A Holistic Approach to Timber Construction in a Regenerative Design Framework
Energy Efficiency in the AEC Industry: Course 2 Materials and Methods

Introduction

This course is presented by the RAIC Centre for Architecture and PowerEd at Athabasca University. It is designed to address the urgent imperative for climate action by focusing on regenerative design with an emphasis on timber as a key element. Acknowledging the considerable impact of the building and construction industry on global greenhouse emissions, the program underscores the critical role and transformative capabilities of timber in promoting sustainable and regenerative practices.

A central theme of the course is the holistic role of timber in regenerative design. Timber has been a fundamental construction material for thousands of years, prized for its versatility and renewable qualities. Recent developments in manufacturing processes, carbon accounting, and regulatory frameworks have further highlighted its significance, positioning timber as a vital component in achieving a regenerative, low-carbon future for our planet.

The industry currently faces a disconnect between knowledge acquired through timber education and its practical implementation. This course aims to bridge this gap by focusing on the application of timber systems and related areas such as low carbon and life cycle assessment. To achieve this, the course incorporates a simulation building and artificial intelligence experience that mimics real office scenarios, thereby preparing learners for practical industry challenges.

This course offers a detailed exploration of timber construction through a regenerative framework, addressing all critical aspects. Participants will engage in an in-depth study of mass timber, biomaterials, life cycle assessment, and design for manufacturing and assembly. Additionally, the course underscores the vital role of timber in progressing toward a circular economy.

Designed as a continuing education program, this course caters to students and industry professionals eager to enhance their knowledge in areas such as mass timber construction, prefabrication, embodied carbon, and life cycle assessment. It is accessible to all learners seeking to broaden their expertise in timber-related disciplines.

The climate emergency demands regenerative approaches and methods for design and construction that allow the learner to understand how they can help mitigate this problem quickly. **For this reason, we have developed a new course focused on timber construction that is expressed holistically across different modules.** Each module guides the learner in understanding the importance of wood construction as a key part of a low-carbon solution.

Figure 1: The Athabasca Cultural Centre simulated building, produced in Twin Motion. Visualization by student Jessica Williams. The simulation building is used as an interactive and integrated learning tool demonstrating timber construction in a regenerative design framework.

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Course Objectives

- To enhance knowledge and expertise in regenerative timber construction within the architecture, engineering, and construction (AEC) industries.
- To equip professionals and students with the skills needed to implement sustainable building solutions.
- To foster understanding of the holistic significance of wood in regenerative design through advanced educational tools and real-world applications.

Curriculum Structure

Developed in response to industry demands for advanced learning, the course fits within the Continuing Education offerings at Athabasca University and the soon to open, Master of Architecture program at Athabasca University includes a series of modules focusing on the critical role of timber in achieving a regenerative future. The curriculum explores timber's versatility and renewability, underpinned by the latest advancements in technology, regulatory frameworks, and carbon accounting.

Course Outline:

Materials and Methods – Timber Education

1. Building with Low Embodied Carbon Materials
2. Considerations for Mass Timber and Prefabrication
3. Non-Structural Biomaterials
4. Conducting Life Cycle Assessment
5. Creating a Business Case – Exploring Through AI

Course Modules with the Broader Context

The course is situated within a broader context of courses Energy Efficiency in the Architectural, Engineering and Construction (AEC) Industry.

1. **Regenerative Design:** Principles and practices for achieving sustainable outcomes in the built environment.
2. **Materials and Methods :** Comprehensive insights into innovative building materials and construction techniques.
3. **Codes and Regulations:** Understanding the legal and regulatory considerations in wood construction.
4. **Managing Facilities for Energy Efficiency:** Exploring complex management of built facilities to achieve energy efficiency for the duration of the building life.

Learning Platforms and Methodologies

The course employs a blend of interactive educational materials, open-access resources, and simulation projects, using artificial intelligence to mirror real-world scenarios. Key features include:

- **Interactive Building Simulation:** The Athabasca Cultural Centre simulation provides a hands-on experience in designing energy-efficient and regenerative buildings.
- **Multimedia Learning Experiences:** Incorporates AI, case studies, gamification, and competency assessments accessible across various digital platforms.
- **Virtual Co-op Experience:** An AI-driven virtual co-op places learners in professional scenarios, promoting active learning through problem-solving and decision-making.

Learning Outcomes

Upon completion, students will have a deep understanding of:

- Mass timber and wood construction techniques, including prefabrication.
- The role of embodied carbon and Life Cycle Assessments in sustainable building.
- Strategies for integrating biomaterials within a circular economy framework.

Simulation Project: Athabasca Community Cultural Centre

Designed to demonstrate the application of mass timber within a regenerative design framework, this simulation building serves as a practical example for students. It enables in-depth exploration of mass timber strategies and real-time problem-solving, guided by AI and supported by expert faculty.

Educational Enhancement

Artificial Intelligence plays a critical role in the learning process, simulating real-life scenarios typical in the construction industry. Students engage in tasks such as assembling business cases, advocating for sustainable practices, and navigating complex design challenges, thereby preparing them for real-world applications and advocacy in sustainable construction.

This course is designed not only to educate but also to inspire and equip architects, engineers, and construction professionals with the knowledge and tools necessary for leading the charge towards a sustainable and regenerative future.

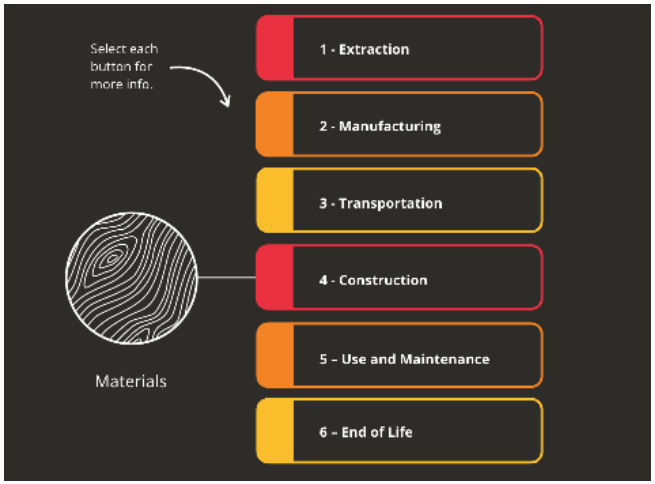

Figure 2: Example of the multmedia learning experience. Graphics prepared by D55.

Figure 3: The Athabasca Cultural Centre simulated building, produced in Twin Motion. Visualization by student Jessica Williams.

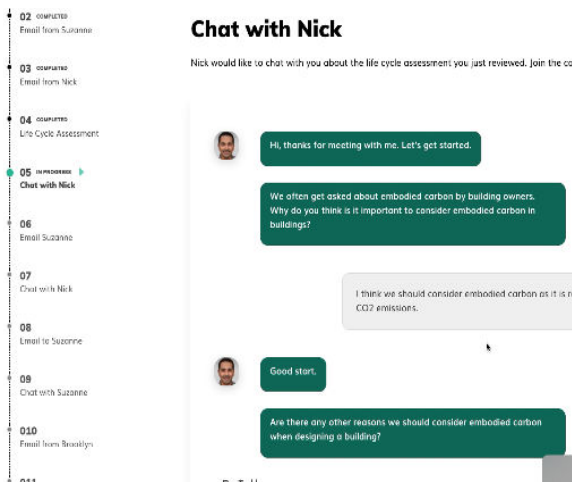

Fig 4: AI powered immersive learning experience (by Ametros) simulating building a case for mass timber and embodied carbon design, as part of the Material and Methods Module 2.

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Module 1: Building with Low Embodied Carbon Materials
Learning Time: 2.5 hours
- Tracking our carbon footprint
- The circular built environment
- The embodied carbon of common materials
- Going back to wood

Module 2: Building the Case for Mass Timber
Learning Time: 2.5 hours
- What is prefabricated mass timber?
- Building a case for wood
- Managing Acoustics
- Mass timber for just communities

Module 3: Designing for Prefabrication
Learning Time: 2.5 hours
- From construction to assembly
- Building information Modelling (BIM)
- Assembling prefabrication structures
- Reskilling for the future

Module 4: Assessing Costs and Impact
Learning Time: 2.5 hours
- Assessing our impact
- Approaches to LCA
- Making a business case

Total Course Learning Time: 10 hours

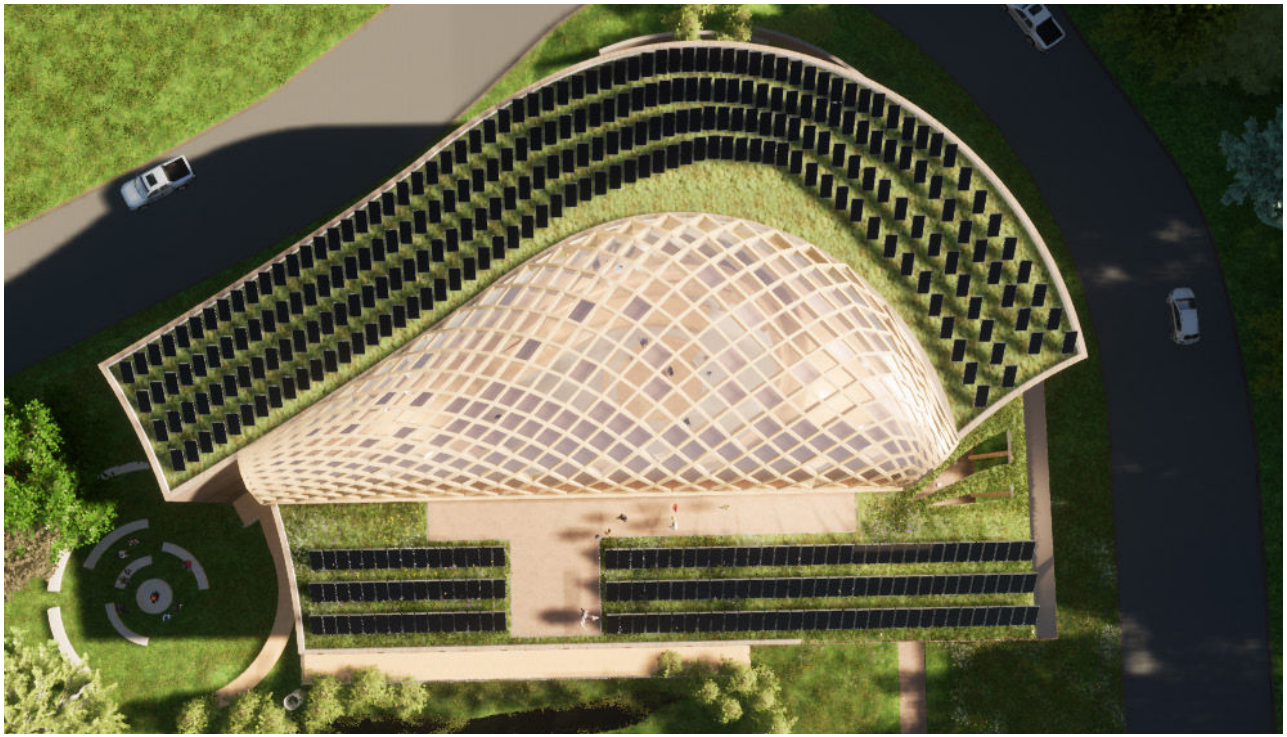


Figure 5: The Athabasca Cultural Centre simulated building, produced in Twin Motion. Visualization by student Jessica Williams. The simulation building is used as an interactive and integrated learning tool demonstrating timber construction in a regenerative design framework.

RESOURCES:
Bioregional, One Planet Living
International Living Future Institute, Living Building Challenge
The Canadian Handbook of Practice for Architects (CHOP)
National Building Codes.
National Energy Codes.
International Green Construction Codes.
Canada Green Building Council / LEED.
WELL Building.
Environment & Climate Change Canada.

PODCASTS
Facades Tectonics: Ted Kesik on Skins,
Façade Tectonics: Embodied Carbon,
Façade Tectonics: Resilience,
Façade Tectonics: Modular Prefab & Offsite Manufacturing: Resilience,
Learning from Nature: The Biomimicry Podcast with Jamie Miller

VIDEOS
Veronica Madonna and Steven Street, Growing Opportunities for Mid-Rise Construction, (2022)
Efficiency Canada, Embodied Carbon – The Blind Spot of the Building Industry
Brock Commons Tallwood House, Chapter 1: Overview
Brock Commons Tallwood House, Chapter 2: Design Process
Brock Commons Tallwood House, Chapter 3: Construction Process

TOOLS
Athena
EC3
GHGMAT
Match Box
One-Click LCA
Tally

READINGS

Berners-Lee, M. The Carbon Footprint of Everything. Vancouver: Greystone Books, (2022).

Brundtland, Gro Harlem. Report of the World Commission on Environment and Development: Our Common Future. United Nations, (1987).

Butler, Trevor, Douglas MacLeod, Veronica Madonna, and Henry Tsang. Carbon Neutral Buildings in Canada – A Holistic Case Study. (2022)

Cole, Raymond J. Transitioning from Green to Regenerative Design. Building Research and Information 40, no. 1 (January 1, 2012): 39–53.

Girardet, Herbert. The Gaia Atlas of Cities: New Directions for Sustainable Urban Living, (1988).

Girardet, Herbert. Creating Regenerative Cities, (2015).

Intergovernmental Panel on Climate Change. Climate Change 2022: Impacts, Adaptation and Vulnerability Summary for Policy Makers, (2022).

McLennan, Jason F., Transformational Thought: Radical Ideas To Remake The Built Environment, (2000).

Madonna, V. et al. Canadian Guide to Mid-Rise Wood Construction. Canadian Wood Council - WoodWORKS!, (2022).

Reed, Bill. Shifting from 'Sustainability' to Regeneration. Building Research &amp, (2007) 674–80.

Reed, Bill and Pamela Mang. Regenerative Development & Design: A Framework for Evolving Sustainability.

ENERGY EFFICIENCY IN THE ARCHITECTURAL, ENGINEERING AND CONSTRUCTION (AEC) INDUSTRY
FACULTY BIOGRAPHIES

Course 2 - Materials and Methods

VERONICA MADONNA

Architect OAA, MAA, FRAIC, M.Arch., B.E.D.S., B.Arch.Sc.
Assistant Professor, RAIC Centre for Architecture
Athabasca University

Veronica Madonna is an Assistant Professor at the RAIC Centre for Architecture at Athabasca University. She is an award-winning architect with wenty years of professional experience leading innovative and sustainable building designs across Canada. At the center of her practice and research are considerations for regenerative design, mass timber advancements, and equity-centred training and education.

Veronica was the Principal Architect on the ground-breaking Limberlost Place, a Ten Storey Mass Timber Net Zero Carbon academic building for George Brown College. The building design included several carbon-reducing strategies, including deep-water cooling and two solar chimneys driving an extensive natural ventilation system for the entire building. The mass timber structural system consists of a distinctive flat slab cross-laminated timber structure. Once construction is complete, Limberlost Place will be the tallest wood academic building in the world. Veronica was also the Principal-In-Charge of the Honey Bee Research Centre for the Ontario Agricultural College at the University of Guelph. The building and site design follow a regenerative philosophy where the site, building and program are woven into a living laboratory for the users and visitors. The structure includes a state-of-art research facility studying the health and wellness of the honeybee, and the site contains an extensive apiary connected by a discovery walk that moves from the landscape to a pollinator rooftop and interpretation tower. Both projects received national and international recognition for design excellence and sustainable innovations.

She is dedicated to further expanding the architectural industry's knowledge and skills in regenerative design embodied carbon and mass timber advancements and have lectured extensivity both in Canada and Internationally. She recently published the Canadian Guide to Mid-Rise Wood Construction, a national document outlining best practices and technical considerations for light-frame wood and mass timber construction for buildings up to six storeys. She is a member of the OAA Sustainable Built Environment Committee and the CaGBC Tall Timber Advisory Board.

In 2020, Veronica Madonna was recognized for her outstanding contributions to the field of architecture and was awarded a Fellowship from the Royal Architectural Institute of Canada.

Course 1 - Regenerative Design

DR. TREVOR BUTLER

Ph.D, PEng, CEng, LEED®AP BD+C, Meng, MSt (cantab), MCIBSE, MICE
Associate Professor, RAIC Centre for Architecture
Athabasca University

Trevor is qualified as an Architectural Engineer (Mechanical & Civil) with over 28 years of experience in the AEC industry - leading the delivery of projects with a strong focus on sustainable and regenerative design.He takes a whole systems approach to design and development to ensure that fully integrated solutions are achieved.

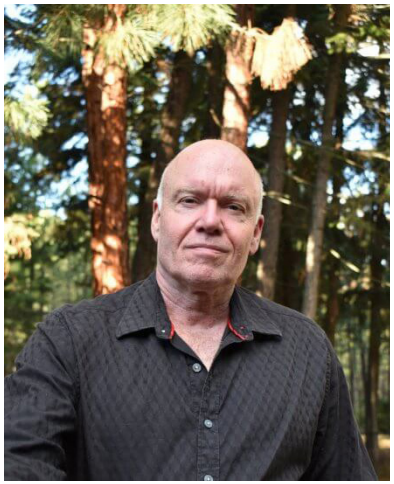
His creative and detailed approach to design and analysis enables the performance of innovative engineering solutions to be proven as a significant step towards net-zero energy and regenerative buildings.

Trevor has worked with the RAIC Centre for Architecture at Athabasca University since 2014. He has been full-time faculty since November 2019, where he provides specialist knowledge on green buildings to the student body.

Course 3 - Code and Regulations

DR. HENRY TSANG
Architect, AAA, FRAIC, RHFAC, LEED GA, WELL AP
Associate Professor, RAIC Centre for Architecture Athabasca University
Athabasca University

Dr. Henry Tsang is an architect and associate professor at the RAIC Centre for Architecture at Athabasca University. His design, teaching and research work explores the intersections between sustainability, health, and culture in the built environment. His design works include multiple sustainable and regenerative projects, such as a new zero-carbon carbon timber building for the Calgary Japanese Community Centre in Alberta, Canada. He also leads some innovative research pedagogical advances, including the development of an AI-integrated micro-credential course on energy-efficient buildings, and research in sustainable rural and regenerative communities in Canada. Many of his research papers are published in scholarly journals, and he has also been invited to speak at international conferences, including ACSA, UNEP, TEDx, and the Bow Valley Sustainable Building Summit, as well as universities worldwide. Before his current role, he has also held a professorship at Keimyung University in South Korea, and the position of director of the Sustainable Architecture Technology Program at Herzing College. As one of the founding members and former Vice-President of the Living Building Challenge Montreal Collaborative, he has been influential in the advocacy and development of the LBC standard in Canada. Tsang is a certified LEED Green Associate and WELL AP, and he has practiced professionally with design firms in Calgary, Montreal, and Tokyo. He completed his B.Sc.Arch., M.Arch. at McGill University, and Ph.D. at the University of Tokyo as a Japan-funded Monbukagakusho Scholar. He is the recipient of the 2015 Educator of the Year Award by the National Association of Career Colleges, 2020 Canadian Architect Award of Excellence, 2021 Construction Canada Emerging Leader Awards and was named Calgary's 2023 Asian Changemaker.



Course 4 - Managing Facilities for Energy Efficiency

DR. DOUGLAS MACLEOD
CAB, FRAIC, NCARB
Chair of the RAIC Centre for Architecture
Athabasca University

Dr. Douglas MacLeod is the Chair of the RAIC Centre for Architecture at Athabasca University – Canada's first online architecture program. The Centre currently serves over 600 students in 16 countries and continues to enhance the quality of architectural education in Canada.

MacLeod is a registered architect, a contributing editor to Canadian Architect Magazine and the former Executive Director of the Canadian Design Research Network. He is also a former Associate with Barton Myers Associates, Los Angeles.

He led pioneering work in virtual reality at the Banff Centre and is recognized as an expert in e-learning, sustainable design and virtual design. He has degrees in Architecture, Computer Science and Environmental Design and has taught at universities and colleges throughout North America.