UNB
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UNIVERSITY OF NEW BRUNSWICK

Off-site Construction Research Centre

With support from industry and the public sector, this Centre will help to transform the construction industry in New Brunswick and grow a new industry – one that will revolutionize the creation and delivery of infrastructure.

-Dr. Jeff Rankin, UNB

REVOLUTIONIZING THE CONSTRUCTION INDUSTRY

The Off-site Construction Research Centre at the University of New Brunswick seeks to transform the construction industry by optimizing alternate solutions to conventional, 'stick-built' on-site construction.

Off-site construction consists of planning and designing building elements that can be pre-manufactured under controlled plant conditions and then rapidly 'assembled' rather than 'constructed' at a job site. This approach, which has been successfully used in the automobile, shipbuilding, aerospace and consumer industries, is often referred to as Design for Manufacturing and Assembly or DfMA since it focuses on ease of manufacture and efficiency of assembly.

Off-site building elements can incorporate a wide range of materials made into many sizes and configurations, such as individual components, flat-packed panels and volumetric room-size modules (DfMA elements). DfMA elements for construction projects can be designed as both structural and enclosure systems integrated with multi-disciplinary functions, such as fire rating, air and vapor barrier, electrical, plumbing, HVAC, aesthetic effect and interior finish.

The vision of the Off-site Construction Research Centre is to transform

- infrastructure and building construction into an industry that's more technology-driven, productive and capital-efficient,
- UNB into an international leader in off-site DfMA construction research, and
- the region into a manufacturing hub of factory-made DfMA elements.

Industry partners and UNB researchers will jointly identify critical problems that require commercially-viable solutions to advance the use of off-site DfMA construction techniques. A major focus will be to develop multi-function, factory-built elements for building and infrastructure projects. Research will encompass design and manufacturing, shipping and field logistics, and rapid on-site assembly. Structural materials used will include light-gauge steel, structural steel, precast concrete and petrochemical-based composites. In addition, research will explore methods to incorporate architectural, mechanical, electrical and other multi-disciplinary components with structural elements.

The Centre will build on UNB's research capabilities and leverage technology that is emerging in the construction and manufacturing industries: automation, robotics, 3D printing, artificial intelligence, augmented and virtual reality, laser scanning and drones to create point clouds and building information modelling.

NECESSITY MEETS OPPORTUNITY

The construction sector is one of the largest in the world economy, with estimates of $10 trillion or 13 per cent of the world's GDP spent annually on construction-related goods and services. These numbers translate to North America with local projections over the coming decade for growth in all related sectors, including residential, institutional, commercial, industrial, new infrastructure projects and maintenance of existing infrastructure.

In addition, what was once an industry with regional markets is ever expanding with industry participants competing on a national and international scale. Yet despite its immense size and economic impact, when compared to other industries, there has been little progress in labour productivity in the construction industry. There are many factors as to why this is the case:

- the construction industry is one of the most fragmented in the world with most parties working together for the first time in a unique project environment;
- traditional projects utilize many site-produced goods and employ temporary teams;
- contract structures typically mismatch risk allocation;
- contractor involvement in the design phase is usually late in the process; and
- regulations and building codes are mostly prescriptive and allow for little innovation.

In addition, often hostile and unsafe work environments, along with large quantities of waste, have made reductions in cost, schedules and defective workmanship challenging. However, with new technology emerging in the construction industry, an opportunity for innovation exists by investigating new methods, materials and products using off-site DfMA construction techniques.

Current trends in the construction industry reflect the need to adopt technological advances and initiate a transformational shift from conventional on-site construction to a DfMA approach:

- Advanced automation and robotics solutions are beginning to have an impact on the construction industry. They include real-time automated material tracking, digital site layout planning, robotic platforms for automated assembly, laser scanning, drones and point clouds to identify in-situ conditions and the Internet of Things.

- The growing adoption of building information modelling technologies in design and construction is changing the way project teams (owners, designers, builders and sub-trades) collaborate, and the way information and communications technologies are leveraged.

- Owners are requesting more efficient use of their capital to build infrastructure. Lean construction initiatives are being adopted by more construction organizations to improve productivity at job sites.

- Owners, governments and other occupiers are requesting more sustainable solutions, and environmentally sensitive buildings and infrastructure. Waste reduction, energy efficiency and other green building initiatives are becoming the norm.

- Contractual relationships are becoming more collaborative. Formats such as Integrated Project Delivery, Public Private Partnerships and Design-Build-Finance-Operate-Transfer are being more widely adopted.

- The construction industry across North America is facing widespread acute shortages of experienced and skilled on-site tradespeople.

The challenges presented by these industry trends create both an urgent need and an exceptional opportunity. Off-site construction is primed for research and development. UNB is poised to break new ground and its partners will benefit from the results.

THE OFF-SITE CONSTRUCTION ADVANTAGE

Just like the shipbuilding, aerospace or automobile industries, with the proliferation of new technology being developed for the architectural, engineering and construction industry, DfMA elements can now be developed for use on construction projects. They can be created using the same materials and design codes and standards as conventionally built projects, or new materials and design standards may be developed. In some cases, up to 90 per cent of individual DfMA elements can be completed on the factory floor prior to being transported to site and assembled in place. This practice is greener, faster and smarter, producing greater flexibility, a higher degree of predictability in costs, a reduced construction schedule and safer construction.

TIME SAVINGS

One of the biggest incentives for off-site construction is time reduction. DfMA can produce a quality product in up to half the time of conventional on-site construction. Building components in a factory-controlled environment means not having to deal with unpredictable weather conditions and challenging site conditions that can cause delays. Additionally, unlike conventional on-site construction, where time delays and costs are sometimes attributed to multiple trades competing for space, off-site construction allows both on-site and off-site tasks to be conducted simultaneously.

STRONGER STRUCTURE AND BETTER QUALITY CONTROL

DfMA buildings are generally stronger than conventional construction with each DfMA element engineered to independently withstand the rigours of transportation and placement. Off-site construction also improves the quality and reliability of the project, due to process consistency and control in a factory environment where delays and cost overruns are minimized. Quality is also improved by avoiding inherent on-site risks such as poor workmanship, site congestion and bad weather.

IMPROVED SAFETY

Removing up to 80 per cent of the building construction activity from the site location significantly reduces site disruption, vehicular traffic and improves overall safety and security. Production in a factory environment is a far more predictable setting than on-site construction, which eliminates a number of risk factors such as unsafe weather conditions, difficult access and unprotected work areas. Having the conditions be the same on a daily basis ensures errors are less likely and dangerous hazards are avoided. A controlled factory setting provides a safe, clean and secure work environment.

GREATER SUSTAINABILITY AND WASTE REDUCTION

Along with the growing need to produce more environmentally friendly building materials, the need to produce friendlier building practices is also on the rise. According to the Waste Resource Action Program, producing a DfMA modular-based building uses only 33 per cent of the energy of a traditionally built project. This reduction in energy use is a result of work being done in a controlled environment. In addition, reducing material waste and impacts on the surrounding environment – such as noise, dust and the interruption of public services and businesses – improves sustainability.

TECHNOLOGY

The application of technologies, ranging from advanced robotics and automation to building information modelling (BIM), gives off-site construction an advantage over traditional practices. With BIM, for example, an accurate virtual model with precise geometry can be constructed at which point users can use the software to perform a number of processes, including visualization, modelling, code reviews, shop drawings, fabrication, communication, cost estimating, construction sequences, and conflict and collision detection. Beyond the design and construction process, off-site provides opportunities to integrate advanced technologies into the end product to create a 'smarter' built environment.

LOGISTICS AND SHIPPING

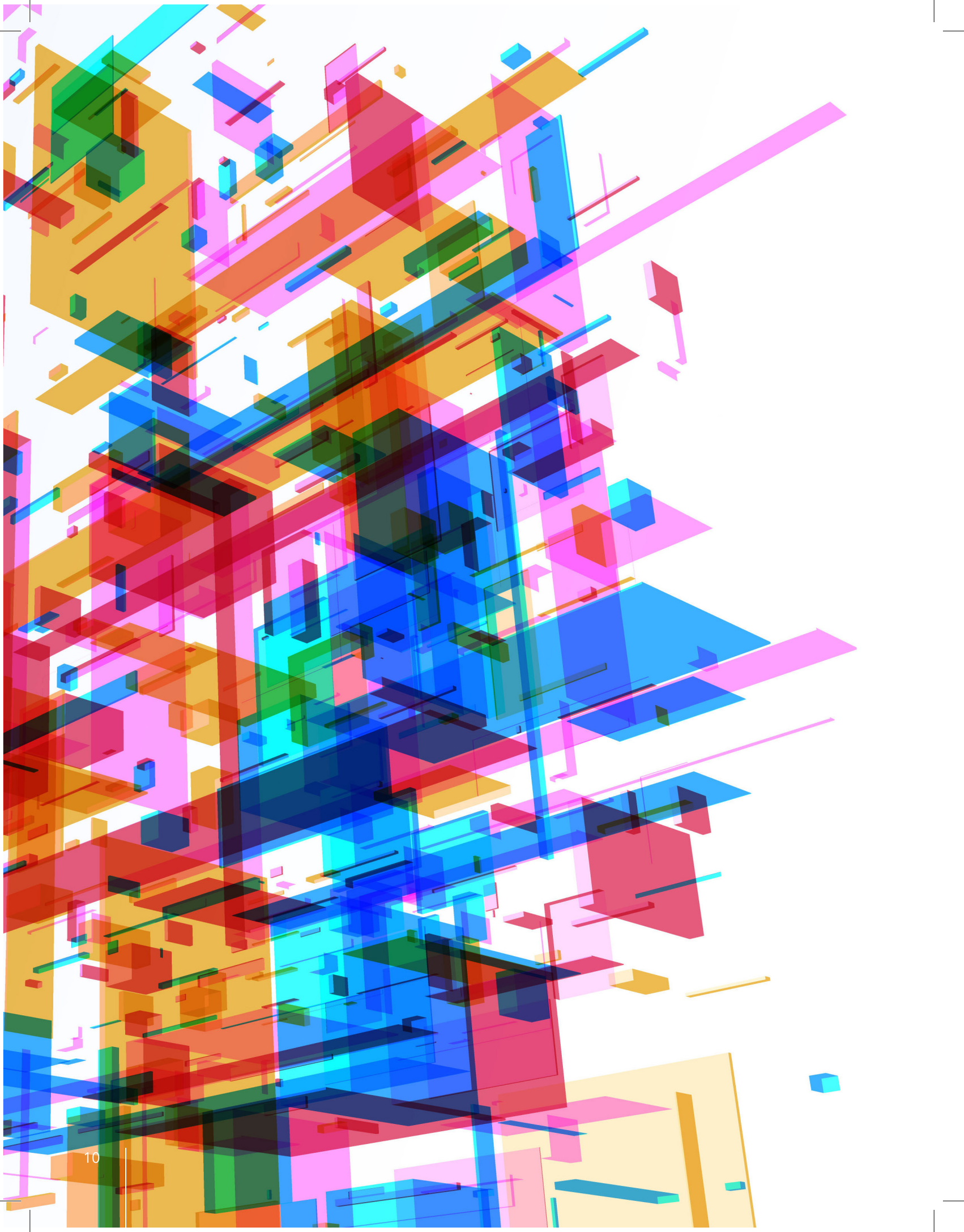
DfMA elements are designed to accommodate the logistics and transportation constraints that are encountered on most construction project sites. Usually, DfMA elements can be sized to fit containers for marine shipping, rail cars and truck trailers. This allows certain DfMA elements to be manufactured and shipped over long distances from geographic locations with access to marine, road and rail connections.

UNB's Off-site Construction Research Centre will challenge current DfMA off-site practices to leap ahead and deliver even better performance in these areas and a superior end product.

Research will investigate how to manufacture multi-disciplinary DfMA elements with a high degree of aesthetic finish to allow owners and designers the freedom to create unique, functional, architecturally-pleasing projects.

The 'industrialization' of construction has begun with the goal of moving substantial on-site activities into a factory environment. We believe UNB, with its research and innovation capabilities and our investment, will become an international leader as this transformation unfolds.

-Hans O. Klohn,
President, OSCO Construction Group



PARTNERING WITH RESEARCH EXCELLENCE

New Brunswick needs innovation, and UNB is delivering it with outcomes ranging from the education of highly qualified people to the creation of research clusters that adapt and grow, driven by the pull of consumer and industrial demand, as well as, the push of academic applied research.

Home of the first engineering program in Canada, UNB offered its first civil engineering course in 1854. Technological innovation and wealth creation have been part of its DNA for a long time. UNB civil engineers played a role in building this country, from the Canadian Pacific Railway and the Trans-Canada Highway to the hydropower development of its rivers. Today they are leaders in national and international construction and engineering organizations.

UNB faculty and alumni helped develop two of the most progressive and successful utilities in North America, NB Power and NBTel (now Bell Aliant), and UNB graduates were instrumental in creating New Brunswick's engineering consulting industry. UNB researchers are playing key roles in developing other emerging industries, including biomedical occupational health and safety, and the recently launched research centres in smart grid technology and marine additive manufacturing. Each of these ventures represents a key research partnership with industry leaders.

UNB is driving the development of regional and national applied engineering research centres in conjunction with private-sector partners such as Cisco Systems; Emera, Google; IBM; Irving Oil, J.D. Irving, Limited; Lockheed Martin; NASA; NB Power; OSCO Construction and Siemens Canada.

UNB has a vision to build even more capacity in engineering, doubling the faculty's research output, significantly increasing the number of research centres and growing the graduate student population. This is underway in all UNB's engineering departments, including civil.

Civil engineering faculty members are recognized nationally and internationally for their expertise. They excel in the core areas of civil engineering – construction, materials, structural, and transportation – and have the ability to leverage UNB expertise in related areas, such as manufacturing, advanced materials, optimization, sensors, data and spatial planning, worker impacts and contract law. UNB has excellent relationships with researchers in universities all over the world and can draw on those relationships to obtain expertise on specific issues.

EXCELLENCE IN CIVIL ENGINEERING

The Off-site Construction Research Centre at UNB is being built on a strong foundation of research groups within the department of civil engineering. Including,

- **The Construction Engineering and Management Group** - led by Drs. Lloyd Waugh, Jeff Rankin and Zhen Lei
- **The Materials Group** – with internationally recognized concrete expert Dr. Michael Thomas and Dr. Xiomara Sanchez
- **The Structures Group** - Drs. Alan Lloyd, Kaveh Arjomandi and Peter Bischoff
- **The Transportation Group** – Drs. Eric Hildebrand and Trevor Hanson

The department is home to the M. Patrick Gillin Chair in Construction Engineering and Management. As the first construction research chair in Canada, established at UNB in 1987, it has led the way in creating strong ties between researchers and the construction industry.

UNB RESEARCH AT A GLANCE

75% OF PUBLICLY FUNDED RESEARCH
in New Brunswick conducted at UNB

20+
leading research institutes and centres

25+
world class research chairs

$40+ MILLION
in external research funding annually

406
PhD students in 2017-18

134
postdoctoral fellows in 2017-18

74 STARTUP COMPANIES
created since 2013-14

58 PATENTS
issued since 2012-13

A UNIVERSITY-INDUSTRY PARTNERSHIP

The UNB Off-site Construction Research Centre and a new research chair in off-site construction have been made possible by the OSCO Construction Group, recognized innovators in the industry. In business since 1955, OSCO – through its subsidiaries which include Ocean Steel and Strescon – designs, manufactures and installs steel and concrete building products, including prefabricated factory-built components. OSCO also provides civil, electrical and mechanical contracting and construction management services. Its geographic markets include Canada and the eastern United States, and its customer base encompasses civil infrastructure, heavy industry, institutional, commercial, retail and multi-storey residential projects.

As a founding partner of this Centre, and with its numerous construction lines of business which serve the marketplace, OSCO foresees great potential in off-site DfMA construction to transform the building industry in North America and beyond.

OPPORTUNITIES TO PARTICIPATE

Engineering researchers at UNB – in partnership with some of Canada's most prominent businesses – are developing technology that generates jobs, wealth and prosperity. An investment in the Off-site Construction Research Centre at UNB will accelerate this process and increase its impact on economic development by an order of magnitude, strengthening New Brunswick, Atlantic Canada and the nation.

By developing innovative solutions to construction industry problems, the Centre will transform partner companies, grow the supply chain in the province and make New Brunswick a hub for off-site construction. Public and private construction owners, designers, and builders all have a stake in advancing the industry and all will benefit from better practices to deliver construction products.

Opportunities to participate range from supporting world-class researchers to contracting research to solve specific problems.

Inquiries are welcome from all private sector stakeholders, including owners, developers, architects, engineers, construction managers, general contractors, design builders, speciality sub trades and other supply chain providers.

For additional information on the Centre and investment opportunities, contact:

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