British Columbia Construction Association

CONSTRUCTION INNOVATION PROJECT

Building BC's vision.

Construction Innovation in BC

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A vision of the future

In a world powered by innovation, action is needed to ensure that BC construction companies are ready to meet the challenges ahead.

It's hard to overstate the importance of construction to BC's economy. As a $16.5 billion dollar industry it provides 8% of the province's GDP and employs more than 200,000 workers, making construction one of BC's largest employers. This means innovation is vital for the continued prosperity of the province.

The industry's future includes profound regulatory, technical, demographic, macroeconomic and consumer changes that will impact every aspect of construction. National and international factors such as an aging population, climate change and the digital design revolution are changing the needs and expectations of regulators, clients and end-users and also putting pressure on the industry to integrate new ideas, technologies and specifications into their projects.

BC construction firms will have to adapt and innovate or risk being left behind. Although BC is strong in green building and wood technologies, we have catching up to do in other areas. Public and corporate investment in innovation in BC lags behind other highly developed countries. The mechanisms for knowledge sharing and collaboration outside of projects do not exist. Fundamentally, the industry has not fostered a culture of innovation that transcends day-to-day problem solving on a construction site.

These gaps are concerning because innovation is the ultimate source of long-term economic growth and competitiveness. The ability to create new products, techniques and services, to find novel uses for existing products and to develop new markets provides will ensure success in the twenty-first century.

This "call to action" is meant for general contracting and trade companies and the many stakeholders that are involved with construction in BC. Our report makes the case that engaging pro-actively with innovation can have a positive impact on business and the ability of businesses of all sizes to succeed. It outlines the key challenges that have to be overcome and highlights the need for a "made-in-BC" construction innovation action plan that can serve as a model for the rest of the country.

The BC Construction Association is pleased to lead the charge on this important issue, and proud to have co-funded this report. We look forward to continuing the conversation and welcome all stakeholders to join us.

The state of innovation in BC's construction industry

Innovation can be defined as the successful introduction of new technologies or procedures into industry. The scope of innovation in the construction industry is broad and applies to everything from building products, materials and systems to construction techniques, equipment and business operations.

The need for more innovation and better innovation deployment systems in the construction sector is well recognized. Compared to other industries, construction in most regions (including BC) remains largely locally-focused, undiversified, and with relatively small export markets.

External forces such as changing societal demands and expectations, the increasingly globalized market and business climate, labour market challenges and advances in knowledge and technology are creating new pressures for construction companies to innovate. Although it may affect individual businesses very differently, there is general agreement that the way construction gets done ten years from now will be very different from today. Innovation will be essential to the industry as a whole to reduce capital construction costs, improve productivity, increase the number of projects completed on time and within budget, and reduce the number of defects and accidents. Investment in innovation can also help companies to differentiate, improve their reputation and compete for the next generation of talent in a tight labour market.

It is imperative for the industry to continue to innovate in response to these drivers or risk being left behind. Construction industry members say that cost of materials and energy, an aging workforce, the need for workers with higher qualifications and sustainability are the four most important drivers of innovation in BC. They are manifesting themselves in trends such as low carbon design, the digital revolution and the influx of cheap products (and labour) from overseas.

There are several areas of strength that the construction industry can leverage as a starting point to build a culture of innovation. BC's economy has strong prospects for growth with low interest rates and an attractive corporate tax regime. The industry has expertise in wood design, construction and the infrastructure that supports the development of innovative wood products, capabilities in digital technologies and building envelope design, testing and assembly. BC builders can also put up a concrete high rise building faster than most. The next generation of talent is putting a fresh face to the industry and a new federal government brings concrete commitments to investing in Canada. The BC construction industry's leadership in green building and in all sorts of innovative applications of wood technologies is coming to the fore just at the moment when the world is looking to the built environment to mitigate environmental and social challenges.

However, the industry also faces challenges—such as the number of stakeholders, risk aversion, the lack of a culture of learning and short term thinking—that are deeply rooted and will be very difficult to dislodge. The threats of continued low productivity, lack of attractiveness as a career path to new workers, and an unsatisfactory reputation (whether justified or not) will only become greater as the regulatory framework continues to become more challenging, materials costs go up and the labour shortage becomes increasingly acute.

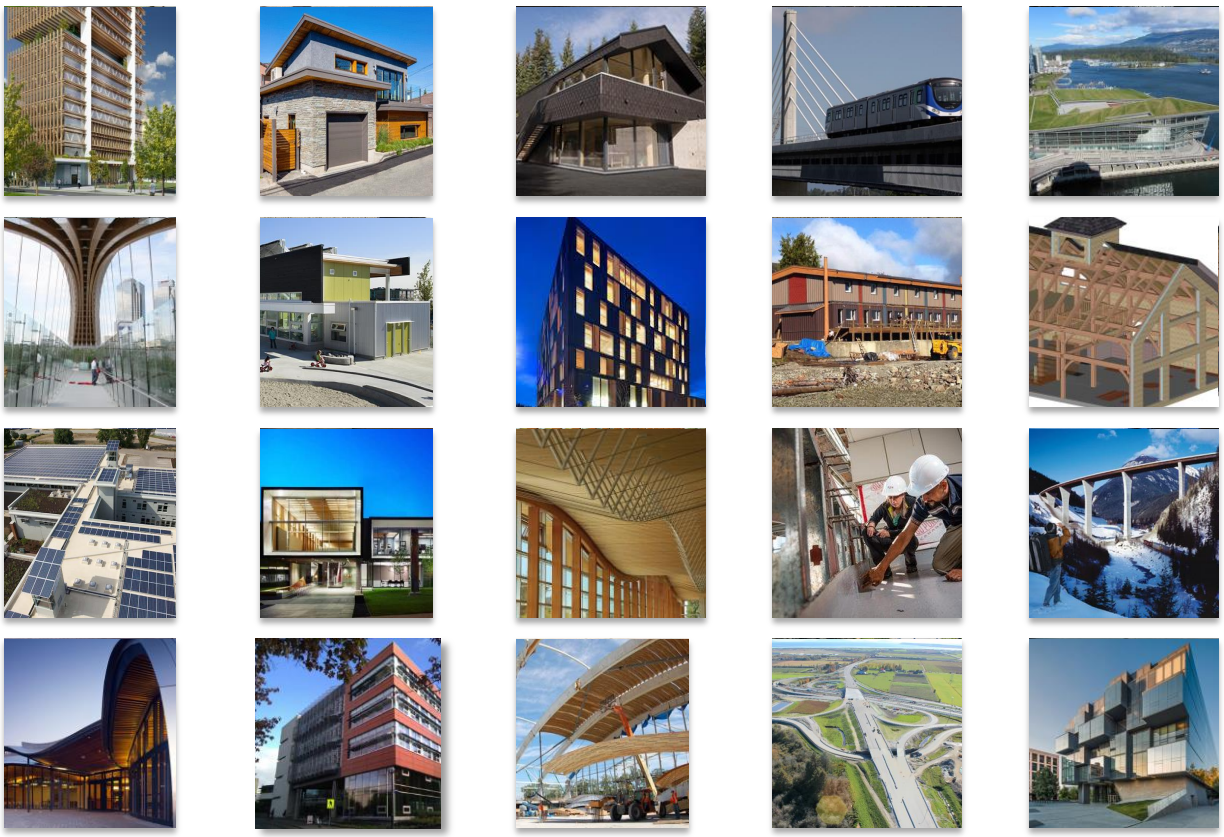
BC is well positioned to tackle the challenges that lie ahead, but it will take a concerted effort. Creating a culture of innovation will not just happen by itself – it requires the commitment, investment and determination of the industry as a whole.

A vision for BC's construction industry

This study shows that embracing innovation will improve project and business performance and position BC construction companies for success. However, a comprehensive industrial action plan is needed to coordinate efforts and catalyze and capture industry innovation. This study presents the case for such a plan and offers five foundational pillars to serve as a guiding framework:

1. **Leadership** – A cohesive industry that embraces and celebrates innovation
2. **Performance** — A responsible industry that continually improves projects' economic, environmental and social performance
3. **People** – A talented industry that attracts a skilled, technologically-savvy workforce
4. **Growth and resilience** – An efficient, competitive and profitable industry that drives economic growth
5. **R&D** – An advanced industry that develops and implements innovative new products, processes and business strategies.

These five pillars lay out an aspirational innovation program of ambitions and recommended activities for the province that reflect best practices and the strengths and weaknesses of the BC construction industry. Their successful implementation will require broad support from government, research organizations and the construction industry as a whole.



Pillar 1: Leadership - A cohesive industry that embraces and celebrates innovation

Ambition 1.1 Establish an action-oriented innovation council to be the "voice" of innovation in construction in BC

a. Establish an action-oriented innovation council to be the "voice" on innovation in construction in BC
b. Develop a formal industrial action plan for innovation
c. Keep the conversation alive with a series of "meeting of the minds" dialogues around the province
d. Develop strategies so that the many voices of small businesses are heard

Ambition 1.2. Report on key performance indicators for construction excellence

a. Engage with industry leaders and stakeholders to determine the optimal suite of indicators, reporting framework, and responsibilities for data collection and monitoring.

Ambition 1.3 Recognize and celebrate innovation "champions"

a. Promote awards and recognition programs for innovation
b. Showcase leading individuals and organizations

Ambition 1.4 Shift misperceptions of the industry via public engagement and stakeholder communication

a. Develop and maintain public engagement and stakeholder communication programs
b. Review and revamp language and images to steer away from traditional perceptions of construction being physically demanding and without opportunities for career advancement.

Ambition 1.5 Pro-actively engage with government on program and policy development, investment and procurement

a. Pro-actively engage with all the relevant departments and agencies of government at the local and provincial level: fostering partnerships where possible so industry stays ahead of codes changes, etc.
b. Consider the pros and cons of advocating for a single point of senior leadership within government to help direct desired reforms

Pillar 2: Performance - A responsible industry that continually improves projects' economic, environmental and social performance

Ambition 2.1 Encourage the adoption of innovative design and construction methods that put quality first

a. Advocate for open universal standards to make communication and data transfer seamless and secure across all platforms and devices
b. Support the adoption of "Modern Methods of Construction" such as off-site construction and lean construction
c. Help businesses of all sizes gain access to and deploy the new tools and technologies they need to be competitive

Ambition 2.2 Continue to push the boundaries in low-carbon, healthy and green construction

a. Leverage BC leadership in green building and the use of wood when focussing on our competitive advantages
b. Promote occupant and operator training to ensure buildings work properly and protect investments in innovation
c. Support the adoption of sustainable materials and technologies

Ambition 2.3 Encourage all businesses to demonstrate corporate responsibility

a. Encourage companies of all sizes to act ethically and transparently at all times to build a positive reputation and win work

Pillar 3: People - A talented industry that attracts a skilled, technologically-savvy workforce

Ambition 3.1 Help businesses of all sizes to acquire the full spectrum of skills necessary to create and implement innovative ideas successfully

a. Foster a culture of learning to develop an engaged and informed workforce
b. Develop business leadership capacity so companies of all sizes can manage for innovation
c. Consider establishing "Best Practice Clubs" to bring the benefits of best practice to a practical, personal and local level

Ambition 3.2 Help businesses leverage innovation to drive recruitment and retention

a. Undertake a review of programs aimed at improving the image and perception of the industry by encouraging "beyond code" best practice
b. Review recruitment messaging so that it explains the career development opportunities and the diversity of jobs available

Pillar 4: Growth and resilience – An efficient, competitive and profitable industry that drives economic growth

Ambition 4.1 Ensure procurement structures meet client and industry needs and provide an equitable framework within which companies can innovate safely

a. Review current procurement practices and implement the improvements identified
b. Advocate for a "quality-first" agenda where life cycle costs and the value of design are recognized
c. Develop common language for how "innovation" should be described and interpreted in the bid process
d. Create and offer procurement training for owners
e. Work with stakeholders to determine how to mitigate adversarial behaviours (such as suicide bidding) and to minimize the underground economy

Ambition 4.2 Support ongoing evolution of standards and codes as a means to push the innovation into the market

a. Foster a close working relationship with policy makers at the municipal and provincial levels and participate proactively in the development of codes and standards
b. Advocate for performance-based building codes as a way to drive innovation into building projects

Ambition 4.3 Develop strong supply chains so new ideas can be realized cost effectively and in a timely manner

a. Encourage methods that close gaps in the supply chain to ensure the reliable release of work between specialists in design, supply and assembly
b. Advocate for centralized, online bidding and tendering
c. Promote a design-led, "life-cycle cost" approach so that consultants are rewarded for their expertise
d. Connect with financial institutions and insurers to explore innovative financing and risk management mechanisms

Ambition 4.4 Prioritize innovations that help BC companies to boost competitiveness so they can realise a return on investment in innovation

a. Showcase BC companies' proficiency in sustainable construction processes and products
b. Leverage BC's various export agencies to promote BC companies' expertise to new markets

Pillar 5: Research and development - An advanced industry that develops and implements innovative new products, processes and business strategies

Ambition 5.1. Support research and development networks and centres

a. Explore the viability of establishing a construction-focussed technology cluster, leveraging the leadership of BC's wood sector as a role model and possible partner
b. Leverage Vancouver's established venture capital capacity and start-up community to support a construction-focussed incubator
c. Create opportunities for industry to feed back ideas from the field into the R&D community

Ambition 5.2 Showcase demonstration projects

a. Build on BC's track record of "being first" when it comes to innovative projects
b. Connect with industry associations, trade agencies and NGOs who can help to profile local success stories, collect data and build a library of projects

Ambition 5.3 Advocate for, enable and direct public funding and business investment in innovation

a. On the strength of a sharply defined vision for the industry, advocate strongly for more public spending on construction-related R&D
b. Help industry advocates (such as associations) make the business case for investment in R&D to construction companies

Ambition 5.4 Strengthen the role of large firms in BC as drivers of innovation

a. Develop tools and resources for large firms to use to engage employees and help them "think like innovators"
b. Help large GC firms to promote their investments in innovation so they can work together effectively and win work
c. Encourage large firms to share ideas and support collaboration to increase the rate of market transformation

Ambition 5.5 Encourage businesses to collaborate to achieve scale and share knowledge

a. Foster a safe and positive environment in which companies can collaborate to develop new (non project-specific) solutions
b. Provide tools and resources for companies to collaborate in order to achieve sufficient scale to compete on large projects

Three top priority actions

1. Create an action-oriented Innovation Council

A "Construction Innovation Council" with an outcome-oriented mandate is essential to create a cohesive and resonant voice and drive the agenda forward. Participation on the Council needs to be carefully sought from representatives within key stakeholder groups (clients, researchers, trainers, consultants, etc.) who are motivated to act and have a proven track record of accomplishments. The Council would be responsible for steering the development of a formal industrial action plan for innovation, fund raising for operations and activities, advocacy and, importantly, government relations.

2. Develop an action plan for construction innovation

To organize and prioritize all the work that needs to get done, companies of all sizes would benefit from an innovation action plan built on clear goals and describing the prioritized focus areas for research, timelines and how projects and activities are decided upon. We recommend the following next steps to start the process:

- **Decide on the role of government in the action plan**.. The rationale for involving government is that many of the enablers needed to advance innovation depend on government support and investment. The potential risk to this approach is that it would reduce the industry's influence on the timelines and final product.
- **Translate ambitions into activities**. This study provides the framework for an innovation action plan, which now needs to be validated and refined in consultation with industry and stakeholders. On the strength of feedback from industry, the ambitions need to be distilled into concrete goals and timelines for implementation so that projects and activities can be developed.
- **Measuring success**: Industry needs to determine if it is prepared to establish targets and performance measures to make sure that investments in innovation are actually improving productivity and performance and delivering business to construction companies.

3. Launch an innovation procurement initiative

As it stands, the procurement process needs to be fixed. There has to be a shift from a culture of "lowest bid" to focus increasingly on quality and "whole-life" value. The first step is a procurement process review to identify options for improving existing approaches to procurement (particularly by public sector building owners), potentially based on effective procurement models from other jurisdictions

Although a procurement review will uncover a range of actions that need to be taken (not least of which will undoubtedly be training for owners and purchasers), something industry leaders could develop right away is a "best practices" document for public procurement agencies with clear guidelines, that include a definition of innovation and how it should be described and interpreted in the bidding process.

There is more that can be done

There are many activities that need to be taken on to build a vibrant innovation ecosystem. The possibilities are extensive and exciting. However, they all start with the willingness to change and the acceptance that it is in the best interest of the broader industry for business of all sizes to get on board. To effect meaningful change will require a long-term commitment and investment; results are not going to happen overnight.

A complete, prioritized, industry-supported list of projects and programs will come from developing a formal industrial action plan that includes concrete goals. The following "shopping list" of seven items illustrates what we heard from survey respondents, interviewees and focus groups and provides ideas of where to focus initial efforts.

1. Develop and host "meeting of the minds" dialogues
2. Conduct more research into KPIs and metrics
3. Explore strategies to improve and communicate workforce capabilities, opportunities and accomplishments
4. Leverage Regional Construction Associations' networks and capabilities to set up "best practice clubs"
5. Develop an integrated province-wide innovation network and centre
6. Organize field trips
7. Develop an education and training strategy oriented around innovation

BC is well-positioned to tackle the challenges that lie ahead; but a concrete action plan is needed to coordinate efforts and catalyze innovation in a way that is meaningful for all construction businesses. To develop and implement this plan requires an industry-wide commitment and investment, but will yield significant benefits for BC's construction companies and the province as a whole.

About the report

Co-funded by the HPO and BCCA, the **Construction Innovation Project** is the culmination of eight months of research underpinned by a province-wide consultation process with contractors, consultants, owners and stakeholders involved in all types of project (from home renovations to aluminum smelting facilities). It lays the groundwork for a coherent, constructive and sustained conversation about innovation that includes all stakeholders. It attempts to weave together the common threads emerging in discussions within and between design and construction businesses (large and small), owners, researchers, investors and policy makers. Ultimately, it captures the vision towards which the BC construction industry is striving to achieve sustainable best practice.

The objective of this study is to summarize the current construction innovation landscape in BC and offer a **definition of innovation as it relates to construction** so BCCA, the Regional Construction Associations (RCAs) and others can focus their advocacy efforts for maximum impact and offer best value to their members in these changing times. Indeed, the project's continued success depends not only on buy-in from businesses throughout BC, but also on strong political and financial support from the government and its agencies. It is therefore a **Call to Action** for businesses, investors and stakeholders to seize on the groundswell of interest in the industry and join the efforts underway in other jurisdictions and work together to best exploit the forces of change. It also offers industry leaders and stakeholders a way to prioritize efforts and Identify how education and applied research can be applied to achieve a vision for the industry.

We need to keep the conversation alive: For some, the findings of this study will raise more questions than it provides answers. If it stimulates further constructive debate then it has been a success. As much as it is a catalyst for those who work in the construction industry to think about what the future might look like, the ambitions proposed need to be broadly accepted and established as a concrete vision that can be embraced and acted upon by senior level decision-makers from across the industry.

This report presents an agenda for strengthening the BC construction industry by enabling innovation. Implementing this agenda will take significant resources and requires an industry-wide commitment to collaborating and investing in new products, processes and business models.

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Acknowledgements

We gratefully acknowledge the financial support of the Homeowner Protection Office, a branch of BC Housing, and the BC Construction Association with in-kind contributions from Brantwood Consulting and the Delphi Group.

This project has benefitted from being able to leverage the momentum created by the Canadian Construction Association's launch of Canadian Construction Innovations (CCInnovations), which has been set up to advance innovation at a national level. They have done an excellent job of making innovation a "hot topic" for many construction companies, large and small. We would like to extend our thanks to the CCInnovations team and to Anibal Valente, chair of the CCA, for their participation and support for this project. We hope that our findings will be useful as they work to build a culture of innovation across Canada.

We would like to thank everyone who participated in the survey, focus groups and interviews as well as BCCA staff for their assistance and support. We would also like to thank over 30 project supporters who wrote letters of endorsement to help us secure funding. We congratulate Juvarya Vletkamp of the Vancouver Economic Commission for winning the survey prize of an Apple Watch.

Finally, the project team comprises Helen Goodland (project lead, Brantwood Consulting) with senior research support from Chris Lindberg (Lindberg Consulting) and Paul Shorthouse (Delphi Group). The BCCA Construction Innovation Committee provided oversight and guidance. Special thanks also to Kevin Hanvey MAIBC (principal with Omicron) for providing a peer review.

Introduction

Construction is the backbone of BC's economy providing 7.9 per cent of the province's wealth.[1] It's a $15 billion dollar industry[2] and has consistently been one of the fastest growing sectors over the past decade. Looking to the future, the industry is facing profound regulatory, technical, macroeconomic, demographic and consumer changes that are shifting both the opportunity horizon and risk outlook. Construction firms have to adapt and innovate or risk being left behind.

Co-funded by the HPO and BCCA, the **Construction Innovation Project** is the culmination of eight months of research underpinned by a province-wide consultation process with contractors, consultants, owners and stakeholders involved in all types of projects (from home renovations to aluminum smelting facilities) from across BC. It lays the groundwork for a coherent, constructive and sustained conversation about innovation going forward that includes all stakeholders. It attempts to weave together the common threads emerging in discussions within and among design and construction businesses (large and small), owners, researchers, investors and policy makers.

The objective of this study is to develop recommendations for how BCCA and other industry leaders can accelerate the adoption of innovation in the industry. This has involved summarizing the current construction innovation landscape in BC and offers a **definition of innovation as it relates to construction** so that the BCCA, regional construction associations (RCAs) and others can focus their advocacy efforts for maximum impact and offer best value to their members in these changing times. Indeed, the project's continued success depends not only on buy-in from businesses throughout BC, but also on strong political and financial support from the government and its agencies. It is therefore a **Call to Action** for businesses, investors, educators and stakeholders to seize on the groundswell of interest in the industry and join the efforts underway in other jurisdictions to work together to best exploit the forces of change. It also offers industry leaders and stakeholders a way to prioritize efforts and Identify how education and applied research can be applied to achieve a vision for the industry.

For some, the findings of this Construction Innovation Project will raise more questions than it provides answers. If it stimulates further constructive debate then it has been a success. As much as it is a catalyst for those who work in the construction industry to think about what the future might look like, the ambitions proposed need to be broadly accepted and established as a concrete "vision" that can be led decisively from the top (i.e. supported by senior level decision-makers from across the industry).

There is a sense that after many years of sailing into a headwind, the forecast is turning for BC's construction industry. Today, the wind is blowing in the right direction but businesses need to develop new types of crafts to catch the breeze and avoid being knocked off course or running aground. We hope that we are able to provide a glimpse of what these crafts might look like and how exciting the ride might be.

How this study was put together….

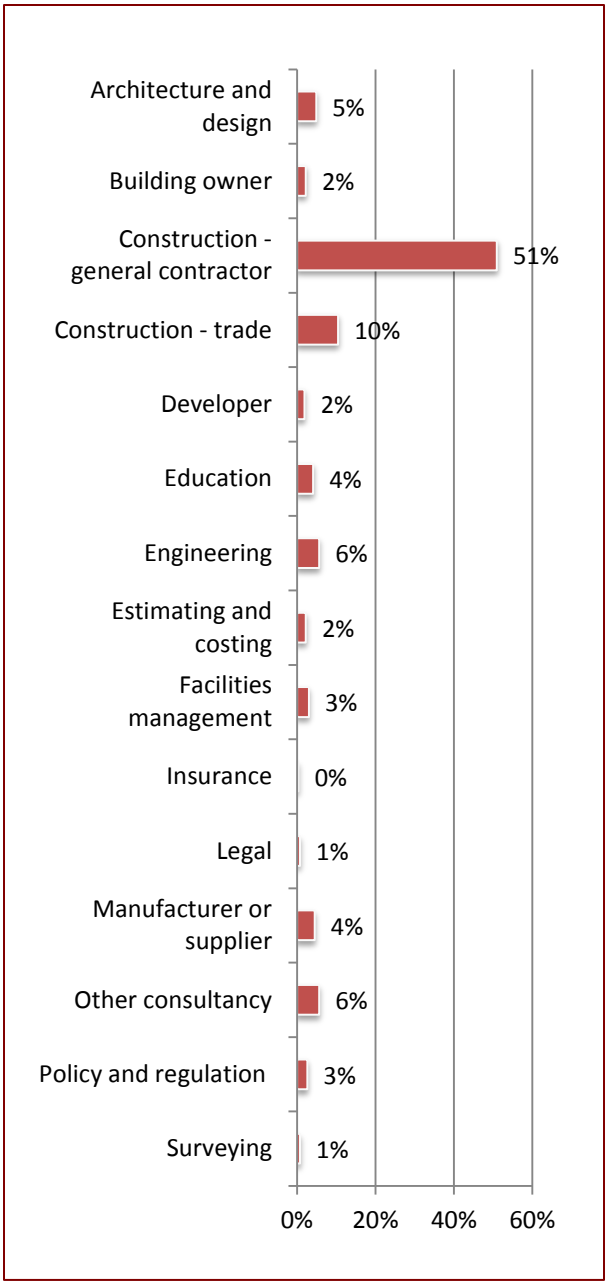


Figure 1 From our survey, "Which of the following sectors are you most closely involved with?"

….. and how to read it

This study is underpinned by a number of research activities, which included a province-wide consultation process. It is intended for busy professionals as opposed to academics. It offers a high-level view of the BC innovation landscape and recommendations for next steps to keep the conversation alive and the innovation agenda moving forward.

Information about the research methodology is presented in **Appendix A**. In brief, the research that went into this project included:

Primary research

The primary research included 16 "thought-leader" interviews, three focus groups, and an on-line survey (with 346 total responses), which ran from early July to the end of September 2015. Our survey respondents came from all corners of the province (54 per cent were from the Lower Mainland region), from all sizes of business (67 per cent were from businesses with less than 5 employees), from all levels of seniority (from unskilled labourers to business owners) and from 17 different types contracting and trade firms, consultancies, government agencies, and related business (Figure 1).

While the make-up of respondents represented a great deal of diversity, it is important to note that the distribution of survey respondents by business size does not accurately reflect the actual industry (Figure 2). In particular, the views of the "hard to reach" sole proprietors ("non-employers" in StatsCan terminology) who make up 67 per cent of the total businesses in BC are under-represented in the survey.

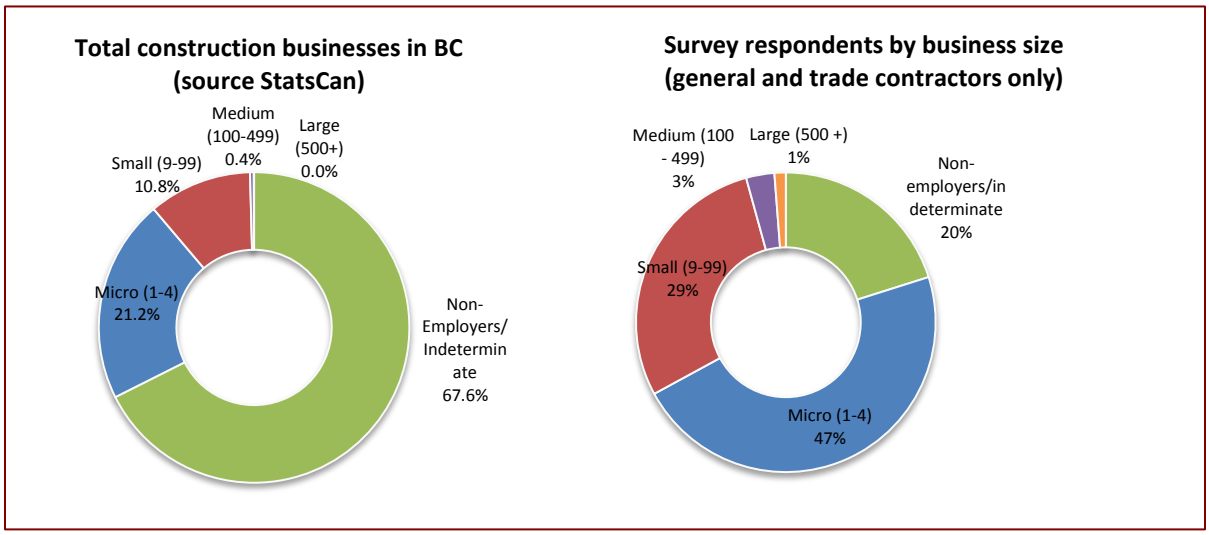


Figure 2 Survey respondents by business type compared to all B.C construction businesses

Secondary research

Secondary research comprised a comprehensive review of publicly available economic, labour market, and industry data; a scan of over 30 best practices from other jurisdictions; this included an in-depth analysis of three strategies from leading regions (Australia, the UK and Scotland summarized in **Appendix B**). We also reviewed of BC's construction innovation capabilities through the assembly of a database of R&D centres, large firms, training programs, investors, incentive programs, policies and regulations, and relevant award programs these resources are provided in **Appendix C**. We also undertook an in-depth evaluation of the progress and success of three construction industry innovation strategies that have been completed in Australia, the UK and Scotland.

Reading the study

In the course of our research we uncovered a large amount of information. To present and discuss everything we found would result in a document few would read end-to-end. Consequently, we have structured the report to be succinct and get to the analyzed findings and recommendations as quickly as possible. We have enriched the report with anecdotes from the research and case study examples as a means to illustrate key points. However, while we employed a rigorous research process, it is not an academic research paper. For those who want to dig deeper into the results, there are separate Appendices documents that provide:

- **Appendix A:** Research methodology
- **Appendix B**: A tale of three strategies in which we explore the strategies prepared in Australia, the UK and Scotland
- **Appendix C**: Resources comprising lists of training, investment programs, trade and export agencies and awards programs with web links
- **Appendix D**: Reference and notes that support the report

We are happy to share a separate file of the survey data upon request.

Understanding innovation: what it is and why BC's construction industry should care

The scope of innovation in any construction industry is broad and applies to everything from building products, materials and equipment to construction methods, systems and business operations.

Part of what makes innovation challenging is the lack of a shared definition and understanding of why it is important, what stops it from happening and how it can be realized successfully. To get started, this section provides an overview of key innovation concepts that can serve as a foundation for future work.

Defining innovation

The UK Chartered Institute of Building defines innovation as **"the successful introduction of new technologies or procedures into industry".**[3] This definition was supported by 92 per cent of survey respondents agreed with this definition and should be used by the BCCA going forward. However, a simple definition is not sufficient: it is important to articulate the value proposition and business case for innovation and establish a clear interpretation of what it means at the project, corporate and industry scales. To this end, this section distinguishes among four categories of innovation, discusses the different ways that innovations can arise and highlights a few key distinctions. The OECD recognizes four distinct categories of innovation:[4]

1. **A product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Product innovations can utilize new knowledge or technologies, or be based on new uses or combinations of existing knowledge or technologies.
2. **A process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products.
3. **A marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product in the market with the objective of increasing sales.
4. **An organizational innovation** is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. Organizational innovations can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies.

In each of these areas, the resulting innovations may be **incremental, disruptive** or **synthetic**. Incremental innovations build on existing products and approaches (e.g. adding new features or functions) whereas disruptive (or breakthrough) innovations introduce significantly new ideas, products or approaches that may replace traditional solutions (e.g. digital design). In contrast, synthetic innovations involve using existing products or processes in a new way. Similarly, innovations may arise from a carefully planned innovation process or they may be spontaneous and serendipitous (Figure 3).

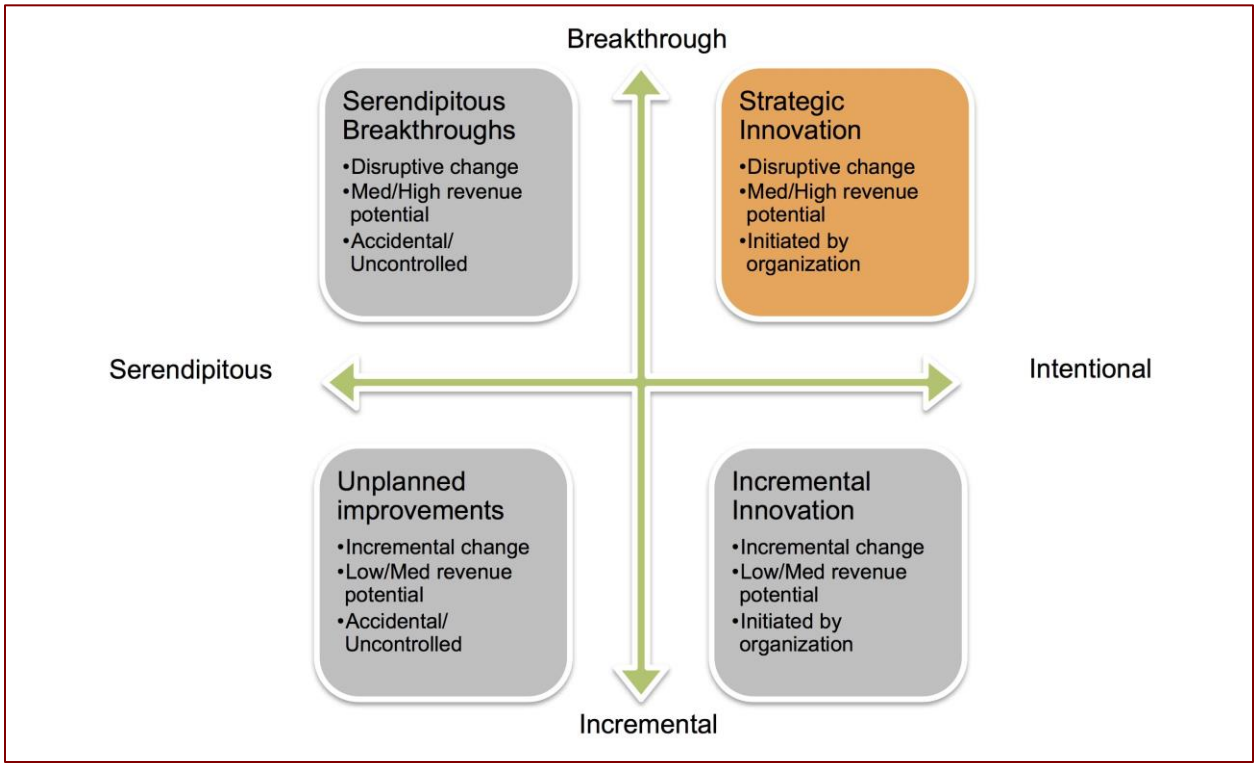


Figure 3 Types of innovation

In general, when thinking about innovation it is important to recognize that:

- **Newness is relative**. What is new in one organization or region may be established practice in another organization or region (e.g. adoption of European technologies and approaches in BC). Similarly, an organization might innovate by using an existing product or process in a new way.
- **Innovations must be implemented**. Prior to implementation, an innovation is still just an idea. A new or improved product is implemented when it is put into practice (e.g. introduced to the market). The value of an innovation derives from its benefits, such as improvements in efficiency, environmental impacts, organizational learning or market share.
- **Innovation is the result of innovation activities**: A diverse set of scientific, technological, organizational, financial and commercial steps are involved in the research, development and implementation of an innovation.
- **Research is not the same as innovation**. Research and development (R&D) are activities that support innovation, but they are not innovations themselves.

The construction innovation ecosystem

A great deal of research has been completed in Canada and elsewhere to try to understand who and what is involved in construction innovation. This research has found that there is a complex multi-dimensional "ecosystem" of stakeholders that influence innovation in the industry.

At the business level, there are three layers of influence that impact how innovations are realized: the construction company's **core business**, the **extended enterprise** which includes those organizations that are typically involved in a direct relationship with the business of construction (consultants, clients/owners, etc.) and an **outer orbit** that comprises the broader business ecosystem which comprises organizations that can have a major influence on the business of construction but not directly involved such as trainers, competitors and society at large (Figure 4).

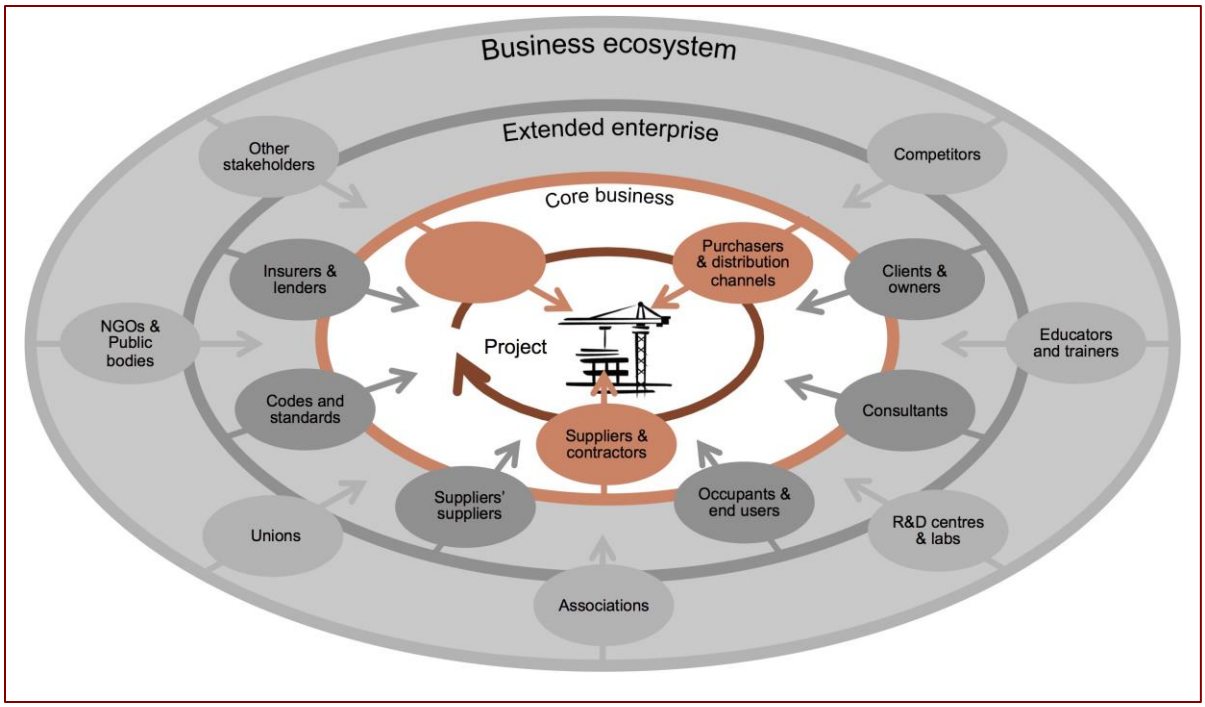


Figure 4 Construction industry innovation ecosystem

Each individual project also involves its own complex ecosystem of actors. A typical construction project team involves a diverse group of individuals who need to work together to implement innovative products and processes and find creative solutions to project challenges. In companies that manage innovation effectively, the process improvements that project teams figure out on-site are brought back into the business and institutionalized for application on other projects in the future (Figure 5).

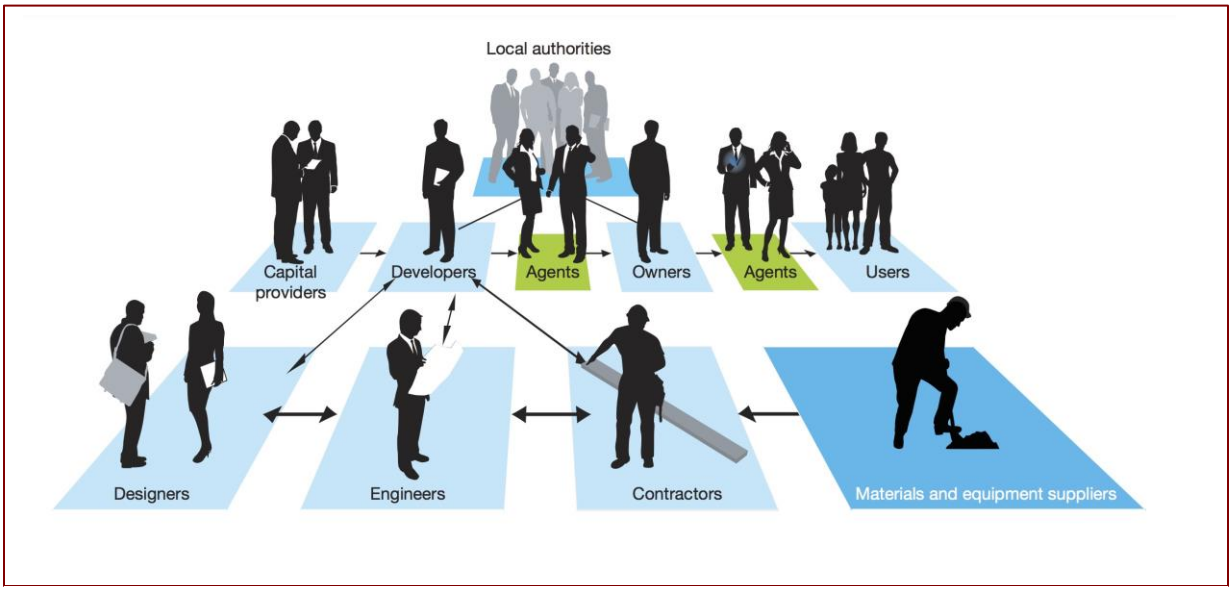


Figure 5 A typical construction project involves many actors and stakeholders

Clearly, the innovation ecosystem for construction is multi-dimensional and extremely complex. At the project level, innovation can happen at any point along the construction supply chain and be championed by any member of the project team. At the industry scale, any of the many, many stakeholders can offer new products and services as well as ways of doing business.

The importance of innovation

Innovation is paramount to continued prosperity. The need for more innovation and better innovation deployment systems in the construction sector is well recognized. Compared to other industries, construction in most regions remains largely locally-focused, undiversified, and with relatively small export markets. Overall, innovative approaches are needed to reduce capital construction costs and timelines, increase the number of projects completed on time and within budget, and reduce the number of defects and accidents.

There is broad agreement among economists on the importance of innovation for long-term economic growth and competitiveness, with some studies attributing as much as 50 per cent of GDP growth to innovation. According to the OECD, long-term growth depends upon "building and maintaining an environment that is conducive to innovation and the application of new technologies."[5]

> "Innovation within the construction industry is not a linear model but closer to the concept of complex products and systems which is highly reliant on knowledge transfer and the flow of information."
>
> **Prof. Thomas Froese, Department of Civil Engineering, UBC**

Numerous studies show that innovation has a direct impact on the competitiveness of a firm and thus its performance. Business performance is enhanced because innovation enables organizations to, "improve the quality of their output, revitalise mature businesses, enter new markets, try out new technologies, and develop alternative applications for existing product categories".[6] Innovation also provides non-economic benefits and may be driven by public policy objectives such as

increasing affordability, accessibility, health or environmental performance. In fact, the economic benefits of improved R&D performance can be substantial. Firms gain a competitive advantage by introducing new products or adopting new work processes. R&D can help overcome global challenges by developing energy efficient climate-friendly buildings or improving the quality of life in an older population through a range of affordable housing choices.

There is also a clear connection between a company's stance on innovation and its appeal to young workers. Given that a major challenge facing BC's construction industry is its aging workforce, attracting and retaining young, technologically-sophisticated workers will become increasingly important (and competitive) over the next five to ten years.

Construction innovation trends and emerging practices

The construction industry is continually responding to internal and external market forces by developing innovative products, processes, marketing methods and business models.

The industry has been responsible for, engaged in and adopted so many different innovations that it is impossible to list them all. As proof of the creativity within the industry today, we asked survey respondents, "If you were given a $5m budget for innovation, what would you invest in or develop?" 80 per cent of respondents offered us a legitimate idea (see also Figure 32).

Emerging construction innovations fall into four main areas (or trends): 1) Environmental and social performance, 2) Design and construction processes, 3) Business strategy, and 4) Materials and technologies (Figure 6). Specific examples and the implications for BC are discussed in the *Creating a Vision and Call to Action* section below.

Figure 6 Summary of current trends n construction innovation

Barriers to innovation in construction

In BC as in other regions and countries, there are systemic challenges that get in the way of innovation. For individual companies, common barriers include the lack of long-term thinking, the lack of a learning culture and the failure to prioritize investment in research and development. For the sector as a whole, common barriers include inadequate leadership and collaboration, the lack of appropriately skilled workers, a cost (not value-based) business environment and a lack of investment in research and development and inadequate systems for collaboration and knowledge exchange.

There are many major barriers to innovation that occur at the level of the sector and the economy as well as at the company level. At the industry scale these barriers can be grouped into five broad categories (Figure 7) that encompass leadership and collaboration, the performance of projects, companies and the industry, people and processes, the business environment and R&D capacity.

Category	Common Barriers To Innovation
1. Sector leadership and collaboration	• Lack of industry cohesion around innovation • Very large number of small businesses • Lack of political leadership
2. Performance	• Lack of performance-based codes • Lack of commonly accepted metrics for success
3. People and processes	• No clear definition or business case • Lack of appropriately skilled workers
4. Business environment	• Cost (not value)-based procurement • Inequitable allocation of risk • Weak market demand • Ill-fitting and inflexible regulations and legal frameworks
5. Research and Development Capacity	• Lack of collaboration and knowledge exchange • Lack of coordinated & sustained public funding • Lack of investment

Figure 7 Barriers to innovation at an industry-wide scale

Within individual companies, the most common barriers to innovation[7] are:

- **Lack of clearly articulated and proven business case for innovation**: Companies are not confident that innovation will be commercially rewarding or that there is sufficient market demand for innovative products and services. There is a strongly held belief that new or unfamiliar products and practices will add cost and risk as opposed to being a lower risk alternative to business as usual, a source of cost savings or a means to deliver a project more efficiently.
- **Stifling legal environment**: For companies to feel sufficiently confident to take on new technologies and processes, there needs to be some form of innovation "safety-net" that allows them, within reason, to fail safely. There is little opportunity for demonstration projects if few clients are willing to bear the risk or if research funding for demonstrators is not available.
- **Lack of a culture of learning**: There is a failure to capture learning from successful innovations and take this forward to future projects. Organizations largely experiment in innovation, without making a sustained effort to incorporate it within their business. This means that there is a shortage of skills in a number of key areas of management and ICT. This portrays the industry as being hidebound, risk averse and resistant to change and hinders its attractiveness to "millennial" workers.
- **Short-term, project focus**: The construction industry is highly cyclical. Many companies only look as far as their next project, which makes it difficult for businesses to take a long-term view. Also, there is a tendency in construction toward the production of unique, highly customized and engineered buildings. This leads to buildings that are complex to construct, with each project building requiring a new learning experience. This tendency can be regarded as a fundamental aspect of the industry's culture that is a significant barrier to innovation at the level of the firm. A more production-oriented approach to building design and construction would support more learning and innovation.

Is BC's construction industry ready for innovation?

BC's economic outlook is good. Governments at all levels are looking to the construction industry as a means to stimulate growth and at green buildings as key plank in their climate change policies. The timing could hardly be better for BC's construction industry to thinking about innovation. So, how is it doing in terms of receptivity to (and adoption of) innovation today, how does it stack up against important competitors and how ready are BC construction companies for what the future is likely to throw at them?

Although BC construction companies are strong in some areas (such as wood technologies), they have a good deal of catching up to do in others (investment in innovation, R&D coordination and constructive industry collaboration). Creating a culture of innovation does not just happen by itself – determination, commitment, investment and effort organized within a coordinated, deliberate strategic approach is essential to create a framework for success.

Drivers of construction innovation

Our survey respondents told us that cost of materials and energy, an aging workforce, the need for workers with higher qualifications and sustainability are the four most important drivers of innovation in BC. They are manifesting themselves in trends such as low carbon design, the digital revolution and access to a global supply chain. It is imperative for the industry to continue to innovate or risk being left behind.

The construction industry is constantly innovating in response to changing societal demands and expectations, the increasingly globalized market and business climate, their evolving workforce needs and advances in knowledge and technology. At the corporate level, the primary driver for innovation is economic: the desire to improve productivity, increase market share and reduce costs. Innovation may also be driven by the organizational culture and vision, such as the desire to be a leader in green construction or workplace safety. However, all firms are impacted by external forces beyond their control that shape how they innovate and run their businesses. Based on a review of regional, national and international trends, these drivers can be grouped into four broad categories: societal demands and expectations, market and business climate, workforce and knowledge and technology (Figure 8).

"For developers, green will be a cost of doing business in the future."

Developer, interview

"We are 10 years behind Europe on some of the easiest things. I mean we still build formwork out of wood – new plywood every time."

Focus group, general contractor

Figure 8 The four categories of innovation drivers

According to the survey, the most important drivers of innovation in the BC construction industry are cost efficiency (identified by 76 per cent of respondents), followed by technology (51 per cent), client demands (43 per cent) and sustainability (42 per cent). Similar messages were heard during the focus groups and interviews: the drivers of innovation that were top of mind for BC's construction industry members included pressures to "professionalize" the industry, to improve attractiveness to labour, to share knowledge (e.g. through discussions at regional construction associations) and to adopt digital solutions, such as online bidding.

> "BC businesses need to ask, 'How will I maintain my share of the North American market given how fast others are moving – especially related to high performance buildings, methods and materials'. "
>
> **General contractor, interview**

When asked which drivers and issues will have the greatest impact on BC's construction industry in the next five years our survey respondents identified the cost of materials and products (48 per cent of respondents), price of energy (40 per cent), aging workforce (37 per cent), need for workers with higher levels of qualification (32 per cent) and sustainability (31 per cent). However, contractors felt that the most important trend will be the rising cost of materials and products whereas other respondents felt that the price of energy will be the most important.

Contractors disagreed with other respondents most on the relative importance of carbon neutral buildings and the availability of developable land.

Many drivers of change are front-of-mind for construction industry members (Figure 9). These drivers are manifesting themselves in the form of trends that construction companies and workers are witnessing in the media and on the ground.

Figure 9 A selection of comments from focus groups and interviews, "What is coming down the road in next 5, 10, 20 years that is causing the most concern in your company specifically in terms of changes in the way the business of construction gets done and your readiness for those changes?

"BIM, which has been around for years, is being used by some firms all the time. Others are totally unfamiliar. However, it is hard to say that today BIM is still an innovation. It is soon going to be business as usual. It is a competitive mandatory."
Focus group

"There is a long ongoing trend towards the "professionalization" of the industry where the management of major issues such as safety, risk, quality, sustainability etc. is being attended to by qualified individuals with specific training and expertise."
University professor, interview

"A few years ago, you saw more tight, closed practices where people kept things to their chest, but more recently, the building industry as a whole, has improved a lot in sharing innovative safety methods, and this has taken a lot of time. In the next 5 -10 years, we will see more of this co-collaborative business model."
Focus group

"The labour shortage is not going to get better – especially as the industry is not doing a good job in making itself appealing to young workers."
Industry association executive, interview

"I can see the [contractual and legal] problems we are dealing with today being magnified and no-one wanting to take on the risk. Don't know what government can do but they should certainly act fairly at the beginning."
Lawyer, interview

"There are increased building safety risks due to lack of compulsory trades training in BC. Unless things are resolved, the situation will only get worse."
Industry association executive, interview

Driver 1: The urgent need for low-carbon buildings and innovative energy solutions

Addressing climate change, resource scarcity and ecosystem degradation is a pressing concern for political leaders in Canada and around the world.

Governments acknowledge that buildings offer the greatest potential for achieving significant energy and GHG emission reductions, and at the least cost (Figure 10). In urban centres, roughly half of the GHG emissions are associated with the energy used to heat, cool, and run buildings. As a result, governments are looking to the building industry to make large structures – condominiums, office towers, institutions, and apartment buildings – more energy efficient because it is one of the most impactful and cost effective means of addressing climate change.[8]

Green building has generated tremendous popular appeal on account of its ability to support job creation, boost local economies, and enhance occupant health, well-being and productivity.[9]

But there is more. In an inclusive, decoupled[10], circular[11] economy that can support a growing global population sustainably, the construction industry stands to be a big winner. It not only offers local solutions to global issues (such as jobs, housing and infrastructure) but a proving ground for the ideas around which the next generation of multi-trillion-dollar industries and technologies will be built.[12]

BC companies that have developed expertise in low carbon building, sustainable materials and solutions for eliminating construction waste are well positioned to capitalize on this trend in the future.

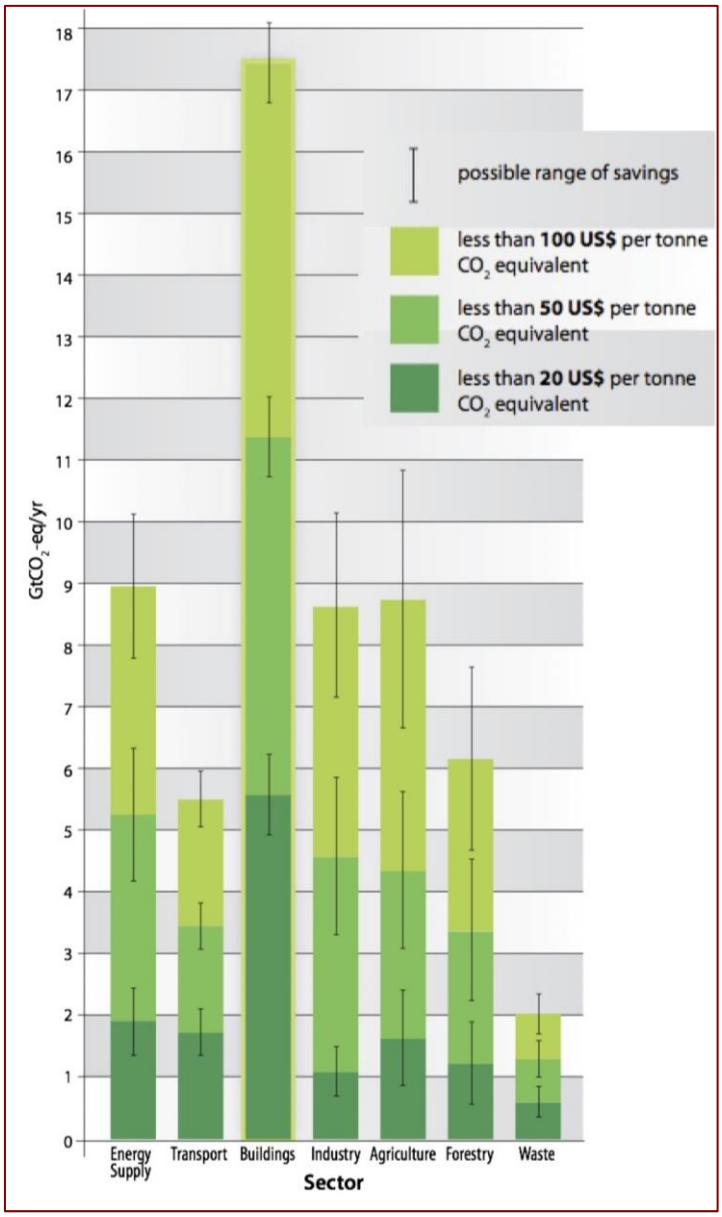


Figure 10 Potential CO2 reductions by sector World totals in $GtCO_2$ eq/yr (source United Nations Environment Programme)

Driver 2: The interconnected future of materials, energy and sustainability

The cost of materials, the price of energy and sustainability are increasingly inter-connected. Trade barriers are being removed and the construction supply chain is now global. Linking carbon emissions to a circular economy (which aims to keep products, components and materials in the supply chain at their highest utility and value at all times) will force builders to rethink the way projects are put together in order to factor in disassembly and re-use.

After oil and gas, and transportation, the construction and operation of buildings is the single largest contributor to global greenhouse gas (GHG) emissions in Canada.[13] However, the construction industry (and the structures it creates) has a substantial emission-saving potential by improved operations and by the efficient use of materials and equipment. In fact, as buildings become more energy efficient the energy associated with materials will become more important. In low-energy buildings, materials can account for as much as 50 per cent of embodied energy and greenhouse gas emissions; in a net-zero-energy building materials may account for up to 100 per cent.[14]

> "The industry has to do things way cheaper – why are we still hand-constructing buildings? How is it that we have not come up with anything better?"
>
> **Building owner, interview**

Moreover, construction is largely regulated at the local level and so governments are looking to buildings as their least cost solution in the fight against global climate change. Despite the fact that costs of materials are rising on account increased global competition, the life cycle costs of material choices are important. In fact, the energy consumption of interior renovations over the lifetime of a building can account for 20 to 30 per cent of the initial embodied energy. Material efficiency therefore has a significant role in reducing the global GHG emissions from buildings and this will become an even grater consideration as energy and raw materials prices continue to climb.

Driver 3: The digital revolution in design and construction

Most design and construction companies we talked to have already turned to digital technology as a response to many of the drivers. It has been argued that the current generation of workers has witnessed the greatest change in the industry since the internal combustion engine. Today, 3D printing, drones, augmented reality and even robots are finding their way into the construction process.

"Industry 4.0" (sometimes known as the industrial internet or the "internet of things") has already had a powerful impact on the way construction gets done. At heart, it is all about digitization, automation, robotics and opening up and democratizing all industries - including even change-resistant construction (Figure 12).

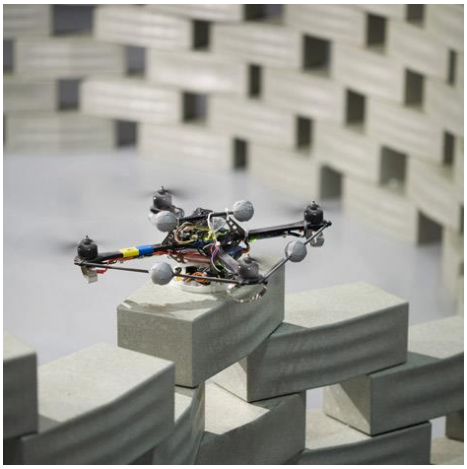


Figure 11 A group of robot helicopters were programmed to lift and stack 1500 polystyrene bricks into a six metre-high tower at the FRAC Centre in Orléans, France (source: Dezeen).

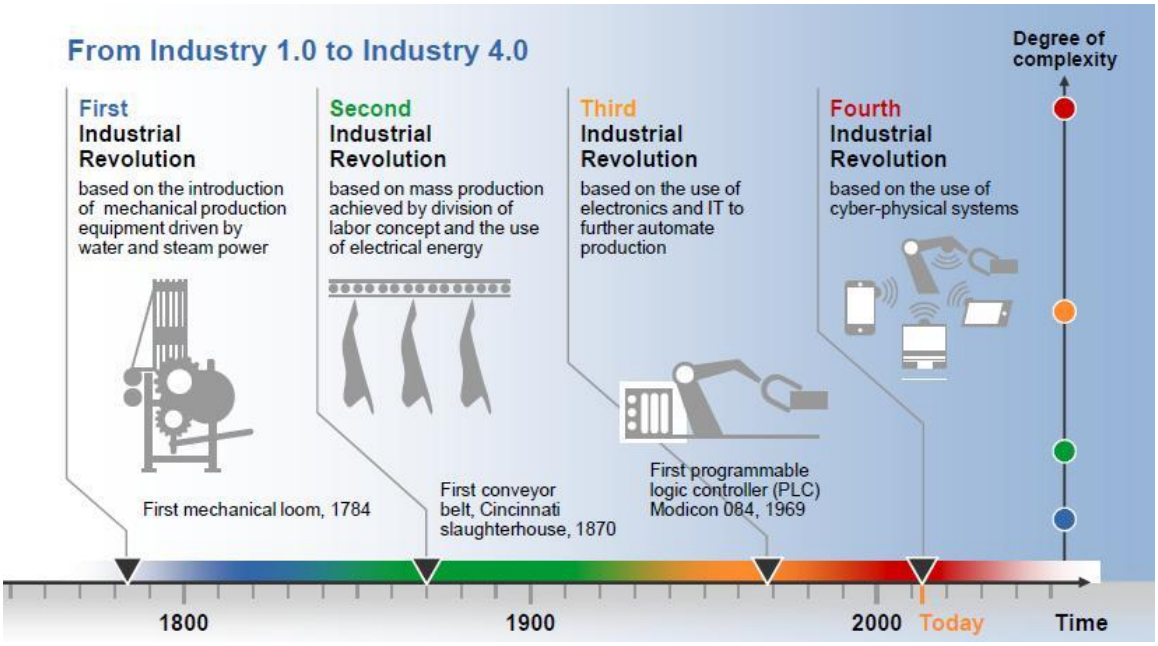


Figure 12 Infographic defining "Industry 4.0" (source Siemens AG)

Driver 4: The emergence of just-in-time, pre-fabricated and modular construction solutions

A shift in strategic approach backstopped by powerful digital tools has ushered in a new way of delivering construction solutions, which are referred to collectively as "Modern Methods of Construction" (MMC). The generally accepted definition of MMC is, "A construction process that can encompass the use of composite new and traditional materials and components often with extensive factory produced sub-assembly sections and components. This may be in combination with accelerated on-site assembly methods and often to the exclusion of many of the construction industry traditional trades. The process includes new buildings and retrofitting, repair and extension of existing buildings."[15] The objective in the substantial investments some companies are making in these areas is a reduction in waste (in terms of money, time and material[16]) throughout the supply chain. The benefits of MMC are optimized by the use of Building Information Modelling (BIM) and supportive procurement solutions such as Integrated Project Delivery (Figure 13)

"We have a huge BIM department and we are pushing BIM all the time. It's a great tool. Part of that is the fact that we are big enough that we can afford to promote it because a lot of clients don't understand what it is. So the benefits of BIM are not fully there yet but if you don't have the bigger companies leading that adoption, then it is not going to happen."

Focus group

"BIM represents the overall computerization trend, which is still underway. The comprehensive building model as a core basis of project information is still transitioning into the industry and is happening now."

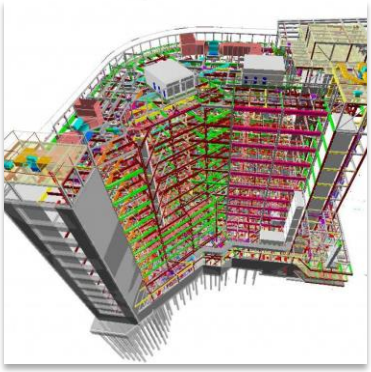
Architect and BIM expert, interview

Large Canadian firms are already realizing that a production management-based approach to project delivery, namely Lean Design and Construction, has the potential to offer a positive environment for innovation. Applied to project design and delivery, Lean aims at improving total project performance, because this is more important

than reducing the cost or increasing the speed of any particular activity. The Canadian Construction Association sees the adoption of Lean principles as an important innovation catalyst and recently launched the Lean Institute[17] to support its adoption across the country.

Building information models for design (virtual prototyping), project management and automated fabrication

- In some countries (e.g. the UK), public projects over a certain size must be delivered using BIM



Connected, "Intelligent" buildings and cities

- Big Data used to optimize building performance on real-time portfolio basis

Internet and cloud-based collaboration

- Construction sites increasingly "paper-free zones"

Lean or "just in time" construction, integrade proejct delivery (IPD)

- CCA has established a Lean Construction Institute

Offsite and modular construction solutions

- Britco completes Canada's first Passive House modular housing in Bella Bella

"End of waste" and the circular economy

- City of Vancouver requires pre-1945 homes to be disassembled

Figure 13 The various topics that comprise "Modern Methods of Construction"

BC strengths, weaknesses, opportunities and threats

A "Strengths, Weaknesses, Opportunities and Threats" (SWOT) analysis is a simple but useful tool to better understand the business environment. We have collated information from numerous studies and reports (related to BC and other jurisdictions) to map the various factors affecting the business of construction. However, the input

provided by our interviews and focus groups has been particularly important in documenting and evaluating the particular situation facing BC construction businesses. We have summarised our findings in a matrix where strengths and weaknesses are internal to the industry, while opportunities and threats generally relate to external factors (Figure 14).

Our results suggest that, overall; the picture for BC is promising. There are areas of strength that the industry can leverage as a starting point to build a culture of innovation. These include BC's expertise in wood design, construction and the infrastructure that supports the development of innovative wood products, green building, capabilities in digital technologies (particularly in software and digital media), speed of construction of high rise concrete structure and building envelope design, testing and assembly. There are also all sorts of opportunities to address barriers with plenty of role models from other jurisdictions. However, the weaknesses within the industry such as the number of stakeholders, risk aversion, lack of a culture of learning and short term thinking are persistent and will be very difficult to dislodge. The threats of continued low productivity, lack of attractiveness as a career path to new workers, and an unsatisfactory reputation (whether real or perceived) will only become greater as codes continue to become more challenging, materials costs go up and the labour shortage becomes increasingly acute.

High level though this analysis is, we believe that our findings suggests that action is required sooner rather than later to not only tackle problems that are only going to get worse but also seize the moment where a strengthening economy, a favourable political climate and industry momentum align to make meaningful change.

The most important messages and findings from the SWOT analysis are explored in more detail below.

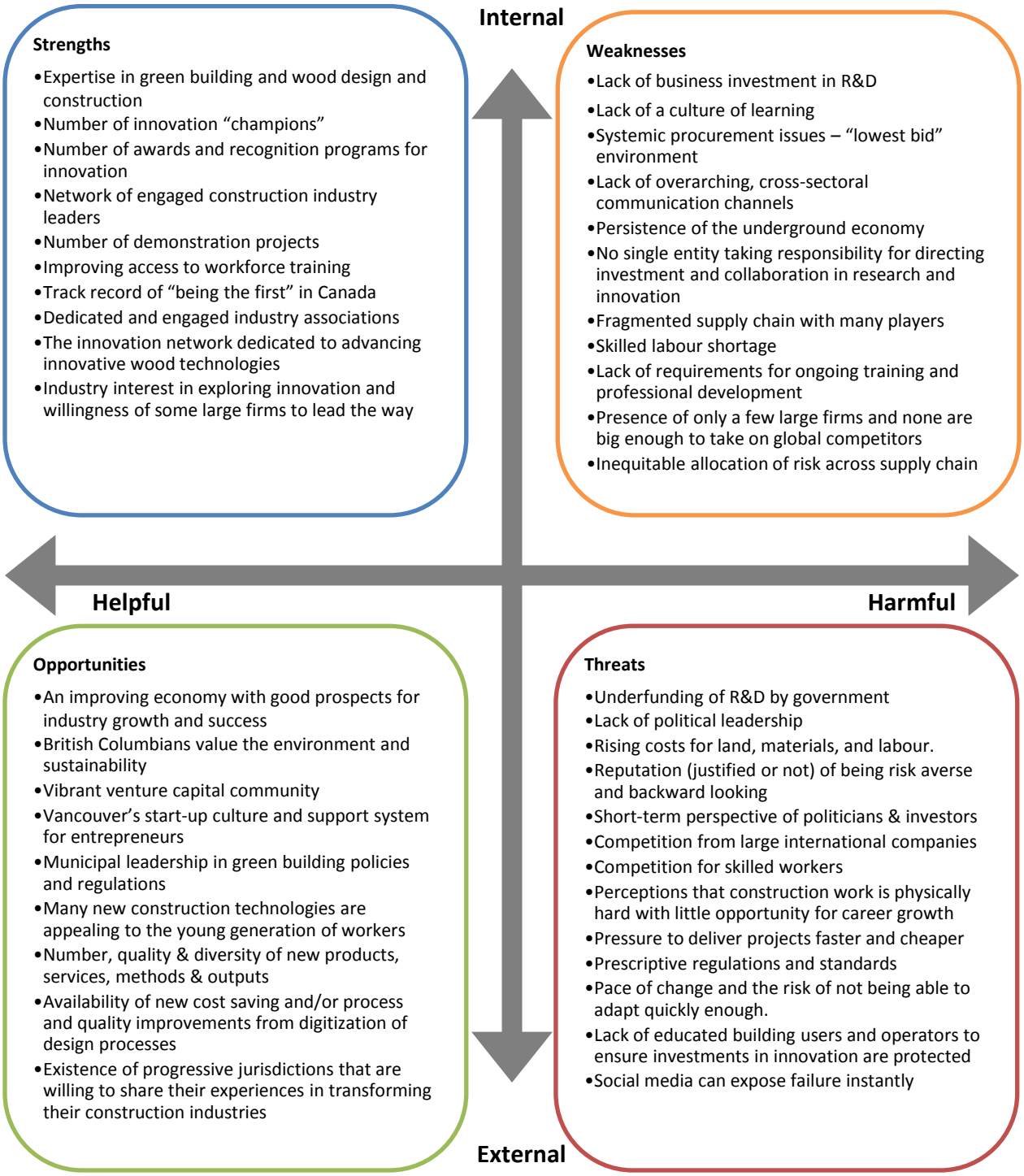


Figure 14 SWOT analysis

1. BC Economic Forecast: Sunny

With roughly 200,000 workers, construction is BC's largest employer with about the same as manufacturing, forestry, oil & gas, mining and fishing combined. Just over half of the $15 billion in construction GDP comes from residential and commercial building construction and another 16 per cent comes from repairs. The remaining 31 per cent is from industrial projects, everything from roadways to hydroelectric dams.[18] The housing market boom of the past decade has been a clear factor in the construction industry's consistently strong growth. This is not expected to change in the future given BC's growing (and aging) population – new homes and renovations of existing homes will be consistent trends. Jobs in the sector closely follow this pattern – most construction jobs in BC are linked to housing, followed by civil engineering projects and repairs to existing infrastructure.

The economic outlook is positive for the construction industry. Interest rates are low and expected to remain so. Economic activity in BC is expected to accelerate in 2015 after emerging from the 2008–2009 recession. This is due to an expectation of improved performance in export-oriented sectors, additional household spending power from lowered gasoline prices, and stronger employment prospects. Also, the BC government not only has one of the lowest levels of taxation in Canada but it is also set to post a $277-million surplus for the 2015-16 fiscal year.

> "The centre of gravity of Canada's trading relationship has shifted. The U.S.-Canada relationship is always going to be big but trade with Asia now is huge. And B.C. is so well placed to take advantage of that."
>
> **Robin Sylvester, CEO Port Metro Vancouver**
> **Globe & Mail, Sept 2015**

The Conference Board of Canada forecasts that the Vancouver region will be the fastest-growing economy this year among its survey of 13 major Canadian metropolitan areas.[19] The Conference Board of Canada and RBC are also picking BC to be number one next year, with predictions for real GDP growth of 3.4 per cent and 3.1 per cent respectively.[20]

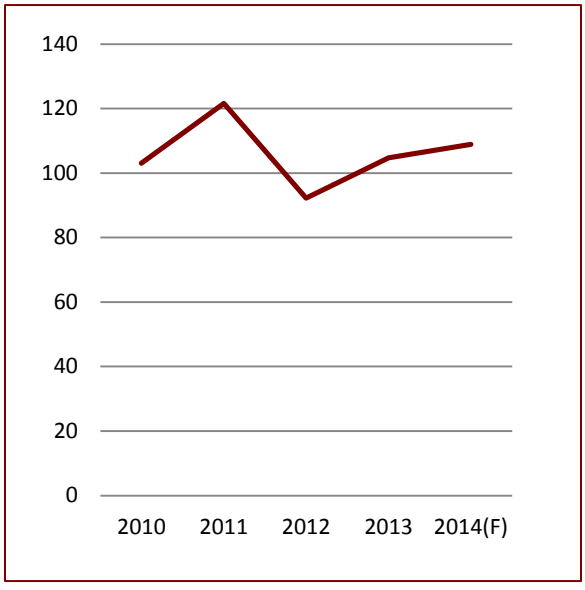


Figure 16 Capital expenditures – BC construction (data source StatsCan)

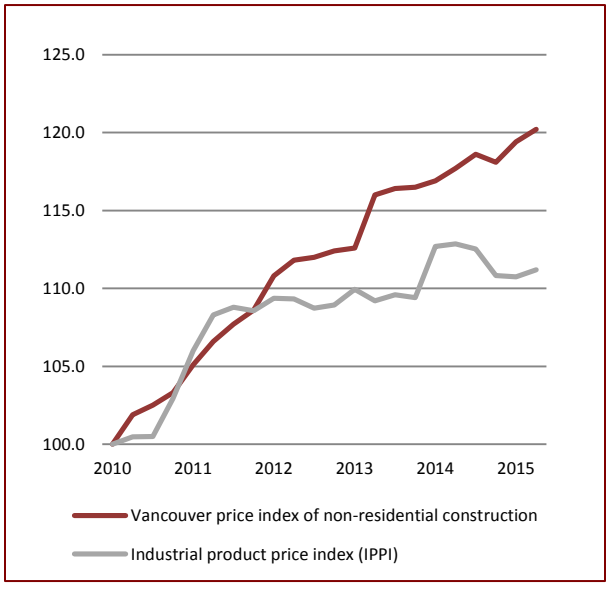


Figure 15 Comparison of Canadian industrial product price index with the price index of non-residential construction in Vancouver (100 set to Q1 2010)

A further boost may come from the federal government's plan to spend $20 billion over 10 years for social infrastructure and $20 billion over 10 years in green infrastructure. Current spending on transit infrastructure is expected to quadruple.[21] In an age of unprecedented urbanization, economic migrants are expected to fuel demand for real estate in BC's major urban centres. In fact, it is estimated that half of the business that Canadian banks do is related to real estate, mortgages and construction lending.[22]

The construction industry has been on a tight leash with capital expenditures remaining unchanged over the past 5 years despite record low interest rates and a recovering economy (Figure 16 above). With the federal government planning a major infrastructure program, investment rates will pick up. Also, since 2012, prices for non-residential construction (in Vancouver at least) have started to increase at a faster rate than materials (Figure 15 above). suggesting that businesses might now have some financial breathing room to invest in new technologies and equipment.

2. Businesses and governments understand that innovation is important but few are investing in a strategic approach

Although innovation may be forced on an industry in economically tough times, it is always better for businesses and governments to consider innovation investment when prospects are improving. Unfortunately, the industry is not fully geared up for innovation and not ready to leverage the opportunities.

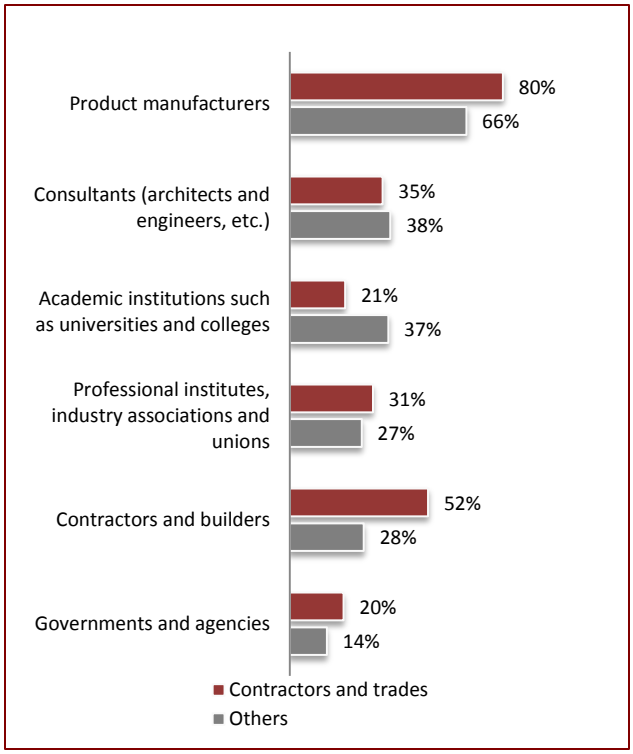


Figure 17 From our survey, "Where do most of the innovations in BC's construction industry come from? Select all that apply."

Unfortunately, relatively few demand-side policies in Canada encourage investment in R&D by creating markets for new technologies, products, or services. The construction industry is particularly challenged in this regard. Further, it is clear that BC construction industry is not geared up for innovation should such policies be introduced. For example, 88 per cent of survey respondents felt that R&D was important or very important to their company and 86 per cent felt that it was important or very important in the job that they do.

However, when asked how creativity and innovation is encouraged in BC's building industry, the largest group of survey respondents (30 per cent) stated that, at best, innovation is forced upon them by codes and regulations. The second largest group (25 per cent) felt that creativity and innovation are not actively encouraged at all. This speaks to the fact that there are significant constraints at the project procurement and business arrangement level that need to be overcome before the industry can engage with innovation positively.

To understand a little about how the innovation ecosystem works in BC, it is important to know where most innovations currently come from and which organizations are thought to be responsible for developing new ideas and solutions and getting them into the

market. Our survey respondents believed that most innovations come from product manufacturers, although 52 per cent of contractors felt that they are also responsible for innovation (Figure 17). Similarly, most of the survey respondents who were consultants declared that most innovations came from consultants and, unsurprisingly, respondents who were researchers did the same. From the focus groups and interviews, we heard that there is insufficient appreciation of what each member of the construction industry does and the value of that contribution.

Certainly, construction industry members do not generally turn to each other for advice on new or unfamiliar technologies. Indeed, 66 per cent of our survey respondents go to Google, YouTube, etc. and 64 per cent call product manufacturers first (Figure 18).

Yet, there appears to be plenty of unanswered questions and therefore many opportunities for R&D. When asked which areas of construction require the most R&D investment 57 per cent of survey respondents selected building methods, 53 per cent pointed to building products and materials, and 47 per cent selected energy efficient building (Figure 19).

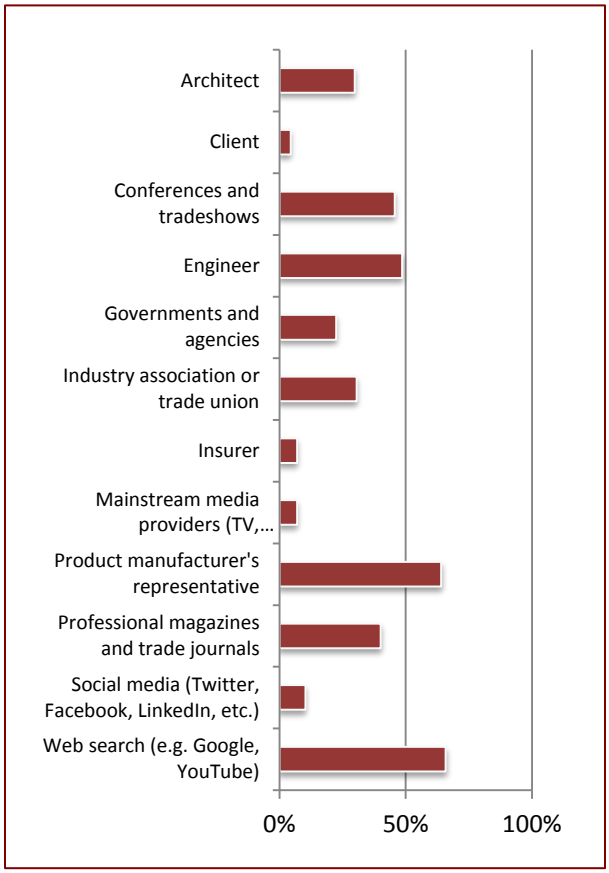


Figure 18 From the survey, "Where (or to whom) do you turn to for advice on new or unfamiliar technologies, products or processes? Select all that apply."

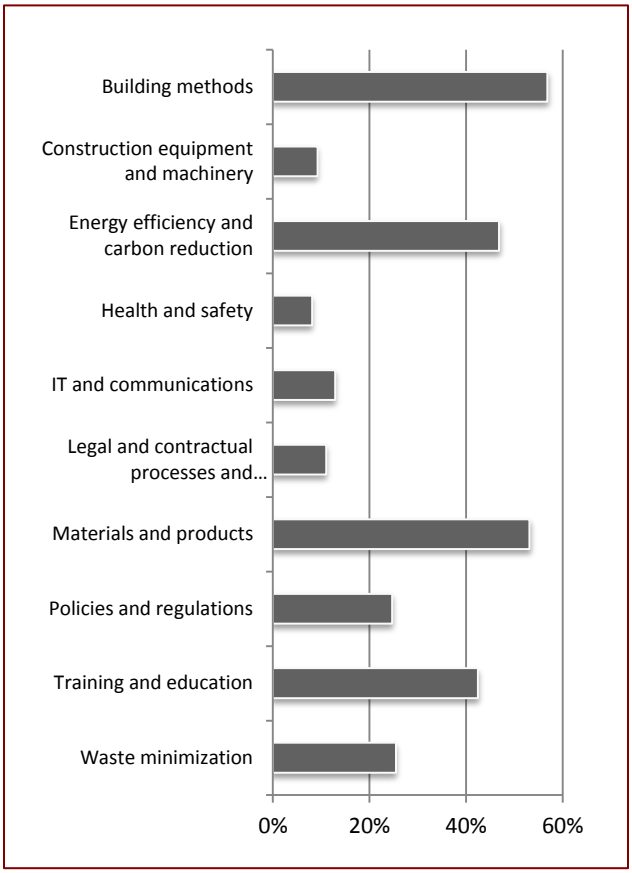


Figure 19 From the survey, "Which of these issues requires the most R&D? (Select UP TO THREE)"

3. BC has labour constraints and productivity issues

While the economic forecast for the industry is rosy, labour capacity is becoming increasingly constrained meaning that it may become difficult for BC construction companies to keep up with demand. The industry is dominated by small businesses: 68 per cent of BC's construction businesses are sole-proprietorships with no employees.[23] The workforce is also aging: two out of three of today's skilled trade workers are over the age of 45.[24] It is estimated that 26,100 construction jobs will be unfilled due to labour shortages by 2023[25] and 31,000 job openings for engineers, geoscientists, technologists and technicians will need to be filled over the next ten years.[26]

The impending labour shortage will be a major driver of innovation to boost productivity because the industry is heading into an improving economy with the potential for a significant up-tick in construction investment. To address the problem, the BC government has prioritized trades training under the Skills and Training Plan[27] and is helping to raise awareness of the benefits of acquiring a trade. To help fill the shortfall, BCCA created the Skilled Trades Employment Program (STEP)[28], which has placed over 12,000 British Columbians into construction jobs.

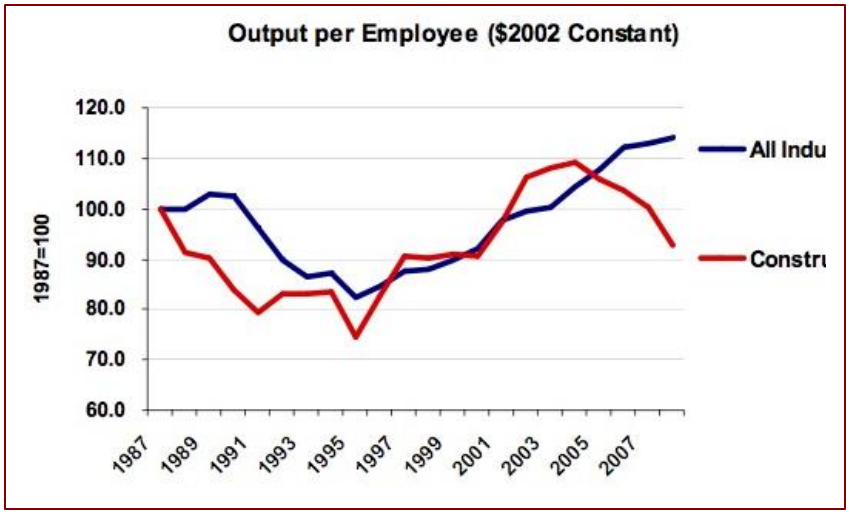


Figure 20 North American construction productivity has remained unchanged since the mid 1980's[1]

Nevertheless, the industry has been dogged with productivity issues (Figure 20). In fact, recent research shows that productivity across North America has been declining by 0.32 per cent per year since 1964.[29] However, data for construction productivity performance may not always be accurate because it does not necessarily account for the growing number of technical skills necessary to deliver a project and the complexity of projects themselves.

4. BC is good at green building and wood technologies

Building on inherent strengths is an excellent way to leverage expertise as well as further investment in R&D. Unfortunately, almost half (43 per cent) of our survey respondents could not think of anything BC was good at and, regrettably, a further 5 per cent believed we were "good at being bad" i.e. delivering sub-standard, poorly performing buildings (Figure 21). More hopefully, 16 per cent felt that BC is a leader in designing and building with wood.

This is true given that BC is home to more than 200 six storey wood frame buildings and many of Canada's mass timber projects. Further, BC architects and engineers have consistently done well at the Canadian and International Wood Design Awards[30] and BC architects and engineers are working on innovative wood projects

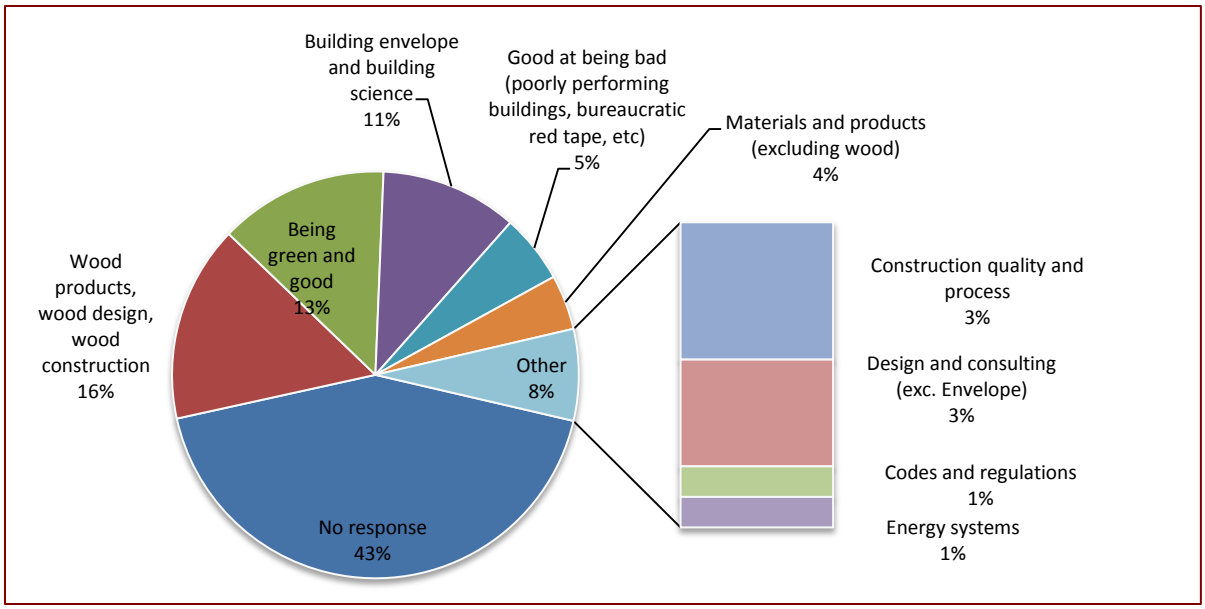


Figure 21 From our survey, "In what areas of construction-related research and development do you think BC is a leader?"

around the world. It is also worth noting that, after construction, forestry and wood product production are primary economic drivers for BC. More than 40 per cent of BC's regional economies are based on forestry activities. Several of the world's largest forestry companies are headquartered in BC and the province is the world's largest supplier of softwood lumber.[31]

Also, 13 per cent believed that the BC is good at green building. BC's energy efficient and green building sector generates approximately $8.4 billion in GDP and 76,450 jobs.[32] There is plenty of evidence that BC is a green building leader in North America and, indeed, that construction is a greener industry than most of its peers[33] (Figure 22).

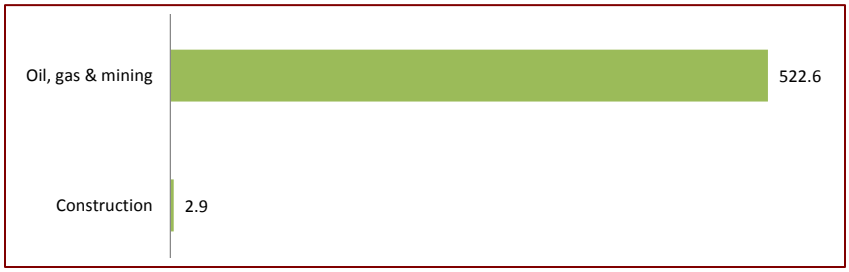


Figure 22 Comparison of GHG emissions per worker in BC (construction v. oil, gas and mining)

The first LEED buildings in Canada were in BC. BC has more LEED projects per capita than any other province in Canada (395 at the end of Q1 2015[34]) and the BC government requires more stringent standards (LEED Gold) for public projects than any other province.[35] BC now has more Passive House projects than elsewhere in Canada and is home to some of the first large projects aiming for Passive House certification. At the city scale, the City of Vancouver is the only jurisdiction in Canada that is committed to carbon neutral construction as part of its Greenest City Action Plan.[36] However, despite our leadership in North America, we do not score so

well when compared to our international peers. For example, Canada ranks number nine out of 16 countries on ACEEE's 2014 International Energy Efficiency Scorecard.[37]

Green building and expertise with wood are mutually compatible areas of expertise. Sourced from sustainably managed forests, wood is considered a green building material on account of its ability to sequester carbon and BC has more area of certified forest lands than any other jurisdiction in the world.[38] BC's forestry sector is predisposed towards supporting wood's contribution to a sustainable built environment,[39] there is tremendous market advantage to BC's construction industry in forging close affiliations with BC's forestry sector whenever possible. Other areas in which BC construction companies were felt to excel include building envelope design and construction waste diversion. It was also observed in one of our focus groups that BC builders put up concrete high-rise structures faster than any other region in Canada.

5. BC has most of the pieces in the innovation development system: it needs to fill in the gaps and put them together

To support a vibrant and successful innovation ecosystem requires the presence of networks and clusters of expertise for specific technologies that can feed off each other and develop sufficient notoriety to attract investors. While BC has many of the components (such as a strong venture capital community), there are gaps when it comes to construction. For example, there is no innovation centre, no industry-specific network of academics and researchers and no incubator to encourage entrepreneurs. Although there are a few gaps and some programs are better funded, a better fit and more accessible than others, the innovation support system in BC and federally does span each of the stages necessary to bring a new technology to market (Figure 23 and a list of programs is available in **Appendix C**).

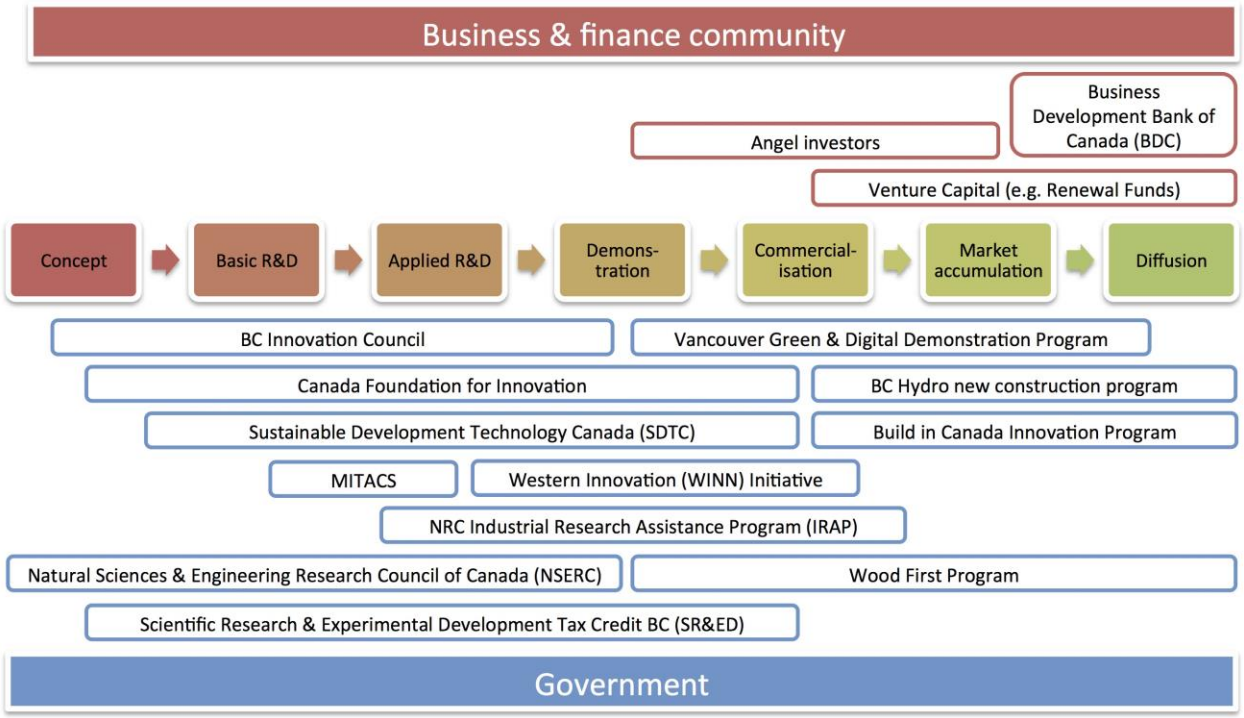


Figure 23 Summary of a selection of innovation funding programs and investment mechanisms applicable to construction.

Creating a vision and a call to action

The next decade will likely bring a major transformation of the industry towards higher-performance, lower-carbon construction that leverages integrated digital design processes and the latest in modular and offsite manufacturing. Companies will have to evolve to this new reality or lose market share to regional, national and even international competitors.

This section presents a "**Call to Action**" to get ahead of the curve and accelerate the adoption of innovative practices in BC's construction industry. It makes the case for developing an industry-supported innovation vision and strategy and then identifies five foundational "pillars" and associated "ambitions" for industry and its partners.

Developing an industry-supported vision for innovation

Embracing innovation will improve project and business performance and will position BC construction companies of all sizes for national and global success. But it won't happen on its own: a concrete action plan is needed to coordinate efforts and catalyze and capture industry innovation. We propose five pillars—Leadership, Sustainability, Growth and Resilience, People, Research and Development—that could serve as the basis for this plan.

Both our survey respondents and focus-group participants indicated cautious support for developing a province-wide innovation strategy that would include setting out performance goals as well as indicators to track how we are doing over time:

> "Aspirational goals can be useful for galvanizing the industry. They communicate clearly that the status quo is not OK. They also declare that a paradigm shift is necessary rather than trying to address the problem by 'nibbling around the edges'."
>
> **University professor, interview**

- Two in three (66 per cent) of those surveyed (including 60 per cent of contractors) agreed that **setting performance goals for the construction industry is an effective way to stimulate innovation**.
- A smaller majority (53 per cent) agreed that it would be useful to **set specific goals for BC's construction industry with a deadline** for achieving each goal, with the remaining either disagreeing (20 per cent) or saying they don't know (27 per cent). For contractors, support was lower with 41 per cent agreeing, 27 per cent disagreeing and 32 per cent pleading ignorance (Figure 24). There was concern that such goals might become binding and that there might be lots of paperwork.
- However, 73 per cent of survey respondents agreed it would be useful to **track and report on the performance of BC's construction industry as a whole** every year; the implication being that tracking accomplishments is acceptable so long as this work would be done by a third party (i.e. not by companies themselves)

Clearly there is support for developing a strategy and goals but more consultation is needed before moving forward with targets or performance indicators.

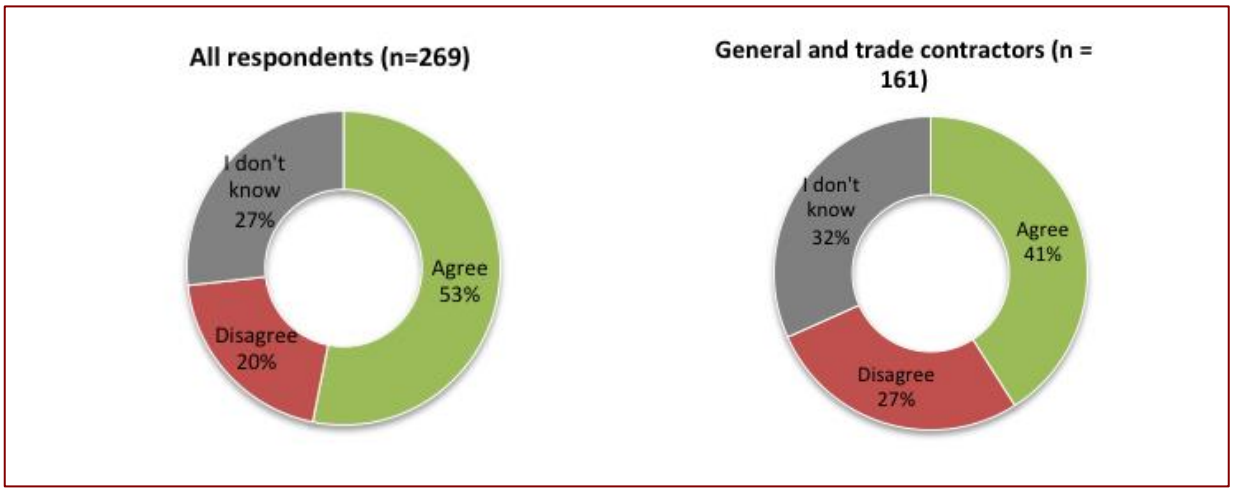


Figure 24 From the survey, "In the UK, a number of industry-wide performance goals have been established as a way to stimulate and direct innovation. For example, there is an industry-wide goal of reducing construction costs by 50% by 2025. Do you think it is useful to set specific goals for BC's construction industry and a deadline by which each goal should be achieved?"

Learning from other jurisdictions

Our research included a review of three jurisdictions' approaches to fostering innovation construction: Scotland, the UK and Australia. Although they were developed at different times to address very different industry needs the results are strikingly similar overall. Each plan set goals to strengthen industry leadership, improve the skills and training of their workforces, grow their industries and develop high-performance, smart and sustainable buildings. Each plan also addressed the same five themes - Leadership, Sustainability, People, Growth and Research.

Figure 25 presents an integrated summary of the themes, goals and targets from the three plans. More detailed summaries and comparisons of each country's strategy and approach are provided in **Appendix B**.

COMMON THEMES AND GOALS	INDUSTRY TARGETS
PEOPLE: Industry attracts and retains a talented and diverse workforce A. Improve the image of the industry B. Attract a computer-literate and highly skilled workforce C. Improve health and safety conditions on-site **SMART: Industry is efficient and technologically advanced** D. Invest in smart construction, digital design and virtual prototyping E. Adopt innovative information and communication technologies for construction F. Increase the effectiveness of research and development activities G. Drive innovation and productivity across the industry H. Increase offsite manufacture and pre-fabrication I. Improve processes for manufacturing constructed products **SUSTAINABLE: Industry leads the world in low-carbon and green construction** J. Work in partnership to deliver a low-carbon, sustainable built environment **GROWTH: An industry that drives growth across the entire economy** K. Develop a clear view of future work opportunities L. Improve client capability and procurement	• **Faster delivery**: 50% reduction in overall time, from inception to completion, for new-build and refurbished assets • **Lower costs**: 33% reduction in initial cost of construction and whole life cost of built assets • **Innovation**: Achieve a 5% increase in reported innovation activity • **Productivity**: Increase productivity by 10% • **Lower emissions**: 50% reduction in GHGs in the built environment • **Efficiency**: 42% of industry waste to be recycled • **Improvement in exports**: 50% reduction in the trade gap between total exports and total imports for construction products and materials • **GVA (Gross Value Added)**: Increase GVA by 10%

M. Develop strong and resilient supply chains
N. Improve the business and regulatory environment

LEADERSHIP: An industry with clear leadership
O. Establish a cohesive voice for the industry
P. Increase industry leadership and investment in research and innovation

Figure 25 Summary of common innovation themes, goals and indicators from the UK, Scotland and Australian construction industrial strategies

A framework for BC

We recommend that the framework for a BC Construction Innovation Action Plan be built around the following five "pillars" and ambitions that together form our proposed vision for the industry: i) Leadership, ii) Sustainability, iii) Growth and Resilience, iv) People and v) Research and Development. These "made in BC" pillars and ambitions align with international best practices, build on BC's strengths and address key gaps in the construction innovation systems.

The five pillars lay out an aspirational innovation program for the province that reflects best practices and the strengths and weaknesses of the BC construction industry (Figure 26). Their successful implementation will require broad support from government, research organizations and the construction industry as a whole. Descriptions and ambitions for each pillar are provided below.

A first step will be to take these statements back to industry for their input and validation. The BCCA will need to work with its partners to prioritize and refine these goals and articulate the construction innovation strategy for the province. It will be important that any goal setting process is led by industry and that all stakeholders are involved. This process will take a great deal of work and strong leadership.

1. Leadership - A cohesive industry that embraces and celebrates innovation

- 1.1 Establish an action-oriented innovation council to be the "voice" of innovation in construction in BC
- 1.2 Report on key performance indicators for construction excellence
- 1.3 Recognize and celebrate innovation “champions”
- 1.4 Shift misperceptions of the industry via sustained public engagement and stakeholder communication
- 1.5 Pro-actively engage with government on program and policy development, investment and procurement

2. Performance - A responsible industry that continually improves projects’ economic, environmental and social performance

- 2.1 Encourage the adoption of innovative design and construction methods that put quality first
- 2.2 Continue to push the boundaries in low-carbon, healthy and green construction
- 2.3 Encourage all businesses to demonstrate corporate responsibility

3. People - A talented industry that attracts a skilled, technologically-savvy workforce

- 3.1 Help businesses of all sizes to acquire the full spectrum of skills necessary to create and implement innovative ideas successfully
- 3.2 Help businesses leverage innovation to drive recruitment and retention

4. Growth and resilience - An efficient, competitive and profitable industry that drives economic growth

- 4.1 Ensure procurement structures meet client and industry needs and provide an equitable framework within which companies can innovate safely
- 4.2 Support ongoing evolution of standards and codes as a means to push the innovation into the market
- 4.3 Develop strong supply chains so new ideas can be realized cost effectively and in a timely manner
- 4.4 Prioritize innovations that help BC companies to boost competitiveness so they can realise a return on investment in innovation

5. Research and development - n advanced industry that developAs and implements innovative new products, processes and business strategies

- 5.1.Support research and development networks and centres
- 5.2 Showcase demonstration projects
- 5.3 Advocate for, enable and direct public funding and business investment in innovation
- 5.4 Strengthen the role of large firms in BC as drivers of innovation
- 5.5 Encourage businesses to collaborate to achieve scale and share knowledge

Figure 26 Summary of the “pillars” and “ambitions” that provide a framework for a construction innovation strategy for BC

In the long-term, a vision and set of broad goals and ambitions will not likely be enough to motivate action by industry and government. To be effective BC’s innovation action plan must include goals and targets that are **Specific, Measurable, Achievable, Realistic, and Time-specific (SMART)** as well as a mechanism for regular reporting on progress towards those goals.

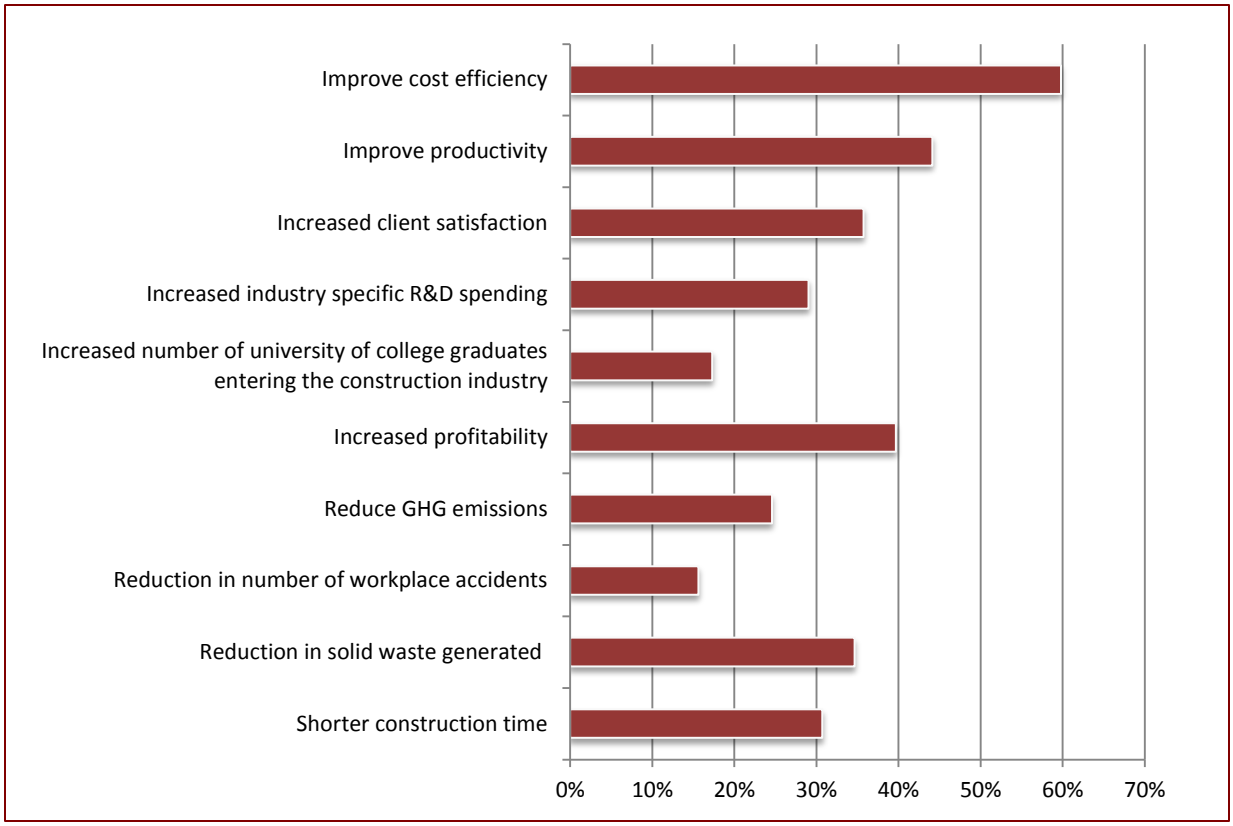


Figure 27 From the survey "Which of the following goals do you think would be effective at stimulating innovation in the construction industry (select ALL THAT APPLY)?" (Only those that thought goal setting was a good idea got to see this question)

Our survey respondents were asked which of the goals they thought would be effective at stimulating innovation in the construction industry (Figure 27). The top five identified were: improving cost efficiency (60 per cent), improving productivity (44 per cent), increasing profitability (40 per cent), improving client satisfaction (36 per cent) and reducing solid waste generated (35 per cent). In a separate question, respondents were asked to identify key performance indicators (KPIs) for tracking the construction industry: the top three were: environmental (energy usage, waste reduction, greenhouse gas emission reduction) (68 per cent), client satisfaction (58 per cent) and economic / financial (52 per cent). (See Ambition 1.2 Report on key performance indicators for construction excellence for more details).

These align well with the Scottish and UK targets to reduce project delivery time, lower costs, increase productivity, reduce GHG emissions, increase construction recycling rates, increase innovation activity and increase the gross value added (Figure 25 above).

Pillar 1: Leadership - A cohesive industry that embraces and celebrates innovation

To drive change requires strong leadership at the political level and a cohesive industry "voice" with a clear business innovation mandate (including delivery of business-facing innovation programs, development of an innovation action plan and maintaining robust communication channels with stakeholders).

The launch of CCInnovations[40] by the Canadian Construction Association will help enormously to focus and promote the conversation at the national level, but it is equally important for BC's industry to shape its own future so that it is ready for investment. This can mean prioritizing, moulding and adopting the ambitions proposed in this study. It could also include getting ahead of anything that could become an opportunity (or a risk) in the future such as labour, construction costs, GHG emissions, delivery times, etc.

Ambition 1.1 Establish an action-oriented innovation council to be the "voice" of innovation in construction in BC

Where an industry-supported vision of innovation has been taken seriously, there has been wholehearted buy-in from industry, support from stakeholders and leadership at the political level. Such a vision needs to not only be sharply defined, it also needs to be owned by a group of motivated industry leaders that have proven experience of getting things done.

The benefits and impacts of innovation will be different depending on the size and focus of individual companies. An innovation council is necessary to bring the many different opinions of the industry together and ensure that the voices of businesses of all sizes from all across the province are heard. The industry is very diverse ranging from home renovations worth a few thousand dollars to billion dollar infrastructure projects. It encompasses international publicly traded companies to one-man bands. In fact, about 75 per cent of BC design and construction companies are SMEs owned individually, through a partnership or by families and generating less than $5 million annually. So, for many, setting aside money to invest in business improvement solutions or R&D is difficult when working within such small margins.

Many SME firms are very hard to reach. Most do not belong to a trade association or a union. Finding ways for them to participate in the conversation about innovation will be critical for the success of the whole industry. More positively, there are many small businesses that are trail-blazers. They are nimble enough to be able to adopt new technologies more quickly than large companies. Several members of large companies know this and look out for up and coming trades and specialists. Groups such as the VRCA's U40 Network[41] offer a good opportunity to showcase innovative ideas from young people in small businesses. An innovation council will also be responsible for crafting and owning the vision and making sure activities are undertaken that support it in a timely way. The BCCA Construction Innovation Committee is moving in this direction. Its mandate and budget will need to be reviewed. By extending membership to individuals from outside the core business of construction (owners, researchers, etc.), it has the potential to become a potent and cohesive voice for innovation in construction in BC.

Case study: Construction Scotland's Construction Industry Leadership Group

In Scotland's construction industry (which employs 175,000 people), there are 121 trade organizations, over a dozen academic R&D centres, all the various consulting institutions, several NGO's and numerous relevant government agencies. It is a huge challenge trying to get into all their networks. The Construction Scotland Industry Leadership Group is charged with developing and co-ordinating the delivery of an industry-led strategy for the sector, providing leadership to stimulate action by businesses and drive industry growth. The group is also focused on pursuing market opportunities for the industry and addressing strategic challenges the industry faces. The group was born out of frustrations that everything that went before had become a "talking shop". They have set a limit of 20 people in the leadership group and they have to apply to be nominated. Membership is based on an individual rather than company/organisation representative basis. Members have to have a track record of having "done something meaningful" in the context of innovation.

www.cs-ic.org/constructionscotland/industry-leadership-group

"Especially in the P3 and design build market, you have to look for different ways to be competitive. You quickly get to know the trades that are also interested and want to learn about how to do things more effectively. You need to find them and support them."
Focus group

"Small construction businesses are fiercely competitive, as would be expected in a business with an average 3% return."
COMREN Construction Report

"There are many micro-SME's run by smart young people that are having a big effect. You need to find your superstars early and give them a megaphone. There are some 20 year olds who are doing amazing things."
Industry association executive, interview

Ambition 1.2 Report on key performance indicators for construction excellence

Creating a vision on its own is probably not enough to motivate action, especially if the vision is not binding in any way. Success can only come from underpinning the vision with meaningful goals and a way to track progress over time. Certainly, if investments are to be made into advancing innovation with a view to improving industry performance, then having a means to measure success will be essential.

"KPIs are good in theory but can be difficult to manage in practical terms. There are so many factors that go into the success of a project and you can't measure them all – especially as many of the players are very small companies."

Industry association executive, interview

Benchmarks and performance tracking using key performance indicators establish priorities, look at what has been accomplished and provide an important feedback loop to where effort can best be applied in the future. In fact, benchmarks can be set for individuals, departments, projects or the company as a whole, and use them to measure everything from manufacturing production to employee performance. At the corporate level, they help companies improve performance and make sure they are on track to achieve their goals. They can even be established at an industry level so companies can benchmark their accomplishments against their peers, demonstrate their track record to clients and win work.

Done well, benchmarking and performance tracking can provide valuable insights into how the industry is responding to external influences (such as economic factors, availability of finance and labour shortages) and provide an early warning system of challenges ahead. Indicators provide clients with tools to assess company performance fairly and objectively using metrics that align with industry practices. Our review of three leading jurisdictions in **Appendix B** shows that performance tracking can have a positive effect on the procurement process because it provides feedback on client satisfaction.

> "Firms should be judged based on clear standardized performance metrics that are derived from their past projects and are dictated by owners' interests. For example, was it delivered on time, on budget, with safety considerations, trained/qualified staff, improved operations, and so on."
>
> **Focus group**

Key performance indicators (KPIs) are specific measurements used to gauge industry and business performance. They are a way to precisely measure performance. For example, the UK has been tracking Construction Key Performance Indicators for 15 years and in that time gathered data on its industry that have helped to focus business and R&D efforts to improve productivity, the timely delivery of projects, quality of service and value for money. In the time since tracking started, client satisfaction has improved and investment from both businesses and government in R&D, training and equipment has jumped.

> "What does productivity mean? It is a metric that is fraught with problems and inevitably will be misconstrued. Projects are much more complicated than 10 years ago and have way more materials and components."
>
> **Large general contracting firm executive, interview**

> "The broader the suite of metrics, the more likely we can counter detractors with facts."
>
> **Building owner, interview**

The top three KPIs identified by our survey respondents as important for tracking of BC's construction industry performance were: environmental (energy usage, waste reduction, greenhouse gas emission reduction) (68 per cent), client satisfaction (58 per cent) and economic / financial (52 per cent) (Figure 28 following page). As with setting performance goals, there is considerable concern that industry reporting processes provide sufficient value to companies to offset any additional paperwork. So, when establishing KPIs, it is important to consider how easy it is to capture reliable and useful data. Additional considerations identified as potential KPIs include:

- **Registered builders / trades in BC** – Tracking the number of registered builders / trades in BC could evolve to include licensing and link to professional development and continuing education. This would be relevant as a way to measure technical competence which ties in with quality and durability.
- **Life cycle metrics –** Tracking performance related KPIs during the operational phase for completed buildings (such as overall operational costs, reduced greenhouse gases, etc.) would require data collection through property owners and managers, utilities, etc.). This could be tied back to individual companies and their projects from a performance perspective.
- **Repair / maintenance costs** – Reduced repair and maintenance costs is linked to overall quality and durability of work performed in the field. Similar to the point above, would require ongoing tracking of building performance over its life cycle.
- **Solid waste volume generated on site** – This information could be considered and tracked by construction industry as well as design and manufacturing sectors.

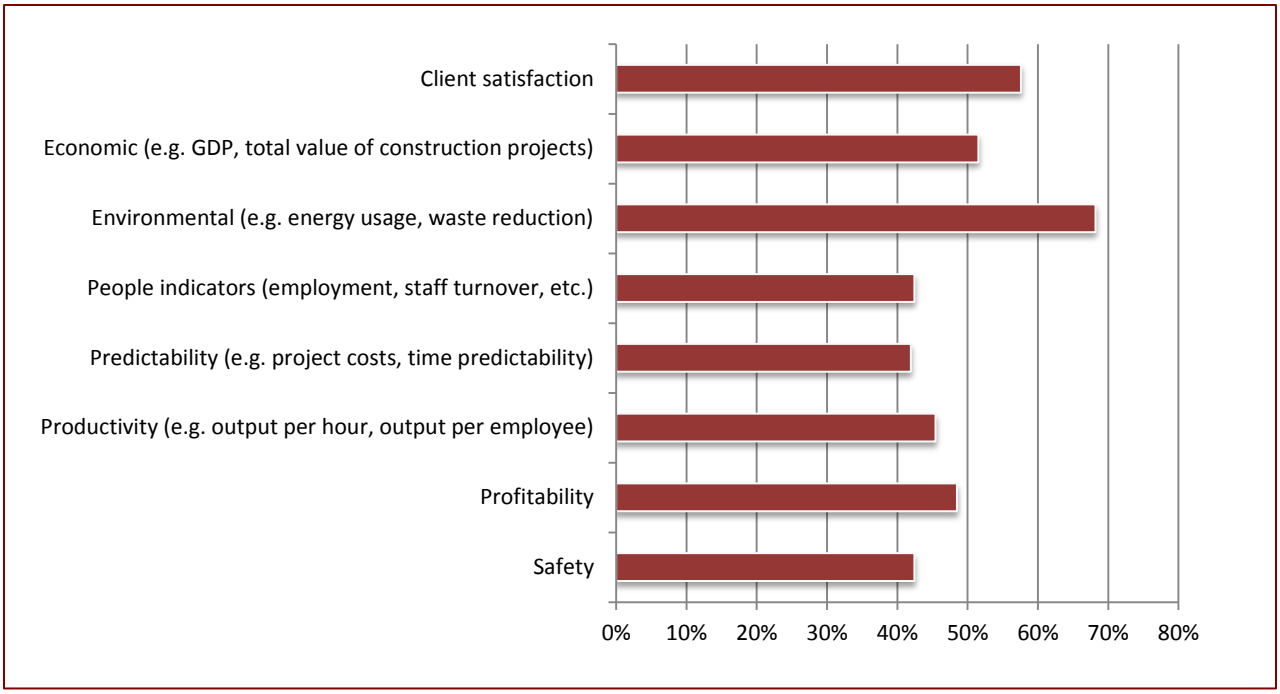


Figure 28 From our survey, "Which of the following indicators would be useful for tracking the performance of BC's construction industry as a whole (Select ALL THAT APPLY)?" (Only those that thought performance tracking was a good idea got to see this question)

Embarking on a performance tracking process comes with challenges. Five specific risks were identified by from our conversations with industry as potentially negative impacts from setting performance targets and KPIs:

- **Increased regulation (red tape) and added cost** – Setting government led goals / targets often comes with more regulation which can add complexities to doing work in the field, which has a negative impact on timelines and increase costs that will be borne by the consumer (affects affordability).
- **Decreased quality / durability** – Setting specific goals such as reducing construction costs could result in a 'race for the bottom' and have a negative impact on quality and durability as contractors may cut corners.
- **Procurement challenges –** Procurement in North America tends to favour the lowest bid, which can have a negative effect on innovation and new processes and may not allow for truly realizing goals.
- **Diverse industry** – The highly diverse nature of the industry in BC could make it a challenge to get buy-in and communicate efforts around goal setting and performance monitoring.
- **Scalability** – If only large companies participate then the data collected may not provide an accurate picture. Tracking and reporting need to be easy for companies of all sizes to do.

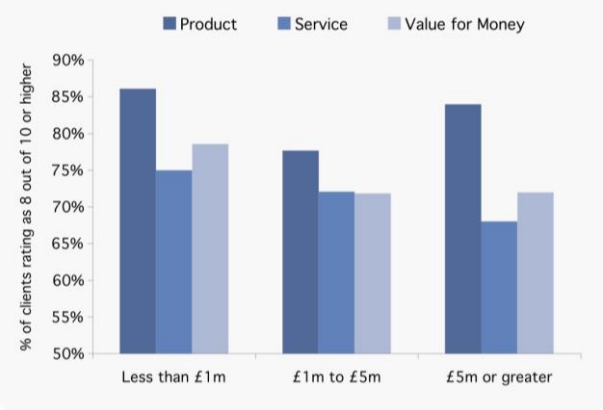
It will be important that the process to establish KPIs is led by industry and that all stakeholders are involved. A framework must first be established and a period of time for measurement, monitoring, benchmarking and engagement prior to setting targets and KPIs in order to better understand the readiness of industry, what is possible, and the potential impact on industry / consumers and potential unintended negative consequences.

It will be vital that any efforts to set goals and targets take into account any potential unintended negative impacts. For example, in setting a cost reduction target the industry needs to ensure it does not negatively impact worker safety or project quality, durability or performance.

Case study: UK Constructing Excellence Annual KPI Reports

The UK construction industry KPIs are published each year by Constructing Excellence using performance data collected from across the UK. The data maps trends and sets benchmarks across the construction sector. Based on data from thousands of projects completed during the preceding year, the Construction KPIs have become a mainstay of the industry since their initial development in 1998. The KPIs are collated from surveys of construction clients, contractors, sub-contractors and consultants, and fall under the following categories:

- Economic Indicators
- Client Satisfaction.
- Contractor Satisfaction
- Profitability
- Predictability
- Respect for People
- Environmental Indicators
- Housing
- Non-Housing
- Consultants



Example of Client Satisfaction KPI by project size (2015)

http://constructingexcellence.org.uk/kpis-and-benchmarking

Ambition 1.3 Recognize and celebrate innovation "champions"

Awards are a powerful way of recognizing the accomplishments of construction teams in the successful adoption of new techniques.

The power of voluntary leadership-level rating systems (such as Passive House, GreenRoads, Living Building Challenge, etc.) are also effective way to push projects to new levels of performance (a list of the mot common programs is presented in **Appendix C**).

While the purchasing power and influence of large firms is important for scaling up innovation capacity, it is often smaller, nimbler firms who are not burdened with corporate systems that can identify, develop and test new ideas more quickly. Survey respondents were asked if they could identify an innovative project (by them or someone else) that they admire. The authors of admired projects overlapped significantly with the "innovation champion" suggested by interviewees and focus groups (Figure 29 following page).

BCIT

Bernhardt Contracting - fiest Passive House multi-family

Canada Green Building Council

Canadian Passive House Institute

Cascadia fibreglass windows

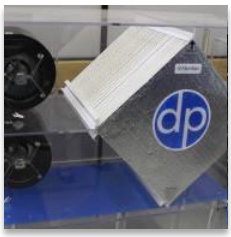
CCA, CCInnovations, the Lean Institute

HDR - CEI Architects - 40 storey wood tower

Cut My Timber digital fabrication

Division 15 Mechancial

Dpoint HRV/ERV cores



Econ Group Passive House home builder

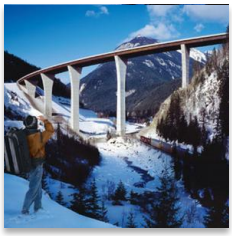
Equilibrium Engineering

Fast & Epp Engineering

HCMA Architects

Integral Engineering

Lafarge-Holcim



Ledcor & Ledcor Renew

Mountain Equipment Coop

Michael Green Architecture

PCL

RDH Engineering

StructureCraft

UBC

WoodWORKS BC

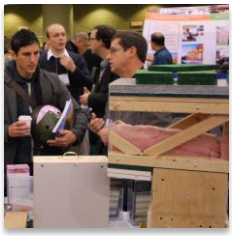


Figure 29 Innovation "champions" identified by our research respondents

Ambition 1.4 Shift misperceptions of the industry via public engagement and stakeholder communication

Commitment to innovation starts with revamping how the industry presents itself to the world.

Progressive construction industries are working hard to eschew traditional images of back-breaking labour and manual tools (Figure 30). For example, the UK industry has invested heavily in communication strategies and public engagement schemes because it no longer wants to be known as the industry offering "job of last resort" and for offering little opportunity for career growth.[42] This is particularly important for companies trying to recruit the "gaming generation"[43] in an increasingly competitive labour market.

Figure 30 Some jurisdictions are working hard to move away from images and language that reinforce the perception of back-breaking work with low tech tools (left) to showcase the latest technology (right).

Public and stakeholder engagement strategies are important to proactively communicate proposed new ideas, different ways of working and to mitigate any unforeseen consequences. Sustained communication with stakeholders improves coordination and impact. In the age of social media, ongoing, open, two-way communication is feasible for most organizations these days and offers an affordable way to encourage co-operation, share information in a timely manner and provide opportunities for open and constructive dialogue. However, knowing what to say to whom, how to say it and when is critical. A communications strategy for both industry stakeholders and the public is thus an important first step.

Ambition 1.5 Pro-actively engage with government on program and policy development, investment and procurement

Construction touches many different government portfolios in BC. Yet, despite its size, construction does not warrant its own ministerial department.

There is an understandable wariness amongst industry leaders of getting "too cosy" with government but, at the same time, a lack of strong communication channels and leadership may leave industry isolated from key decision-making related to policies and regulations that can help or hinder everything from project opportunities to workforce planning.

At the regulatory level, it is certainly important to proactively participate in the development of codes and standards. Indeed, an innovative industry should embrace increasingly stringent standards because it will not only restrict the potential for competition from other regions but also boost the competitiveness of local companies. However, governments also invest in R&D, training and, of course, capital projects. Pro-active involvement in the discussions around all of these areas is imperative to ensure that the needs of the industry are clearly understood.

Lack of government leadership makes it very difficult to drive change across an industry as broad as construction but government involvement can only be useful if the need is clearly defined. Countries that have been successful at reforming their industry to be more receptive to innovation (see **Appendix B**) have worked closely with their government representatives at all levels to convey their vision for the future (for example, the UK's Construction 2025 Industrial Strategy[44] was co-authored by the Confederation of British Industries and HM government), in order to ensure that government supports them fully. Indeed, these countries created a Ministry for Construction, even if only on a limited time basis, while the reforms were being implemented.

> "Every 4 years there are regulatory changes. But every time, the industry waits until day before the change to pretend to be surprised and say they are not ready. Usually government caves and gives them more time or waters down the new standards. It is all the wrong way round. Government should engage the right industry voices on the development of regulations and industry should have the mechanisms to proactively embrace change."
>
> **Industry association executive, interview**

Pillar 2: Performance - A responsible industry that continually improves projects' economic, environmental and social performance

BC's construction industry is continually responding to internal and external forces by embracing innovative products, processes, marketing methods and business models to improve economic, social and environmental performance. Who knows? Tomorrow: things like drones, Augmented Reality and wearable technologies[45] could be part of "business as usual".

Ambition 2.1 Encourage the adoption of innovative design and construction methods that put quality first

Most design and construction companies we talked to are already turning to digital technology and "Modern Methods of Construction" (pre-fabrication, "lean" construction, etc.) as a response to many of the trends impacting the industry: in particular, the pressure to produce projects faster, cheaper and greener.

To catalyze market adoption, there needs to be open universal standards to make communication and data transfer seamless and secure (across all platforms and devices) so that all members of the industry can participate in construction projects on a level playing field. Small businesses may need to explore new approaches without fear of having to deploy them on projects from the outset. To this end, the Construction Scotland Innovation Centre received £1.8m to establish a technology platform that allows builders to experience MMCs such as offsite

construction facilities under the guidance of experts prior to investment. There are also opportunities to "try before you buy" tools and equipment.

Ambition 2.2 Continue to push the boundaries in low-carbon, healthy and green construction

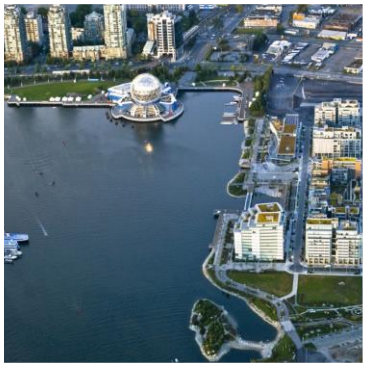
Focussing investment on our competitive advantage in green construction and building an international reputation will not only attract the brightest talent but it will also offer opportunities to enter new markets.

Green and sustainable building design

- Jim Pattison Centre of Excellence in Sustainable Building Technologies and Renewable Energy Conservation, Okanagan College

Sustainable neighbourhoods (e.g. SMART growth, transit oriented development)

- South East False Creek Vancouver, LEED ND Platinum



Occupant accessibility, health and well-being

- Collett Manor, Kelowna is aiming to be Canada's first WELL certified project

Affordability (e.g. mixed use, intensification, small house movement)

- Dumfries St laneway house, Vancouver

Building operations and management

- Shangri La, complex Vancouver BOMA BESt Level 4

Green Infrastructure

- South Fraser Permiter Road, GreenRoads certified

Figure 31 Aspects of sustainable construction that our survey respondents felt were important

Attention to the health and sustainability benefits of buildings is illustrated by the uptake of voluntary rating programs (such as LEED, WELL and GreenRoads) and a range of related policies at the local and provincial level. Our survey respondents agreed that the BC construction industry excels in these areas (see "BC is good at green building and wood technologies") and identified various aspects of sustainable building that they felt were important (Figure 31 previous page).

It is impossible to keep track of all new technologies entering the BC market and our survey respondents suggested a great variety of products, tools and equipment that they feel are changing the way they do their work (Figure 33 following page). The standards applied to construction materials can vary in terms of the scope and rigour and there are many different testing programs to choose from. Industry leaders can forge working relationships with governments, and certification bodies (which includes green building rating system providers such as the CAGBC) to stay abreast of new developments, resolve discrepancies and provide valuable feedback from the field.

We also asked our survey respondent to identify what innovation they would invest in or develop to if they were given $5 million to get a sense of where they think gaps exist. 78 per cent of respondents offered an idea and the range of responses covered all aspects of the design and construction process. We have organized these ideas under topic headings to see if there is consensus around particular areas of the industry that needed support (Figure 32). The most commonly proposed ideas involved some aspect of education (for owners, occupants, trades, regulators) and green building (energy efficiency, materials, waste management, etc.).

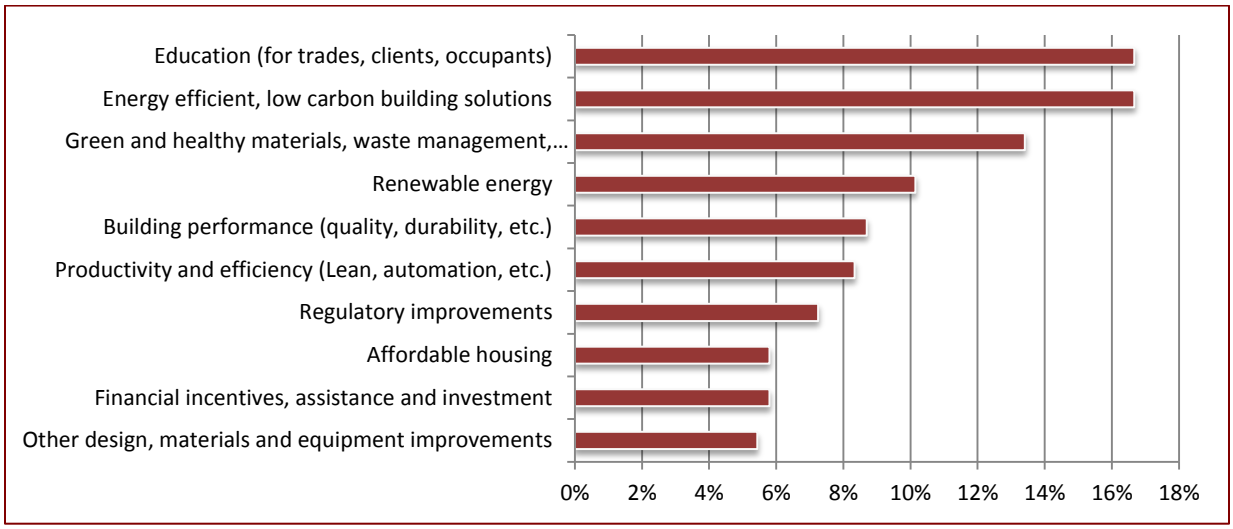


Figure 32 From our survey, "If you were given a $5m budget for innovation, what would you invest in or develop? (Top ten categories of responses)

Operating innovative buildings effectively is how the returns on innovation investment are realized and give confidence to owners and constrictors to keep trying new things. Unfortunately, the 2011 "Building Operator Scoping Study" for EcoCanada[46] found that a number of challenges and gaps within the building operator profession, which should be addressed in order to build a strong, qualified and valued workforce for the future as well as protect owners' investment in high performance construction projects. These challenges include a lack of consistent definitions, professional qualifications and standards, as well as gaps in training and education, and human resource practices. Addressing these challenges will enhance the value of building operators by preparing them to operate high performing buildings in the present and future.

Construction equipment

•Safety, borescope, earth scraper, Total Station, drones, etc.

Building envelope

•Insulation, windows, rainscreen, etc.

Architectural ecology

•Green roofs and living walls

Lighting and controls

•LED, induction, etc.

Renewable energy and efficient equipment

•Solar, wind, heat pumps, HRVs

Innovative cement & concrete products

•ICFs, PLC, etc.

Innovative wood products

•Mass timber, 6 storey wood frame

Building components

•Cascadia Clip, adhesives, etc.

Functionalized materials

•IP-addressable equipment, programmable walpaper, etc.

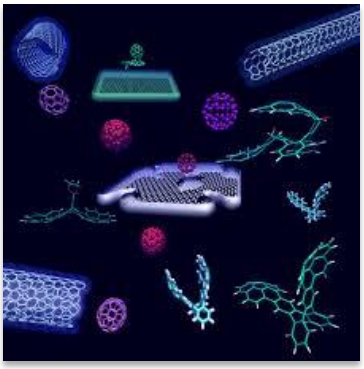


Figure 33 From out survey, "What is the most innovative product, process or technology that has directly benefited you over the last 5 years?" (organized by us into themes)

For innovative solutions to be adopted successfully, clients need to ensure that operators and end users understand their roles. For example, early adopters of cross laminated timber (CLT) structures are noticing a tendency for building operators to make holes through the wood structure for service relocation. Obviously, proposed holes over 10cm should be reviewed by a structural engineer, but the relative ease of modifying of the CLT panel means that such steps are not always being taken.

Ambition 2.3 Encourage all businesses to demonstrate corporate responsibility

There are strong links between CSR, sustainability and innovation. Many companies view CSR initiatives as representing opportunities for more efficient management of their human resources and supply chain to achieve improved competitive advantage.

There is a large amount of research that shows that companies that are held in high regard by their employees and the public have stronger financial performance and profitability through operational efficiency gains. Such efforts to corporately do the right thing fall under the banner of corporate social responsibility (CSR). The World Business Council for Sustainable Development (WBCSD)[47] has defined CSR as "the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large". Of course, it is also vital to be forthcoming, honest and transparent. Social media can amplify a company's mistakes to a global scale – instantly.

Recent trends suggest that more and more companies are adopting CSR approaches to help ensure efficiency, stimulate innovation, and create continued organizational growth. They also enjoy improved relations with the investment community and better access to capital. Enhanced employee relations yield better results respecting recruitment, motivation, retention, learning and innovation, and productivity and stronger relationships with communities in which they work can enhance their "social" license to operate.

Case Study: Singapore's "Green and Gracious Builder Scheme"

The Building and Construction Authority in Singapore developed the "Green and Gracious Builder Scheme" to raise the environmental consciousness and professionalism of builders. It offers a, "Benchmark of a builder's corporate social responsibility to the environment and the general public. Apart from setting standards for green practices, it also sets standards for gracious practices. These gracious practices will improve the image of our builders and the construction industry particularly among neighbours and residents, some of whom may have been affected by construction activities near them." The program provides criteria for:

Green Practices
- Company Policy
- Reduce/Reuse/Recycle
- Energy
- Environmental/Water
- Housekeeping & Air Quality

Gracious Practices
- Company Policy
- Accessibility
- Public Safety
- Noise & Vibration
- Communications
- Workforce Management

Innovation
- Energy Efficient Site Office
- Green and Conducive Site Environment
- Other Innovative Gracious Practices
- Demolition Protocol

www.bca.gov.sg/Awards/GGBA/others/GGB_book.pdf

Pillar 3: People – A talented industry that attracts a skilled, technologically-savvy workforce

Because the predominant form of innovation in construction firms is incremental, the role of the broader workforce is central in the generation, adaptation and diffusion of technical and organizational change.

However, the extent to which a firm's workforce actively engages in innovation is not only determined by technical skills, but also by the management and leadership structures in place to foster a workplace culture of innovation and the ability of workers to "think like innovators".

Ambition 3.1 Help businesses of all sizes to acquire the full spectrum of skills necessary to create and implement innovative ideas successfully

To advance innovation takes the establishment of a company-wide top to bottom network that turns the ideas into practice.

It takes an organized and methodical approach to build a systemic capability—whether that is Amazon's logistics prowess or the near-flawless service you receive as a guest at a five star hotel. So it is with innovation. Skills, tools, metrics, processes, platforms, incentives, roles, and values all have to come together in one supercharged, all-wheel-drive, race-winning innovation machine. A helpful starting point is to think of business-scale innovation "enablers"[48] as:

- Accountable and capable innovation leaders
- Innovation-friendly management processes
- Employees who have been taught to think like innovators

Understanding and deploying business strategies to advance innovation is an area that keeps a large number of consultants employed. Certainly, it is not easy. In a 2015 study by McKinsey,[49] 94 per cent of the managers surveyed (from a wide range of companies) said they were dissatisfied with their company's innovation performance.

> "Currently, 1 in 86 students leaving school are going into construction. We need 1 in 5 or we are in big trouble. Even if robots do it all in the future, we still need the thinkers behind the robots."
>
> **Focus group**

To drive a culture of innovation within a company, there needs to be an anchor point – an innovation leader or champion. Typically this will be an existing manager or leader who communicates well with the senior management team but also has a good rapport with the wider workforce. Ultimately, this person is going to want to be supported by senrior management and get the entire company involved in wider activities, and turn this into a way of life within the business.

Many large general contracting firms we talked to already do this to some extent. There are senior executives tasked with overseeing quality, prefabrication, technology and equipment investments, etc. Very large firms have set up dedicated divisions to source new ideas and drive the business forward. For example, Foresight is Arup's internal think-tank and consultancy,[50] which deals with the future of the built environment and society at large. Arup is a large engineering firm. They serve Arup's global business as well as external clients from a broad range of regions and sectors. They help organizations understand trends, explore new ideas, and radically rethink the future of their business. They developed the concept of 'foresight by design', which uses innovative design tools and techniques to bring new ideas to life and engage clients and stakeholders in meaningful conversations about change. However, the degree to which small firms can do this may be limited and rest on the interests and motivations of the owner.

Business strategy for innovation is a vast subject and outside the scope of this study. There is a great deal of literature about how to develop a culture of innovation among a company workforce that includes management practices, corporate communications, compensation schemes, and so on. For now, it is sufficient to mention that strategies that businesses should be aware of that support innovation fall into the following broad areas:

- Ethical standards and corporate social responsibility (e.g. code of conduct)
- Supply chain management (e.g. centralized on-line bidding, responsible sourcing)
- Business and financial models (whole-life building/ asset management, green leasing, performance-driven insurance, triple-bottom-line accounting)
- Quality/value and performance-based procurement (P3, Integrated Project Delivery and other performance-based delivery methods)
- Employee recruitment and training

Training for managers and senior executives is essential. In the UK, a Best Practice Club (BPC) program was set up to provide support to individuals, companies, organizations and supply chains seeking to improve the way they do business. These programs resonate with much of what Regional Construction Associations (and several trades associations and unions) have been doing in BC. However, the UK experience differs in the focus on innovation, the cross-discipline approach (i.e. not focusing just on trade-specific issues in silos), the degree of funding and the creating of qualified advisors to help companies adopt new techniques and implement organizational change

Certainly, skill development is the first place to start to create the foundation upon which other changes can be built. Education was identified in our research as the most important requirement for advancing innovation. At the same time, the pace of change within the industry means that mid-career workers need to stay up to date. The BC government investment of $185m over 3 years in trades training equipment and facilities underlines the commitment to modernize vocational training.[51] Further, education providers are acutely aware of the drive to "professionalize" the construction industry. The result is that a large number and variety of courses are emerging to meet the need for continuing professional development. For example in March 2015, the BC government announced an enhanced licensing system for BC's residential builders. These changes will raise the bar of professionalism in the homebuilding industry. It will not only give of all sizes the business and technical tools to help them deal with change effectively but it will also severely limit illegal activity.

There is a great deal of opportunity for educators to develop courses to fill the continuing education gap. However, students need to show up. Companies need to recognize the need for ongoing training and help to instil a culture of learning within the industry. Several "boundary-expanding" programs and courses are available today (see **Appendix C**). HPO will be announcing the list of approved training for enhanced homebuilder licensing shortly.

Case study: Constructing Excellence – Best Practice Clubs

The Constructing Excellence Best Practice Club programme (BPC) provides a forum for individuals to learn about the principles of Best Practice, while creating a culture and local support network of continuous improvement. It offers the opportunity for an informal group of forward thinking, innovative people to learn from each other, share that knowledge, and ultimately improve their business bottom line. CBP offers a range of services that raise awareness, gain commitment and support action. The CBP program identifies, publicizes and supports the use of improved business and management practices particularly for SMEs. It is funded by the Department of Trade and Industry and jointly steered by the Government and the Construction Industry.

BPCs are organized locally and present an ideal opportunity for construction professionals from across all sectors and all sizes of business to come together and learn from each other and share invaluable knowledge and experiences (in the classroom and on the job site). They bring the benefits of best practice to a practical, personal and local level for SMEs. BPCs encourage a stronger appreciation of Best Practice principles, spreading the message to create a culture of continuous improvement throughout the industry. Clubs can provide information on what is actually happening in the area by educating the membership. First hand experience will be obtained from those bodies that are directly undertaking and/or are engaged to deliver projects. Club members can guide others in the region and provide support and advice to enable better business, industry cohesion and consistency of approach. Club activities include workshops, newsletters, seminars, site visits, networking events, etc. supported by associations, unions, etc.

The BPC team have recently trained a number of CBP Assessors and Advisors to work with construction organizations to find better ways of doing business and guide the BPCs so they don't dissolve into "talking shops". All the advisors have a background in performance improvement (business and technical) and considerable experience in the construction sector.

http://constructingexcellence.org.uk/clubs

Ambition 3.2 Help businesses leverage innovation to drive recruitment and retention

A reinvigorated image of the industry will go a long way to dispelling misperceptions about life working in construction.

The industry's stance on innovation can provide a powerful means to communicate the range and potential of career opportunities available (see the UK Considerate Construction Scheme). It can also inform how communication language and images are projected (see Ambition 1.4 Shift misperceptions of the industry via public engagement and stakeholder communication). Certainly, there is pressure to refresh and update training for incoming workers as a result of the aging workforce and the growing needs of the industry.

> "Attracting labour is really important. We need to get into high schools to educate kids, parents and teachers that this is not a bottom rung job – there is everything you could want to do in this industry."
>
> **Focus group**

While many studies point to a need to update vocational programs to better reflect market needs (e.g. energy efficiency, waste minimization, etc.),[52] the type and range of training programs offered as well as the job opportunities themselves can do a great deal to communicate the sort of future careers young workers might experience.

Case study: UK Considerate Constructors Scheme

The Considerate Construction Scheme (CCS) aims to improve the image and perception of the construction industry by seeking sustainable solutions, minimizing waste, and effectively using resources within the industry. Set up by the construction industry as a non-profit independent organization in 1997, CCS is designed to encourage best practice beyond statutory requirements. The UK's industrial strategy for 2025 calls for an effort to continuously gain a positive image for the construction industry and encourages all relevant construction activity to be registered under the CCS program. CCS provides monitoring of registered websites, companies, and suppliers and transparently displays posters around construction sites where name, telephone, and site manager contacts are clearly displayed. Issues that CCS has been tackling in order to improve the construction industry's image include occupational cancers, mental health, safety, best practice sharing, and apprenticeship training. The CCS "code of considerate practice" comprises:

- Considerate constructors seek to improve the image of the construction industry by striving to promote and achieve best practice under the Code.
- The Code of Considerate Practice outlines the Scheme's expectations and describes those areas that are considered fundamental for registration with the Scheme.
- The Code is in five parts. Each section of the Code contains an aspirational supporting statement and four bullet points, which represent the basic expectations of registration with the Scheme.
- The Code of Considerate Practice applies to all registered sites, companies and suppliers regardless of size, type or location.

The 5 areas of focus of the code of considerate practice include:

- Care about Appearance
- Secure everyone's Safety
- Respect the Community
- Value their Workforce
- Protect the Environment

www.ccscheme.org.uk

Pillar 4: Growth and resilience - An efficient, competitive and profitable industry that drives economic growth

Business resilience is an organization's capacity to address change - not only in surviving change, but also in evolving and adapting to change so that it yields greater opportunity for growth. A great deal will be asked of BC's construction industry over the next decade if BC is to realize its development goals (LNG, infrastructure, housing, etc.) as well as its social and environmental aspirations.

Ambition 4.1 Ensure procurement structures meet client and industry needs and provide an equitable framework within which companies can innovate safely

The number one barrier to innovation according to survey respondents, focus group participants, and interviewees, is related to structural problems with the procurement process.

Promoting the sustainability and development of the construction sector (thereby allowing it to invest in the necessary R&D, education and equipment) includes ensuring that, particularly, small businesses are given the economic oxygen to allow them to thrive, and if desired, to grow and develop to become the larger companies of tomorrow. At the same time, the public sector has to maximize value for money, in order that limited funds can deliver as much as possible. These two facts are frequently at odds with each other. Some of the procurement-related issues raised include:

- **Lack of client knowledge:** It was recognized that there is a lack of client understanding of the construction process and expertise in procurement that is not keeping pace with advances in the technical complexity of projects. For example, there is no common language for how innovation should be described and interpreted in the bid process. In fairness, there is also a lack of compiled knowledge of construction procurement practices. Consequently construction businesses find it difficult to navigate the various procedures and methods available. Clearly, it is paramount that public and private clients are sufficiently informed, so as to ensure best value for money and take into account risk accordingly. For example, public bodies are under pressure to achieve best value for money from construction projects, but "value for money" is often not defined clearly and is leading to the de facto selection of lowest bid and risking poor quality projects that will result in unplanned increases in cost and time later.

> "Some contractors will kill on price (drive the price down so they eliminate the value-oriented competition) and then they are allowed to kill the client with change orders later."
>
> **Focus group**

> "We need more drive from the professional side. We find that consultants have had to cut their fees to stay competitive so particularly engineers feel they are safe with a particular design and are not paid to change it."
>
> **Focus group**

- **Lack of fairness and inequitable allocation of risk**: Many respondents pointed to the pressure to offload risk down the supply chain to those businesses least able to support it. There is a need for all the

stakeholders in the procurement process to treat each other fairly. For example, prompt and fair payment to sub-contractors was an issue that many respondents felt very strongly about. It is also worth noting that some builders find insurance coverage for innovative projects can be hard to come by because they are not connected to the brokers who are willing to create unique products for a market as small as BC.

> "RFPs will ask for innovation but then they don't score it transparently (or at all). Really, they are only based on experience and lowest bid. Clear measurable criteria and scoring/weighting needs to be used, such as: operational cost of the building over the longer term, the process improvements that get applied (e.g., offsite fabrication, lean processes, IPD etc.)."
>
> **Focus group**

- **Failure to recognize a value-based approach to market and the importance of design:** In an age of increasingly complex projects, there is still a bias toward selecting the lowest-bid in the traditional "design-bid- build" approach as opposed to value-based "quality first" responses (via calls for proposal), which leaves no room for innovation – particularly at the design stage. Instead, respondents felt that there is a "commoditization" of engineering and design services. There is also a general sense that there is a "race to the bottom" when it comes to rationalizing quality over timelines and money.

> "The public tendering process doesn't allow for anything but the lowest price."
>
> **Focus group**

- **Lack of governance, accountability and leadership:** In delivering particular high performance building projects there is a lack of structured frameworks to assist the project teams. Survey respondents generally felt that clearer leadership at the political level is needed to ensure that construction is properly planned using a design-led, "whole life" cost approach. A voice at the political level can forge a culture of change in the way construction projects are delivered and to ensure that everyone plays fairly. Problems such as "suicide bidding" – the practice of bidding unusually lower than competitors – and the pervasiveness of the "underground economy" need to be reined in. It was noted that in countries that had managed to make significant strides towards reforming their industries, a senior and visible political figure (such as a Minister for Construction) was put in charge of the process – even if only on a limited time basis.

In summary, while project owners have the option of using various procurements methods when realizing a built asset, lack of awareness, understanding and information is a significant challenge in ensuring the right option is used, and used successfully. There are usually financial stakeholders beyond the owner whose expectations (in terms of risk reward requirements, timeline, etc.) may not align with the best interests of the project as a whole.

In some quarters, the construction industry is still characterized by contentious behaviours, and more collaboration with clients and within the supply chain is needed. For innovation to be brought into the design and construction process to the advantage of all parties, the procurement of projects of all sizes and levels of complexity needs to foster an approach which achieves better collaboration in design-led, efficient and effective procurement and which has regard to sustainability in all senses of the word.

Owners need to be knowledgeable of how the construction process works sufficient to see how to get best value from their team by providing the right combination of latitude to innovate effectively and controls to ensure that quality, cost and performance goals are met. They also need to understand the value of innovation investment and the positive business case it offers. If owners appreciate the potential for innovation, they will ask for it. Indeed, owner training for procurement was identified as important many times in our research. Procurement for capital projects in BC has largely been based on selecting the lowest compliant bid. Lowest bid procurement has been

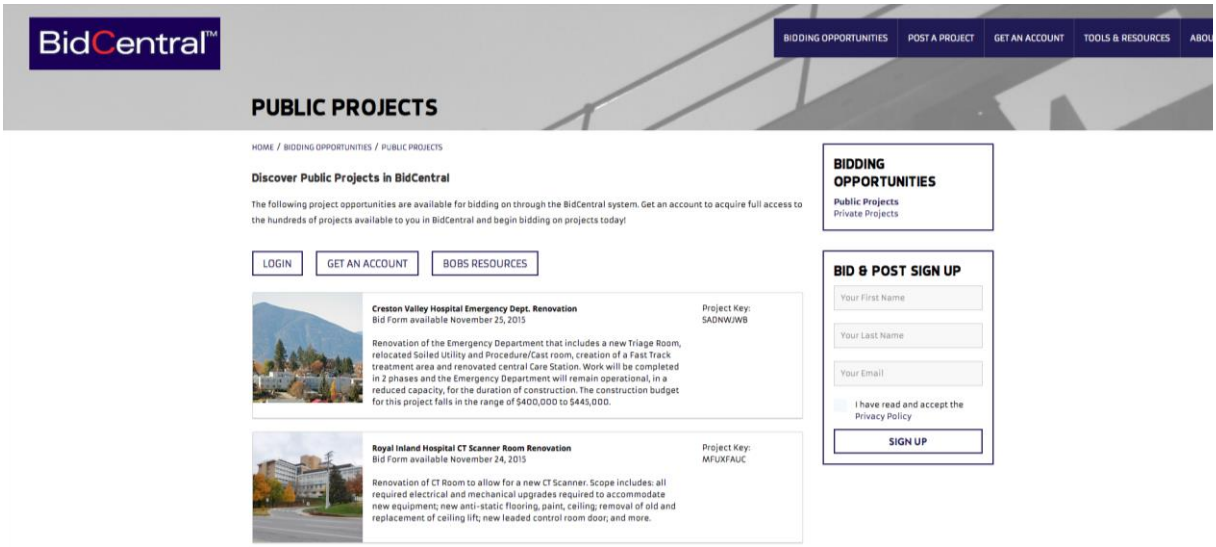
widely criticized for the way it compromises the “best value solution” and disregards the environment and society. Currently there is a lack of awareness and lack of resources available for selecting a best value solution for construction projects.

As a result of a comprehensive procurement review on Scotland, five regional "hubCos" were set up. These are institutional public private partnerships owned 60 per cent by a private sector partner, 30 per cent by the public sector partners within each of the five territories, and 10 per cent by the Scottish Futures Trust. The rights to the private sector share ownership in each of the hubCos were competitively tendered and a diverse range of public sector partners are involved (for example health, local authorities, emergency services). The aim of this approach is that each hubCo will take a strategic, long-term planning approach of its infrastructure requirements (estimated at more than £2bn over its first 10 years) to support the delivery of community services. This system is intended to provide a mechanism for delivering and managing assets more effectively, with continuous improvement leading to better value for money, which will be measured through detailed key performance indicators.[53]

Another area of concern that we heard about in our research is the rise of the “project manager”. Although the evolution of the construction professions has produced many skilled and motivated people, it has also developed specialists in narrow fields with limited business relationships beyond their fellow professionals and clients. These project managers (which include client representatives) may be open to new ideas within their own fields but often fail to spot new ideas outside their fields that connected together could lead to new ways of doing things. This is because project management is focused on the delivery of projects and so is all about breaking projects down into packages to procure low prices and control suppliers rather than about integrating components into completed projects.

Several of our interviewees felt that the prevalence of project managers is a result of clients outsourcing their role as project leaders. It is eroding consultants’ fees and not conducive to innovation. This is not to suggest that the construction industry does not need professional people or project management, but if the industry is serious about innovation and improving performance then clients need to be able to learn how to find ways of organizing people and processes that maximizes connectivity and makes best use of the diverse knowledge that is available.

Case study: BidCentral



In order to o make procurement simpler and more efficient and to make it easier for small and medium sized businesses to compete for public contracts, BCCA created BidCentral as a centralized online bidding and tendering platform. Built *by* BC's construction industry *for* the construction industry, BidCentral centralizes the complete construction bidding process for owners, general and trade contractors, architects, and consultants across both the private and public sectors. Users can bid on or post opportunities in the Planroom, submit or receive bids online, send out by-invitation-only projects, and virtually eliminate non-compliant bids -- all with a single web-based application. Designed with the objective of improving margins and competitiveness for BC construction contractors and trades, BidCentral offers access to BC's largest network of projects and uplink to BC Bid (BC's provincial public tendering site).

www.bidcentral.ca

Case study: Priority Saskatchewan

In 2014, the Saskatchewan government launched Priority Saskatchewan, a new branch of SaskBuilds that is responsible for ensuring procurement across ministries and the Crown sector is fair, open, transparent, and based on international best practice. Priority Saskatchewan is committed to ongoing consultation with industry and stakeholders and continuous procurement improvement. SaskBuilds is implementing the Procurement Transformation Action Plan announced in March 2015, a 13-point plan based on the feedback gathered from more than 160 consultations with industry stakeholders and our broader public sector partners (municipalities, universities/colleges, health authorities etc.). The plan is a best-practice approach to ensuring Saskatchewan businesses are treated fairly and that procurements are open, accessible, and transparent.

www.saskbuilds.ca/PrioritySK

Ambition 4.2 Support ongoing evolution of standards and codes as a means to push the innovation into the market

A regulatory, financial and procurement framework which encourages performance-based, longer-term (life-cycle) thinking is key to being able to bring new ideas into construction projects successfully.

Policy makers have a wide rage of tools at their disposal to encourage industry to adopt new products and practices, and to restrict undesirable practices. For example, BC is ahead of other provinces when it comes to energy efficiency and green building. The BC Building Code references ASHRAE 90.1 (2010) for large buildings and Energuide 80 for houses and small structures. BC is the only province on Canada to require LEED Gold for its public buildings. The City of Vancouver has charted a very clear trajectory towards carbon neutral new construction by 2020 (Figure 34). Metro Vancouver uses market-based instruments such as fees and levies to steer contractors towards material efficiency and waste diversion.

A combination of incentives (such as density bonuses) and code updates can ease the path for construction companies. Improved performance standards in buildings have been a priority for provincial and local governments for some time and, in line with the rest of the developed world, will continue to be so in the future. To best prepare for change and prioritize the innovations necessary to achieve policy goals, the industry needs to be a regular and engaged participant in public and stakeholder engagement processes.

Nevertheless, the BC Building Code can act as a significant deterrent to the adoption of innovative solutions. Prescriptive codes can hinder creativity and innovation. They either completely exclude non-traditional materials and techniques, limit their use through narrow and restrictive criteria or allow only "experimental" building systems. It is very difficult and time consuming to get acceptance for solutions that, due to novel elements of the solution, do not conform to specific provisions of Division B, (i.e. not an Acceptable Solution), or do not provide equivalence to specific detailed provisions of the BCBC (i.e. not an Alternative Solution) even though they provide an acceptable or equivalent level of performance overall.

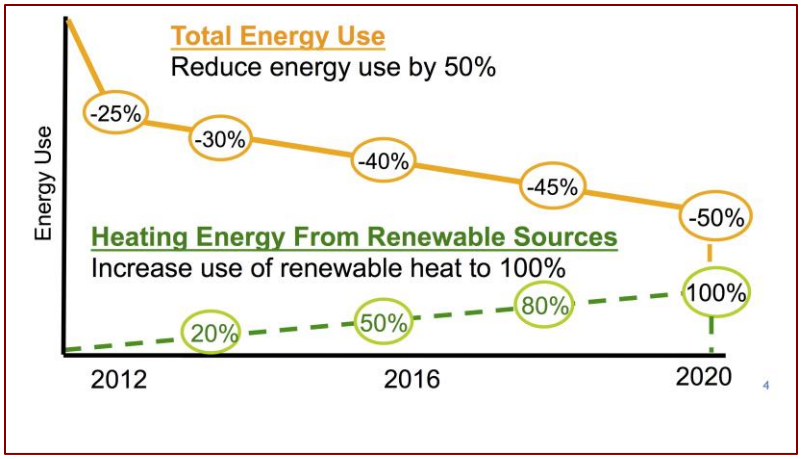


Figure 34 City of Vancouver road map to carbon neutral new construction by 2020

Currently, each code "equivalency" is pursued on an ad hoc basis. It is proprietary and project/situation specific. There is no opportunity for educational feedback loops so such processes do not have to be repeated in the future. This problem has been recognized by the BC Building and Safety Standards Branch, which has retained RDH Engineering in association with GHL Consultants and Innes Hood Consulting to complete policy analysis. A report with policy recommendations is due to be submitted to BSSB shortly.

Ambition 4.3 Develop strong supply chains so new ideas can be realized cost effectively and in a timely manner

Creating conditions for construction supply chains to thrive means addressing access to finance and ensuring prompt and fair payment practices for all parties.

It is also important to explore and promote innovative construction financing methods so new types of projects can get off the ground. For example, Vancity offers an integrated suite of non-traditional financial products aimed at developing "community-focused" real estate, including affordable owned or rental housing and community buildings, high performing environmental housing, workspaces or buildings.[54]

In order for construction firms to challenge the belief that there must always be trade-offs between time, cost, and quality, strong and trustworthy supply chain relationships need to be established where everyone from the supplier to the trade, general contractor and design consultant are all aligned around a common meaningful purpose. The reliable release of work between specialists in design, supply and assembly assures value is delivered to the customer and waste is reduced. It also provides a supportive environment in which innovation can happen successfully.

Ambition 4.4 Prioritize innovations that help BC companies to boost their competitiveness so they can realise a return on investment in innovation

Investment in innovation to boost competitiveness reaps rewards to firms when they expand into new markets.

The global construction market is projected to grow by over 70 per cent to $15 trillion by 2025[55] and the world market for green building materials is projected to more than double from $116 billion in 2012 to over $250 billion in 2020.[56] Although BC has traditionally focussed on supplying the international construction markets primarily with natural resources (lumber, minerals, etc.), this growth offers tremendous opportunity to BC construction businesses, because we can showcase our proficiency in sustainable construction processes and products. In particular, expertise in green building and innovative wood design and construction is highly exportable.

Of course, entering larger markets also means that there is greater competition for materials and labour. As the degree of competition in an economy increases, investment in R&D is strengthened because "healthy" competition normally creates the imperative to develop new products and lower costs. To ensure competition remains healthy, construction business leaders need to develop and refine the pipeline of future work opportunities and make it more useable for all construction businesses. There are also opportunities to leverage the work of government trade missions organized by municipalities (such as City of Vancouver) and various provincial agencies to raise the profile of BC's construction industry (a list of trade and export agencies is presented in **Appendix C**).

Pillar 5: Research and development - An advanced industry that develops and implements innovative new products, processes and business strategies.

Research and development (R&D) is the process that is undertaken to make the introduction of innovative technologies and procedures possible. Formal investment in R&D underpins the progress of any industry, helping businesses to maintain competitiveness and build resiliency. However, this investment needs to be strategically directed towards high priority areas and the development, commercialization and adoption of technologies need to be supported from start to finish.

The roles of R&D in construction can range from increasing consumer satisfaction today to addressing the most pressing global issues facing society tomorrow. 96 per cent of our survey respondents felt that research and development (R&D) was important or very important to the success of the construction industry. 88 per cent said that R&D is important or very important to their company and 86 per cent said that R&D is important or very important to them personally in the job that they do. Indeed, when asked who they felt was responsible for carrying out R&D, survey respondents primarily pointed to product manufacturers but also noted that all key stakeholders had a role to play.

Ambition 5.1 Support research and development networks and centres

Innovation clusters, networks and communities of practice and associated events (e.g. learning forums put on by Regional Construction Associations, peer-to-peer learning at U40 events, etc.) are key to the successful deployment of innovative practices and solutions.

They have become a bit of an obsession in certain parts of the world (Silicon Valley being the largest). Clusters are springing up everywhere. BC and the City of Vancouver, notably, has become flushed with innovative and entrepreneurial hubs that focus on everything from financial technology ("Fintech")[57] to digital media (in which there are four primary industry sectors including animation/special effects, video games, web 2.0 and wireless).[58] BC, often referred to as Hollywood North, is already considered third largest hub for animation and special effects in the world and growing – expertise that has potential overlap in the creation of 3D visualization software used in building design. When it comes to technology clusters and R&D centres that support, directly or indirectly, the construction industry, BC is quite well served (see **Appendix C** for a list of R&D centres).

> "Technology comes from associating with groups outside of our little network. Innovation tends to come from Europe, and there are all kinds of things happening. However, if we just continue to take a Vancouver-centric view of things, we'll just keep doing the same thing and we need time to sit back and look at what is going on in other places."
>
> **Focus group**

Clusters are groups of companies, academics and public sector organisations with an in-depth knowledge of a particular sector, located in geographical proximity to each other or via virtual networks. But they are also so much more than this. As catalysts for new ideas, commercial growth and local regeneration, they have captured the imaginations of 'born global' entrepreneurs who want the quickest route to going international and are changing the face of business in

BC. Examples include the Discovery Parks Commercialization Centre in Vancouver,[59] which provides offices, lab space and research facilities to start-ups in the ICT, clean and biotechnology space. There is no technology cluster dedicated to construction in BC at present but BC's wood industry has developed a very robust network of R&D, government organizations, market development agencies, industry associations and technical experts.

Clusters (real and virtual) are proven to work. Thriving modern industries such as advanced manufacturing, biosciences and digital technologies are driven by brain rather than brawn: knowledge and ideas rather than manpower and equipment. Clusters work because they help concentrate expertise and talent within a geographical area, enabling knowledge and skills to be transferred rapidly and effectively. For example, in the UK, "Catapult centres" have been set up by Innovate UK[60] in various locations across the country as organizations to, "invest in, and support, research excellence; ensure we support areas of UK industry which have the ability and absorptive capacity to capture a share of high value activity; and close the gap between universities and industry through a 'translational infrastructure' to provide a business focused capacity and capability that bridges research and technology commercialisation".[61] They include one for "Future Cities".[62]

Although it is not uncommon for professional consultants to provide support and commercialization support to early stage technologies, there is no formal "incubator" solely dedicated to construction industry. Recently, Sustainable Development Technology Canada[63] ran its first green building technology funding workshop (what they call a "virtual incubator"). Also, there are several members of DigiBC[64] and BC Technology Industry Association (BCTIA)[65] whose primary market is the construction industry. Both DigiBC and BCTIA offer a range of business support and networking solutions to its members but neither offer dedicated sector channel support for construction yet.

We heard from our survey respondents that there are many, many ideas borne out of experiences in the field. Currently, there is no formal feedback loop to the R&D centres to help to test and commercialize these ideas. While many of these ideas are related to improving digital communication, there was just as many related to construction methods and equipment (e.g. telematics for earthmovers, solar charging stations for power tools).

The innovation cluster that is most established for the development of expertise in BC is for wood technology. Led by government under the Wood First program, it offers a joined-up approach to forestry management, wood product development, and building design and construction. Indeed, while it has had a polarizing effect on the construction materials sector, Wood First has been an effective catalyst in driving innovation into the design and construction industry and establishing BC as a "shop window" to overseas buyers of the latest in wood technology.[66]

Case study: Construction Scotland Innovation Centre

The Construction Scotland Innovation Centre (CSIC) was launched in October 2014 and was designed in part to address the historically fragmented nature of innovation investment in Scotland. The project links industry team leaders, businesses, public sector providers, and university experts to deliver a paradigm shift in the construction industry. It is a networked community that aims to provide effective, necessary, and appropriate innovation industry support.

The vision of the Scotland Construction Innovation Centre is, "To create a networked community of industry, academic and public sector talent, channelled towards providing necessary, effective and appropriate innovation support to industry in order to deliver a paradigm shift in the sector's approach to innovation and drive transformational change within the industry". The specific objectives are to:

- Uncover and develop with industry the value that lies in innovating;
- Drive future demand for the innovation support available from Scotland's leading universities;
- Empower industry to take ownership of the innovation process;
- Align academic expertise and public sector agency support;
- Bridge existing gaps by matching industry need to appropriate innovation support packages; and
- Deliver support from inception to commercialisation.

CSIC focuses on technology, procurement, and building efficiency and optimization. A key mandate for CSIC is to break down the barriers to adopting innovation. To date, CSIC has created a formal structure around 12 university partners in order to deliver innovation that is underpinned by a robust collaboration agreement. CSIC has developed a pipeline of projects backstopped by approximately 60 industry leaders who are committing time and effort to stimulate and grow its research portfolio. CSIC recognizes that having the industry drive the research agenda is invaluable and a key to its early success. CSIC focuses on 5 key areas:

- Energy and ICT
- Environment
- Infrastructure – underpins other work in other sectors
- Design performance – infrastructure and buildings are we learning from what we build, are we using technology effectively
- Advanced construction and building fabric materials – off-site to timber cladding, natural materials, new materials that currently not made by local industry, etc.

They offer assistance from academic, project management and support in 4 innovation support streams:

- Business – they help companies to develop their business culture
- Product innovation support – they facilitate the development of new products
- Process innovation support – off-site and on-site
- Service innovation – they help companies identify and be ready for new markets

www.cs-ic.org

Ambition 5.2 Showcase demonstration projects

The construction industry needs pilot projects to see new ideas in action.

BC has a strong track record of being first in Canada when it comes to innovative, green buildings (first Passive House in Canada, first LEED projects in Canada, etc.). There are hundreds of projects in BC that, over the years, have played an important role in advancing new ideas. Often, there is only a brief period when an innovation is considered ground-breaking before it is accepted into routine practice. The list of influential projects is a compilation of suggestions from survey respondents, recent award winners, and a couple of older role model projects that can still teach us a thing or two about how to put a building together while achieve leading-edge performance (Figure 35). Of course, there are many, many others. What is heartening to see is the trend towards creating inspiring places for educating the next generation of construction workers.

Austria Olympic Passive House Pavilion, Whistler

Canada Line, Vancouver & Richmond

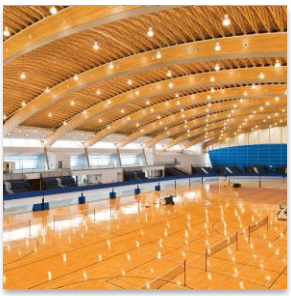
CK Choi building, UBC

Jim Pattison Centre of Excellence in Sustainable Building Technologies. Okanagan College

Trans Canada Highway improvement, Kicking Horse Canyon bridge, Golden

Kingsway Pedestrian Bridge, Burnaby

Olympic Oval, Richmond



South Fraser Perimeter Road

The Ecosmart Sustainable Condo mobile display

Vancouver Coastal Health modular housing for staff, Bella Bella

VanDusen Garden Visitors Centre, Vancouver

Wood Innovation & Design Centre, Prince George

Figure 35 A selection of demonstration projects mentioned by survey respondents

Case study: demonstration project: UBC – CIRS

The Centre for Interactive Research on Sustainability (CIRS) at the University of British Columbia officially opened in 2011 as the first state-of-art "regenerative" building in Canada. Features include waste heat recovery from a neighbouring building, solar energy system, and ground-source heating and on-site wastewater treatment system. CIRS earned LEED Platinum and recognition under the Living Building Challenge. It is also a pioneer in the use of cross laminated timber (CLT) structure along with a host of new systems and approaches that have since become widespread.

The aim of CIRS is to serve as a "living laboratory" and serves as a test bed for new technologies as well as for researchers, educators and students to discover and evaluate how buildings work. CIRS shares ongoing building operational performance data so they can share and learn from successes and failures. To reflect this, the Technical Manual is a 'living document' of the lessons learned from the design, construction, and operation of CIRS.

Partnership was a key component of the basic vision of CIRS. Strategic alliance partners (BC Hydro, Haworth, Honeywell, and Modern Green Development Company Ltd) provide expertise, knowledge, and monetary contributions to the design and construction. The diverse collaboration through academic research, extended network and non-academic stakeholders enhanced the project credibility and financial viability.

http://cirs.ubc.ca/building

Ambition 5.3 Advocate for, enable and direct public funding and business investment in innovation

When it comes to public spending on R&D, Canada remains near the bottom of its peer group on innovation and BC ranks among the lowest of Canada's provinces. The fact that construction invests the least in R&D of all business sectors means there is a great deal of catching up to do.

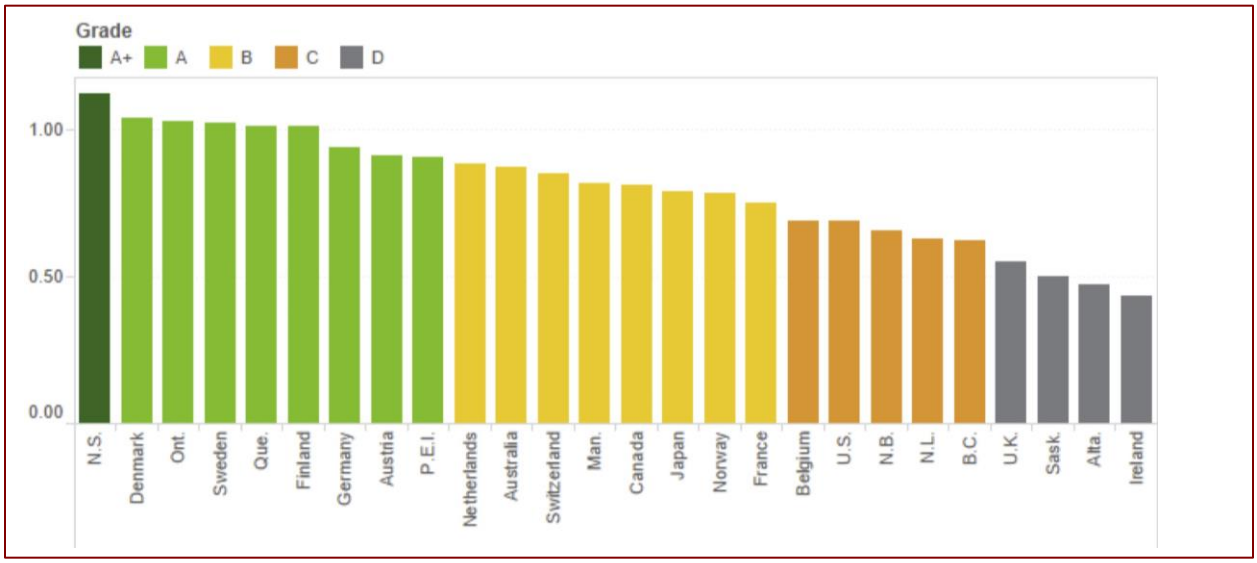


Figure 36 The Conference Board of Canada scorecard of public R&D spending, provinces and international peers, 2013 or most recent year (data from StatsCan, OECD)

The Conference Board of Canada ranks BC among the lowest in terms of public spending on R&D (Figure 36). Across all business sectors, construction was the lowest R&D investor of all major industries in 2015. Industrial spending on construction R&D was $79m (down from $101m in 2012), which comprises only 0.5 per cent of the $15.5bn total spent by industry across all sectors and compares with an average sector spend of $2.8bn.[67] When R&D expenditures for architectural and engineering services of $354m are added then the total share of industry R&D spending climbs to 3 per cent. Comparing the dollar spent on R&D per GDP dollar generated across major industry sectors, construction ranks the lowest. This is a concern given that construction contributes to about 6 per cent of Canada's economy (Figure 37).

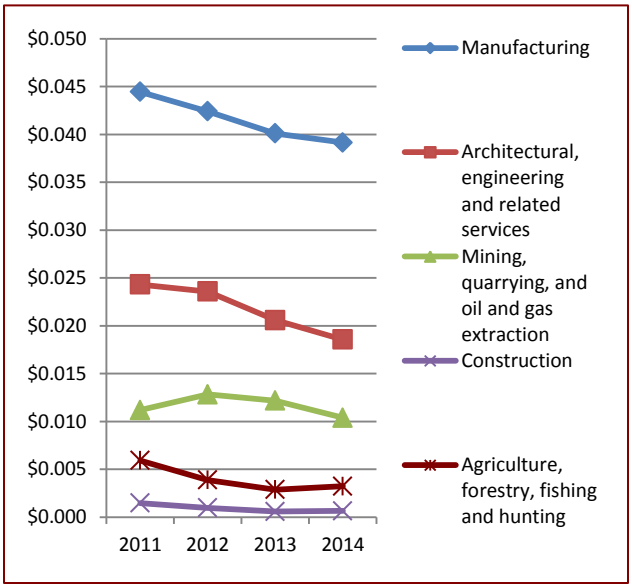


Figure 37 Comparison of $ spent on R&D per GDP $ earned (2015 data) (source StatsCan)

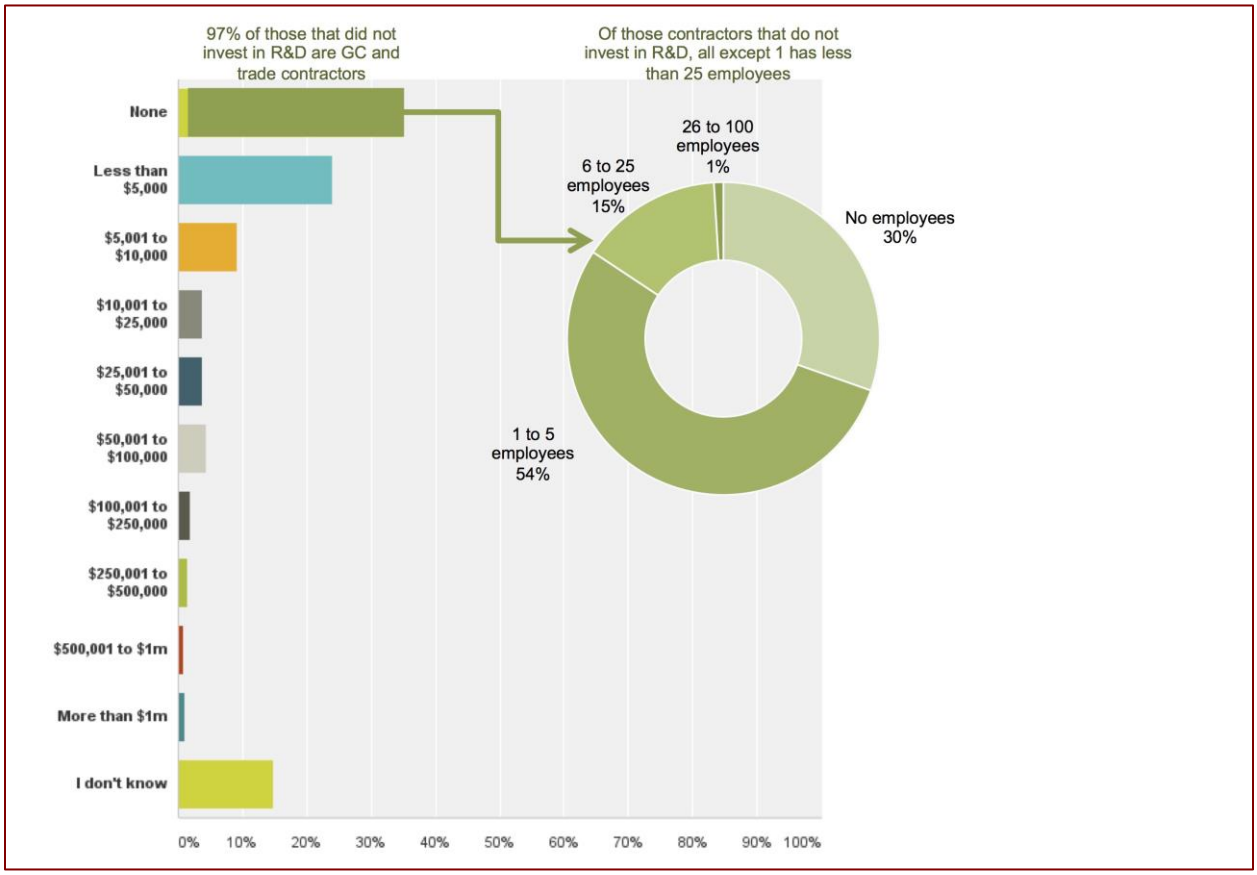


Figure 39 From our survey, "How much does your company invest in research and development annually?" (All respondents)

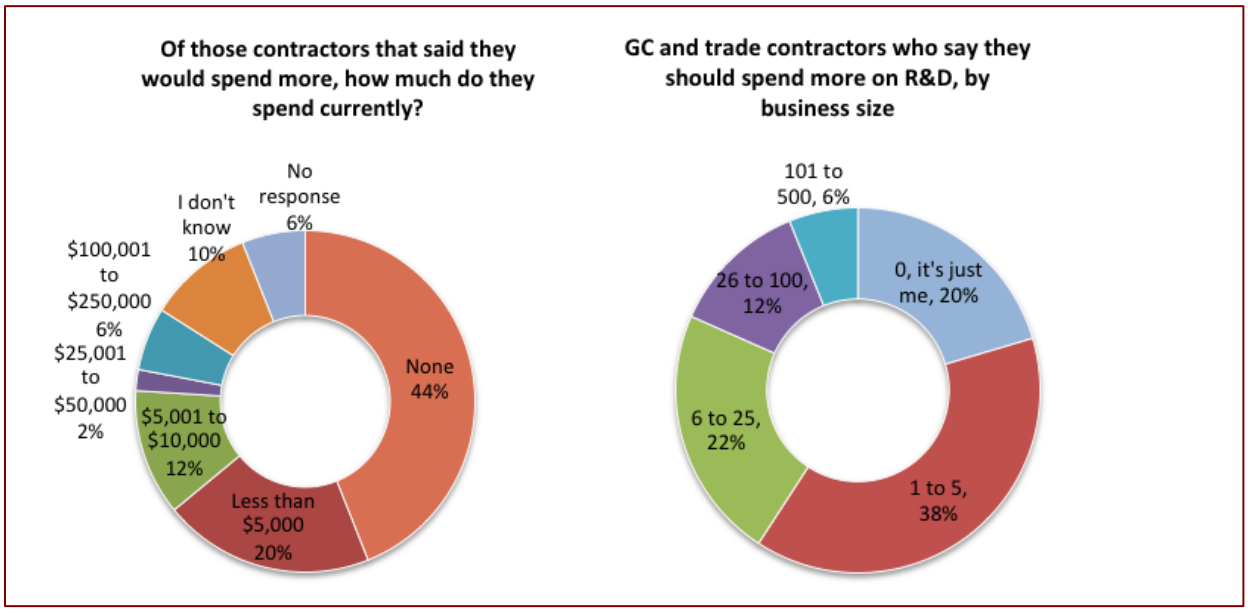


Figure 38 Our survey results suggest that there may be willingness among contracting businesses of all sizes to invest in R&D

These trends were borne out in our research findings. 35 per cent of our survey respondents and 57 per cent of general and trade contractors surveyed stated that they do not invest in R&D at all (Figure 39 previous page). However, of those contractors who stated that they do not invest in R&D, only one employed more than 25 people (Figure 38 previous page). Of those that do, only 4 per cent invested more than 1 per cent of their estimated annual earnings.

Although there was general enthusiasm for the idea, feedback from focus groups and interviews suggest that the benefits of innovation (that it drives competitive advantage, improves productivity, and enables companies to capture higher value components of the value chain) are not well understood. However, there may be cause for optimism. 42 per cent of contractors surveyed felt that they should spend more on R&D than they currently do. Of those GC and trade contracting businesses that currently do not invest in R&D, 28 per cent felt that they should spend more in the future.

Further, 25 per cent of all sole proprietor business owners (not just contractors), a segment that might be considered the least engaged in innovation, stated that they do invest in R&D already and 30 per cent agreed that they should spend more. An important role for innovation advocates will be to develop a robust value proposition for innovation investment so businesses can understand how best to get involved.

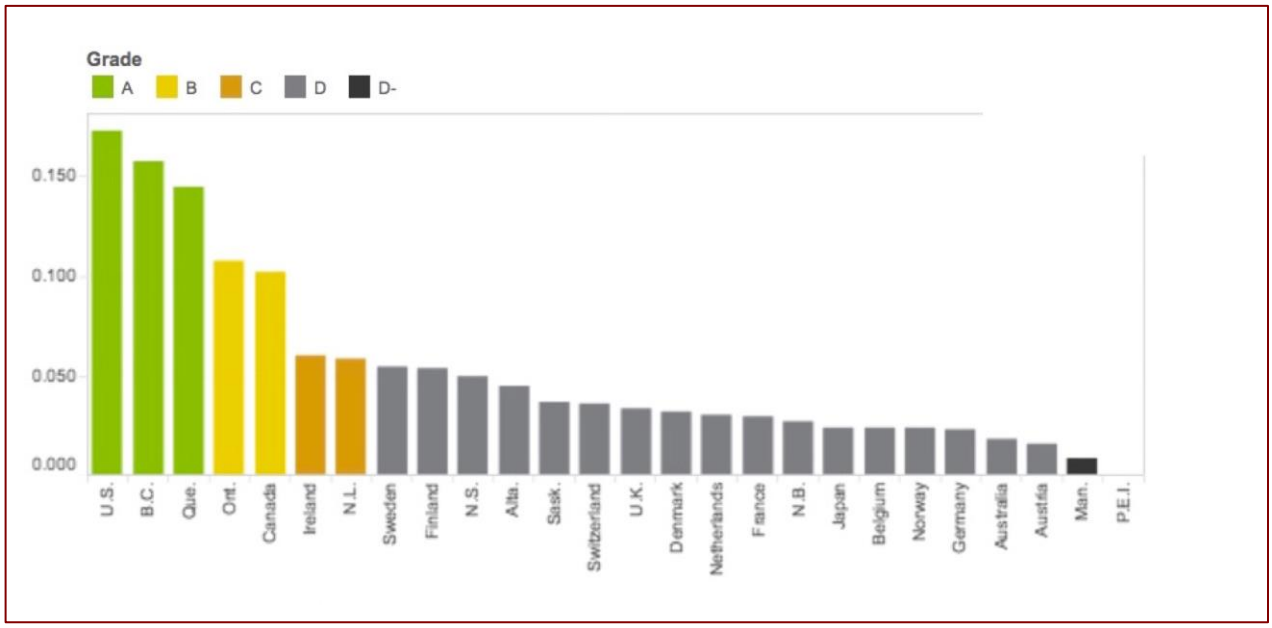


Figure 40 Venture Capital Investment, 2012–14 (provinces and Canada), 2012-2013 (international) (percentage of GDP), source Industry Canada, OECD and The Conference Board of Canada

However, a bright spot is that BC is home to a vibrant venture capital community, which, although not traditionally focussed on construction, might be encouraged to pay closer attention if the value proposition was made clear. In fact, BC has been ranked highest of all Canadian provinces, trailing only the US[68] (Figure 40). Venture capital plays an important role in a region's innovation ecosystem by providing emerging firms with early-stage financing - such as pre-seed, seed, start-up, and other early-stage funding - or later-stage financing - i.e., funding provided after commercial manufacturing but before an initial public offering. This risk capital provides firms with the financial resources they need to invest in further research and development, manufacturing, and marketing before they are able to generate solid revenue streams to do so on their own. Venture capital is also an important source of

managerial expertise, which is a key ingredient in successful innovation. Along with financing, venture capitalists bring entrepreneurial experience, industry knowledge, and networks of customers, suppliers, and other funders—all of which many new entrepreneurs lack.

While there are not enough funding and incentive programs to support innovation in BC, there are some that offer a good place to get started (see **Appendix C**). Unfortunately, the "Catch 22" is that until industry is more clear about what funding makes sense, what is going to get done, what the appropriate resources might be, and so on then investors and funders are not able to create the right platform, structure and system so industry, public sector and academic function on equal footing.

Ambition 5.4 Strengthen the role of large firms in BC as drivers of innovation

Large firms are important enablers of innovation because they have the capacity to take on innovative processes and practices. They can invest in the necessary people and resources and because they have significant purchasing power in the market.

BC's construction industry is made up of very many small businesses that may not have the financial or structural bandwidth to engage with innovation (Figure 41). 89 per cent of BC construction businesses have less than 5 employees and "small business heavy" when compared with other Canadian provinces. BC is home to 18 per cent of Canada's smallest construction firms (less than 10 employees) but only 12 per cent of Canada's largest firms (over 100 employees). None of Canada's largest firms (over 500 employees) are headquartered in BC. Yet, there is a good diversity of firms with over 100 employees. Of these, building equipment contractors, real estate services, engineering services and non-residential construction firms form the largest sub-sets (Figure 42 following page).

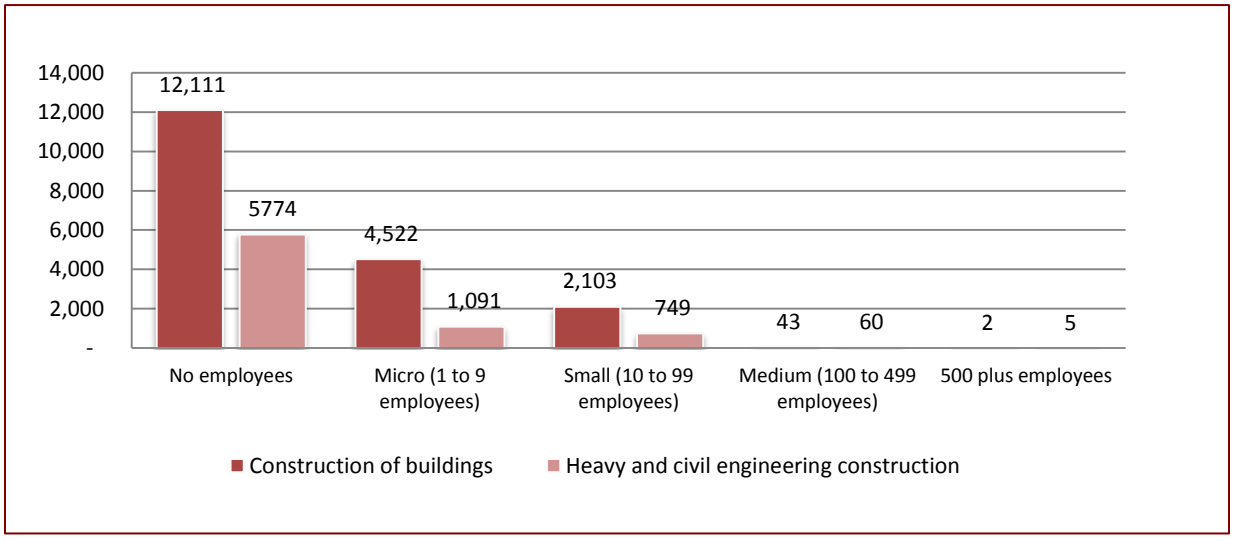


Figure 41 Number of BC construction businesses by size (source data StatsCan)

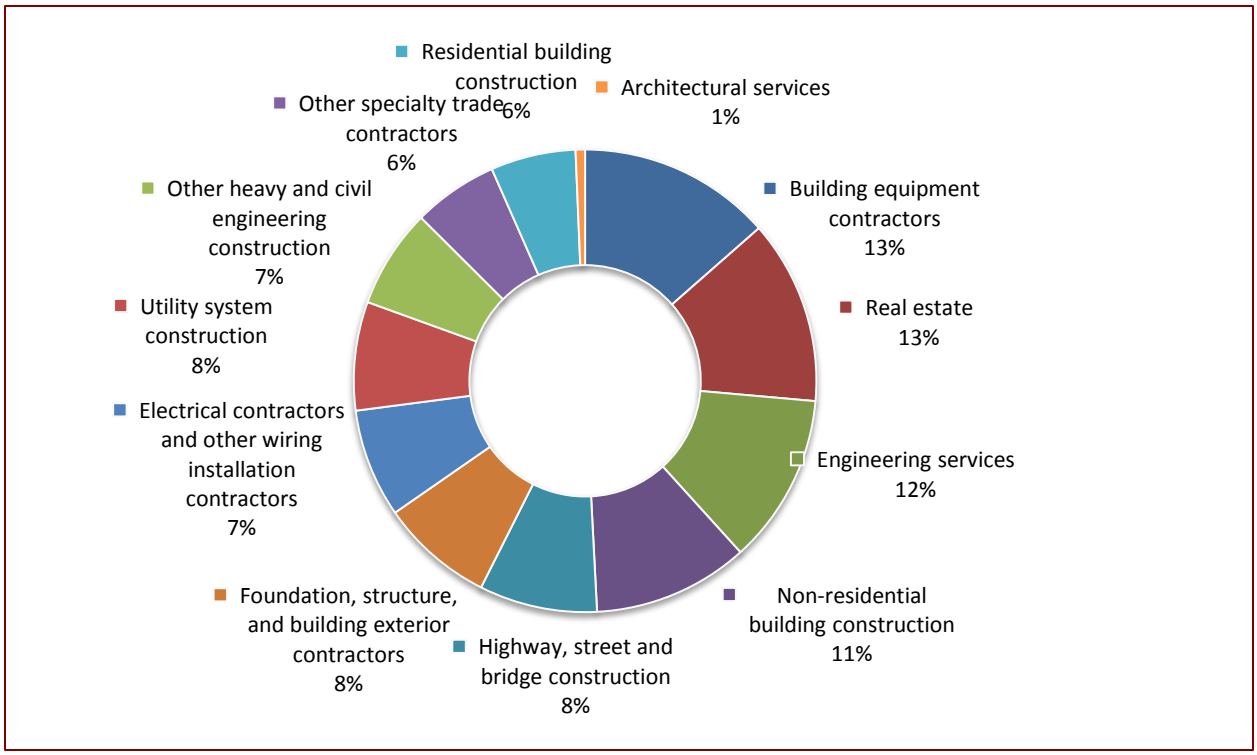


Figure 42 Distribution of BC's largest construction firms (more than 100 employees) by business type (source data StatsCan)

To get a sense of how engaged BC companies are with innovation, we asked survey respondents if they knew what their company's R&D budget might be. Only 15 per cent stated they had no idea. Of those that did know, 73 per cent reported that they did have an annual R&D budget of over $5,000. Unfortunately, only 35 per cent of respondents from large firms (over 100 employees) knew that their company had a budget for R&D, which suggests that more work needs to be done to help large companies communicate the advantages of innovation, their accomplishments and be more transparent with their employees about their R&D activities. This will help employees to understand their employer's appetite for risk, how much autonomy employees have and how much (and what kind of) failure is acceptable in the pursuit of innovation.

Employees of large firms informed us of all sorts of innovative activities currently under way (e.g. PCL's investments in lean construction and prefabrication[69]). For these investments to reap positive returns, sub-contractors and consultants need to be aware of and support these efforts. Also, if efforts are to be applied to strengthening the role of large firms as innovation drivers, then these firms need to see the "shared value" of collaboration (even with potential competitors) and sharing ideas outside of project work for the good of advancing the industry as a whole and increasing the rate of market transformation.

Ambition 5.5 Encourage businesses to collaborate to achieve scale and share knowledge

There are many situations where it is beneficial for companies to collaborate to develop new solutions that do not infringe on proprietary business advantages.

Innovation happens every day on most construction sites. These experiences are absorbed into companies' corporate memory and become their competitive advantage. There has been a great deal of research into the way businesses learn and the concept of "intelligent failure".[70] However, there are many situations where companies can collaborate to develop new solutions that do not infringe on individual business positions. For example, the cost to undertake certain types of R&D can be very high, the need for the research may not be project specific or the expertise to undertake the research may be in short supply.

While BC's construction industry does collaborate on certain research projects, and indeed, there are several "centres of excellence" for certain aspects of building design and construction (such as BCIT's Centre for Architectural Ecology[71] and Building Science Centre of Excellence[72]), there is no centralized entity that provides a knowledge-sharing platform to organize projects and disseminate the findings.

We also heard from interviewees and focus groups that BC-based businesses might be losing out on very large projects because they are not big enough to compete head to head with very large international companies. Collaboration is therefore one way to resolve this challenge. Indeed, some local firms are already doing so and are accessing new ideas and solutions as an additional benefit (for example, Ledcor is working with Balfour Beatty to build the Teck Acute Care facility for BC Children's and Women's Hospital[73]). However, collaboration to achieve scale is a solution that is available to businesses of all sizes and facilitating the connections in a safe and respectful way is a role that could be coordinated by industry associations.

Recommendations for next steps

This report has outlined an agenda for strengthening the BC construction industry by enabling innovation. Implementing this agenda will take significant resources and requires an industry-wide commitment to collaboration and investment. We recommend starting with three key initiatives: 1) Creating an action-oriented **Innovation Council**, 2) Developing a formal **Construction Innovation Action Plan** and 3) Launching an **Innovation Procurement Initiative**. These three activities will lay the foundation for transforming the industry's performance, reputation and efficiency.

Figure 43 summarizes the pillars, ambitions and potential activities from the *Creating a vision and a call to action* section above. There are three "top priority" actions (highlighted in red) that, we believe, need to be completed first to so the completion of other actions has the greatest chance of success. They could be taken on by BCCA with the support of the regions. The top priority actions are discussed in more detail below.

Figure 43 Summary of pillars, ambitions and potential "next step" activities

Pillar 1: Leadership – A cohesive industry that embraces and celebrates innovation	
Ambition 1.1 Establish an action-oriented innovation council to be the "voice" of innovation in construction in BC	**a. Establish an action-oriented innovation council to be the "voice" on innovation in construction in BC** **b. Develop a formal industrial action plan for innovation** c. Keep the conversation alive with a series of "meeting of the minds" dialogues around the province d. Develop strategies so that the many voices of small businesses are heard
Ambition 1.2. Report on key performance indicators for construction excellence	a. Engage with industry leaders and stakeholders to determine the optimal suite of indicators, reporting framework, responsibilities for data collection and monitoring, etc.
Ambition 1.3 Recognize and celebrate innovation "champions"	a. Promote awards and recognition programs for innovation b. Showcase leading individuals and organizations
Ambition 1.4 Shift misperceptions of the industry via public engagement and stakeholder communication	a. Develop and maintain public engagement and stakeholder communication programs b. Review and revamp language and images to steer away from traditional perceptions of construction being physically demanding and without opportunities for career advancement.
Ambition 1.5 Pro-actively engage with government on program and policy development, investment and procurement	a. Pro-actively engage with all the relevant departments and agencies of government at the local and provincial level: fostering partnerships where possible so industry stays ahead of codes changes, etc. b. Consider the pros and cons of advocating for a single point of senior leadership within government to help direct desired reforms
Pillar 2: Performance - A responsible industry that continually improves projects' economic, environmental and social performance	
Ambition 2.1 Encourage the adoption of innovative design and construction methods that	a. Advocate for open universal standards to make communication and data transfer seamless and secure across all platforms and devices b. Support the adoption of "Modern Methods of Construction" such as off-

put quality first	site construction, lean construction, etc. c. Help businesses of all sizes gain access to and deploy the new tools and technologies they need to be competitive
Ambition 2.2 Continue to push the boundaries in low-carbon, healthy and green construction	a. Leverage BC leadership in green building and the use of wood when focussing on our competitive advantages b. Promote occupant and operator training to ensure buildings work properly and protect investments in innovation c. Support the adoption of sustainable materials and technologies
Ambition 2.3 Encourage all businesses to demonstrate corporate responsibility	a. Encourage companies of all sizes to act ethically and transparently to build a positive reputation and win work
Pillar 3: People - A talented industry that attracts a skilled, technologically-savvy workforce	
Ambition 3.1 Help businesses of all sizes to acquire the full spectrum of skills necessary to create and implement innovative ideas successfully	a. Foster a culture of learning to develop an engaged and informed workforce b. Develop business leadership capacity so companies of all sizes can manage for innovation c. Consider establishing "Best Practice Clubs" to bring the benefits of best practice to a practical, personal and local level
Ambition 3.2 Help businesses leverage innovation to drive recruitment and retention	a. Undertake a review of programs aimed at improving the image and perception of the industry by encouraging "beyond code" best practice b. Review recruitment messaging so that it explains the career development opportunities and the diversity of jobs available
Pillar 4: Growth and resilience - An efficient, competitive and profitable industry that drives economic growth	
Ambition 4.1 Ensure procurement structures meet client and industry needs and provide an equitable framework within which companies can innovate safely	**a. Review current procurement practices and implement the improvements identified** b. Advocate for a "quality-first" agenda where life cycle costs and the value of design are recognized c. Develop common language for how "innovation" should be described and interpreted in the bid process d. Create and offer procurement training for owners e. Work with stakeholders to determine how to mitigate adversarial behaviours and minimize the underground economy
Ambition 4.2 Support ongoing evolution of standards and codes as a means to push the innovation into the market	a. Foster a close working relationship with policy makers and participate proactively in the development of codes and standards b. Advocate for performance-based building codes as a way to drive innovation into building projects c. Work with policy makers to establish a publicly available database of accepted building code interpretations
Ambition 4.3 Develop strong supply chains so new ideas can be realized cost effectively and in a timely manner	a. Encourage methods that close gaps in the supply chain to ensure the reliable release of work between specialists in design, supply and assembly b. Advocate for centralized, online bidding and tendering c. Promote a design-led, "life-cycle cost" approach so that consultants are rewarded for their expertise d. Connect with financial institutions and insurers to explore innovative financing and risk management mechanisms
Ambition 4.4 Prioritize	a. Showcase BC companies' proficiency in sustainable construction

innovations that help BC companies to boost competitiveness so they can realise a return on investment in innovation	processes and products b. Leverage BC's various export agencies to promote BC companies' expertise to new markets
Pillar 5: Research and development - An advanced industry that develops and implements innovative new products, processes and business strategies	
Ambition 5.1 Support research and development networks and centres	a. Explore the viability of establishing a construction-focussed technology cluster, leveraging the leadership of BC's wood sector as a role model and possible partner b. Leverage Vancouver's established venture capital capacity and start-up community to support a construction-focussed incubator c. Create opportunities for industry to feed back ideas from the field into the R&D community
Ambition 5.2 Showcase demonstration projects	a. Build on BC's track record of innovative projects b. Connect with industry associations, trade agencies and NGOs who can help to profile local success stories, collect data and build a library of projects
Ambition 5.3 Advocate for, enable and direct public funding and business investment in innovation	a. On the strength of a sharply defined vision for the industry, advocate strongly for more public spending on construction-related R&D b. Help industry advocates (such as associations) make the business case for investment in R&D to construction companies
Ambition 5.4 Strengthen the role of large firms in BC as drivers of innovation	a. Develop tools and resources for large firms to use to engage employees and help them "think like innovators" b. Help large GC firms promote their investments in innovation so they can work together effectively and win work c. Encourage large firms to benefit from the value created by sharing R&D, ideas and best practices
Ambition 5.5 Encourage businesses to collaborate to achieve scale and share knowledge	a. Foster a safe and positive environment in which companies can collaborate to develop new (non project-specific) solutions b. Provide tools and resources for companies to collaborate in order to achieve sufficient scale to compete on large projects

Three top priority actions

Ideally, the following action items need to be addressed ahead of any others. An innovation Council (Action 1) is necessary to provide strategic direction and an action plan for construction innovation. (Action 2) will provide the road map and goals for the council and stakeholders. Fixing the procurement process so that it is optimized for innovation (Action 3) will stand the industry in good stead for future investments in innovation and make it possible for businesses to benefit directly from innovation.

1. Create an action-oriented Innovation Council

A "Construction Innovation Council" with an outcome-oriented mandate is essential to create a cohesive (and loud) voice and drive the agenda forward. Participation on the Council needs to carefully sought from representatives within key stakeholder groups (clients, researchers, trainers, consultants, etc.) who are motivated to act and take have a proven track record of accomplishments. The Scottish model (the Construction Scotland Leadership Group) may offer a helpful starting point where there is an application process and members are required to "earn the right to sit at the table". It is also not unlike the set-up of the board of the CAGBC.[74]

The Council would be responsible for steering the development of a full industrial action plan, fund raising, advocacy and, importantly, government relations. It will be vital to get government engaged and invested in change and why this needs to happen now, so they can steer investment into the industry effectively. The action plan will need to showcase the full range, scope and magnitude of the risk of doing nothing (including the business case for the risk and what's being lost out on) and bucket list for ways to address this.

The innovation Council can also establish specialist task forces to address key technical, educational or political issues. For example: in the UK a BIM technical task force was established to make sure that common standards of practice and documentation were adopted. Also, a tribunal system could be established to guide how innovation is worked into code advancements in a way that does not add costs, delays, or added risks to consumers. This could serve as a flexible, fast, unbiased, and effective way to ratify discrepancies in the building code.

2. Develop and implement an innovation action plan for construction

Companies of all sizes would benefit from an innovation action plan built on clear goals and describing the prioritized focus areas for research, timelines and how projects and activities are decided upon. More research and engagement with industry is needed in order to develop a plan that has the right focus, scope and ambition, and has buy-in from key stakeholders. We recommend the following next steps to start the process:

- **Decide on the role of government in the action plan**. The rationale for involving government is that many of the enablers needed to advance innovation depend on government support and investment. The UK's Construction 2025 is an excellent example of a joint industry-government strategy that has yielded impressive results. The potential risk to this approach is that it would reduce the industry's influence on the timelines and final product.
- **Translate ambitions into activities**. This study provides the framework for an innovation action plan, which needs to be validated and refined in consultation with industry and stakeholders. On the strength of feedback from industry, the ambitions need to be distilled into concrete goals and timelines for implementation so that projects and activities can be developed.

- **Measuring success**: Industry needs to determine if it is prepared to establish targets and performance metrics. A majority of survey respondents (66 per cent) agreed that setting performance goals is an effective way to stimulate innovation. However, many were wary of setting ambitious targets without an adequate infrastructure in place to achieve them.

3. Launch an innovation procurement initiative

As it stands, the procurement process needs to be fixed. There has to be a shift from a culture of "lowest bid" to focus increasingly on quality and "whole-life" value.

The first step is a procurement process review, to review and improve existing approaches to procurement (particularly by public sector building owners), potentially based on a review of effective procurement models from other jurisdictions. For example, the system in the UK requires a bill of quantities that is always accompanied by a feasibility study so the client can plan the project and adjudicate effectively and allowing proposals to be compared effectively. Scotland experienced similar issues to BC and undertook a comprehensive review that uncovered 66 recommendations of which 65 were accepted by government. Interestingly, the only one rejected by the government was the industry's call for a Minister of Construction to oversee the process of reform. Saskatchewan has also recently completed a similar process resulting in the Priority Saskatchewan initiative.

This work needs to involve an assessment of the various procurement methods available for building construction projects to achieve the best value for key stakeholders and include an in-depth review to identify traditional and innovative project procurement approaches. Published literature, procurement guides and request for proposals will also need to be reviewed to identify common objectives to create best value. The knowledge generated can then create a conceptual framework to achieve best value in building construction projects. Imperative though this study is, responsibility for reforming the procurement process does not rest solely with owners, and so any steps to do so should involve construction firms that work for public agencies.

Although the procurement review will uncover a range of actions that need to be taken (not least of which will undoubtedly be training for owners and purchasers), something industry leaders could develop right away is a "best practices" document for public procurement agencies with clear guidelines, that include a definition of innovation and how it should be described and interpreted in the bidding process. This information guide could also outline the need for changing procurement practices by highlighting the how opportunities are being missed, the inequitable allocation of risk, and how clients may not be getting the value for money they anticipated. The document could even explore the potential to develop more clearly defined and transparent metrics (KPIs) around procurement – usually driven by the owners interests such as cost, time, operations; this, in turn, will help with reframing the word 'innovation' in order to make it less obscure.

There is more that can be done

There are many activities that need to be taken on to build a vibrant innovation ecosystem. The possibilities are extensive and exciting. However, they all start with the willingness to change and the acceptance that it is in the best interest of the broader industry for business of all sizes to get on board. To effect meaningful change will require a long-term commitment and investment; results are not going to happen overnight.

A complete, prioritized, industry-supported list of action items will come from developing a formal industrial action plan that includes concrete goals. The following “shopping list” of seven items illustrates what we heard from survey respondents, interviewees and focus groups and provides ideas of where to focus initial efforts. They also link to the recommended action items provided in Figure 43.

1. Develop and host “meeting of the minds” dialogues

Under Ambition 1.1 (Strengthen industry cohesion by establishing an action-oriented innovation council to be the "voice" of innovation in construction in BC) we recommend developing and hosting a series of “meeting of the minds” dialogues with industry to review study findings, coalesce key objectives and identify a way for lasting tools to be developed.

They could also be used to gather industry experts together to solve code, cost, schedule and quality in specific project situations (such as tall wood structures). Certainly, there is interest among other stakeholders such as NGOs, materials advocates etc. to forge a closer relationship with the construction industry on topical issues such as energy and climate policy, zero waste, pre-fabrication, etc.

2. Conduct more research into KPIs and metrics

Ambition 1.2. (Report on key performance indicators for construction excellence) recommends that industry leaders engage with stakeholders to determine the optimal suite of indicators, reporting framework and responsibilities for data collection and monitoring.

Establishing a way to measure and monitor performance to produce useful, relevant and timely information is challenging and our research suggest that a great deal of research and consultation needs to be done to convince businesses that this is worth their while and will not overload them with paperwork. There are some indicators that are currently tracked such as safety records and economic data. The question is which indicators should be implemented that will guide innovation spending and prove that there is a positive return on investment? KPIs can be as little or as much as industry is willing to take on.

To simplify the process, BRE (in the UK) has developed a KPI Engine to help support the collection, reporting and analysis of data for construction companies that may be adaptable to BC. The engine is an on-line tool that enables businesses to easily benchmark their performance against a national average, and projects against each other or the nation. Benchmarking provides a 'yardstick' by which to judge performance. The KPI Engine allows companies to:

- Identify their own suite of KPIs from over 200 different measures
- Include bespoke KPIs
- Report KPI scores easily in tables, graphs and action plans
- Benchmark projects and the company against a range of data sets.

3. Explore strategies to improve and communicate workforce capabilities, opportunities and accomplishments

As part of Ambition 1.4 (Shift misperceptions of the industry via public engagement and stakeholder communication), we suggest that industry leaders develop ways to celebrate success of companies and individual employees at all levels. This is an excellent way to demonstrate the wide range of jobs and activities that go on in construction and to engage workers so they feel invested in their future. In an increasingly competitive labour market, most companies are keen to boost their attractiveness to new workers, and increase overall competitive advantage. Activities that BCCA and others can consider to help their members improve employee engagement and communication with the public:

- Track and publish safety information
- Evaluate opt-in programs such as the UK's "Considerate Constructors Scheme" for application to BC
- Look for ways to celebrate and promote diversity in the workforce (including at leadership levels)
- At K-12 education events, showcase how emerging technologies being used in construction (e.g., digital technologies such as BIM), as well as the full breadth of innovative career opportunities in construction.

4. Leverage RCAs networks and capabilities to set up best practice clubs

Ambition 3.1 (Help businesses of all sizes to acquire the full spectrum of skills necessary to create and implement innovative ideas successfully) recommends establishing "Best Practice Clubs" to bring the benefits of best practice to a practical, personal and local level. RCAs have strong connections that span the full construction supply chain from suppliers to owners and can bring experts tighter to solve for particular issues, share knowledge and provide solutions. They are also best placed to provide a means for industry members to address issues as they arrive that will improve supply chain performance, provide feedback on product performance and development, service quality, codes and standards, etc.

On the strength of a well-defined definition of innovation, vision and goals, the RCAs can not only provide non-threatening business-to-business opportunities for collaboration on research projects, education and training, etc. but also celebrate innovation success by through their existing events (e.g. the VRCA Leadership Forum) and award programs. The RCAs can gather input from members on knowledge and resource gaps for feedback to the Innovation Council. They can also reach out to established innovation hubs such as Wood First, BCTIA and DIGIBC to explore the potential to leverage existing programming and networks. It may also be worthwhile for RCAs to evaluate what they would need to take on the responsibility for benchmarking, monitoring and reporting industry KPIs in their region.

5. Develop an integrated province-wide innovation network and centre

Ambition 5.1 (Support Research and development networks and centres) pre-supposes that such entities exist. While there are networks and centres for specific facets of the construction industry (such as UBC CIRS for green building and FP Innovations wood technologies) there is no dedicated network or centre for construction as a whole.

There is proposal in early stages of development led by Athabasca University[75] in collaboration with UBC Okanagan, the Edmonton Construction Association and others to establish an Architecture, Engineering and Construction Innovation Network (AECIN). Starting with nodes in Vancouver, Kelowna and Edmonton supported by a comprehensive web platform, AECIN will help the industry research, develop, test and commercialize products and services essential to its future. Each node will leverage its own area of expertise to become a centre of excellence in a specific area of applied R&D with the intention of bridging the gap between the laboratory and the construction site. In addition all nodes will work together to serve the needs of the AEC industry throughout both provinces and coordinate incubator services for entrepreneurs seeking access into the construction industry.

Starting as a distributed and virtual network, AECIN will provide the training and skills development, business and technical support and resources for SMEs to realize the benefits of these new technologies and to compete effectively in a rapidly evolving market. The intent is to create a collaborative technology and innovation network backstopped by a pool of highly qualified personnel, which will transform construction in Alberta and BC and provide a model for the rest of Canada.

Based on initial success, there is the potential to establish a "bricks and mortar" innovation centre following the Construction Scotland model or the London Building Centre[76] as a meeting place for ideas, showcase industry accomplishments and to engage the public (Figure 44).

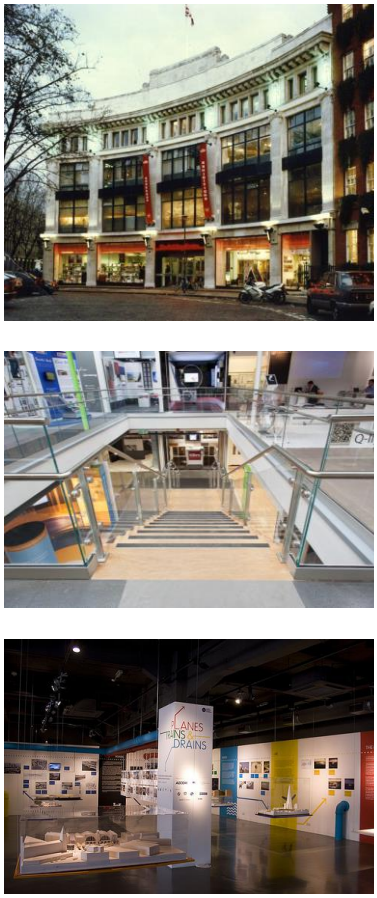


Figure 44 The Building Centre in London, UK

6. Organize field trips

Ambition 5.2 (Showcase demonstration projects) is intended to provide inspiration of what leading edge construction solutions look like. There is no better way to generate excitement than by seeing innovation in action. Because BC is generally ahead of other North American jurisdictions (particularly when it comes to green building and innovative wood construction), these trips may need to go further afield to visit "best of the best" construction sites and completed projects around the world. Trade agencies and consulates frequently organize week long trips, however they can be expensive, as participants need to cover their travel costs. This means that scholarships may need to be established for SMEs as it is particularly important for specialist trade contractors to attend.

7. Develop an education and training strategy oriented around innovation

Several ambitions rely on education and training for workers, management, stakeholders, policy makers or owners. An over-arching education and training strategy is therefore vital. For example, there is no question that ongoing education and training for all levels of the workforce is essential if we are to instil the "culture of learning" necessary for companies to keep up with the pace of change. Beyond the established apprenticeship programs, there are numerous training programs and events happening in BC on an ongoing basis, but they are not coordinated. More importantly, industry leaders need to gain a deeper understanding of the barriers to training and education (particularly for SMEs) and if there are better ways to get information to workers. Indeed, CHBA BC

has been exploring alternative apprenticeship models to better fit with the realities of the home building industry (short project time frames, small crews, etc.) and to stay abreast of performance requirements and consumer demand.[77]

In the UK, it was found that providing enhanced opportunities for collaboration and peer-to-peer learning when and where workers needed to have the knowledge resulted in good attendance. “Twilight” sessions that were short, practical and shared with peers were also successful. RCAs are well positioned to coordinate Best Practice Clubs, which can focus on issues such as procurement, ISO 9001 certification, BIM, airtight construction, etc. as requested by members. The UK Best Practice program has since developed a roster of qualified experts to provide guidance in the field (similar to how WoodWORKS! BC provides expert field support for innovative wood construction in BC already).

In conclusion

Innovation is vital for continued prosperity not only of BC's construction companies but the province as a whole. BC is well positioned to tackle the challenges that lie ahead; however an action plan is needed to coordinate efforts and catalyze innovation. To develop and implement this plan requires an industry-wide commitment and investment, but will yield significant benefits for years to come.

Construction industry members were highly engaged in this study and are vested in its results. It has been impossible to tackle all of the ideas and suggestions we received during this work, and undoubtedly many people will be disappointed if the conversation does not continue.

It is true that the industry is so large and includes so many different types of business that not everyone will be motivated to act from the outset. However this research has shown there is strong interest in exploring how innovation can be harnessed successfully to boost productivity, profitability, reputation and performance among all sizes of company from all corners of the province. There are concerns about how future demands for housing, infrastructure and business are going to be met in the light of rising materials costs, a tightening labour market and the shift to a low carbon economy – especially given that there are systemic problems with the current public procurement process.

This study offers a practical framework for how to think about innovation and points to some of the most important areas to focus on as BC's construction industry catalyzes a culture of innovation. We have laid out an aspirational innovation program for the province that reflects best practices and the strengths and weaknesses of the BC construction industry.

Implementing the agenda laid out in this study will require broad support from government and research organizations, and determination from the construction industry as a whole. By tackling the three priority actions— creating an Innovation Council, developing a formal construction innovation action plan and fixing the procurement process – the industry will send a clear message to stakeholders and the public that they are committed to moving with the times and doing what it takes to attract the next generation of talent.

Appendix A: Research methodology

Why we chose the three strategies as a basis for our project

- UK – the most ambitious, results were the most comprehensive and included funding of £150m.
- Scotland – example of how to build off the UK effort, also led to funding and innovation centre. Industry the same size as BC
- Australia – high level, R&D focused. Did a follow up. Example of how lack of tangible goals did not reap the same degree of investment

The primary research included 16 "thought-leader" interviews, 3 focus groups, and an on-line survey (with 346 total responses). We modelled our survey after the UK Chartered Institute of Building, "Innovation in Construction: Ideas are the currency of the future, Survey 2007"[78] in order to be able to compare data and check for anomalies. The survey ran from July 1st to September 21, 2015. It was promoted via HPO, BCCA social media and the consultants' networks.

Respondents hailed from all corners of the province (only 54 per cent were from the Lower Mainland region), from all sizes of business (67 per cent were from businesses with less than 5 employees), from all levels of seniority (from unskilled labourers to business owners) and from 17 different types consultancies, contracting firms, government agencies, and related business (62 per cent of respondents were general or trade contractors). While the make-up of respondents represented a great deal of diversity, it is important to note that the distribution of survey respondents by business size does not accurately reflect a representative profile of the actual industry. In particular, the views of the "hard to reach" sole proprietors ("non-employers" in StatsCan terminology) who make up the 67 per cent of the total businesses in B.C are under-represented in the survey.

The 16 thought-leader interviewees included:

- **Rob Capar,** President**,** Maison d'Etre Design Build Inc
- **Scott Chatterton,** BIM and quality control manager**,** CEI Architecture **&** Canadian BIM Council
- **Prof. Thomas Froese,** UBC - Civil engineering
- **Tyler Galbraith,** Partner, Jenkins Marzban Logan LLP
- **Stephen Good RIBA,** CEO, Construction Scotland Innovation Centre
- **Jason Glue,** District manager**,** Graham Construction
- **Jarrett Hutchinson,** Building & Safety Standards Branch, Office of Housing and Construction Standards**,** Ministry of Natural Gas Development and Minister Responsible for Housing
- **Geoff McDonell P.Eng LEED AP,** Principal & mechanical engineer**,** Integral Group
- **Sean Pander,** Green Building Manager, Sustainability Group**,** City of Vancouver
- **Mike Pistrin,** Vice president**,** BC Housing
- **Prof. Henry Reiser,** President**,** College of New Caledonia
- **Jennifer Sanguinetti P.Eng LEED AP,** Director, Project Services**,** UBC - Infrastructure Development
- **Don Schouten,** Manager Industry & Labour Services – Construction Workers and Employer Services Division**,** Worksafe BC
- **Tom Sigurdson,** President & CEO**,** British Columbia and Yukon Territory Building and Construction Trades Council
- **Anibal Valente P.Eng,,** Vice president**,** PCL Construction & Chair, Canadian Construction Association
- **Dr. Guido Wimmers Dr. Tech, Dipl. Ing., Arch (NL), MRAIC, LEED AP,** Chair & Associate Professor**,** Master of Engineering, Integrated Wood Design**,** UNBC & co-founder, Canadian Passive House Institute

The three focus groups comprised:

1. **Urban Development Institute, Vancouver (August 7, 2015)**
   - Jeff Fisher, Vice-President and Senior Policy Advisor, Urban Development Institute
   - Diana Delves, President and CEO, Quantum Properties
   - Rob Bortolusi, Operations Manager, Townline Homes
   - Jonathan Meads, Development & Sustainability Manager, Concert Properties
   - David Jacobson, Director of Development, Intracorp
   - Mark Lawton, Principal, Morrison Hershfield
   - Evan Allegretto, Senior Development Manager, WesGroup
   - David Porte, President, Porte Development Corporation, chair Urban Development Institute.

2. **Vancouver Island Construction Association, Victoria (September 11, 2015)**
   - Steve Vanderwal, Ledcor Construction
   - Kyle Hasenkox, Rocky Point Engineering
   - John Knappett, Knappett Projects
   - Keir Lewis, Lewis Sheet Metal Ltd
   - Tom Morin Morinwood Mfg Inc.
   - Warren Perks, BCCA
   - Bruce Johnson, Read Jones Christoffersen
   - Harry Whitfield, Studio 2009 Architecture Ltd.

3. **Vancouver Regional Construction Association, Vancouver (September 24. 2015)**
   - Richard Shipway, Project Director, Ledcor Construction Limited
   - Gerhard Botha, Director of Business Development, Stuart Olson
   - Bryan Wallner, CEO, RCABC
   - Mark Pucsek, Assistant Vice-President, Partnerships BC
   - Stephan Blank, Senior Estimator, Kinetic Construction

We then presented the draft vision, pillars and ambitions as well as the recommendations at the VRCA's tri-council meeting (General Contractors, Trade Contractors and Manufacturers & Suppliers), December 2nd, 2015 for feedback.

Secondary research comprised a comprehensive review of economic, labour market, and industry data; a scan of over 30 best practices from other jurisdictions; and a review of BC's construction innovation capabilities through the assembly of a database of R&D centres, large firms, training programs, investors, incentive programs, policies and regulations, and relevant award programs.

Appendix B: A tale of three strategies

The UK, Scotland and Australia have all developed construction innovation strategies that set goals to strengthen industry leadership, improve the skills and training of their workforces, grow their industries and develop high-performance, smart and sustainable buildings. Overviews of each of the three country's approaches are provided below.

UK Rethinking Construction and Construction 2025 Strategy

In October 1997, the UK government commissioned a Construction Task Force to advise on the opportunities to improve the efficiency and quality of the UK construction industry's service and products and to make the industry more responsive to the needs of its customers. In July 1998 the Task Force published their report, '**Rethinking Construction**'[79], which recommended:

- The establishment of **a forum for improving performance in house building.**
- The implementation of projects which would demonstrate the approach outlined by **a '5-4-7' model for cultural change**, comprising:
    - Five key drivers for change (committed leadership, a focus on the customer, integration of the process and the team around the project, quality-driven agenda and commitment to people)
    - Four key integrated project processes (general product development, specific product application, partnering in the supply-chain, and product components)
    - Seven targets for improvement (10 per cent reduction in capital cost and construction time, 20 per cent reduction in defects and accidents, 10 per cent increase in productivity and profitability, and 20 per cent increase in predictability of project performance).
- The **creation of a knowledge centre** giving the industry and its clients access to information and learning from the demonstration projects;
- A **commitment from government itself to leading public sector bodies toward the goal of becoming best practice clients** seeking improvements in efficiency and quality.

The recommendations of the report have since been more or less entirely implemented by the UK government through a number of "Rethinking Construction" initiatives. These initiatives are now supported entirely by industry and include:

- A **Construction Best Practice Programme** delivered through regional "Rethinking Construction" centers.
- A "**Movement for Innovation**" (m4i)[80] initiative that comprises Demonstration Projects, regional Cluster Groups, Working Groups, Knowledge Exchange and Movement for Innovation Clubs.
- A **Housing Forum** that demonstrates demonstration of best practice and innovation in house building.
- A **Local Government Task Force** that promotes Movement for Innovation principles among local authorities.
- A **Government Construction Client Panel** that ensures that all government clients have the techniques to become and remain best practice construction clients and to obtain value for the tax payer.

Construction 2025 was published in 2013 and builds on the success of the Rethinking Construction strategy. It is a joint initiative of industry and government that sets long-range goals for transforming the construction industry. These goals are predicated on a whole-hearted adoption of sustainability, efficiency and productivity measures. To

achieve these goals requires the British construction industry to fundamentally rethink the way buildings are designed, procured, built and operated, such as by making greater use of efficient processes such as digitization, prefabrication, preassembly, modularization and off-site fabrication.

Construction 2025 was developed in response to a serious multi-dip recession in the construction industry starting with the global economic meltdown in 2008. Concerned that focusing on marginal improvement would leave companies vulnerable and result in a slow recovery, the strategy instead focused on creating "discontinuous growth" to avoid "death by incrementalism". The goals were not regulated in any way but rather were intended to be aspirational and orient both industry and stakeholders (policy makers, R&D and investors) towards technologies and processes that offer the fastest and greatest return on investment. An important offshoot from this effort is the development of sustainable procurement tools such as BES 6001 (see below).

Case study: The UK's BES 6001 Responsible Sourcing of Construction Products supports innovation across the construction supply chain

BES 6001 Standard for the Responsible Sourcing of Construction Products along with an associated independent third-party certification scheme is designed to:

1. Help construction companies manage and reduce the impacts throughout the construction supply chain
2. Provide manufacturers with a means by which their products can be independently assessed and certified as being responsibly sourced
3. Offer designers and builders a holistic approach to managing a product from the point at which component materials are mined or harvested, through manufacture and processing.

The purpose is to support the implementation of sustainable procurement and purchasing policies by European governments and building owners with a means to frame potentially complex information about construction products consistently. This in turn helps the construction industry to focus its R&D efforts and compete on a level playing field.

Sustainable procurement and purchasing policies encourage construction companies to not only take into account the economic value (price, quality, availability and functionality) but also the related environmental and social impacts of the goods and services they buy. Public authorities can thereby provide industry with real incentives for developing and adopting new and sustainable technologies and products. This is happening in many European countries and increasingly stringent codes and standards in BC are starting to have a similar effect.

www.bre.co.uk/page.jsp?id=1514

Construction 2025 presents five visions, three strategic priorities, six drivers of change and ten commitments, as summarized below.

Five Visions for 2025				
1. PEOPLE	**2. SMART**	**3. SUSTAINABLE**	**4. GROWTH**	**5. LEADERSHIP**
An industry that attracts	A UK industry that	An industry that has	An industry that drives	An industry with

and retains a diverse group of multi-talented people, operating under considerably safer and healthier conditions, that has become a sector of choice for young people inspiring them into rewarding professional and vocational careers	leads the world in research and innovation, transformed by digital design, advanced materials and new technologies, fully embracing the transition to a digital economy and the rise of smart construction	become dramatically more sustainable through its efficient approach to delivering low carbon assets more quickly and at a lower cost, underpinned by strong, integrated supply chains and productive long term relationships	and sustains growth across the entire economy by designing, manufacturing, building and maintaining assets which deliver genuine whole life value for customers in expanding markets both at home and abroad	clear leadership from a Construction Leadership Council that reflects a strong and enduring partnership between industry and Government

Three Strategic Priorities and Related Commitments

1. Smart construction and digital design	2. Low carbon and sustainable construction	3. Improved trade performance
Commitment #1: Build the UK's competitive advantage in smart construction and digital design through the Digital Built Britain agenda	*Commitment #2: Develop market and technology based plans to secure the jobs and growth opportunities from driving carbon out of the built environment, led by the Green Construction Board.*	*Commitment #3: Identify global trade opportunities for UK professional services, contracting and product manufacturing, develop partnerships and promote UK construction through the GREAT brand*

Six Drivers of Change and Related Commitments

1. Improved image of the industry	*Commitment #4: Improve the image of the industry by inspiring young people and through a coordinated approach to health and safety and improving performance in the domestic repair and maintenance market*
2. Increased capability in the workforce	*Commitment #5: Engage with bodies across the industry to ensure that capability and capacity issues in construction are addressed in a strategic manner*
3. A clear view of future work opportunities	*Commitment #6: Develop and refine the pipeline of future work opportunities and make it more useable for all construction businesses*
4. Improvement in client capability and procurement	*Commitment #7: Drive procurement efficiency and explore options for further efficiency gains in the procurement process, led by the Government Construction Board and the IUK Client Group*
5. A strong and resilient supply chain	*Commitment #8: Create conditions for construction supply chains to thrive by addressing access to finance and payment practices.*
6. Effective research and innovation	*Commitment #9: Work with academic and research communities to bring forward more research, development and demonstration to the wider industry and work to remove barriers to innovation*

Leadership

Commitment #10: Lead the transformation of the industry through the new Construction Leadership Council, with actions owned and delivered by industry bodies

Joint Government-Industry Targets

- ***Lower costs: 33% reduction in initial cost of construction and whole life cost of built assets***
- ***Faster delivery: 50% reduction in overall time, from inception to completion, for new build and refurbished assets***
- ***Lower emissions: 50% reduction in GHG in the build environment***
- ***Improvement in exports: 50% reduction in the trade gap between total exports and total imports for construction products and materials***

Case study: Centre for Construction Innovation North West

The UK Centre for Construction Innovation North West provides assistance to construction companies in the areas of business performance (mostly) and innovation. It organizes seminars, workshops and conferences and showcases of technologically new products and processes (e.g. conversion of waste paper products into building materials/components). Its network comprises over 600 companies, advocacy organization such the Construction Best Practice Programme (CBPP), Movement for Innovation (m4i), training boards and research centres.

In conjunction with the North West Construction Forum, CCINW delivers a series of "twilight" seminars and workshops on issues relating to the Rethinking Construction and Accelerating Change agendas in the North West. For example, they have held seminars and workshops on topics such as Developing an Integrated Supply Chain - how you can start to build effective supply chain relationships to rapidly gain a competitive advantage – Integrating Facility Management into Design, and a CCI Debate "PFI: Boom or Bust?"

CCINW has been able to complete a full Benchmark Index for SMEs free of charge as part of a "DTI-PII" funded "Business Improvement through Benchmark Index" programme. Benchmarking is about comparing and measuring your performance against others in key business activities, and then using the lessons learned from the best to make targeted improvements. To stay competitive, leading organizations regularly benchmark their own products, services and business processes against the best from within or outside their industry - seeking to unearth and implement best practice from whatever source. The Benchmark Index is a tool that has been developed and supported by the DTI and delivered by the Small Business Service. It is a simple computer based system that, through a series of questions, allows companies to measure their performance against others in about 80 aspects of finance, management and business excellence.

CCI received EU funding to deliver a free programme of Workforce Development which aims to increase the number of construction managers and supervisors who will understand the larger national "Rethinking Construction" innovation agenda and be able to apply the ethos to improve their own performance and that of their company. The programme involves a number of workshops on the following topics:

- Benchmarking in Construction and the Benchmark Index
- The Effective Use of Information & Communication Technology in Construction
- An Introduction to "Rethinking Construction
- An Introduction to "Respect for People'
- Profiting from Sustainability"
- "Supervisory & Management Skills Development for the Construction Industry"

The workshops will give individuals and companies the opportunity to gain an understanding of the larger national Rethinking Construction agenda and offer them the opportunity to take what they have learned back into the workforce - enabling the construction industry in the North West to become more competitive and self-sustainable. The programme also allows people and companies to gain qualifications in topics such as company performance benchmarking, supervisory skills, etc. The organization has also received funding to explore use of robotics [technological process innovation / improved safety].

www.ccinw.com

Implementation

On the strength of the Construction 2025 Strategy and Action Plan, the UK government announced a £150m investment[81] in September 2013 over the next five years to help reduce construction times, improve quality and make buildings more efficient. £60 million is being invested through the UK's Technology Strategy Board (now known as Innovate UK[82]) to support the UK construction industry in designing and developing more energy efficient buildings. The projects are expected to leverage in an additional £60 million of industry investment and £30 million extra funding from across government and other agencies.

So far, Innovate UK has invested >£31.5m in 378 projects through the Low Impact Buildings Innovation Platform.[83] In addition the it has has funded projects on Smart Meters smart homes, Ultra Efficient Lighting, High value manufacturing and advanced materials on low impact buildings topic.

Already, the UK government has developed a Building Information Management Strategy[84] on the grounds that construction 2025 identified "BIM as the first truly global digital construction technology which will soon be deployed in every country in the world. It is a 'game changer' and we need to recognize that it is here to stay." The strategy has led to public and private investment in a connected digital economy "catapult", and in a future cities "catapult", together with £25 million to create a future cities demonstrator which was awarded to the city of Glasgow[85] leading to important urban revitalization and new jobs.

Building for the Future: The Scottish Construction Industry's Strategy (2013-16)

Published in 2012, Building for the Future is Construction Scotland's response to the UK Construction 2025 strategy. It is an industry-led initiative that presents a three-year vision and set of targets for Scotland's construction industry. The strategy's success depends on buy-in from businesses throughout Scotland, but also on strong political and financial support from the Scottish Government and its agencies. The strategy demonstrates that the industry recognizes the need for change, and that it is committed to achieving growth, making its full contribution to the Scottish Government's Economic and Low Carbon Economic strategies.

Building for the Future presents four areas of focus, eighteen areas of action and a number of targets, as summarized in the table below.

Area of Focus	Priority Actions
1. Developing a safer, successful and forward looking construction industry	1. Working with others to develop and promote innovative construction financing methods 2. Working with the public sector to simplify procurement processes, and enable more small and medium sized businesses to compete for public contracts 3. Increasing the number of successfully completed apprenticeships, ensuring that qualifications and training meet the industry's current and future requirements 4. Working with others to ensure the development of world-class leadership and management capability in the industry 5. Working with Scottish Development International (SDI) and others to develop new export markets, focusing on sustainable construction processes and products
2. Driving innovation and productivity across the industry	6. Working with the industry to establish accurate data on current levels of innovation and the setting of clear targets for innovation in the industry over 2013-2016 7. Building stronger engagement with colleges and universities to facilitate increased knowledge transfer and learning into the industry 8. Encouraging businesses to collaborate, particularly focusing on joint approaches to innovation, efficiency and tendering for larger projects

Area of Focus	Priority Actions
3. Working in partnership to deliver a Low Carbon Built Environment	9. Working with government and others to demonstrate and educate customers on the benefits of sustainable construction - potential resource efficiencies and energy savings 10. Informing businesses about the opportunities in this area 11. Further developing the skills, capability , products and solutions within the Scottish business base and supply chain to serve these markets 12. Focusing on retrofit solutions (not simply products), particularly in housing stock 13. Continuing to work with colleges and universities to advance research and development in this area
4. Establishing a cohesive voice for the industry	14. Proactively engaging with the Scottish Government, local authorities, hubco's and utilities to champion the priorities of the industry 15. Engaging in key policy and legislative developments which affect and impact on the industry 16. Forging strategic links and working collaboratively with other key sectors of the economy such as Energy and Tourism to understand and deliver the infrastructure required to enable them to grow - thus ensuring as much of this work as possible is retained in Scotland 17. Promoting and celebrating the successes of the Scottish construction industry, to help attract talent and investment into the industry 18. Promoting innovation, collaboration and the sharing of best practice across the industry to allow businesses to improve their competitiveness.

2016 Targets

- **GVA (Gross Value Added)**: Increase GVA by 10% to £9.62bn
- **Innovation**: Achieve a 5% increase in reported innovation activity
- **Productivity**: Increase productivity by 10%
- **Efficiency**: 42% of industry waste to be recycled
- **Exports**: Increase exports activity by 10%
- **Skills**: Maintain Modern Apprenticeships completion levels
- **Leadership**: Increase leadership and management development activity in the industry, focusing on the future leaders of the industry

Implementation

In 2014, Construction Scotland launched the Construction Scotland Innovation Centre[86], a 'one-stop shop' for accessing a team of experts and public support. This industry-led team links together businesses, university experts and public sector providers including Scottish Enterprise and Scottish Development International to deliver transformational change in construction. The Centre is one of eight industry led and demand driven Innovation Centres supported by Scottish Funding Council, Scottish Enterprise, Highlands & Islands Enterprise and 12 Scottish university partners. The Centre's vision is to "*To create a networked community of industry, academic and public sector talent, channelled towards providing necessary, effective and appropriate innovation support to industry in order to deliver a paradigm shift in the sector's approach to innovation and drive transformational change within the industry*."

The Centre has pulled together technical advisory groups around five themes—Advanced Construction, Design & Performance, Energy & ICT, Environment and Infrastructure—and helps businesses to develop and implement their innovation ideas through access to expertise, prototyping and testing facilities, funding, and training, education and networking.

Australia Construction 2020 and Construction 2030

"Construction 2020: A Vision for Australia's Property and Construction Industry"[87] presents a set of future directions for Australia's construction industry, outlines the barriers to achieving them and identifies the research and education activities needed to support them. It was published in 2004 by the Cooperative Research Centre for Construction Innovation to present a vision for the industry and a roadmap for "*leading the transformation of the Australian property and construction industry to a new era of applied research and innovation.*"

Construction 2020 identifies nine visions for the future (Figure 45); for each vision it presents a rationale, summary of the current state and an overview of the education and R&D pathways required to achieve the vision. It also identifies barriers and potential measures for assessing progress.

The strategy was further refined in 2012 with the report "Construction 2030: A Roadmap for R&D Priorities for Australia's Built Environment"[88] produced by the Sustainable Built Environment National Research Centre (SBEnrc)[89]. The SBEnrc is the successor to Australia's CRC for Construction Innovation and is a key research broker between industry, government and research organizations servicing the built environment.

The 2030 report provides an industry R&D roadmap establishing priorities that respond to likely industry futures. It identifies six R&D priorities:

1. Model-based facility lifecycle business models
2. Intelligent infrastructure and buildings
3. Solutions for a more sustainable built environment
4. Information and communications technology (ICT) for radical redesign
5. Biotechnology for tree-based materials
6. Educational curricula

1. Environmentally sustainable construction	For industry to design, construct and maintain its buildings and infrastructure to minimise negative impacts on the natural environment, thereby preserving environmental choices for future generations.
2. Meeting client needs	For the design, construction, and operation of facilities to better reflect the present and future needs of the project initiator, owners/tenants, and aspirations of stakeholders.
3. Improved business environment	For a regulatory, financial and procurement framework which encourages longer-term thinking and returns, a sharing of ideas and innovation between stakeholders, and a fair distribution of risk and returns.
4. Welfare and improvement of the labour force	For the industry workforce to be computer-literate and highly skilled, showing mutual respect for each other through management and workers acting collaboratively, with improved health and safety conditions on-site.
5. Information and communication technologies for construction	For communication and data transfer to be seamless and include mobile devices providing a commercially secure environment.
6. Virtual prototyping for design, manufacture and operation	For the opportunity to try before you buy — from inception to design, construction, demolition and rebuild.
7. Off-site manufacture	For a majority of construction products to be manufactured off-site and brought to the site for assembly.
8. Improved process of manufacture of constructed products	For developing new production processes, allowing the industry to work more efficiently.
9. Australian Leadership in research and innovation	For the industry to be taking more responsibility for leading and investing in research and innovation.

Figure 45 Nine "visions" for construction innovation in Australia

Implementation

Australia's Construction 2020 and 2030 are not as comprehensive or specific as the UK and Scotland Strategies, and they do not include a set of concrete commitments or an action plan. Their focus is primarily on outlining future directions for education and R&D, and providing baseline information to inform research activities. The vision statements are very qualitative in nature and avoid setting quantifiable metrics for performance benchmarking and tracking. It is interesting to note that in the time between the first and second research projects, investment in construction related R&D rose significantly.

One output of this work was the establishment of the Sustainable Built Environment National Research Centre (SBEnrc) in 2010 as the successor to the CRC for Construction Innovation. The SBEnrc is a key research broker between industry, government and research organisations servicing the built environment industry. The Centre's research focuses on environmental, social and economic sustainability, areas identified by national industry stakeholders as the key areas that will drive productivity and industry development in the built environment industry. SBEnrc's three research streams are:

- Greening the built environment
- People, processes and procurement
- Productivity through innovation

The initiatives implemented by the SBEnrc and CRC for Construction Innovation include:

- Creation of BIM National Guidelines and a National Portal[90].
- Creation of the Australian Sustainable Built Environment Council (ASBEC)[91].
- Creation of www.YourBuilding.org a portal to the best advice on greening the performance of commercial property.

Summary and Comparison

The three strategies share many of the same goals and actions. The table below presents an integrated framework organized around the UK's five themes—People, Smart, Sustainable, Growth, Leadership— that includes all three plans' goals, commitments and targets.

THEME AND GOALS	COMMITMENTS AND TARGETS
PEOPLE: Attracting and retaining a talented and diverse workforce A. Improved image of the industry B. Increased capability in the workforce (computer-literate and highly skilled) C. Improved health and safety conditions on-site	1) Improve the image of the industry by inspiring young people and through a coordinated approach to health and safety and improving performance in the domestic repair and maintenance market 2) Engage with bodies across the industry to ensure that capability and capacity issues in construction are addressed in a strategic manner 3) Increasing the number of successfully completed apprenticeships, ensuring that qualifications and training meet the industry's current and future requirements 4) Work with others to ensure the development of world-class leadership and management capability in the industry 5) Management and workers act collaboratively to deliver improved health and safety conditions on-site **TARGETS** • None identified

THEME AND GOALS	COMMITMENTS AND TARGETS
SMART: Industry is efficient and technologically advanced D. Invest in smart construction and digital design (e.g. BIM) E. Effective research and innovation F. Drive innovation and productivity across the industry G. Information and communication technologies for construction H. Virtual prototyping for design, manufacture and operation I. Increase offsite manufacture J. Improved process of manufacture of constructed products	6) Build competitive advantage in smart construction and digital design through a digital and BIM agenda 7) Work with academic and research communities to bring forward more research, development and demonstration to the wider industry and work to remove barriers to innovation 8) Work with the industry to establish accurate data on current levels of innovation and the set clear targets for innovation in the industry 9) Build stronger engagement with colleges and universities to facilitate increased knowledge transfer and learning into the industry 10) Encourage businesses to collaborate, particularly focusing on joint approaches to innovation, efficiency and tendering for larger projects 11) Work with industry to make communication and data transfer seamless and include mobile devices providing a commercially secure environment 12) Work with industry to create opportunities to try before you buy — from inception to design, construction, demolition and rebuild. 13) Work towards having a majority of construction products manufactured off-site and brought to the site for assembly 14) Support the development of new production processes, allowing the industry to work more efficiently **TARGETS** • Faster delivery: 50% reduction in overall time, from inception to completion, for new-build and refurbished assets • Lower costs: 33% reduction in initial cost of construction and whole life cost of built assets • Innovation: Achieve a 5% increase in reported innovation activity • Productivity: Increase productivity by 10%
SUSTAINABLE: Industry leads the world in low-carbon and green construction K. Low carbon and sustainable construction L. Work in partnership to deliver a Low Carbon Built Environment	15) Develop market and technology based plans to secure the jobs and growth opportunities from driving carbon out of the built environment 16) Working with government and others to demonstrate and educate customers on the benefits of sustainable construction - potential resource efficiencies and energy savings 17) Work with industry to design, construct and maintain its buildings and infrastructure to minimise negative impacts on the natural environment, thereby preserving environmental choices for future generations 18) Inform businesses about the opportunities in this area 19) Further develop the skills, capability, products and solutions within the business base and supply chain to serve these markets 20) Raise the profile of retrofit solutions (not simply products), particularly in housing stock 21) Work with colleges and universities to advance research and development in this area 22) Invest in biotechnology for tree-based materials **TARGETS** • Lower emissions: 50% reduction in GHG in the build environment • Efficiency: 42% of industry waste to be recycled
GROWTH: An industry that drives growth across the entire economy M. Develop a clear view of future work opportunities N. Improve client capability and procurement O. A strong and resilient supply chain P. Improved business environment	23) Identify global trade opportunities for professional services, contracting and product manufacturing, develop partnerships and promote the construction industry 24) Develop and refine the pipeline of future work opportunities and make it more useable for all construction businesses 25) Drive procurement efficiency and explore options for further efficiency gains in the procurement process 26) Working with others to develop and promote innovative construction financing methods 27) Working with the public sector to simplify procurement processes, and enable more small and medium sized businesses to compete for public contracts 28) Create conditions for construction supply chains to thrive by addressing access to

THEME AND GOALS	COMMITMENTS AND TARGETS
	finance and payment practices. 29) Work to develop new export markets, focusing on sustainable construction processes and products 30) Work to better align the design, construction, and operation of facilities with the present and future needs of the project initiator, owners/tenants, and aspirations of stakeholders. 31) Advocate for a regulatory, financial and procurement framework which encourages longer-term thinking and returns, a sharing of ideas and innovation between stakeholders, and a fair distribution of risk and returns 32) Promote and celebrate the successes of the construction industry, to help attract talent and investment into the industry **TARGETS** • Improvement in exports: 50% reduction in the trade gap between total exports and total imports for construction products and materials • GVA (Gross Value Added): Increase GVA by 10%
LEADERSHIP: An industry with clear leadership Q. Establish a cohesive voice for the industry R. Industry takes responsibility for leading and investing in research and innovation	33) Lead the transformation of the industry through a Construction Leadership Council, with actions owned and delivered by industry bodies 34) Proactively engage with the government, local authorities, hubco's and utilities to champion the priorities of the industry 35) Engage in key policy and legislative developments which affect and impact on the industry 36) Forge strategic links and work collaboratively with other key sectors of the economy such as Energy and Tourism to understand and deliver the infrastructure required to enable them to grow - thus ensuring as much of this work as possible is retained locally 37) Promote innovation, collaboration and the sharing of best practice across the industry to allow businesses to improve their competitiveness. **TARGETS** • None identified

Appendix C: Resources

A selection of innovation funding programs and investors

BC Hydro new construction program	www.bchydro.com/powersmart/business/programs/new-construction
BC Innovation Council	www.bcic.ca
Build in Canada Innovation Program	https://buyandsell.gc.ca/initiatives-and-programs/build-in-canada-innovation-program-bcip
Business Development Bank of Canada	www.bdc.ca
Canada Foundation for Innovation	www.innovation.ca
City of Vancouver Green & Digital Demonstration Program	www.vancouvereconomic.com/gddp
MITACS	www.mitacs.ca
Natural Sciences and Engineering Research Council of Canada (NSERC)	www.nserc-crsng.gc.ca
NRC Industrial Research Assistance Program (IRAP)	www.nrc-cnrc.gc.ca/eng/irap/index
Renewal Funds	http://renewalfunds.com
Scientific Research & Experimental Development Tax Credit BC	www2.gov.bc.ca/gov/content/taxes/income-taxes/corporate/credits/scientific-research-development
Sustainable Development Technology Canada	www.sdtc.ca
Western Innovation (WINN) Initiative	www.wd-deo.gc.ca/eng/14857
Wood First	www.bcfii.ca

A selection of innovation awards and recognition programs

BCRMCA Safety Awards	www.bcrmca.ca/right-col-icons/safety/safety
BOMA Awards of Excellence	www.boma.bc.ca/events-sponsorship/awards
BuiltGreen	www.builtgreencanada.ca
CCA National Awards Program	http://awards.cca-acc.com/#awards-list-excellence
CHBA Georgie Awards	www.georgieawards.ca
City of Vancouver Urban Design Awards	http://vancouver.ca/home-property-development/urban-design-awards.aspx
Greenroads Rating System	www.greenroads.org
Lafarge-Holcim Award for Sustainable Construction	www.lafargeholcim-foundation.org/Awards
LEED	www.cagbc.org
Living Building Challenge	http://living-future.org/lbc
Passive House Certification Standard	www.passivehouse.ca
Regional Construction Association Awards of Excellence (VRCA, SICA, etc)	www.vrca.bc.ca, www.sica.bc.ca, www.vica.bc.ca, www.bccanorth.ca
SAB Magazine Green Building Design Awards	www.sabmagazine.com/blog/tag/canadian-green-building-awards
WoodWORKS! Wood Design Awards	http://wood-works.ca

A selection of best practice education and training programs and courses

Sustainable Construction Management Technology **(Okanagan College)**	www.okanagan.bc.ca/Programs
5 Day Passive House Trades Course **(CANPHI & BCIT)**	http://canphi.ca/event/passive-house-trades
The City Program **(SFU)**	www.sfu.ca/city
Master of Engineering in Integrated Wood Design **(UNBC)**	www.unbc.ca/engineering-graduate-program
International Wood Symposia **(WoodWORKS! BC)**	http://wood-works.ca/bc/educational-events/symposiums
Autodesk Revit - BIM training for architects,	www.bcit.ca/study/courses

builders and MEP **(BCIT)**	
Construction Industry Institute Best Practices **(The University of Texas at Austin)**	www.construction-institute.org
The Lean Construction Institute **(online)**	www.leanconstruction.org
Certificate in Business Innovation **(The University of Toronto School of Continuing Studies and the Canadian Innovation Centre)**	http://innovationcentre.ca

A selection of technology hubs and R&D centres

Athabasca University RAIC Centre for Architecture	http://architecture.athabascau.ca
BCIT Building Science Centre of Excellence	http://commons.bcit.ca/bsce
BCIT Centre for Architectural Ecology	http://commons.bcit.ca/greenroof
BC Technology Industries Association (BCTIA)	www.bctia.org
CCInnovations	www.ccinnovations.ca
Construction Engineering & Management Group, University New Brunswick	www.unb.ca/fredericton/engineering/grad/civil/fields/consengmangement.html
Construction Industry Institute, The University of Texas at Austin	www.construction-institute.org
DigiBC	www.digibc.org
FP Innovations	https://fpinnovations.ca
National Research Council (Construction)	www.nrc-cnrc.gc.ca/eng/rd/construction
Simon Fraser University (4D Labs, Centre for Sustainable Community Development)	www.sfu.ca www.4dlabs.ca www.sfu.ca/cscd
Tall Wood and Hybrid Structures Engineering Research Chair, UNBC Wood Innovation & Design Centre	www.unbc.ca/engineering-graduate-program/construction-wood-innovation-design-centre
UBC Centre For Interactive Research on Sustainability	http://cirs.ubc.ca
UBC Civil Engineering (Materials, Project & Construction Management, Structural & Seismic)	www.civil.ubc.ca/research/research-areas

A selection of trade and export agencies

Asia-Pacific Economic Cooperation (APEC)	www.apec.org
BC Asia Pacific Business Centre	www.britishcolumbia.ca
BC Wood	www.bcwood.com/programs-services/global-buyers-mission
Canada China Business Council	www.ccbc.com/about/council-overview/
Canadian Construction Export Group	www.canadianconstructionexport.ca
Export Development Canada (EDC)	www.cca-acc.com/ei/cm.esp?id=28&start=eiscript&cd=32130&pageid=MAIN
Forestry Innovation Investment Ltd	www.bcfii.ca/bc-forest-sector/key-markets
The Canadian Trade Commissioner Service	www.tradecommissioner.gc.ca
Vancouver Economic Commission	www.vancouvereconomic.com/focus/asia-pacific

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