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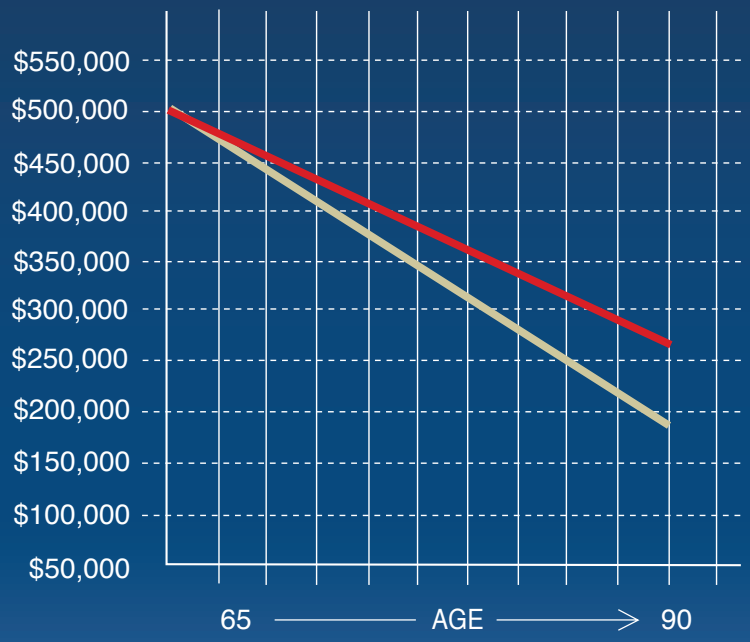

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Presenter: Jean-Luc joined the firm Lasalle | NHC in 2018 as a project engineer. He has a Ph.D. in hydrology and climate change from the École de technologie supérieure (ÉTS). He has published scientific papers and presented his research at international conferences. Jean-Luc serves on several boards and committees in addition to teaching fluid mechanics and water resources to ÉTS undergraduate students.

lasalle nhc

Presented by
Jean-Luc Martel, Ph. D., P.Eng., MCSCE

Tour dates & Registration @ csce.ca/events/list

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CANADIAN CIVIL ENGINEER | L'INGÉNIEUR CIVIL CANADIEN
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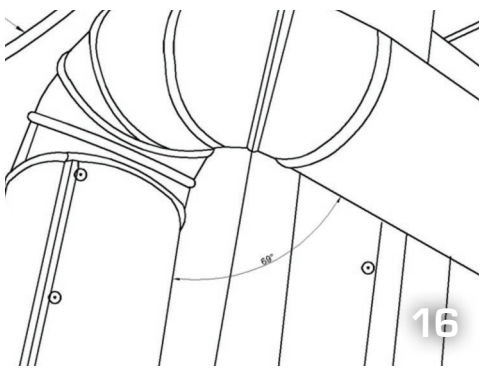

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The Growing **Labour Crisis** in Civil Engineering

Michel Khouday, P.Eng., M.Eng.,
PMP, C.Adm., M.B.A., Ph.D.
President, CSCE
president@csce.ca

Dear friends, members and partners,

There are two types of trends that are quickly growing in Civil Engineering today: technical growth in areas such as construction, structures, hydro-mechanical, etc., and the rapid growth in labour trends. While my colleagues will walk you through trends in their respective disciplines, I would like to bring some needed attention to the growing labour crisis.

It's no secret that there has been a surge in baby boomers retiring every year with high numbers since 2011. But how many of them are civil engineers, and how is it impacting our industry? The numbers might just shock you.

It's projected that from 2011 through 2020, approximately 95,000 civil engineers in Canada would have retired – leaving these positions vacant. While in that same period, approximately 102,000 new engineers would have graduated. While on the surface it seems awfully convenient to have so many round pegs to fill these holes, the reality of the situation is not so simple.

While the numbers line up, the experience is just not there. These retirees are leaving behind legacies of 40 years of experience, the kind that is acquired over time – not the kind that can be caught up with by taking a few extra courses. Professionals in any field refine the art of combining their book smarts with their 'street' smarts over time, and are able to provide judgement based on a combination of what they've learned, what they've experienced, and what they can project.

Although new graduates don't have time on their side, they do have what they have learned, but more importantly, they have an eagerness, which will push them ahead. Coupled with the chance to expedite their real-world learning curve by becoming significantly involved in all possible volunteer, mentorship, job-shadowing and entrepreneurial opportunities, there is a fighting chance for those who are determined.

> So the question is: while the supply and demand in our industry forge ahead like two freight trains, what can we do to curve their paths towards a meeting point?

In the meantime, it is projected that upwards of 80,000 immigrants will fill these job openings. While the remaining 15% will be filled by strongly encouraging women in civil engineering to pursue more senior-level positions, and by finding a way to allow seniors to continue working part-time, while allowing them to be eligible for their pension.

The next decade – 2020-2030 – is unfortunately not going to be any easier. While the growth in our industry is projected to slow down, the number of people retiring is not. Today, there are four people in the workforce for every one person who is retired. By 2035, it's projected to be two to one. That doesn't just mean fewer workers; it also means more people in need.

So the question is: while the supply and demand in our industry forge ahead like two freight trains, what can we do to curve their paths towards a meeting point?

The truth is there isn't much we can do about the demand because eventually, people are going to retire, regardless of what they are offered. So, that leaves us with the option of altering the supply.

We need to find high-impact ways of expediting the hands-on experience of these new engineers. This requires big changes in our industry – both from the engineers themselves, but also from the companies in demand of labour. This will require both parties to be open-minded and flexible more than ever.

At CSCE, we will be exploring our role in this matter in depth over the coming months with the promise to deliver more impactful opportunities for our young members to develop their professional skills, their technical know-how and managerial qualities. We will also look to our corporate partners to encourage initiatives from the industry.

The question remains, what are you doing to make a difference? Share your initiatives on our social media – we need to share every brilliant idea.

As always, 'Be seen. Be heard. Be relevant.'

Best regards,
Michel Khouday, P.Eng., M.Eng.,
PMP, C.Adm., M.B.A., Ph.D.
President, CSCE/Président, SCGC
President@csce.ca

Sources: *Engineerscanada.ca*
The Conference Board of Canada
(*https://www.jflglobal.com/media/uploads/news/2018-11/Canada_2030_-_Part_2_-_The_Defining_Forces_Disrupting_Business.pdf*) ■

Amplification de la **crise de l'emploi** en génie civil

Michel Khouday, ing., M.Ing.,
PMP, Adm.A., MBA, Ph.D.
Président de la SCGC
president@csce.ca

Chers amis, membres et partenaires,

En génie civil, deux types de tendances sont en train de prendre rapidement de l'ampleur : la croissance technique dans divers secteurs comme en construction, en structure et en hydromécanique, et une croissance rapide des tendances en main-d'œuvre. Mes collègues aborderont avec vous les tendances dans leurs disciplines respectives. Pour ma part, j'aimerais attirer votre attention sur la crise de l'emploi qui gagne en importance.

Personne n'ignore que les baby-boomers sont de plus en plus nombreux à partir à la retraite. Depuis 2011, en fait, le nombre de départs par année est élevé. Ce que l'on connaît moins, c'est la proportion d'ingénieurs civils parmi ces nouveaux retraités et les répercussions sur notre secteur d'activité. Vous pourriez être surpris d'apprendre que, selon les prévisions, environ 95 000 ingénieurs civils partiraient à la retraite entre 2011 et 2020 au Canada. Pour pourvoir les postes laissés vacants par ces nouveaux retraités, 102 000 nouveaux diplômés en ingénierie arriveront sur le marché du travail. Cela peut paraître encourageant, mais la situation n'est pas si simple.

Même si les chiffres semblent s'équivaloir, l'expérience fait cruellement défaut. Les retraités partent avec quatre décennies d'expérience, le genre d'expérience acquise avec les années et qui ne s'acquiert pas en suivant quelques formations supplémentaires. Au cours de leur carrière, les professionnels de tous les domaines deviennent de plus en plus habiles à combiner connaissances théoriques et expériences afin de porter un jugement basé sur un heureux mélange entre ce qu'ils ont appris, ce qu'ils ont vécu et ce qu'ils prévoient.

Par contre, même s'ils n'ont pas des années d'expérience à leur actif, les nouveaux diplômés ont de bonnes connaissances et, surtout, un vif désir de progresser. En outre, les plus déterminés qui profitent en plus de toutes les occasions possibles de bénévolat, de mentorat, d'entrepreneuriat et d'observations de professionnels à l'œuvre ont de bonnes chances de tirer leur épingle du jeu.

> Si l'offre et la demande dans notre secteur progressent comme deux trains de marchandises, comment fait-on pour s'assurer qu'ils aillent dans la même direction?

Parallèlement, plus de 80 000 immigrants devraient arriver pour occuper les postes laissés libres par les nouveaux retraités. Pour les 15 % de postes encore à pourvoir, la solution consistera à encourager fortement les femmes déjà en génie civil à devenir ingénieures principales ou cadres et à permettre aux retraités de travailler à temps partiel sans perdre leur admissibilité à leur pension.

La prochaine décennie (de 2020 à 2030) ne sera malheureusement pas plus facile. Même si la croissance devrait ralentir, le nombre de départs à la retraite ne suivra pas la même tendance. On compte aujourd'hui quatre travailleurs pour chaque personne à la retraite, mais cette proportion devrait être de deux pour un en 2035. Cela ne signifie pas seulement qu'il y aura moins de chantiers; c'est dire aussi qu'il y aura plus de gens dans le besoin.

Si l'offre et la demande dans notre secteur progressent comme deux trains de marchandises, comment fait-on pour s'assurer qu'ils aillent dans la même direction?

En vérité, il n'est pas vraiment possible d'influer sur la demande puisque, peu importe les options alléchantes proposées, tôt ou tard, les ingénieurs partent à la retraite. C'est donc sur l'offre qu'il faut agir.

Nous devons trouver des solutions déterminantes pour accélérer l'acquisition d'expérience par les nouveaux ingénieurs. Cela exige de grands changements dans notre secteur, tant de la part des ingénieurs que de celle des entreprises en quête de main-d'œuvre. Les deux parties doivent faire preuve d'ouverture d'esprit et de flexibilité.

À la SCGC, nous examinerons notre rôle à ce sujet au cours des prochains mois. Nous mettrons en œuvre les meilleurs programmes pour permettre à nos jeunes membres d'améliorer leurs compétences professionnelles, leur savoir-faire technique et leurs qualités de gestionnaire. Nous nous tournons également vers nos partenaires de l'entreprise pour encourager les actions venant de l'industrie.

Et vous, que faites-vous pour améliorer la situation? Partagez vos initiatives sur nos médias sociaux. Nous devons faire connaître toutes nos idées géniales.

Et, comme toujours, « soyez vus, soyez entendus, soyez pertinents. »

Cordialement,
Michel Khouday, ing., M. Ing.,
PMP, Adm. A., MBA, Ph. D.
President, CSCE/Président, SCGC
President@csce.ca

Sources : *ingenieurscanada.ca*
Le Conference Board of Canada
(*https://www.jflglobal.com/media/uploads/news/2018-11/Canada_2030_-_Part_2_-_The_Defining_Forces_Disrupting_Business.pdf*) ■

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Edmonton Section: Where is Civil Engineering Growing?

Hazel Battad, P.Eng., 2019-2020 Chair, Edmonton Section
Eugene Hsung, P.Eng., 2019-2020 Vice Chair, Edmonton Section

Photo supplied by Varun Mudholkar, P.Eng, PMP

"Even if you're on the right track, you'll get run over if you just sit there." - Will Rogers

The Civil Engineering industry is constantly evolving. Remaining static and maintaining the status quo means being left behind.

With that in mind, the Edmonton Section hosted our inaugural symposium in October 2018 under the banner of *Innovations In Civil Engineering*. Presenters from across the country shared their knowledge and expertise with the local civil engineering community and the discussions and engagement that occurred were invaluable! To keep the momentum going and to build on the success of that inaugural event, we are planning our second symposium for May 2020, focusing on the same theme of innovations in the industry. This one-day event will be another opportunity to come together and share ideas as we highlight emerging technologies, intelligent design aids and other game-changing methods and processes in planning, design, construction and project management.

> The relationships that are developed and cultivated, and the camaraderie that results from our shared experiences, help create a culture and a unique identity which raises our profession.

Despite the fast-paced advancement of technology and its often disruptive effects in the industry, growth in the civil engineering profession is still driven by the engagement of its members. The relationships that are developed and cultivated, and the camaraderie that results from our shared experiences, help create a culture and a unique identity which raises our profession. To help foster these connections, the Edmonton Section has a strong focus on networking and social events within the civil engineering community and with industry partners. By bringing people together through these events, we are able to better stay in touch with colleagues, expand our professional networks and keep up with the latest industry developments.

The Edmonton Section, with support from many generous local sponsors and a dedicated group of volunteers, has an established dinner presentation program which runs from September to April. Our Executive Committee curates a program which spans the diverse field of civil engineering, and presentations typically highlight award-winning, industry-recognized projects by local firms. These events bring together different demographics within the civil engineering community, adding diverse context and depth to conversations between professionals, retirees, and students.

One of the most active groups within the Edmonton Section is our Young Professionals (YoPro) Group, which was conceived in 2013 during conversations over pizza. Today, the Edmonton Section YoPro Group is an established professional organization which offers regular social, networking and volunteering events and technical site tours for YoPros and YoPros-At-Heart. One of the Edmonton CSCE YoPro Group's flagship events is an annual curling funspiel where teams compete for the PCL YoPro Cup, and winners are commemorated with the addition of a plate engraved with their names. The event started out with eight teams participating to now, a sell-out with 16 teams! It has become a popular event that YoPros and students have come to look forward to and often sells out early. The sixth Annual YoPro Curling Funspiel took place on November 2, 2019.

The Edmonton Section stays involved with student life by partnering with the University of Alberta Civil and Environmental Engineering Students' Society (CEESS). We provide event sponsorships, academic scholarships and bursaries, along with key connections to industry professionals. The CEESS recently hosted its fourth Annual Civil Engineering Specialization Panel, where professionals in Geotechnical, Construction Management, Water Resources, Transportation, Environmental, and Structural

Engineering shared insights with students to provide them with a better understanding of the careers available to them as Civil Engineers. The Edmonton Section is also proud to support the long-running CEESS Popsicle Stick Bridge Competition. This year, the competition was extended to high school students to build and reinforce their interest in the engineering field – hopefully, Civil Engineering! The 31st Annual Popsicle Stick Bridge Competition was held on November 29, 2019.

Keeping pace with the industry, the Edmonton Section continues to grow and adapt by providing engaging programs and events. Whether it be at one of our dinner presentations, a technical tour, or just a night out to relax with like-minded engineers, please join us in one of our events when you are in Edmonton!

Follow us on Twitter (@csce_edm) for updates. Ideas for symposium presentations and speakers are welcome (#CSCEyeg2020 or email *chair@csceedmonton.ca*). ■

“Keeping pace with the industry, the Edmonton Section continues to grow and adapt by providing engaging programs and events.”

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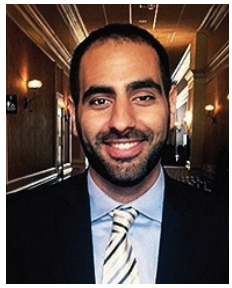
How Computers are Changing the Way **We Design**



Rami Mansour, MASc., P.Eng.
Bridge Designer, SYSTRA-IBT *Chair, National Young Professionals Committee, CSCE*

The Brooklyn Bridge was designed by John Roebling in the mid-19th century using basic computational tools, a good understanding of the physical principles that govern the behaviour of materials, and experience in the testing and building of structures. The design was developed over many years, and was only possible because of new technologies, which emerged at the time.

In the past few decades, the development of new computational tools has revolutionized the role of engineers. The speed at which complex calculations can be conducted has increased efficiency in all aspects of civil engineering, including in the design and construction of buildings, bridges, and water systems. Using the tools that are currently available, an experienced engineer can conduct a full analysis of the Brooklyn Bridge, in a significantly shorter period of time than it took in the 19th century.

The continuous improvement of these computational tools is one of the most significant ways our profession will change in the coming decades. This change is already evident throughout the civil engineering industry. Engineers are now more willing to undertake complex analysis and conduct daring designs, which result in more efficient and economical solutions. These computational tools are being developed with improvements in user interface, increasing transparency and control of results. Engineers can take advantage of increased efficiency by allocating more time for creativity. The potential for more creativity increases the value of engineering work, which can have a positive impact on the public perception of the civil engineering profession.

This increase in creativity and efficiency can also lead to new discoveries. In the paper published in 2018 by Fairclough et al. entitled, 'Theoretically optimal forms for very long-span bridges under gravity loading', the authors used the latest computational tools to determine the ideal structural form for a bridge with a main span of 5 km, which is twice the length of the longest main span ever built. Although a bridge with a main span of this length is not yet possible given the materials currently available, this paper identifies a new structural form that has not yet been fully explored by engineers. These types of studies will continue to push boundaries in the pursuit of economy, efficiency and safety.

As with all advancements in technology, there are some important aspects that engineers need to consider. First, the use of these technologies does not replace an engineer's understanding of the fundamental principles used by the computational tool. Misinterpreting analysis results can cause errors, and engineering judgement is needed to avoid these problems. In addition, increasing the efficiency of a design using complex computational tools may not provide significant enough savings than traditional, more conservative computational tools.

The advancement of computational tools will continue to have a significant impact on the civil engineering profession. It is critically important that young engineers focus on understanding the fundamental principles behind these tools, to avoid over-reliance and potentially costly mistakes. If engineers are able to harness the full potential of these tools, then it is safe to say that the civil engineering profession will continue to push the boundaries of knowledge and improve our infrastructure.

Rami Mansour, MASc., P.Eng.
CSCE Young Professionals Committee Chair
rmansour@systra.com ■

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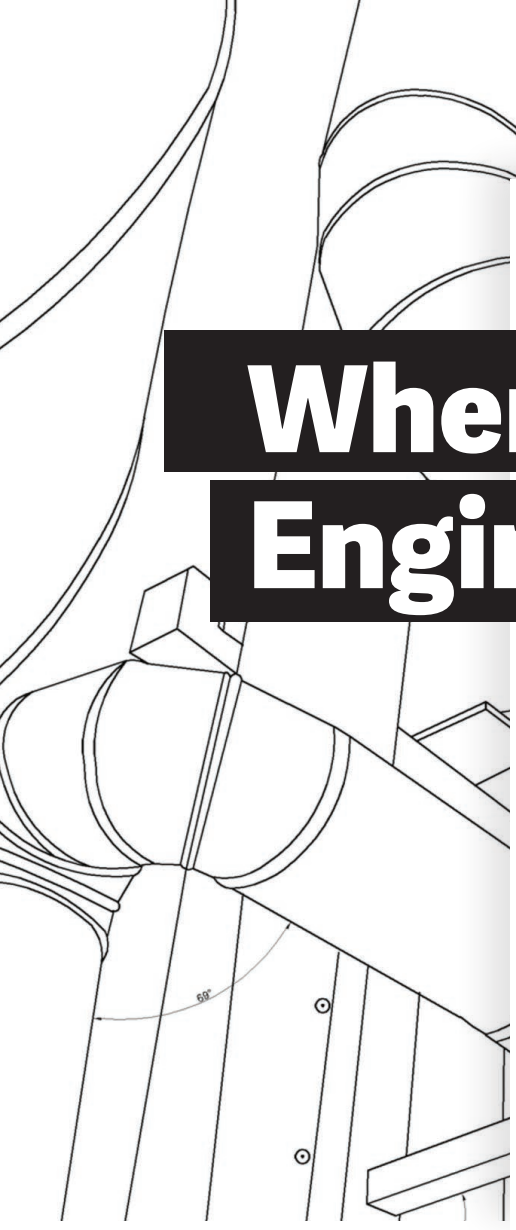

BY LYANNE ST. JACQUES
Director, Marketing & Communications, CSCE

Where is Civil Engineering Growing?

While construction, structural, transportation and water resources are the frontrunners in terms of growth in the technical sectors; the truth is that the labour crisis is a hindrance to growth in any discipline these days.

While technical developments such as the Internet, programs such as Autocad, and the ability to confer with colleagues overseas are as simple as pushing a button on your cell phone, none of these advances can relieve the abundance of work that is being left behind by the aggressive number of baby boomers leaving the workforce. This, of course, doesn't take into account the added work produced from industry growth, which is at approximately eight percent year over year.[1]

The majority of this 'new' work is filled more readily as it pertains to the more recent, technically advanced work that is being studied by the new, younger generation of engineers. The rest of the gap, however, requires less automation, more traditional skills, and years of experience that you can't buy over the counter.

The notion that the new generation of engineers are aiming at replacing people with machines to ease some of the workload is not unfathomable, it is, nevertheless, a work in progress and not something that solves the problem today.

On the brighter side, the advances we are seeing in the technical sectors are moving us in directions towards more sustainable solutions our industry has never seen. Coupled with the 'no one left behind' approach put out by the UN in their 2030 Agenda for Sustainable Development Goals[2], if organizations such as CSCE, and other industry leaders set the example; this could mean a very different picture for the future of Canadians.

At CSCE, we are determined to do our part to address the labour crisis by drastically shortening the learning curve for new engineers – but we understand that this is not an overnight solution. In the meantime, we take comfort, and pride, in the fact that we are heavily involved in the expansion of the sustainability efforts across Canada and will be part of the solution to bring basic infrastructure to all citizens. After all, the stronger we are as a nation, the more we can give back to others in need.

SOURCES:

1. *www.engineerscanada.ca*
2. *https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E* ■

PAR LYANNE ST-JACQUES
Directrice, Marketing et communications, SCGC

Où est la croissance en génie civil?

Dans les secteurs techniques, la croissance se voit surtout en construction, en structures, en transports et dans le secteur des ressources hydriques. Toutefois, la pénurie de main-d'œuvre est sans contredit le plus grand frein à cette croissance, tous secteurs confondus.

Bien que des avancées technologiques comme Internet, des programmes comme Autocad et des applications de téléconférences facilitent grandement la vie des ingénieurs, aucune de ces innovations ne peut compenser l'abondance de travail créée par le départ à la retraite massif des baby-boomers. Sans compter le surplus de travail occasionné par la croissance annuelle d'environ 8 % que connaît notre secteur d'activité.[1]

La majorité de cette « nouvelle » demande est récupérée plus facilement puisqu'elle touche des domaines récents ou des avancées technologiques qui font partie des programmes d'études des ingénieurs nouvellement diplômés. Par contre, une portion de la pénurie touche des compétences plus classiques et moins automatisées qui ne se maîtrisent pas en un tournemain.

La notion que la nouvelle génération d'ingénieurs cherche à remplacer des personnes par des machines pour faciliter le travail n'est pas inconcevable. Néanmoins, il s'agit encore de projets en cours qui ne résolvent aucunement la pénurie actuelle.

Sur une note plus positive, je terminerais en soulignant que les avancées technologiques actuelles nous permettent d'obtenir les solutions les plus durables à ce jour dans notre secteur. Si, à l'instar de l'approche « personne ne doit être laissé pour compte » mise de l'avant par l'ONU dans son Programme de développement durable à l'horizon 2030, la SCGC[2], d'autres organisations similaires ainsi que les chefs de file de l'industrie donnent l'exemple, l'avenir pourrait être bien différent pour les Canadiens et Canadiennes.

À la SCGC, nous sommes déterminés à contribuer à résoudre la crise de la main-d'œuvre en accélérant considérablement la phase d'apprentissage des nouveaux ingénieurs. Nous sommes conscients que cela ne se fait pas du jour au lendemain, mais nous sommes fiers du rôle important que nous jouons dans la croissance des activités de développement durable partout au pays. Nous participons à la solution et travaillons à donner accès à des infrastructures de base à tous les citoyens. Après tout, plus nous sommes forts en tant que pays, plus nous pouvons redonner à ceux et celles qui sont dans le besoin.

SOURCES :

1. *www.engineerscanada.ca/fr*
2. *https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=F* ■

By Adel Francis, P. Eng., M. Sc., Ph.D.

TRENDS IN CONSTRUCTION:

THE PORTRAIT, EVOLUTION AND LIMITATIONS OF AN INDUSTRY

CURRENT PORTRAIT

The construction industry is currently being shaped by transformative forces reminiscent of the first decades of the 20th Century, which saw the introduction of machinery. The current technological advancements and social pressures are forcing the industry to adapt its contractual, operational and technical modus operandi. On the one hand, technological changes have surpassed the industry's adaptation capacity. The digital revolution, the arrival of new technologies and the development of new construction techniques are all impacting the way industry stakeholders compete. On the other hand, this industry is grappling with rapid population growth in urban areas all around the world, creating greater demand for housing, infrastructure, transportation and public services. According to the United Nations Department of Economic and Social Affairs, 68% of the world's population is projected to live in urban areas by 2050.[1] The public authorities need to consider the significant impact of this industry on society, particularly in terms of the economic, social and environmental costs. A good example relates to the current initiative to embed information and communication technologies (ICTs) into city infrastructure to make the turn to smart cities and apply a governance model that integrates policies where human capital facilitates social, environmental, economic, educational and cultural development.[2]

The construction industry is also traditionally regarded as a fragmented industry that resists change and evolves slowly. During the last 20 years, productivity increased by only 1% per year, i.e. approximately one-third of the growth rate of the global economy and one-quarter of the growth rate of the manufacturing sector.[3] Although most other industries have experienced tremendous changes in the last decades and have harvested the fruits of process and product innovation, the construction industry has been hesitant to fully exploit the latest technological developments. This response may be fueled by a host of internal and external challenges, including the persistent fragmentation of the sector, insufficient collaboration with suppliers and subcontractors, the difficulties inherent with recruiting a talented workforce and an insufficient transfer of knowledge from one project to the next.[4]

TECHNICAL, METHODOLOGICAL AND TECHNOLOGICAL EVOLUTION

Trends in the construction industry are mixed. Improvements have been applied to many, but not all, processes, techniques, materials and tools. As a case in point, masonry has only partially taken advantage of technological progress. Despite integrating sophisticated scaffolding systems, lift trucks, power mixers and epoxy grout and additives to increase performance and adapt to the changing climate, the trade itself has essentially remained the same for thousands of years, and consists in laying brick on top of brick. Robotics and 3D printing in this sector will likely be a game changer in terms of accessibility, practical adaptability and cost. Computer-assisted design (CAD) is another good example. Computers replaced drawing tables, yet we are still drawing lines and arcs to produce the plans of future projects. Indeed, there have been few improvements in terms of sharing information and project knowledge.

Digitalization has, however, provided this industry with new impetus for growth. BIM, for instance, has changed the way different actors collaborate. The difference with CAD is that the new 3D software makes it possible to go beyond an object's geometry by integrating information directly into the model. These are parametric tools that rely on elements whose geometric properties have been programmed with relations and rules, i.e. parameters, families and hierarchies.[5] Digital models are useful even after the design phase, as information can be transferred and updated from one project phase to the next. 4D and 7D dimensions were added to BIM, integrating planning, cost estimation, sustainable development and energy efficiency, and operations.

Management and monitoring techniques, from risk management and quality assurance to worksite follow-up, are constantly improving. For instance, in project planning, methods such as the Last Planner System,[6] takt time planning[7] and spatiotemporal planning[8] have replaced or could replace traditional methods in the near future. Lean methods have also been introduced in order to optimize work processes and eliminate waste in the chain of operations.

Several new technologies have broken through and will continue to break through every day to impact the industry in the coming decades. Virtual and augmented reality, laser scanning, photogrammetry, RFID, drones, 3D printing, automation and smart materials all come to mind.

The still nascent Industry 4.0 will surely impact the construction industry over the long term. The objective of Industry 4.0 is to merge intellectual production with physical production, namely by integrating ICT with production methods.[9] According to Poirier,[10] Industry 4.0 could lead the construction industry to use big data in real time and automate tasks via artificial intelligence and machine learning.

OBSTACLES IN THE NEW TECHNICAL AND TECHNOLOGICAL LANDSCAPE

The construction industry has both micro and macro dimensions that add to the complexity of its evolution. The macro dimension depends on the stability, clarity and equity of the policies, laws and regulations; the impact of misaligned interests between large unions and associations; the contractual model and how it is applied, particularly in terms of defining new roles and responsibilities in the new technological landscape; and market composition, i.e. the size of companies and the multiplications of actors. However, since each country or region has its own specific characteristics that can change in keeping with orientations and interests, it would be for the most part inappropriate to generalize this dimension.

The complexity of the micro dimension simultaneously relates to the industry's difficulty with adaptation due to the unique characteristics of projects and resistance to change; the lack of maturity and adaptability of emerging technologies; the lack of interoperability between systems; and the loss of information throughout the project's life cycle, which in turn impacts the capitalization of knowledge and information exchange between projects. The challenge also involves dealing with occasionally conflicting objectives, such as viability, durability, adaptability, profitability, safety, comfort, and smaller carbon footprints, particularly in terms of energy efficiency and waste management.

Performance strategies that integrate adapted policies and contractual modes of operation and that boost market competitivity, combined with new techniques, processes and technologies, can lead to beneficial trade-offs. By involving different industry actors in re-engineering, value analysis, life cycle profitability, waste reduction and productivity gains, it becomes possible to strike a balance between these objectives. For example, improving the design quality of a project by rethinking its constructability and its future mode of operation enhances final product quality, extends its service life, decreases maintenance and repair needs, delays its replacement and decreases its impact on the economy and the environment.

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LES TENDANCES DANS L'INDUSTRIE DE LA CONSTRUCTION : ÉTAT, ÉVOLUTION ET LIMITES

ÉTAT DE LA SITUATION

L'industrie de la construction, depuis l'introduction de la machinerie durant les premières décennies du vingtième siècle, n'a jamais était poussée à évoluer de la même manière que l'on voit actuellement. Les présentes avancées technologiques et pressions sociales l'oblige à adapter ses modes contractuels, opérationnels et techniques. D'un côté, cette industrie est confrontée à une évolution technologique plus rapide que sa capacité d'adaptation. Le virage numérique, l'apparition des nouvelles technologies et le développement des nouvelles techniques de construction impactent l'état de la concurrence. De l'autre côté, cette industrie est confrontée à une augmentation rapide de la population des zones urbaines du monde. Ce qui implique une demande croissante en logements, en infrastructures, en transports et en services publics. Selon le département des affaires économiques et sociales des Nations Unies, 68 pourcent de la population mondiale devrait vivre en zone urbaine d'ici 2050.[1] Les instances publiques doivent ainsi considérer l'impact important de cette industrie sur la société notamment sur les coûts économiques, sociaux et environnementaux. Un bon exemple concerne l'initiative actuelle pour utiliser les technologies de l'information et de la communication (TIC) pour virer vers des villes intelligentes et appliquer une gouvernance qui intègre les politiques relatives au capital humain facilitant le développement social, environnemental, économique, éducatif et culturel.[2]

L'industrie de la construction est aussi traditionnellement perçue comme une industrie fragmentée, résistante aux changements et possède une lente évolution. Au cours des 20 dernières années, la productivité n'a augmenté que de 1% par an, soit environ un tiers du taux de l'économie mondiale et seulement environ un quart de celui de l'industrie manufacturière.[3] Alors que la plupart des autres industries ont subi d'énormes changements au cours des dernières décennies et ont récolté les fruits des innovations en matière de processus et de produits, cette industrie hésite à saisir pleinement les dernières opportunités technologiques. Ce bilan peut être attribué à divers problèmes internes et défis externes, notamment, la fragmentation persistante du secteur, la collaboration insuffisante avec les fournisseurs et les sous-traitants, les difficultés à recruter une main-d'œuvre talentueuse et le transfert insuffisant de connaissances d'un projet à l'autre, pour n'en nommer que quelques-uns.[4]

ÉVOLUTION TECHNIQUE, MÉTHODOLOGIQUE ET TECHNOLOGIQUE

En observant les tendances dans le domaine de la construction, nous remarquons une image mixte. Malgré l'amélioration de plusieurs processus, techniques, matériaux et outils, de nombreux autres restent essentiellement inchangées. La maçonnerie fournit un bon exemple. Une activité qui a profité partiellement de l'évolution technologique en intégrant des systèmes d'échafaudages sophistiqués, des chariots élévateurs, des mélangeurs motorisés et des mortiers époxydes et additifs qui augmentent la performance et l'adaptabilité au climat. Par contre, la pose elle-même n'a pas changée, depuis des milliers d'années, on place encore une brique sur une brique. Probablement, une évolution future de la maçonnerie robotique et de l'impression 3D, notamment en terme d'accessibilité, d'adaptabilité pratique et de coût d'utilisation, pourront changer la donne. L'introduction du dessin assisté par ordinateur (CAD) est un autre bon exemple. En effet, l'ordinateur a simplement remplacé la table de dessin. On dessine toujours des lignes, d'arcs pour représenter le plan du futur projet. Ainsi, le partage de l'information et des connaissances du projet a été peu amélioré.

Le virage numérique, donne actuellement une très bonne occasion à cette industrie pour se développer. L'introduction du BIM, par exemple, a comme effet de changer la manière de collaborer entre les différents acteurs. La différence avec le CAD réside dans le fait que les nouveaux logiciels 3D permettent de représenter plus que la géométrie d'un élément d'un bâtiment, en intégrant des informations au modèle. Il s'agit donc d'outils paramétriques à base d'objets dans lesquels un ensemble de relations et de règles permettent de définir des propriétés géométriques, à travers des paramètres, des familles de modèles et des hiérarchies de familles.[5] Au-delà de leurs utilités durant la phase de conception, ces modèles numériques permettent l'évolution de l'information entre les différentes phases du projet. Les dimensions 4D à 7D se sont introduites au BIM intégrant la planification, l'estimation des coûts, le développement durable et l'efficacité énergétique, et l'opération.

Que ce soit pour la gestion des risques, l'assurance qualité ou le suivi des chantiers, les méthodes et les techniques de gestion et suivi ne cessent d'évoluer. À titre d'exemple, pour la planification des projets, des méthodes telles que le last planer,[6] la planification Takt-time,[7] et la modélisation spatiotemporelle[8] remplacent ou pourront remplacer, dans un futur proche, les méthodes traditionnelles. Des méthodes Lean se sont aussi introduites afin d'optimiser les processus de travail et d'éliminer les gaspillages au sein de la chaine d'opération.

Plusieurs autres percées technologiques se sont ajoutées et continues de s'ajouter tous les jours et vont impacter l'industrie pour les décennies à venir. La réalité virtuelle et augmentée, les balayages laser, la photogrammétrie, la RFID, l'utilisation des drones, l'impression 3D, l'automatisation, et les matériaux intelligents, sont des bons exemples.

L'introduction, encore précoce, de l'industrie 4.0 à la construction impactera surement cette industrie à long terme. Cette industrie vise une connexion entre la production intellectuelle et la production physique. C'est un concept qui vise l'intégration des processus de production aux technologies et techniques de l'information. Il combine les méthodes de production avec les technologies de l'information et de la communication.[9] Selon,[10] son application à la construction peut se traduire à une utilisation des données numériques massives en temps réel et à l'automatisation des tâches par l'application de l'intelligence artificielle et l'apprentissage machine.

OBSTACLES AU VIRAGE TECHNIQUE ET TECHNOLOGIQUE

Dans l'industrie de la construction, la complexité qui impact son évolution réside dans ses deux dimensions macro et micro. Une dimension macro qui dépends de la stabilité, la clarté et l'équité des politiques, lois et règlements; de l'impact causé par les divergences entre les intérêts des divers syndicats et associations; du modèle contractuel et du mode de fonctionnement, notamment à la définition des nouveaux rôles et responsabilités dus au virage technologique; et de la composition du marché, notamment la grosseur des entreprises et la multiplication des acteurs. Puisque chaque pays ou région possède ses spécificités qui peuvent changer en fonction des orientations et des intérêts, une généralisation de cette dimension sera peu appropriée.

La complexité de la dimension micro concerne à la fois les difficultés d'adaptations de cette industrie due à l'unicité des projets et à la résistance aux changements; au manque de maturité et d'adaptabilité des technologies émergentes; au manque d'interopérabilité entre les systèmes et la perte de l'information tout au long du cycle de vie, ce qui impact la capitalisation des connaissances et des échanges d'information entre les projets. Le défi concerne aussi des objectifs qui sont parfois perçus comme contradictoires, tel que la viabilité, la durabilité, l'adaptabilité, la rentabilité, la sécurité, le confort, et la réduction de l'impact sur l'empreinte de carbone collective, notamment en matière d'efficacité énergétique et de gestion des déchets.

Des stratégies de performance qui intègrent des politiques et des modes d'opérations contractuels adaptés et qui augmentent la compétitivité du marché, combinées aux nouvelles techniques, processus et technologies peuvent faire en sorte de trouver des compromis bénéfiques. L'implication des différents acteurs de l'industrie dans la réingénierie, l'analyse de la valeur, la rentabilité sur le cycle de vie, la réduction du gaspillage et l'amélioration de la productivité peut aider à concilier entre ces objectifs. Comme exemple, l'amélioration de la qualité de la conception d'un projet en repensant sa constructibilité et son mode opératoire futur augmente la qualité finale du produit, prolonge sa vie utile, diminue le besoin d'entretien et de réparation, retarde son remplacement et diminue son impact sur l'économie et l'environnement.

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CSCE's Interview Series /
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Two Civil Engineers from different backgrounds agree on two key issues: Where CSCE needs to focus its efforts, and the #1 tip for future engineering graduates

This issue of MAD FOR ENGINEERING features two members from two very different backgrounds sharing their experiences with CSCE: how and why they joined; the journey it has taken them on; the great connections they have made; and a key tip they both agree is the best piece of advice for the next generation of engineers.

At what point in your engineering journey did you join CSCE and why?

BRENDA: I joined as a student during my undergraduate degree. I saw it as a great way to stay in touch with other students and connect across Canada. I'm a poor farm girl from northern Alberta – never intended to go to University – so I was a little older than my classmates. But I'm still in touch with many of them.

JÉRÉMIE: I joined as an undergraduate student as well. I had a friend who was involved with [the local] student chapter. She was leaving and I was able to take over her position until the end of my degree. I remained a CSCE member after graduation, and after six years, I joined the local section executive and became the Young Professionals Representative, then Vice Chair, then Chair of the East New Brunswick & PEI Section.

How did you realize what area of civil engineering you wanted to focus on?

BRENDA: It was serendipitous.Directly out of high school, I was working in land surveying and drafting for 11 years. Then realized I wanted more education. I chose engineering because I liked the infrastructure of it coming from a construction background; with land survey, it seemed to be a good fit. Becoming a professor was the result of going where the jobs are. My research focus on construction is the centre of all the disciplines. Geotechnical, transportation, etc., it's what makes them a reality.

FEATURING:

BRENDA MCCABE, FCSCE

SVP, Chair of Regional Coordinating Committee
Professor of Civil Engineering, University of Toronto
Toronto, Canada

JÉRÉMIE AUBÉ, MCSCE

Section Chair, East NB & PEI
Chair, Student Competitions
Civil Engineer, Transportation, Roy Consultants
New Brunswick, Canada

JÉRÉMIE: There's not really a family history in engineering – hopefully I'm paving the way for future relatives! I wanted to do bridges when I was a little kid, but after I did my first structures class, I realized it wasn't what I wanted to do. After the first 2 years of my degree, I saw more about transportation and was curious; learning about it through the final years of my bachelor made me realize that's what I wanted to do. I started my career with the New Brunswick Department of Transportation and Infrastructure, where my work focused mostly on highway work. After a stint in the municipal engineering world, I came back to transportation, where I discovered it was my true passion. Nine years now in the field and it's very dynamic; I meet lots of people from various fields and backgrounds, and I really like it.

How has civil engineering translated into your day-to-day life?

BRENDA: In a couple interesting ways. I used to be a sailor and I was learning about currents and going up wind – how to make the boat go faster and win races. I like understanding it from an engineering and physics perspective. But I went to the dark side – traded it in for a power boat! Exploring the canals and locks in Ontario is amazing. There's so much to do and discover using that mode of transportation . We're one of few boats on the lake with solar panels – we can be comfortable for weeks at anchor without a generator. That combination of bringing my technical knowledge to my pass time is a lot of fun!

JÉRÉMIE: I have an engineer's personality for sure. I'm very systematic. I'm also very organized and I believe it's an asset in my profession. It made me realize that the way I behave at work is very similar to my personal life, or vice-versa. I try to be efficient in everything that I do. But I'm not a robot, I swear!

What one area of civil engineering do you feel CSCE needs a more focused effort?

BRENDA: Women in engineering. We've been working on it for a long time. This summer at survey camp there were 50% women. Now we need to ensure that they have the opportunities to succeed in the industry! There's good work on equity, diversity and inclusivity getting started in CSCE to facilitate this. It's certainly going to be a focus for the next few decades.

JÉRÉMIE: I agree with Brenda. Women in engineering is something that is very much in the spotlight. I remember when I started my university degree about 15 years ago and they were talking about it then. We definitely see more women in STEM today, but still room for improvement and this is something we could and should increase even more. CSCE can certainly help and support the efforts in doing so!

What advice would you give young graduates?

For the answer to this question and more about their proudest moments in their work; how to get the most out of your CSCE network and more, log into the CSCE HUB to listen to the entire interview.

Closing comments?

BRENDA: Remember to have fun! Enjoy what you're doing, otherwise it makes for a long day. Work hard, but have fun.

JÉRÉMIE: I keep a Post-it on my computer that says 'Have fun'! We all get stuck in the professional-life routines, but you have to keep it fun. ■

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Glenn Hewus,
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Tony Bégin,
P.Eng., M. Sc., CDP, FCSCE

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