects: A Data-driven Approach

07 Evaluation of Impact of Exoskeletons on Performance and Safety of Construction Workers

08 Federated Platform for Construction Simulation

09 Industrialization and Decarbonization of the Construction Process

10 Robotic wall construction using innovative building blocks and processes for enhanced productivity, safety, and sustainability.

11 Practical Methods for Accurate Estimation of Overall R-Values of Masonry Walls

12 Structural Steel Project Development Integrating Structural Design and Construction Engineering: Quantitative Methods and AI-based Tools

CIC-approved Projects

13 A Computer Vision-Based, User-Centric, and Integrated Decision Support System for Construction Project Management

14 AI-Driven Solutions for Enhanced Safety and Productivity in Building Prefabrication

15 An Open Platform for Predicting Energy Performance of Buildings: Accelerating Energy Code Adoption

16 Automated Work Planning Method for Self-Healing and Optimal Construction Schedules

17 Defining the Employability Attributes and Required Job Readiness Skills for Graduates of Construction Engineering Management

18 Driving Change Toward a Wider Adoption of Collaborative Delivery Methods in Canada

19 EEG-based Cognitive Monitoring Framework to Prevent Operators Cognitive Failure for Construction Safety and Productivity

20 Extended Reality and Optimization for Constructability Improvement in Industrial Construction

21 Fast and Flexible Manufacturing of Industrial-Size Components Using Weld-Based Additive Manufacturing

22 Performance-targeted Hybrid Multistory Buildings for Resilient and Sustainable Construction

23 Towards Carbon-Neutral Steel Buildings for Sustainable System Selection in Commercial and Residential Construction

BY THE NUMBERS

PROJECT STATS

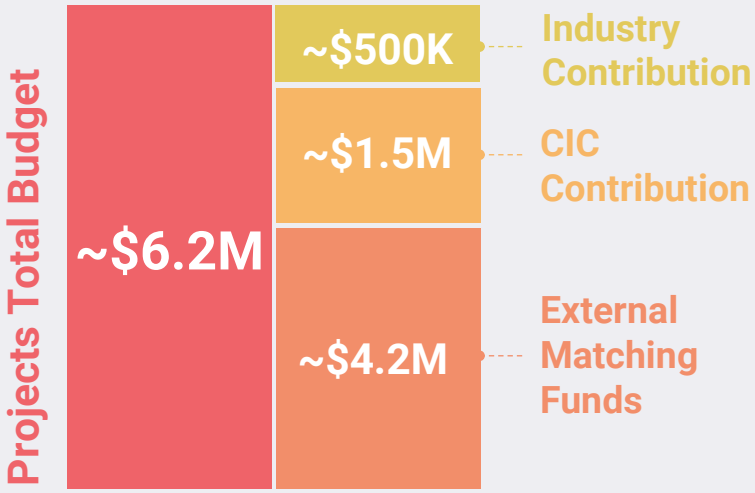
23
APPROVED PROJECTS

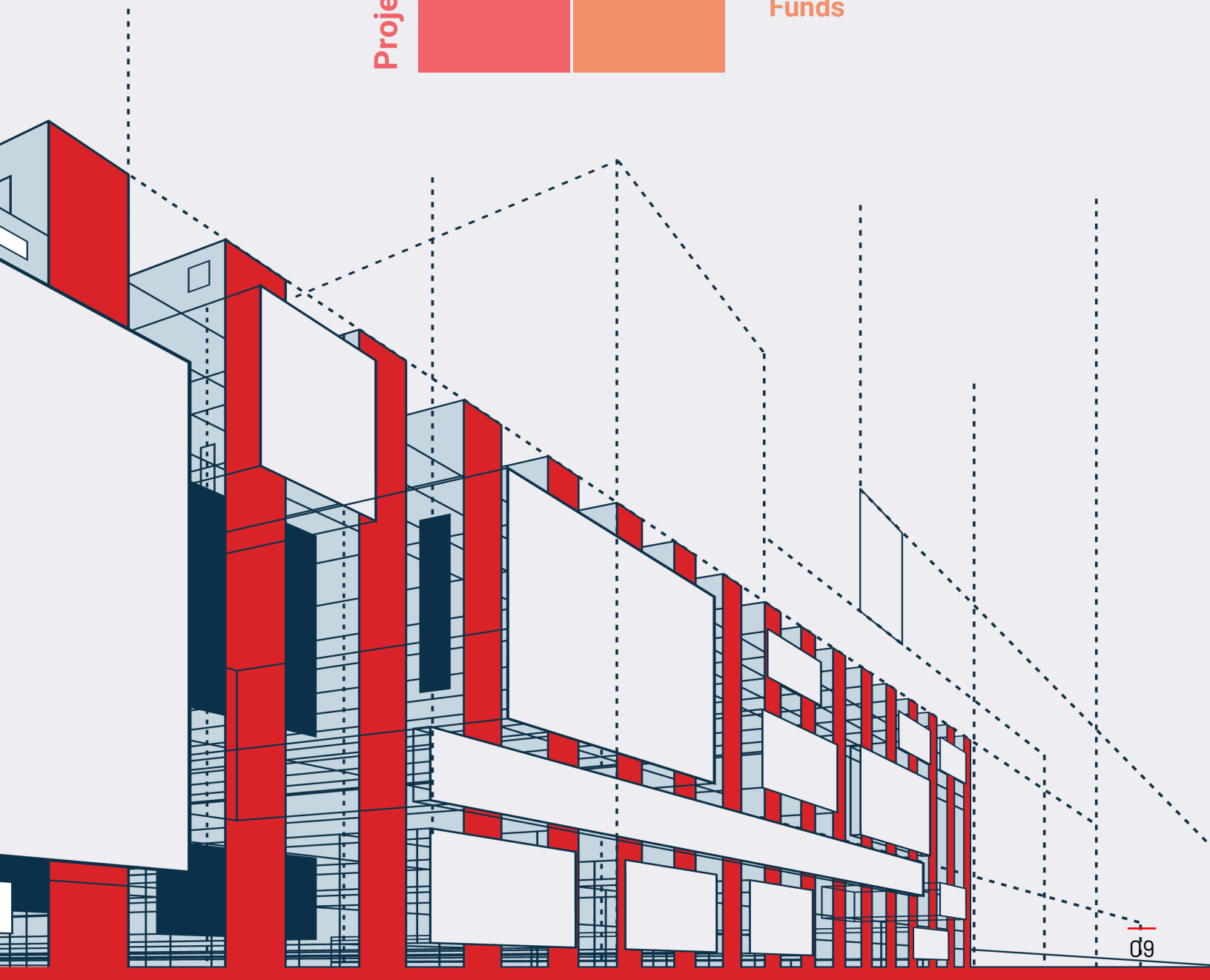
42
ACADEMIC RESEARCHERS

53
INDUSTRY PARTNERS

BY THE NUMBERS

PROJECT STATS





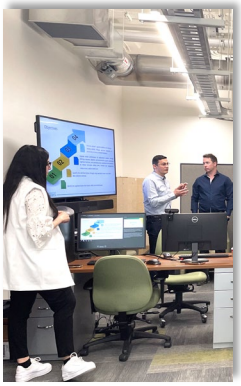
ACTIVITIES

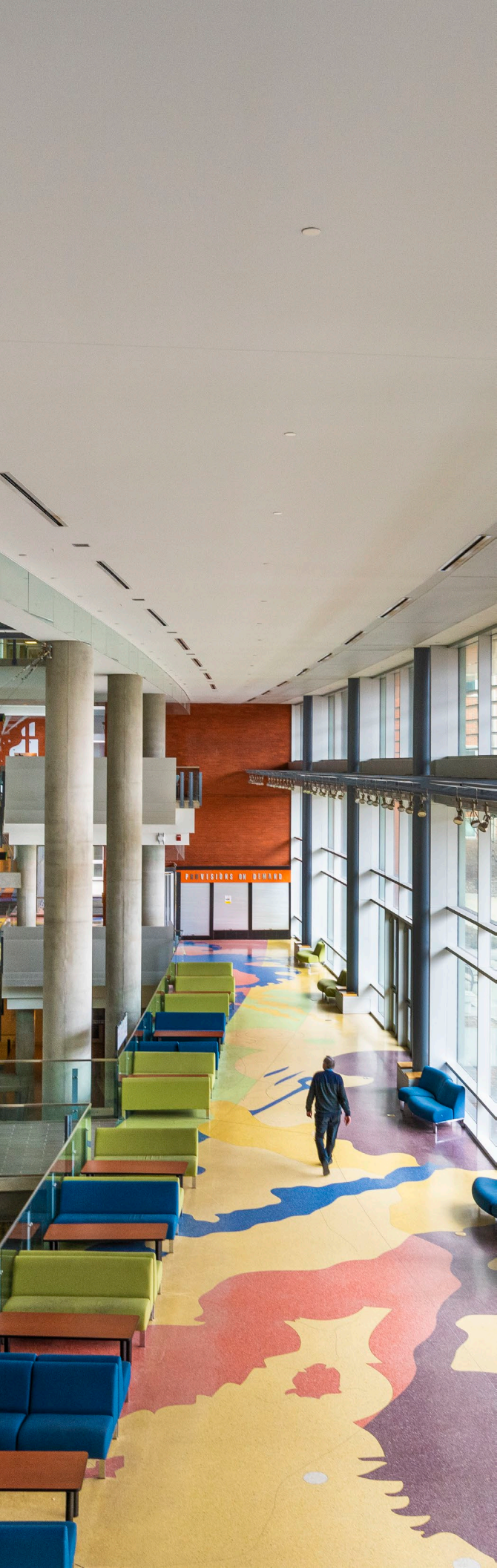
CIC EVENTS

CIC Visits and Lab Tours

The CIC hosted visits and lab tours for several groups of local, national, and international visitors over the past year. Visitors included:

- **Minister of Technology & Innovation, Nate Glubish**
- **Associate Vice President of Engineering, NRC**
- **Alberta Innovates**
- **Enbridge**
- **Clark Builders**
- **Member of Parliament, Matt Jeneroux**
- **NRC IRAP Construction Team**
- **OCRC and Roberts Group**





Webinar: Sustainability in Construction

February 2024

This webinar was organized jointly by the CIC, the Off-Site Construction Research Centre (OCRC) at the University of New Brunswick, and the Centre for Innovation in Construction and Infrastructure Engineering Management (CICIEM) at Concordia University. Presentations included "Getting to Future Ready: Ups, Downs, and Workarounds" by Anna Robak, Director of Research and Innovation at WSP Canada; "Potential Role of Utilidors in Improving the Sustainability of Our Cities" by Amin Hammad, Associate Director at the CICIEM at Concordia University, and Terri Matthews, Director of Town+Gown: NYC.

ELEVATE Student Competition

June 2024

For the CIC's first annual ELEVATE Student Competition, we invited aspiring entrepreneurs to pitch their ideas on how to solve existing and upcoming challenges of the construction industry. Participants presented novel ideas using a variety of advanced technologies, including Construction 4.0 concepts, digitalization, IoT, automation, robotics, digital twinning, and other innovative approaches. The event was a great success, and our guest judges awarded cash prizes for the top three presenting groups.

81 Students

28 Teams

12 Universities

14 Finalist Teams

University of Alberta · The University of British Columbia · University of Toronto · Université Concordia University · Indiana State University · University of Victoria · Carleton University · Western University · Canada · NAIT · University of Manitoba · Université Laval

SPONSORS

Aecon · ECA Edmonton Construction Association · Landmark Homes · Ledcor Group · Alberta Construction Safety Association

EVENTS

Alberta RISE Conference

November 2024

As part of the RISE: Alberta Robotics and Intelligent Systems Expo, the CIC organized a session entitled "Construction Robotics: Opportunities, Challenges, and the Road Ahead." This session explored the transformative role of robotics in the construction industry, featuring insights from industry experts, researchers, and innovators on the evolving landscape of this rapidly advancing field. The session featured presentations highlighting cutting-edge advancements, emerging market opportunities, challenges to widespread adoption, and key research trends driving innovation. The panel discussion that followed also offered diverse perspectives on how robotics is reshaping the construction industry, with a special focus on Alberta's unique potential to lead in this sector.

INITIATIVES

CIC's Tech Transfer & Commercialization Focus Group

This CIC initiative brings together members of the construction industry, academia, the startup community, and government and funding bodies to support the transfer and commercialization of research activities in the construction innovation ecosystem. The group's more than forty registrants have met twice in 2024 to begin setting out the group's scope and strategic direction. The focus group welcomes all researchers, industry practitioners, entrepreneurs, innovators, investors, change agents, entrepreneurs, and students interested in advancing the adoption of innovation and technology in the construction industry.

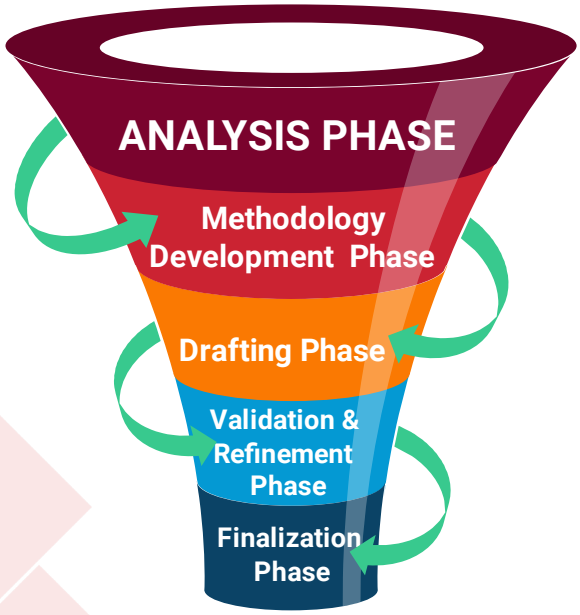
From Lab to Market
Path to Research Impact

INITIATIVES

Updated CIC Research Roadmap Project

The CIC is committed to pursuing worthwhile areas of research that are collaborative in nature, have significant potential for academic breakthroughs, and will lead to the greatest positive impact on the construction industry at large. The CIC's five-year research roadmap, having reached the end of its intended lifecycle, is currently being revisited and refined to ensure the CIC continues to engage in the most relevant avenues of research.

Activity 1: Setting a Flexible Strategic Vision – establishing long-term, flexible objectives based on emerging technologies and threats, while maintaining adaptability as a core principle.



Activity 2: Creating a Core Research Focus – categorizing research areas into immediate needs, medium-term goals, and long-term innovations, and prioritizing areas based on potential impact and feasibility.

Activity 3: Engaging Stakeholders – engaging stakeholders in ongoing discussions and collaboration, to establish a framework to move innovations from the lab to the market or operational settings.

Activity 4: Implementation – breaking down the roadmap into 6-month or 1-year cycles and setting clear deliverables and key performance indicators, allowing for iterative feedback.

Activity 5: Monitoring – using insights from research projects, pilot programs, and industry trends to inform future research, and regularly evaluate progress against key performance indicators.

INITIATIVES

CIC Studentships

The CIC has started offering studentship opportunities to its members. Studentships are an internship position providing members with access to talented students and are fully paid by the CIC. In 2024, six studentships were completed by graduate and undergraduate students from the Department of Civil and Environmental Engineering as well as the Computing Science Department. Sample projects of the completed studentships can be seen below. The CIC will continue to offer studentships during the 2025 Spring and Summer semester.

- ✓ Customizing ERP for Small and Medium Scale Manufacturing Companies
- ✓ Integrating Lean in SOPs to Obtain Continuous Improvements in Building Construction
- ✓ RLAI Benchmarking of Construction Sequences
- ✓ Improvement of Carry Steel's Employee Competency Management System

EVENTS

CIC Forum 2024

The CIC annual FORUM provides a platform to share the most recent advancements in construction innovation and to form collaborations among innovators, researchers, and construction professionals. This year, the CIC celebrated 30 years of success in advancing construction innovation through high-impact research, and sessions included presentations on automation, robotics, artificial intelligence, data, and modeling applications in construction.

The program also included Interactive panel discussions on front-line safety and artificial intelligence in the construction industry, a student poster competition, and trade booths for local startups.









Innovative Solutions for Today's Construction Challenges

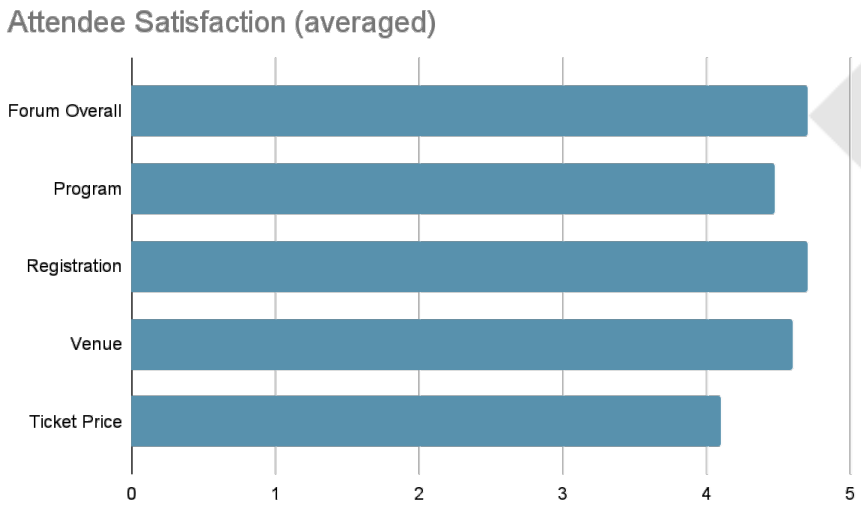
June 12-13
Edmonton, AB

EVENTS

CIC Forum 2024

180
Total Registrants

167	164
Day 1	Day 2



Startup Booths

nialli™ QuoteToMe™ Pursuit Zen Quickly

TRACECOST Xradar IrisCX warmset® LAMINATED HEATING TECHNOLOGY ZS2 technologies

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CIC Members and Partners

CIC Advisory Board and Team

Travis Chorney

Senior VP
PCL

Jim Kanerva

General Manager
Carry Steel

Simaan AbouRizk

Dean and Professor
University of Alberta

Reza Nasseri

CEO
Landmark Group

John Singleton

Senior VP
Aecon

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Jamie Feuffel

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CIC Project Spotlight

ROBOTIC WALL CONSTRUCTION USING INNOVATIVE BUILDING BLOCKS AND PROCESSES FOR ENHANCED PRODUCTIVITY, SAFETY, AND SUSTAINABILITY

Duration: 5 years
Budget: $2,250,000

This project is developing and integrating new technologies in structural design, thermal efficiency, computational design, and robotic construction to improve the design and construction of high-performance exterior walls.

What was the need?

The construction industry is rapidly adopting new technologies, such as computer vision and building information modeling. But current developments in building envelope technology lack integration of thermal mechanisms with resilient, damage-resistant structures suitable for prefabrication and robotics. A holistic solution is needed to integrate modern technologies into construction sectors more effectively.

What was done?

Our work has primarily involved the modeling of various wall components, simplifying certain geometries and determining linear transmittance values. As a multidisciplinary project, this work includes a variety of other activities, such as implementing motion control in the robotic system to enable the identification and placement of objects and designing a hybrid decision support system for software user interface in partition wall design.


Yuxiang Chen


Carlos Cruz Noguez


Douglas Tomlinson


Farook Hamzeh


Rafiq Ahmad


Yong Li

What were the outcomes?

Some of the outcomes to date include new methods that simplify complex geometries in masonry construction, a novel masonry unit (SWARM) tailored for robotic construction, a controller for manipulating objects of various weights without weight specifications, and an app for monitoring PPE in masonry construction sites.

CCMPA
automationexperts technical recruitment specialists
SCORPIO MASONRY
CIMS
Masonry Contractors Association of Alberta

CIC Project Spotlight

PRACTICAL METHODS FOR ACCURATE ESTIMATION OF OVERALL R-VALUES OF MASONRY WALLS

Duration: 4 years
Budget: $510,000/year

This project is developing practical methods for obtaining values of effective thermal resistance and linear transmittance (thermal bridging) of exterior walls.

What was the need?

Accurately estimating the R-values of composite wall assemblies is challenging due to the complex interactions of material thermal properties, component geometries, 3D heat transfer, and thermal bridges. Existing calculation methods are limited, and professionals require R-value estimation methods that are intuitive, universal, easy to use, and provided free of cost to the building industry.

What was done?

Researchers developed a method to estimate the R-value of common concrete masonry veneer wall configurations, which include parameters such as concrete block density, ties, and shelf angles. This approach accounts for both the mechanical and thermal properties (including thermal bridging effects) of different configurations.

Yuxiang Chen

Carlos Cruz Noguez

What were the outcomes?

In addition to a comprehensive literature review, analysis, and discussion, researchers have provided design charts and R-value multipliers that relate to key parameters to the R-values of different masonry wall configurations. With these new approaches, designers can choose optimum wall component material properties in the early design phase to meet structural and thermal requirements without the need for experimental investigations or computer simulations.

Alberta Masonry Council

SCORPIO MASONRY

Masonry Contractors Association of Alberta

CIC Project Spotlight

EVALUATION OF IMPACT OF EXOSKELETONS ON PERFORMANCE AND SAFETY OF CONSTRUCTION WORKERS

Duration: 4 years
Budget: $630,000

Researchers are evaluating the suitability of exoskeletons to reduce injury in physically demanding construction tasks and working to develop a systematic framework for the selection and implementation of exoskeletons in the construction industry.

What was the need?

Repetitive strain and musculoskeletal injuries make up a significant portion of disabling injury claims in construction. Exoskeletons (body-worn devices that reduce physical strain during certain tasks) are emerging as a possible solution; however, given the dynamic nature of construction tasks, the many hazards of construction worksites, and the lack of studies on construction-specific applications of exoskeletons, it is unclear how they could be safely and effectively implemented in the industry.

What was done?

In collaboration with industry partners, CIC researchers have developed research activities to investigate the **impact and efficacy of employing exoskeletons in construction tasks**. Using inertial measurement units, motion-capture systems, and biosensors, CIC researchers simulate the tasks that cause the most frequent and debilitating injuries. Then, analyzing the biomechanics and kinematics of the worker's body, measuring fatigue, and evaluating task performance, researchers will **develop and test exoskeleton solutions that improve construction safety while improving productivity**.

Hossein Rouhani

Mahdi Tavakoli

Ali Golabchi

What were the outcomes?

A systematic approach and decision-making framework for prescribing, adopting, and implementing industrial exoskeleton-based solutions on a job-specific basis is developed. Implementing the developed framework results in improving profitability of construction companies by enhancing performance and reducing lost-time and insurance costs, while also directly improving quality of life for workers by reducing pain and injury.

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