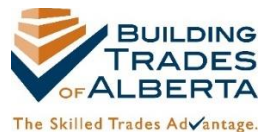


# Upskilling Alberta's Construction Workforce: A Response to Changing Technology



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<b>Executive Summary</b>	2
Barriers	3
Recommendations	3
<b>Introduction</b>	10
Why Do We Need This Strategy?	10
Approach	11
<b>Current State of the Construction Industry</b>	11
Industry Overview	11
Innovation in Construction	12
Benefits of Innovation	12
<b>Evolving Skills Requirements</b>	13
Advanced Manufacturing Techniques	13
Smart Equipment	14
Digital Solutions	15
Innovative Processes	16
Sustainable Construction	18
<b>Barriers to Skill Adoption</b>	18
Lack of Skilled Labour	18
Industry Fragmentation	19
Lack of Collaboration and Knowledge Exchange	20
Project Based Nature of Construction	20
Skills Training System	21
Industry Awareness and Investment	22
<b>Recommendations</b>	23
Recommendation 1: Focus on Improving Awareness	23
Recommendation 2: Government Support for Innovation	24
Recommendation 3: Reform the Training System	26
Recommendation 4 - Continue the Discussion	27
<b>Conclusion</b>	28
<b>Bibliography</b>	29
<b>Appendices</b>	31
Appendix A	31
Appendix B	31

# Executive Summary

The construction industry makes up a significant portion of Alberta’s economy and is a major employer. Rapid innovation in the sector promises productivity gains and economic growth, but also shifts the skill sets that will be needed in the future. Alberta’s construction industry risks being left behind and outcompeted in an increasingly challenging marketplace if efforts are not made to identify and overcome barriers to adopting emerging technologies.

Through an extensive literature review and interviews with industry experts, this strategy seeks to understand what emerging skill sets will be needed by the industry in the future, identify what barriers exist to driving adoption of those skills, and present recommendations to help overcome those barriers.

Emerging technologies requiring new skill sets identified can be categorized as follows:

Category	Technologies
Advanced Manufacturing Techniques	<ul style="list-style-type: none"> <li>● Prefabrication</li> <li>● Modularization</li> <li>● 3D printing</li> </ul>
Smart Equipment	<ul style="list-style-type: none"> <li>● Autonomous equipment</li> <li>● Drones</li> <li>● Wearable exoskeletons</li> </ul>
Digital Solutions	<ul style="list-style-type: none"> <li>● Building Information Modelling (BIM)</li> <li>● Data analysis</li> <li>● Machine learning</li> <li>● Cyber security</li> </ul>
Innovative Processes	<ul style="list-style-type: none"> <li>● Lean construction</li> <li>● Collaborative delivery models</li> </ul>
Sustainable Construction	<ul style="list-style-type: none"> <li>● Low carbon buildings</li> </ul>

## Barriers

A number of systemic barriers that prevent industry adoption of these new technologies were identified:

### **Lack of Skilled Labour**

Between new entrants and replacing retiring workers, Alberta is expected to need approximately 60,000 new workers by 2028. As the number of apprentices has declined, the industry will need to improve the negative public image of construction as a career and appeal to a more diverse base of talent.

### **Industry Fragmentation**

The construction industry in Alberta is fragmented, by sector, role, and size. Most firms are small and lack the resources to pursue innovation.

### **Lack of Collaboration and Knowledge Exchange**

The nature of traditional construction contracts hinders the spread of innovation through the construction ecosystem. Avenues for collaborative knowledge exchange are limited.

### **Project Based Nature of Construction**

The unique nature of most construction projects limits the transfer of innovative solutions, as every site and project team tends to be different. The high degree of worker movement between employers and projects, coupled with the lack of a system to demonstrate upskilling to employers exacerbates this.

### **Skills Training System**

Most skills training in construction is on-the-job. Many tradespeople receive limited formal training, and there are barriers to upskilling the journeypeople who mentor apprentices. Due to the slow pace of apprenticeship curriculum updates, apprentices may not have studied the current skill sets they need while in school.

# Recommendations

Industry interviews confirmed that the level of awareness and adoption of emerging technologies is in general very low. To overcome the barriers identified, a number of recommendations are made:

## **Recommendation 1: Focus on Improving Awareness**

### 1.1 Initiate industry dialog with owners

As confirmed by industry interviews, awareness of many emerging technologies remain low, both among construction firms and owners. Further industry/owner dialogue around desired project outcomes, potential roles of innovation in improving outcomes, barriers to introducing innovation, and measures to reduce such barriers need to take place to change the fundamental incentives that drive adoption of new technologies. Owners are not necessarily interested in learning about individual emerging technologies, but greater efforts are required to demonstrate the long-term value of innovation, and how emerging technologies can reduce costs through clash detection, improved safety, and other benefits.

#### **Action Items:**

- A. Present findings to Industry Liaison Committee – Alberta Infrastructure/CEA/CAA/ACA.
- B. Encourage Alberta Infrastructure to procure several demonstration projects where successful project team must demonstrate demonstrable improvements in key outcomes determined by Alberta Infrastructure (eg. safety, productivity).
- C. Give presentations on technological opportunities (equipment, material and training) to owners at provincial conferences - i.e. RMA, AUMA and Transportation Connects Alberta (CEA Conference).
- D. New models need to be developed that allow for a 'shared risk' approach with governments of all levels; in today's environment builders / owners take all risks and incur additional costs in trialing new technologies.

### 1.2 Foster additional communities of practice

Creating avenues for industry collaboration are essential to spreading awareness. Communities of practice enable users to come together to discuss the benefits and limitations of innovative solutions. Communities of practice exist for BIM and Lean Construction in both Edmonton and Calgary, but opportunities are limited elsewhere. Communities of practice should be established in smaller centres, where awareness and adoption of BIM and Lean tend to be lower, and in larger centres for technologies such as drones and exoskeletons that are still emerging.

### **Action Items:**

- A. Associations engage in dialogue with existing COPs for their advice on extending existing COPs to other locations.
- B. Industry support partnerships with post-secondaries similar to ACA support for NAIT's innovation application. Goal is to lever additional resources. Support conditional on promoting COP for specific technologies across Alberta.
- C. Pick two areas in the province (outside of Edmonton and Calgary) to establish committees/ communities of support.

### **Recommendation 2: Government Support for Innovation**

#### 2.1 Consider requiring BIM on public projects

Government can spur adoption of emerging technologies by adapting procurement to “break the inertia that slows the construction industry from entering a digital era”. “Procurement policy can drive local economic activity, investment, job opportunities, while creating demand for innovative solutions to meet future needs”.

There is strong support demonstrated through industry interviews and the 2nd Annual BIM Report for a government mandate on BIM usage on public projects to drive adoption. As a major owner, government can provide the incentive to invest in BIM while delivering cost savings on public infrastructure through gains in efficiencies “attributable to high-quality, streamlined information flows that result in fewer errors and support global optimization of asset life cycle practices”.

Many other jurisdictions have adopted BIM mandates such as the United Kingdom, Finland, Denmark, Norway, France, Germany, and Russia. In fact, Canada remains the only G7 nation without a BIM national strategy.

### **Action Items:**

- A. Encourage Alberta Infrastructure to procure several demonstration projects to deliver level 400 BIM model. School projects may provide an excellent opportunity, as they would be spread around the province and provides many firms the opportunity to participate and learn.
- B. Educate government on the benefits of BIM usage (i.e. create white paper or present at local conferences), with focus on RMA and AUMA - Ministers are more likely to attend these types of events compared to industry conferences.

## 2.2 Support collaborative delivery methods on public projects

Government should consider using public procurement to support the use of more collaborative project delivery methods. Public sector contracts have increasingly forced contractors to assume a level of risk that is unsustainable at current price levels. Though there is a need to ensure transparency and impartiality in public projects, some jurisdictions such as Colorado have successfully implemented collaborative delivery models in public procurement. Collaborative delivery increases quality, communication, and change performance and more equitably share risk.

### **Action Items:**

- A. Create a word box / list of keywords to help guide conversations between industry and local MLAs.
- B. Encourage GOA to fund “lessons learned best practices” review of the IPD projects of Red Deer and Edmonton Public Schools and share the findings with industry and public owners.
- C. Information related to public projects (design, schedule, specifications, delivery model – performance against budget and schedule) should be shared to provide performance data on whether collaborative approaches bring value.

## **Recommendation 3: Reform the Training System**

### 3.1 Explore incentivizing upgrading for journeypeople

Journeypeople are an essential component of the apprenticeship training system. Journeypeople act as mentors and conduct the on-the-job training that makes up the majority of the education that tradespeople receive. But as there is no mandatory requirement for journeypeople to upgrade their skills, they may be unable to train apprentices in emerging skill sets.

However, expert interviews noted that there is a complex set of factors that de-incentivize journeypeople and their employers from seeking out additional training, including the necessity to keep skilled workers on the jobsite, the unwillingness of journeypeople to lose income while in training, and the lack of a clear way to demonstrate new credentials to employers.

Stakeholders, including employers, governments, and tradespeople need to find innovative ways to overcome these barriers and incentivize upskilling after apprenticeship.

### **Action Items:**

- A. Urge PACs to produce timely biannual updates of new skill requirements and mandate Journeypeople to take short microcourses to maintain currency. Journeypeople should be given opportunity to demonstrate competency. Explore with the Government of Alberta and Federal Government the potential for cost sharing the same as Canada Job Grant, 2/3 government, 1/3 employer.
- B. Expand compliance mandate of Apprenticeship and Industry Training to monitor compliance of A.

### 3.2 Provincial Advisory Committees

Local Apprenticeship Committees (LACs) and Provincial Apprenticeship Committees (PACs) form a vital link between industry and Alberta's apprentice training system. However, industry members with experience with emerging technologies are not always represented on these committees.

The Desired Competencies of the nomination criteria for LACs and PACs should be updated to prioritize recent field experience to ensure that the committees are knowledgeable about recent innovations in the sector.

#### **Action Items:**

- A. Work to ensure PAC and LAC nomination criteria favour recruitment of field level personnel.
- B. Apprenticeship and Industry Training to coordinate with industry associations / unions to ensure regular ongoing dialogue with cross-section of grassroots industry about hanging technologies / skill sets.
- C. Mandate accelerated review of curriculum from current average 7 year cycle to 2-3 years.

### 3.3 Embrace competency-based, supplementary education for journeypersons

Supplementary education based on verifiable competencies will allow workers to learn additional skills they require, minimizing costs and time away from the jobsite.

However, it should be emphasized this is not a replacement of the traditional apprenticeship training system.

The value of a journeyperson's credential is enhanced by the understanding they have the necessary skills and knowledge to perform in their trade in most any circumstance, and broad-based experience in their trade facilitates labour mobility and worker retention.



Supplementary education should be understood as a mechanism to facilitate further training for journeypeople, not replace it, allowing them to obtain credentials that demonstrate competency in new skills.

## **Recommendation 4 - Continue the Discussion**

### 4.1 Disseminate this strategy to industry

Though the partners on this project's steering committee broadly represent the construction industry, it is important that each partner share this strategy with their networks to raise awareness and gather a diversity of feedback. This strategy is intended as a starting point for discussion.

#### **Action Items**

- A. Present strategy to Trades Caucus of the Alberta Government.
- B. Create a communications strategy that can be applied to the varying organizations on the committee (i.e. sharing information on social media).

### 4.2 Recruit champions

To carry out the recommendations, strong champions need to be found to coordinate action and ensure that progress is being made. The project steering committee needs to tap their network to find engaged, committed, industry members who can follow up on the recommendations made in this strategy.

#### **Action Items**

- A. Share this strategy via e-newsletters to communicate to steering committee groups.
- B. Industry associations expand their volunteer committees to specifically encompass workforce and innovation issues.

### 4.3 Maintain the project steering committee

The steering committee for this project should be maintained to direct future industry collaboration on this topic and ensure that the recommended actions are carried out. A future update to track performance on the recommendations and gauge changes in industry awareness and adoption of technologies may be advisable.

# Introduction

Innovation is rapidly changing the construction industry. While innovation has the potential to drive increased productivity and economic growth, taking advantage of emerging technologies requires a different skill set than that traditionally required in the industry. With that in mind, a number of stakeholders representing the industry (see Appendix A) have come together to identify labour market trends in light of technological change, analyze potential training needs to respond to this change and develop an industry-based human resource plan to prepare for future skill requirements.

This report is intended as a first step and common starting point to assisting the industry in sharing best practices in human resource development, career planning, and employment training; with a focus on adapting to technological change. It will also facilitate planning for future industry action on labour market issues, in particular, redeploying and upskilling workers to enhance worker retention in response to technological change

## Why Do We Need This Strategy?

Construction is the third largest employer in Alberta, employing approximately 240,000 people, or one in ten working Albertans. It is a major driver of the economy, contributing \$27 billion (or 8%) to Alberta's GDP. The success of the industry going forward will have significant impacts on Alberta's prosperity.

The sector is facing a number of challenges. Globally, the construction industry has historically struggled with low productivity growth and a lack of skilled labour. Projects continue to increase in scale and complexity. Environmental concerns are driving shifts in construction methods. An increasingly competitive market necessitates greater investment in productivity.

As new technologies are adopted to address these challenges, the skill sets required by construction firms is shifting. The type of skills needed to drive innovation - such as digital literacy, data analysis, and online collaboration - are also being pursued by other sectors such as the technology industry. Construction firms will increasingly have to compete for talent with top firms such as Google or Apple.<sup>1</sup>

Technology adoption in the industry has been low, but adoption is beginning to be driven by owner demand<sup>2</sup>. Canadian firms are increasingly facing large, sophisticated competition from Europe, Asia, and the United States.<sup>3</sup> Alberta firms need to embrace innovation before they are outcompeted by their competitors that to a large extent already have adopted these new technologies. Without a coordinated effort to ensure that their workforce has the required skills to succeed, Alberta's construction industry risks falling behind.

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<sup>1</sup> World Economic Forum, *8 ways the construction industry can rebuild itself for the 21st century*, p. 2

<sup>2</sup> Canadian Construction Association. *Industry trends report 2019* (2019), p. 4

<sup>3</sup> Canadian Construction Association. *Industry trends report 2019* (2019), p. 8

## Approach

This strategy seeks to understand what emerging skill sets will be needed by the construction firm of the future, identify what barriers exist to driving adoption of those skills, and present recommendations to help overcome those barriers.

To this end, an extensive literature review was conducted in the area of innovation in construction. Academic research, discussion papers, and sector strategies from other jurisdictions were included in the review, with an eye to identifying trends and possible responses. To supplement this, economic, labour market, and industry data were analyzed for labour market trends, and to identify the current state of the industry.

To get a better sense of facts on the ground, and to confirm trends identified in the literature review, one-on-one interviews were conducted with a number of industry experts. Thirteen interviews were conducted with firms representing commercial general and trade contractors, homebuilders, and roadbuilding contractors and suppliers (see Appendix B for more details on the interviews).

## Current State of the Construction Industry

### Industry Overview

This strategy encompasses the three major sub-sectors of the construction industry: residential construction, civil construction, and non-residential construction.

#### **Residential Construction**

The residential sub-sector includes a small number of developers, larger numbers of home builders that own the finished product, and many subcontractors such as framers, brought on as needed. The same end product will to some extent be built by different teams of subcontractors

Unlike the other sub-sectors, while the prime contractor owns the product, the ultimate owner is the consumer.

#### **Civil Construction**

The civil construction sub-sector covers the construction of roads, bridges, and waterworks. Procurement authorities for these types of projects are usually provincial or municipal governments, or possibly private developers for neighborhood infrastructure. This means that the volume of civil work is heavily dependent on public sector budgets, and on pace of neighborhood development

Roadbuilding and other civil construction is, by its very nature, outdoor work. In Alberta, this means that this work is highly seasonal, more so than in the other sub-sectors where it is possible to conduct some work indoors.

### **Non-Residential Construction**

The non-residential sub-sector encompasses commercial, institutional, and industrial projects. Emphasis within this study is on commercial and institutional markets, and less so on heavy industrial construction such as Alberta's energy industry

Commercial and institutional projects are largely unique, one-off experiences for the contracting team, with some scope for learning by doing through repeat projects such as school tenders, or big-box warehouses for the same client.

## **Innovation in Construction**

Innovation is a broad concept and can apply to everything from new materials and equipment to new systems, methods and business operations. One major challenge in discussing innovation is the lack of a shared definition. This strategy chooses to adopt the definition of innovation used by the British Columbia Construction Association (and originally formulated by the UK Chartered Institute of Building): "the successful adoption of new technologies, products, or procedures into industry".<sup>4</sup>

This definition is broad enough to include within the scope of analysis construction technologies such as software (such as BIM and other digital tools), automation, and off-site manufacturing, products including new construction materials and equipment (such as drones, sensors, and exoskeletons) and procedures such as Integrated Project Delivery, data management, or Lean Construction. This definition excludes activities such as research and development of new ideas that are not yet ready for adoption by industry.

### **Benefits of Innovation**

Innovation is closely tied to economic growth and improvements in productivity. As such it is essential to increasing standards of living; indeed "innovation is paramount to continued prosperity".<sup>5</sup>

Like many developed countries, Canada's productivity growth in the last decade has been poor.<sup>6</sup> Compared to other industries, productivity growth in construction has been stagnant, and in some markets negative, over the last few decades. This has been attributed to multiple

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<sup>4</sup> British Columbia Construction Association, *Construction Innovation Project* (2015), 4

<sup>5</sup> British Columbia Construction Association, *Construction Innovation Project* (2015), 7

<sup>6</sup> Government of Canada, *Building a Nation of Innovators* (2019), p. 4

factors, such as fragmentation in the industry, increasingly complex projects, and low returns on initial investments.<sup>7</sup>

However, uptake of new technologies that could raise productivity has also been low, and construction has not fundamentally changed in the last 50 years.<sup>8</sup> The construction industry spends considerably less on research and development than other industries.<sup>9</sup>

Efforts to spur innovation in the construction industry are vital to increase productivity growth, and in turn, wealth creation. Innovative technologies, products, and procedures will be crucial to responding to a changing, increasingly competitive marketplace, and will “also provide a key opportunity for the industry to differentiate itself internationally.”<sup>10</sup>

## Evolving Skills Requirements

Innovation is rapidly changing the skill sets required by the construction industry. The type of skill sets that the construction industry will need to attract and retain will be different than those of the past. New technologies are increasingly displacing the need for low skilled workers, but utilizing these technologies requires a highly-skilled workforce with different skills.<sup>11</sup> Up to 50% of current positions in the industry could be automated<sup>12</sup>, especially in repetitive, manual tasks such as bricklaying.<sup>13</sup> The back office is “undergoing a technological revolution” that will fundamentally alter the skills needed by office employees<sup>14</sup>. Construction firms must invest in new emerging skill sets in order to maintain competitiveness in a changing environment.

A myriad of technological solutions currently exist, with new innovations constantly being developed and brought to market. While this limits the usefulness of analyzing the skill requirements of any one technology, several broad groups can be examined. It should be kept in mind that there is some overlap between these categories, and that they are not exhaustive.

## Advanced Manufacturing Techniques

New technologies such as prefabrication, 3D printing, and automation are changing the way that projects are constructed, and shifting the required skill sets. Projects in the future may require

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<sup>7</sup> Blanco et al., *The New Age of of Engineering and Construction Technology*, p. 1

<sup>8</sup> World Economic Forum, *Shaping the Future of Construction - Inspiring innovators redefine the industry*, p. 9

<sup>9</sup>Rajat Agarwal, Shankar Chandrasekaran, and Mukund Sridhar, *Imagining construction's digital future*, p. 2

<sup>10</sup> Government of Scotland, *Building for The Future* (2013), p. 13

<sup>11</sup> World Economic Forum, *Shaping the Future of Construction - A Breakthrough in Mindset and Technology*, p. 13

<sup>12</sup> Sabine Hoover, Jay Snyder and Alyssa Menard, *Automation and Robotics: Rethinking Engineering and Construction Jobs*, p. 1

<sup>13</sup> Balfour Beatty, *A Digital Future for the Construction Industry*, p. 5

<sup>14</sup> Canadian Construction Association. *Industry trends report 2019* (2019), p. 7

less traditional building trades, and more people skilled in programming and using semi-autonomous machinery.

Prefabrication and modularization reduces the need for manual labour<sup>15</sup>, reduces waste and eliminates weather related delays.<sup>16</sup> Production in a factory setting also can create safer working environments.<sup>17</sup> The McKinsey Global Institute estimates that firms changing from a project-based to a manufacturing production system could experience productivity gains of five to ten times<sup>18</sup>.

Though still in the early stages, 3D printing is expected to have a “disruptive impact”, with productivity gains of up to 80% for the manufacture of certain customized components.<sup>19</sup> 3D printing is being used in multiple application, from creation of difficult to fabricate parts, to prefabrication of building sections, and the printing of entire structures. Skilled workers will be needed to operate and maintain the printing machinery.

## Smart Equipment

Automation has begun to replace manual labour in certain application - including the use of autonomous bulldozers or welder robots.<sup>20</sup> Autonomous equipment has the potential to increase health and safety by replacing humans in dangerous work. While their use is currently limited, Balfour Beatty predicts that by 2050 most of the construction process will be automated, with humans remotely managing multiple projects by accessing visuals and data from the on-site machines.<sup>21</sup>

Drones are increasingly used to track people, machinery and components as they move through the construction site.<sup>22</sup> Drones equipped with cameras are used to survey and inspect sites, including autonomous out-of-sight flights.<sup>23</sup> They have also been equipped to generate 3D footage, which is compared to models in real time to track progress and identify deficiencies.<sup>24</sup> They are also used in retrofit and maintenance projects, using aerial mapping and laser scanning to create 3D models of buildings.<sup>25</sup>

New equipment will also change how traditional tradespeople work on construction sites. Wearable exoskeletons are already in use to increase productivity and safety for tasks that

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<sup>15</sup> World Economic Forum, *Inspiring innovators*, p. 34

<sup>16</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 19

<sup>17</sup> Gerbert et al., *Digital in Engineering and Construction*, p. 8

<sup>18</sup> McKinsey Global Institute, *Reinventing Construction: A Route to Higher Productivity*, p. 20

<sup>19</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 22

<sup>20</sup> World Economic Forum, *Inspiring innovators*, p. 62

<sup>21</sup> Balfour Beatty, p. 16

<sup>22</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 24

<sup>23</sup> Gerbert et al., p. 5

<sup>24</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 32

<sup>25</sup> Gerbert et al., p. 6

require heavy lifting and repetition.<sup>26</sup> Bricklayers have been trained to manage a bricklaying robot, which can lay 3,000 bricks during a work day using a conveyer belt and robotic arm.<sup>27</sup> Other technologies such as augmented reality tools can enable lower-skilled workers to perform complex, higher skill work.<sup>28</sup>

Utilizing these new technologies effectively require people with skill sets that may not have even existed a decade ago. As an example, “thousands of drone pilots and drone data analysts” are needed in the industry, which was not previously foreseen.<sup>29</sup> It is difficult to predict what skills may be necessary in the future, but fostering a culture of continuous learning and development is essential in a “radically changing industry environment that requires different skills”.<sup>30</sup>

## Digital Solutions

One of the largest emerging opportunities is the digitization of construction; a combination of connected sensors, machine learning, and new software applications which will be “integrated on a central platform of Building Information Management (BIM)”<sup>31</sup>.

Building Information Management (BIM) is the 3D model based successor to Computer Aided Design (CAD), and forms the software control layer for many other supporting technologies<sup>32</sup>. BIM provides a collaborative shared model extending through a building’s life cycle.

BIM is a growing market, worth \$2.5 billion and growing at more than 15% per year.<sup>33</sup> The benefits of investing in BIM are clear - 75% of adopters reported positive return on investment.<sup>34</sup> BIM also provides ancillary opportunities, through new ways of information sharing between stakeholders<sup>35</sup> and providing the foundation for lean construction.<sup>36</sup>

However, as a collaborative tool, the full benefits of BIM are realized when all participants in the value chain are actively contributing. First movers may see little initial benefits.<sup>37</sup> Both owners and contractors need to dedicate resources for BIM implementation and invest in capability building.<sup>38</sup>

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<sup>26</sup> Balfour Beatty, p. 17

<sup>27</sup> Sabine Hoover, Jay Snyder and Alyssa Menard, p. 3

<sup>28</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 36

<sup>29</sup> Balfour Beatty, p. 14

<sup>30</sup> World Economic Forum, *8 ways*, p. 4

<sup>31</sup> Gerbert et al., p. 3

<sup>32</sup> Gerbert et al., p. 4

<sup>33</sup> Gerbert et al., p. 15

<sup>34</sup> Agarwal, Rajat, Shankar Chandrasekaran, and Mukund Sridhar, p. 6

<sup>35</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 10

<sup>36</sup> Gerbert et al., p. 16

<sup>37</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 25

<sup>38</sup> Agarwal, Rajat, Shankar Chandrasekaran, and Mukund Sridhar, p. 7



Of the vast amounts of data generated by construction sites, currently the “majority of which is not even captured, let alone measured and processed”.<sup>39</sup> However, this is changing rapidly. Embedded sensors linking objects to the internet are available at an increasingly affordable cost.<sup>40</sup> These sensors can provide constant streams of data during both construction and during operation of the project. The number of embedded sensors is projected to grow from 3.5 billion now to 1 trillion by 2022.<sup>41</sup>

The data collected from the growing number of sensors will be used to preemptively identify issues. They have the potential to reduce unexpected failure by 50%, improve building-management productivity by 20-30% thanks to less need for inspections, and improve the building’s energy performance by 10% over its lifetime.<sup>42</sup> Machine learning programs are already analyzing jobsite data to predict and prevent safety incidents, which leads directly to cost savings through less injury claims<sup>43</sup>.

Managing and making sense of all of this data will introduce new skill requirements not traditionally required by the construction industry. It will require new software, algorithms, and databases, along with the skilled IT personnel, data scientists, and analysts to implement them and analyze the results.<sup>44</sup>

Control over this amount of data will also introduce new challenges around privacy and cyber security. Construction firms will need to protect end user privacy by ensuring high levels of data encryption and anonymisation.<sup>45</sup> Building sensors that control access and vital systems are vulnerable to “increasingly frequent and sophisticated attacks”.<sup>46</sup> This will require firms to increasingly compete with other industries for cybersecurity and data privacy experts.

## Innovative Processes

The structure of traditional construction contracts is one of the highest barriers to greater productivity in the industry.<sup>47</sup> Traditional arrangements can hamper communication and collaboration, fail to incorporate project uncertainties and ineffectively share risk among stakeholders.<sup>48</sup> Alternative delivery methods and Lean Construction methodology have become increasingly popular to mitigate these disadvantages.

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<sup>39</sup> Agarwal, Rajat, Shankar Chandrasekaran, and Mukund Sridhar, p. 9

<sup>40</sup> Gerbert et al., p. 5

<sup>41</sup> Balfour Beatty, p. 20

<sup>42</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 23

<sup>43</sup> Brown, Kathleen, “By predicting risk, AI tool shapes top firms' safety conversations”, *ConstructionDive* (2019)

<sup>44</sup> Balfour Beatty, p. 20

<sup>45</sup> Balfour Beatty, p. 20

<sup>46</sup> Balfour Beatty, p. 21

<sup>47</sup> McKinsey Global Institute, p. 48

<sup>48</sup> McKinsey Global Institute, p. 73

Integrated Project Delivery (IPD) is a delivery system characterized by a multiparty agreement and very early involvement of key participants in the construction project.<sup>49</sup> IPD projects may also include mechanisms for sharing risk and reward, equality of stakeholders, limiting liability, and transparent finances<sup>50</sup>. Such arrangements are intended to increase collaboration between owners, designers, and contractors.

IPD has been shown to have a superior performance in metrics related to quality, communication, and change performance<sup>51</sup> and overwhelmingly positive responses in a survey of stakeholders that had engaged in IPD projects.<sup>52</sup> IPD can also facilitate the use of other emerging skills such as Lean Construction, being seen by some owners as “the logical delivery method to extend their Lean thinking to a building project”.<sup>53</sup>

However, IPD is still used by a minority of projects. While there are concerns around risk, legal instruments, and insurance, there is also a need for “new competencies and skills relating to collaboration and information management to support IPD”.<sup>54</sup>

Though widespread in other sectors such as the automotive industry, lean methods are still not widely prevalent in the construction industry, despite the relatively low investment needed.<sup>55</sup> Lean principles seek to reduce complexity and uncertainty, which increase productivity and profitability by eliminating waste and non-value adding activities.<sup>56</sup>

Construction’s project base nature presents unique difficulties to applying lean methods, but the payoff is significant; widespread use could reduce completion times by 30% and cut costs by 15%.<sup>57</sup> Successfully implementing lean principles requires collaboration throughout the value chain; firms need to provide training and motivation not only to their new and existing workforce, but to everyone on site, including the personnel of their subcontractors.<sup>58</sup>

Firms need to invest in training and acquiring talent that can implement lean principles and manage alternative delivery models for their projects. Contractors that fail to implement these innovative processes “risk falling behind in their increasingly competitive markets”.<sup>59</sup>

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<sup>49</sup> Mounir El Asmar, Awad Hanna, and Wei-Yin Loh, “Quantifying Performance for the Integrated Project Delivery System as Compared to Established Delivery Systems”, p. 2

<sup>50</sup> University of Minnesota, *MOTIVATION AND MEANS: How and Why IPD and Lean Lead to Success*, p. 1

<sup>51</sup> Mounir El Asmar, Awad Hanna, and Wei-Yin Loh, p. 13

<sup>52</sup> Renee Cheng, Markku Allison, and Carrie Sturts Dossick, *IPD: Performance, Expectations, and Future Use*, p. 4

<sup>53</sup> University of Minnesota, p. 20

<sup>54</sup> David Kent and Burcin Becerik-Gerber, “Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery”, p. 816

<sup>55</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 30

<sup>56</sup> Greiser et al., *The Lean Advantage for Large Construction Projects*, p. 5

<sup>57</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 10

<sup>58</sup> Greiser et al., p. 11

<sup>59</sup> Greiser et al., p. 14

## Sustainable Construction

Canada has made extensive commitments to reduce Greenhouse Gas (GHG) emissions. In order to meet these commitments, the way that buildings are constructed will likely need to be overhauled.

The opportunity is significant, the Canada Green Building Council has estimated that large GHG emission reductions could be achieved by 2030 through the adoption of zero carbon building standards. Sectoral emissions could be reduced by 17% compared to 2005 levels if all new buildings are built to zero carbon standards; a further 51% reduction could be achieved by retrofitting existing large buildings.<sup>60</sup>

In addition to the skills required for new technologies such as geothermal and photovoltaic systems, constructing low carbon buildings requires a greater emphasis on soft skills; “green literacy”, cross-disciplinary cooperation, and communication skills are essential to project success.<sup>61</sup>

## Barriers to Skill Adoption

Identifying barriers to adopting innovation is a critical first step to promoting increased innovation in the industry. There are a number of systemic barriers that prevent industry from investing in the necessary emerging skillsets identified above. These barriers need to be addressed by concerted industry efforts in order to drive adoption.

### Lack of Skilled Labour

The type of skill sets that the construction industry will need to attract and retain will be different than those of the past. Lack of skilled labour is widely acknowledged as a key challenge facing the industry. In a recent World Economic Forum survey, more than three-quarters of respondents agreed that the industry is not doing enough to attract and retain talent, and none of the respondents fully agreed that the industry is investing enough in recruitment.<sup>62</sup>

The shortage in skilled personnel will only get worse, as the workforce ages and other new skills become necessary.<sup>63</sup> It is expected that between 2021 and 2028, Alberta will create over 20,000 new jobs in construction – an 11% increase over a seven-year period<sup>64</sup>. This is in addition to an estimated 40,800 retirements in the sector as the workforce ages.

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<sup>60</sup> Canada Green Building Council, *Trading Up: Equipping Ontario Trades with the Skills of the Future* (2019), p. 10

<sup>61</sup> Canada Green Building Council, *Trading Up: Equipping Ontario Trades with the Skills of the Future* (2019), p. 22

<sup>62</sup> World Economic Forum, *8 ways the construction industry can rebuild itself for the 21st century*, p. 2

<sup>63</sup> Santiago Castagnino, Michael Buehler, and Ibrahim Odeh, p. 4

<sup>64</sup> BuildForce Canada, *2019 Construction and Maintenance Looking Forward Highlights* (2019), p. 2

Likely due to the recent recession in Alberta, the number of apprentices currently in training has also dropped. Total apprentices declined by 26% from 2015, while the number of new entrants declined by 20%<sup>65</sup>. This is concerning, as the existing workforce ages and retires, there may not be sufficient apprentices graduating to journeypeople to replace them. Investment in automation and other labour-saving technologies may be necessary not only to raise productivity, but to solve future labour shortages.<sup>66</sup>

To successfully attract talent, the industry will have to make itself more attractive to potential recruits. A major barrier to attracting the high-skill talent needed is the poor public perception of the construction industry. Construction is seen as “dull and dirty”, not innovative or forward-thinking.<sup>67</sup> Industry needs to do a better job communicating the desirable aspects of construction to potential talent sources.

Diversity is also a recruitment issue in the industry. A clear link exists between diversity and innovation, but male employees with an engineering background still predominate in the industry.<sup>68</sup> In an industry where women constitute just 9% of the workforce<sup>69</sup> there is a need to “boost positive culture around women in the industry”.<sup>70</sup>

## Industry Fragmentation

The construction industry in Alberta is highly fragmented between general contractors, sub-contractors, and suppliers. This fragmentation results in poor communication between stakeholders, obscures market signals, and constrains the take-up of new innovation.<sup>71</sup>

The majority of the firms in the industry are also small. More than three quarters of firms in the industry employ less than one hundred people<sup>72</sup>. Many firms are small family businesses, without the dedicated human resources staff or training budgets available to larger firms. The varying degree of available resources and sophistication of small firms makes “building new capabilities at scale” a distinct challenge.<sup>73</sup>

The industry is also fragmented into the sub-sectors described in the introduction to this strategy. There is very little overlap between firms operating in each sub-sector, and there are sub-sector specific challenges to embracing innovation.

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<sup>65</sup> Government of Alberta, *Apprenticeship and Industry Training statistical profiles*, (2018)

<sup>66</sup> Sabine Hoover, Jay Snyder and Alyssa Menard, *Automation and Robotics: Rethinking Engineering and Construction Jobs*, p. 1

<sup>67</sup> World Economic Forum, *8 ways*, p. 5

<sup>68</sup> World Economic Forum, *8 ways*, p. 3

<sup>69</sup> World Economic Forum, *Breakthrough in Mindset and Technology*, p. 42

<sup>70</sup> BRE Academy, *Boardroom to Building Site Skills Gap Survey*, p. 2

<sup>71</sup> NRC Institute for Research in Construction, *Nature of Innovation in the Canadian Construction Industry* (1997), 31

<sup>72</sup> Government of Alberta, *Industry Profiles: Construction Industry* (2018), p. 4

<sup>73</sup> McKinsey and Company, *Imagining construction's digital future* (2016), 4

Innovation in residential construction is ultimately driven by consumer demand, as they are the ultimate owners of the buildings. If the innovation does not translate to a lower price for the finished product or a more desirable home that the consumer is willing to pay a premium for, then it is difficult to introduce. Home builders are also constrained by the building code and municipal inspections, which often means that there are regional variations in what is allowed to be built.

Civil construction is uniquely dependent on public investment in infrastructure, and the political risk that is inherent in that. Public sector owners need to ensure innovation is prioritized over multiple budget cycles and make this a feature of bidding, as otherwise the sub-sector has no incentive to pursue innovation.

For non-residential construction the degree of innovation is governed in large measure by the outcomes desired by the owner captured through the specifications provided. In a low bid environment it is very difficult to offer an innovation that raises the bid price, even if there are substantial future cost-savings or performance enhancements.

## Lack of Collaboration and Knowledge Exchange

Traditionally, contractual arrangements in construction are adversarial rather than collaborative. “The nature of construction procurement frequently restricts collaboration between client and supply chain, particularly at an early enough stage to fully explore options for innovation”.<sup>74</sup> Irrespective of project delivery type, the contract terms may not reward innovation. Further the contract chain usually passes risk through the chain - especially when the winning bid depends on lowest price, it is difficult for anyone along the contract chain to introduce new technology as it is difficult to recoup the cost of investing in that technology through the bid price. Expert interviews confirmed that this inequitable allocation of risk is a major deterrent to innovation.

Avenues for knowledge exchange are limited in the industry. While communities of practice have developed around certain technologies such as BIM and Lean Construction, “collaboration between industry, academia and research organisations is patchy, which limits effective knowledge transfer”.<sup>75</sup>

## Project Based Nature of Construction

Construction, especially non-residential construction, tends to be a series of unique projects in which site conditions and building characteristics differ for every building. Project delivery, especially Design, Bid, Build means that there are multiple parties involved: owner, various design consultants, general contractor, various subcontractors specializing in unique trades, and suppliers. Due to this, an innovation that is created to solve a problem on one site may have limited knowledge transfer between stakeholders or within the involved construction firms

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<sup>74</sup> Government of the United Kingdom, *Construction 2025* (2013), p. 61

<sup>75</sup> Government of the United Kingdom, *Construction 2025* (2013), p. 61

themselves. Even if the prime contractor is the same, it is very likely that the rest of the project team is different so it is difficult to share learning by doing.

This has driven the sector to focus on incremental improvements, due to the belief that “it is not possible to scale up new ideas, and that embracing new technologies is impractical.”<sup>76</sup>

There is also a very high degree of movement of workers among employers and projects. This is inherent in an organized labour model, but is also prevalent throughout. There is no easy system for workers to demonstrate credentials to prove that they have undertaken upskilling, which limits the incentive to do so.

## Skills Training System

For construction, the apprentice training model prevails for most occupations, at least in non-residential construction. In the other sub-sectors, unregulated occupations are more prevalent. However as apprenticeship is the more formalized system, it will be the focus of analysis.

Apprenticeship training is largely conducted on the job, only about 20% takes place in a classroom. On-the-job training is supervised by journeypeople who mentors the apprentice and teaches skills in a hands-on context. A challenge arises if the journeyperson conducting this training has not themselves upgraded their skills, as they are then unable to pass those new skills to the apprentice.

The nature of the contractual and employment relationships within all segments of the construction industry make it difficult for workers to have the time or compensation to unilaterally upgrade their skills. There is also no mandated training for many trades once the journeyperson credential is gained, and many workers do not receive any more formal training once they graduate from their apprenticeship. It is often challenging for employers to release the most experienced and productive workers to receive upskilling therefore there is no opportunity to pass those skills along

For apprentices, the pace of curriculum change lags the pace of technological change, and if the journeyperson that is mentoring them has not received upskilling, then they will finish their apprenticeship without ever receiving training in new technologies. National harmonization of apprenticeship standards actually works to slow down the pace of curriculum change even further.

Many innovative building techniques require skills that span several traditional trade roles (e.g. assembling building envelopes or installing thermal breaks on balconies)<sup>77</sup>. Traditional methods of delivering training are categorized by trade, and do not necessarily enable these cross-disciplinary skills to be taught.

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<sup>76</sup> McKinsey and Company, *Imagining construction's digital future* (2016), 4

<sup>77</sup> Trading Up p. 41

# Industry Awareness and Investment

Industry awareness and investment in a range of emerging technologies tends to be low in Alberta. This varies by region, sub-sector, role (general contractor vs trade contractor), and firm size. Though certain technologies are more widely used than others, in general “adoption is still fairly low for technologies that assist us on the job site.”<sup>78</sup>

Interviews with industry experts revealed a disparity in awareness and adoption of new technologies, with large general contractors operating in urban areas more likely to be familiar with and investing in new technologies than smaller firms that are operating in Alberta’s rural areas. Interviewees also demonstrated a large disparity in their estimates of industry adoption of technologies, which tended to match their own company’s awareness and adoption. This suggests that companies that remain relatively unaware of innovation in the sector are also underestimating the degree to which their potential competition is investing, which may be related to the fragmented nature of the industry

Awareness and adoption vary greatly by technology. Interviewees generally agreed that that 3D Printing, Autonomous Equipment, Exoskeletons, Embedded Sensors, and AI have very low awareness and adoption. Conversely, use of BIM is much more widespread in the industry, though it was noted that BIM encompasses a variety of uses, and that many construction firms are not utilizing BIM to its full potential. This is further supported by the 2nd Annual BIM Report, in which 75% of respondents indicated that the industry is not fully aware of the capability of BIM.<sup>79</sup>

Some technologies are more relevant to certain industry sub-sectors than others. For example Geographic Information Systems (GIS) and GPS technology is much more prevalent in the roadbuilding and residential construction sectors. However, investment in these sub-sectors remains tentative, with only 10 per cent of earthmoving equipment in Canada estimated to have machine control”.<sup>80</sup>

Lack of industry awareness of the benefits of emerging technologies is a major barrier to adoption. Interviewees acknowledged that a traditional attitude resistant to change is present in many firms. Statistics Canada found that the largest reason for not adopting or using advanced technologies is that the investment was not necessary for continuing operations<sup>81</sup>. This was considerably higher for construction than any other industry included in the survey. This suggests that awareness needs to be a focus in any attempt to increase adoption of new technologies.

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<sup>78</sup> British Columbia Construction Association *State of Construction Technology Survey* (2019)

<sup>79</sup> Building Tall Research Centre, *2nd Annual BIM Report* (2019), p. 15

<sup>80</sup> Cameron, Grant, “What does roadbuilding of the future look like?”. *Daily Commercial News* (2019)

<sup>81</sup> Statistics Canada, Table 27-10-0368-01: Reasons for not adopting or using advanced technologies by industry and enterprise size (2017)

However, industry awareness in isolation is not enough to drive innovation. As owners ultimately choose contractors, they too must be aware of the benefits of emerging technologies, Interviewees identified owners not valuing innovation as the largest single barrier. 70% of respondents to the 2nd Annual BIM Report indicated that their clients lack understanding of BIM, despite their crucial role in motivating the transition as they experience more of the benefits of BIM<sup>82</sup>. It is critical to engage with owners to demonstrate that embracing innovation can drive cost savings and increased performance in their buildings.

## Recommendations

**Without addressing the systemic barriers identified above, efforts from a specific upskilling strategy will not be optimally realized.**

### Recommendation 1: Focus on Improving Awareness

#### **1.1 Initiate industry dialog with owners**

As confirmed by industry interviews, awareness of many emerging technologies remain low, both among construction firms and owners. Further industry/owner dialogue around desired project outcomes, potential roles of innovation in improving outcomes, barriers to introducing innovation, and measures to reduce such barriers need to take place to change the fundamental incentives that drive adoption of new technologies. Owners are not necessarily interested in learning about individual emerging technologies, but greater efforts are required to demonstrate the long-term value of innovation, and how emerging technologies can reduce costs through clash detection, improved safety, and other benefits.

Recent work by the Alberta Construction Association demonstrates that contracts frequently contain clauses with risks that are unquantifiable or unmanageable, causing an increase in bid prices.

#### **Action Items:**

- A. Present findings to Industry Liaison Committee – Alberta Infrastructure/CEA/CAA/ACA
- B. Encourage Alberta Infrastructure to procure several demonstration projects where successful project team must demonstrate demonstrable improvements in key outcomes determined by Alberta Infrastructure (eg. safety, productivity).
- C. Give presentations on technological opportunities (equipment, material and training) to owners at provincial conferences - i.e. RMA, AUMA and Transportation Connects Alberta (CEA Conference).

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<sup>82</sup> Building Tall Research Centre, *2nd Annual BIM Report (2019)*, p. 15



- D. New models need to be developed that allow for a ‘shared risk’ approach with governments of all levels; in today’s environment builders / owners take all risks and incur additional costs in trialing new technologies.

## **1.2 Foster additional communities of practice**

Creating avenues for industry collaboration are essential to spreading awareness. Communities of practice enable users to come together to discuss the benefits and limitations of innovative solutions. Communities of practice exist for BIM and Lean Construction in both Edmonton and Calgary, but opportunities are limited elsewhere. Communities of practice should be established in smaller centres, where awareness and adoption of BIM and Lean tend to be lower, and in larger centres for technologies such as drones and exoskeletons that are still emerging.

### **Action Items:**

- A. Associations engage in dialogue with existing COPs for their advice on extending existing COPs to other locations.
- B. Industry support partnerships with post-secondaries similar to ACA support for NAIT’s innovation application. Goal is to lever additional resources. Support conditional on promoting COP for specific technologies across Alberta.
- C. Pick two areas in the province (outside of Edmonton and Calgary) to establish committees/ communities of support.

## **Recommendation 2: Government Support for Innovation**

### **2.1 Consider requiring BIM on public projects**

Many of the international strategies reviewed included strong funding commitments from governments. However, in a time of budget restraint, Government can also spur adoption of emerging technologies by adapting procurement to “break the inertia that slows the construction industry from entering a digital era”<sup>83</sup>. “Procurement policy can drive local economic activity, investment, job opportunities, while creating demand for innovative solutions to meet future needs”.<sup>84</sup>

There is strong support demonstrated through industry interviews and the 2nd Annual BIM Report for a government mandate on BIM usage on public projects to drive adoption. As a major owner, government can provide the incentive to invest in BIM while delivering cost savings on public infrastructure through gains in efficiencies “attributable to high-quality, streamlined

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<sup>83</sup> McKinsey & Company, *Governments can lead construction into the digital era* (2019)

<sup>84</sup> Government of Victoria, *Construction Technologies Sector Strategy* (2016), p. 16

information flows that result in fewer errors and support global optimization of asset life cycle practices”<sup>85</sup>.

Many other jurisdictions have adopted BIM mandates such as the United Kingdom, Finland, Denmark, Norway, France, Germany, and Russia<sup>86</sup>. In fact, Canada remains the only G7 nation without a BIM national strategy<sup>87</sup>.

**Action Items:**

- A. Encourage Alberta Infrastructure to procure several demonstration projects to deliver level 400 BIM model. School projects may provide an excellent opportunity, as they would be spread around the province and provides many firms the opportunity to participate and learn.
- B. Educate government on the benefits of BIM usage (i.e. create white paper or present at local conferences), with focus on RMA and AUMA - Ministers are more likely to attend these types of events compared to industry conferences.

**2.2 Support collaborative delivery methods on public projects**

Government should consider using public procurement to support the use of more collaborative project delivery methods. Public sector contracts have increasingly forced contractors to assume a level of risk that is unsustainable at current price levels<sup>88</sup>. Though there is a need to ensure transparency and impartiality in public projects, some jurisdictions such as Colorado have successfully implemented collaborative delivery models in public procurement. Collaborative delivery increases quality, communication, and change performance<sup>89</sup> and more equitably share risk.

**Action Items:**

- A. Create a word box / list of keywords to help guide conversations between industry and local MLAs.
- B. Encourage GOA to fund “lessons learned best practices” review of the IPD projects of Red Deer and Edmonton Public Schools and share the findings with industry and public owners.

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<sup>85</sup> Construction Canada, *BIM in Canada: Moving toward a national mandate for building information modelling* (2016), p. 3

<sup>86</sup> Construction Canada, *BIM in Canada: Moving toward a national mandate for building information modelling* (2016), p. 3

<sup>87</sup> Building Tall Research Centre, *2nd Annual BIM Report* (2019), p. 15

<sup>88</sup> Canadian Construction Association. *Industry trends report 2019* (2019), p. 11

<sup>89</sup> Mounir El Asmar, Awad Hanna, and Wei-Yin Loh, p. 13

- C. Information related to public projects (design, schedule, specifications, delivery model – performance against budget and schedule) should be shared to provide performance data on whether collaborative approaches bring value.

## Recommendation 3: Reform the Training System

### **3.1 Explore incentivizing upgrading for journeypeople**

Journeypeople are an essential component of the apprenticeship training system. Journeypeople act as mentors and conduct the on-the-job training that makes up the majority of the education that tradespeople receive. But as there is no mandatory requirement for journeypeople to upgrade their skills, they may be unable to train apprentices in emerging skill sets.

However, expert interviews noted that there is a complex set of factors that de-incentivize journeypeople and their employers from seeking out additional training, including the necessity to keep skilled workers on the jobsite, the unwillingness of journeypeople to lose income while in training, and the lack of a clear way to demonstrate new credentials to employers.

Stakeholders, including employers, governments, and tradespeople need to find innovative ways to overcome these barriers and incentivize upskilling after apprenticeship.

#### **Action Items:**

- A. Urge PACs to produce timely biannual updates of new skill requirements and mandate Journeypeople to take short microcourses to maintain currency. Journeypeople should be given opportunity to demonstrate competency. Explore with the Government of Alberta and Federal Government the potential for cost sharing same as Canada Job Grant, 2/3 government, 1/3 employer.
- B. Expand compliance mandate of Apprenticeship and Industry Training to monitor compliance of A.

### **3.2 Strengthen Provincial And Local Apprenticeship Committees**

Local Apprenticeship Committees (LACs) and Provincial Apprenticeship Committees (PACs) form a vital link between industry and Alberta's apprentice training system. However, industry members with experience with emerging technologies are not always represented on these committees.

The Desired Competencies of the nomination criteria for LACs and PACs should be updated to prioritize recent field experience to ensure that the committees are knowledgeable about recent innovations in the sector.

#### **Action Items:**

- A. Work to ensure PAC and LAC nomination criteria favour recruitment of field level personnel.
- B. Apprenticeship and Industry Training to coordinate with industry associations / unions to ensure regular ongoing dialogue with cross-section of grassroots industry about hanging technologies / skill sets.
- C. Mandate accelerated review of curriculum from current average 7 year cycle to 2-3 years.

### **3.3 Embrace competency-based, supplementary education for journeypersons**

As skill demands become more complex and worker mobility a reality, workers need a “more nuanced and agile means to effectively develop, capture, and communicate new competencies and experiences, in ways that employers understand and value”.<sup>90</sup>

Supplementary education based on verifiable competencies will allow workers to learn additional skills they require, minimizing costs and time away from the jobsite. They can also allow for easier cross-skilling in complex areas that bridge several traditional trades such as building envelopes.

The value of a journeyperson’s credential is enhanced by the understanding they have the necessary skills and knowledge to perform in their trade in most any circumstance, and broad-based experience in their trade facilitates labour mobility and worker retention. Supplementary education should be understood as a mechanism to facilitate further training for journeypeople, not replace it, allowing them to obtain credentials that demonstrate competency in new skills.

## **Recommendation 4 - Continue the Discussion**

### **4.1 Disseminate this strategy to industry**

Though the partners on this project’s steering committee broadly represent the construction industry, it is important that each partner share this strategy with their networks to raise awareness and gather a diversity of feedback. This strategy is intended as a starting point for discussion.

#### **Action Items**

- A. Present strategy to Trades Caucus of the Alberta Government.

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<sup>90</sup> Deloitte and Autodesk Foundation, *Supporting worker success in the age of automation* (2019), p. 7

- B. Create a communications strategy that can be applied to the varying organizations on the committee (i.e. sharing information on social media).

#### **4.2 Recruit champions**

To carry out the recommendations, strong champions need to be found to coordinate action and ensure that progress is being made. The project steering committee needs to tap their networks to find engaged, committed, industry members who can follow up on the recommendations made in this strategy.

#### **Action Items**

- A. Share this strategy via e-newsletters to communicate to steering committee groups.
- B. Industry associations expand their volunteer committees to specifically encompass workforce and innovation issues.

#### **4.3 Maintain the project steering committee**

The steering committee for this project should be maintained to direct future industry collaboration on this topic and ensure that the recommended actions are carried out. A future update to track performance on the recommendations and gauge changes in industry awareness and adoption of technologies may be advisable.

## **Conclusion**

The construction industry employs many Albertans and is an important component of Alberta's economy. New innovations and rapid technological change can be the catalyst of productivity growth in the sector, but workers will need new skills in fields unrelated to those traditionally required in the industry.

Significant barriers exist in the way the industry operates, the incentives for change, and how training is currently delivered. But efforts to ready the sector for change are necessary; Alberta's construction industry risks being left behind and outcompeted in an increasingly challenging marketplace if efforts are not made.

The recommendations made in this report are just a first step to address the barriers identified, but continued work to ensure that the industry in Alberta is ready to adopt innovation will be necessary.

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# Appendices

## Appendix A - Project Steering Committee

- Alberta Building Trades
- Alberta Construction Association
- Alberta Roadbuilders & Heavy Construction Association
- BILD Alberta
- BuildForce Canada
- Christian Labour Association of Canada
- Government of Alberta - Ministry of Labour
- Northern Alberta Institute of Technology - School of Skilled Trades

## Appendix B - Industry Interviews

<b>Interview Participants</b>	
<b>Company</b>	<b>Type</b>
Delnor Construction	Commercial General Contractor
Westcor Construction	Commercial General Contractor
Wright Construction	Commercial General Contractor
Chemco Electric	Commercial Trade Contractor
Chermik Group	Commercial Trade Contractor
Kerr Interiors System	Commercial Trade Contractor
Lynnwood Roofing	Commercial Trade Contractor
Pad-Car Mechanical	Commercial Trade Contractor



Brookfield Residential	Residential
ATCO Group	Residential
Lincolnberg Master Builder	Residential
Standard General	Roadbuilding & Heavy Construction
Colas Canada	Roadbuilding & Heavy Construction

## Interview Questions

### 1. Confirmation of list of evolving technologies:

#### Advanced Manufacturing Techniques

- Prefabrication
- Modularization
- 3D Printing

#### Smart Equipment

- Autonomous Equipment
- Drones
- Wearable Exoskeletons

#### Digital Solutions

- Building Information Management (BIM)
- Embedded Sensors
- Virtual and Augmented Reality (VR and AR)
- AI

#### Innovative Processes

- Lean Construction
- Integrated Project Delivery (IPD)

#### Questions:

- Is the list of evolving skill requirements reasonable?
- Are there any missing?
- For each above:
  - Is your firm aware of it? Is it adopting it? Estimate of investment in it
  - Do you think the industry is aware of it? Adopting it? Investing in it?
  - Does awareness/adoption vary by size? Are only large companies investing? Only GCs vs Subs? Specific trades?

- Are owners including requirements for these in bids? What kind of projects and what kind of owners?
- What could owners do to encourage adoption of these new technologies?
- What could government do to encourage adoption?

## 2. **Barriers to innovation**

- Does your company experience the following barriers to innovation?
  - Lack of skilled labour, image problem of industry for new hires
  - Industry fragmentation, lots of players on a jobsite
  - Do existing building codes pose a barrier? If so why?
  - Cost-based (not value-based) procurement
  - Lack of collaboration and knowledge exchange
  - Inequitable allocation of risk, innovation stifling contract terms (intellectual property rights)
  - Project based nature of construction (every project is different, every team of outsiders is different, every internal project team is different)
  - Traditional attitude; difficulty getting buy-in in the organization (what level in the organization? Senior leadership? Field staff? Older workers?)
- Are there any other barriers not mentioned above?
- Which barriers are the most important? The least? why?

## 3. **Best Practices**

What best practices does your company implement or are aware of in the following categories:

- Skill assessment
- Training delivery and upskilling existing workforce
- Career planning and ensuring a future skilled workforce (K-12, post-secondary, new entrants)
- Change management
- Industry collaboration
  - Communities of practice
    - Does your company participate in existing COPs?
    - Is there a gap that needs to be filled with a new COP?
  - Redeployment of workers
    - Aware of informal arrangements that exist (ex. Edmonton electrical contractors, Edmonton GCs with carpenters, Medicine Hat mechanical contractors)
    - See a role for a formal arrangement, perhaps coordinated by construction associations?