



CANADIAN CIVIL ENGINEER  
L'INGÉNIEUR CIVIL CANADIEN

2016 | WINTER/HIVER

- Envision Platinum Road Project
- Total Design at Hong Kong Airport
- Viaduct Challenges in Hong Kong
- Implications of China's Belt and Road Initiative

# LESSONS FROM ASIA LEÇONS D'ASIE



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On the cover: Hong Kong International Airport, Midfield Concourse, photo by Kerun Ip/AAHK





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## CSCE is relevant to the conversation

Civil engineering in Canada is evolving in a global market where the competition for resources continues to become more acute. In a highly competitive economy, all organizations and individuals should feel compelled to re-assess their priorities in order to ensure that limited resources are spent in ways that maximize their return on investment. CSCE must respond by ensuring that it is optimizing the use of its resources, and maximizing its return on investment for its stakeholders. CSCE continues to monitor industry trends in Canada and around the world, while encouraging member engagement so that the relevance of the CSCE organization will be clear.



The many conversations I have had about CSCE initiatives has confirmed to me that we are focused on issues of importance to corporate and individual members, as well as to other organizations across Canada and around the world interested in sustainable infrastructure. This year, CSCE has broadened its relationship with the Canadian Construction Association by partnering to develop and promote a Canadian Sustainable Infrastructure Rating System. The Association of Engineering Consulting Companies in Canada has formally supported this initiative, and other organizations such as Engineers Canada have also expressed interest. In November 2016, the CSCE lead a formal presentation of this initiative to Infrastructure Canada in Ottawa. This presentation was well received and as I write this article, InfraCan is considering its support of our initiative.

The Canadian Network of Asset Managers and CSCE signed a memorandum of understanding together at the 2016 Annual Conference in London, Ont. Our relationship has developed quickly and has recently resulted in the formation of a working group to identify ways of incorporating the skills required for managing infrastructure into the civil engineering curriculum across Canada. The need for asset management as part of developing sustainable infrastructure was identified by CSCE years ago, and we now know that we share this priority with CNAM. Engineers Canada is also interested in this initiative because of its responsibility for accreditation of all Canadian civil engineering programs.

Conversations with our corporate partners, such as Lafarge, Canam and SNC-Lavalin, have confirmed to me that CSCE's focus on sustainable infrastructure is valued. The companies and employees of these organizations are eager to participate in the development of new sustainable infrastructure innovations.

The message I have received from conversations with members is loud and clear: the CSCE must improve how we communicate with our stakeholders so they understand more clearly what innovations we are developing and why we think they should be listening. In fact, I believe this is

exactly the value proposition that our members are looking for: member access to new and industry-leading innovations, and an understanding of how CSCE is promoting sustainable infrastructure in Canada.

The role of the CSCE in Canada has become clear to me as my level of involvement has increased. We are uniquely positioned to develop and promote new innovations for Canadian sustainable infrastructure, and continued progress in this field is critical for Canadian prosperity now and into the future. I am confident that CSCE is a relevant and important contributor to this vision. ■

## La présence de la SCGC est pertinente au débat

L'ingénierie civile au Canada se développe au sein d'un marché international où la concurrence pour les ressources continue de devenir de plus en plus intense. Dans une économie hautement compétitive, toutes les organisations et les personnes devraient se sentir contraintes de réévaluer leurs priorités afin de s'assurer que les ressources limitées sont utilisées d'une manière permettant de maximiser leur retour sur investissement. La SCGC doit répondre à cette situation en s'assurant qu'elle optimise l'utilisation de ses ressources et qu'elle maximise son retour sur investissement au profit de ses parties prenantes. La SCGC continue d'être à l'affût des tendances de l'industrie au Canada et à travers le monde, tout en encourageant l'engagement des membres afin que la pertinence de la SCGC soit claire et évidente.

Les multiples conversations que j'ai eues à propos des initiatives de la SCGC m'ont confirmé que nous avons mis l'accent sur des questions primordiales et importantes pour les membres individuels et les membres d'entreprises, ainsi que pour les autres organisations à travers le Canada et à l'international se sentant concernées par les infrastructures durables. Cette année, la SCGC a élargi ses liens avec l'Association canadienne de la construction en collaborant conjointement à l'élaboration et à la promotion du système canadien de notation de

la durabilité pour les infrastructures. L'Association des firmes d'ingénieurs-conseils du Canada a soutenu officiellement cette initiative et d'autres organisations telles qu'Ingénieurs Canada ont également exprimé leur intérêt. En novembre 2016, la SCGC a procédé à une présentation formelle de cette initiative auprès d'Infrastructure Canada, à Ottawa. Cette présentation a reçu un bel accueil et, au moment où j'écris cet article, InfraCan considère sérieusement de soutenir notre initiative.

Le Canadian Network of Asset Managers (Réseau canadien des gestionnaires d'actifs) et la SCGC ont signé un protocole d'entente lors du congrès annuel 2016 de London (Ontario). Nos liens se sont développés rapidement et ont récemment mené à la formation d'un groupe de travail visant à identifier des façons d'intégrer les compétences requises à la gestion des infrastructures dans le cursus du génie civil à travers le Canada. La nécessité d'une gestion des actifs dans le cadre du développement des infrastructures durables a été identifiée par la SCGC il y a déjà plusieurs années, et nous savons maintenant que nous partageons cette priorité avec le CNAM. Ingénieurs Canada est également intéressé par cette initiative en raison de sa responsabilité en matière d'agrément de tous les programmes canadiens de génie civil.

*Suite à la page 6*

### CSCE LEADERSHIP IN SUSTAINABLE INFRASTRUCTURE: FIVE ADVOCACY POSITIONS

- 1 Innovative Procurement Practices
- 2 Long-Term Investment Planning
- 3 Measure Sustainable Performance
- 4 Leverage Asset Management Processes
- 5 Sustainability Education

### LEADERSHIP DE LA SCGC EN MATIÈRE D'INFRASTRUCTURES DURABLES : CINQ PLAIDOYERS STRATÉGIQUES

- 1 Pratiques d'approvisionnement novatrices
- 2 Planification à long terme des investissements
- 3 Mesurer le rendement durable
- 4 Utiliser au mieux des processus de gestion des actifs
- 5 Enseignement de la durabilité

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*Suite de la page 5*

Des discussions avec nos entreprises partenaires, tels Lafarge, Canam et SNC Lavalin, m'ont confirmé que l'accent mis par la SCGC sur les infrastructures durables est apprécié et justifié. Les compagnies et les employés de ces organisations sont enthousiasmés à l'idée de participer au développement d'innovations en matière d'infrastructure durable.

Le message que j'ai reçu de toutes ces discussions avec les membres est fort et clair : la SCGC doit améliorer la façon dont nous communiquons avec les parties prenantes afin qu'elles comprennent de manière plus limpide quelles sont les innovations que nous sommes en train de développer et pourquoi nous croyons qu'elles devraient nous écouter. En fait, je crois que c'est exactement la proposition

de valeur que nos membres recherchent : un accès des membres à des innovations à la fine pointe de l'industrie et une compréhension de la façon dont la SCGC fait la promotion des infrastructures durables au Canada.

Le rôle de la SCGC au niveau national devient de plus en plus clair pour moi au fur et à mesure que mon niveau d'implication augmente. Nous profitons d'une position unique afin d'élaborer et de promouvoir des innovations en matière d'infrastructures durables canadiennes et des progrès continus en ce sens sont primordiaux pour la prospérité actuelle et future du Canada. Je suis persuadé que la SCGC est un contributeur pertinent et important à cette vision. ■

## FROM THE REGIONS: SECTION NEWS | DE NOS RÉGIONS : NOUVELLES DES SECTIONS

## A rewarding year for the Montreal Section

Frédéric Brunet, AMCSCE

PRESIDENT, MONTREAL SECTION, CSCE

In Quebec, many large projects were started during the last year. For example, the construction of the new Champlain Bridge is among the largest infrastructure projects in Canada. For this reason, the Montreal Section of CSCE contacted the Signature on the St. Lawrence consortium to arrange site visits for more than 250 student members of the CSCE. This event attracted strong interest for the six student chapters of the Quebec Region.

Meanwhile, the first edition of the CSCE-CISC Canadian National Steel Bridge Competition was held last May in Montreal. It was organized jointly with the Canadian National Concrete Canoe Competition at McGill University. This initiative of the Montreal Section was a success. A second edition will take place at Laval University in May 2017. All Canadian universities are invited to participate.

Also, the Montreal Section has planned six conferences to take place on the last Monday of each month. In order to gather as many participants as possible, the conferences will focus on topics relating

to the different spheres of civil engineering without being too technical. For example, two of our conferences will address the role of the international engineer and will be presented by speakers working for companies active in various areas of expertise. Specifically, the CEO of Engineers Without Borders Québec will be invited to promote international aid, while the various job prospects abroad will be presented by an engineer who worked abroad for several years.

We are also planning the third edition of our career forum; about 100 students and professionals are expected to participate.

The Montreal section is also completing the design of a new website in order to modernize and standardize the image of the CSCE sections in the Quebec region. In addition to centralizing information and increasing the visibility of our partners, this initiative facilitates the promotion of the upcoming events on different social networks.

If you have suggestions or are interested in knowing more about our activities and our events, please contact me: [president@scgc-montreal.ca](mailto:president@scgc-montreal.ca). ■

## Une année enrichissante pour la section de Montréal

Frédéric Brunet, MASCGC

PRÉSIDENT, SECTION DE MONTRÉAL DE LA SCGC

Au Québec, plusieurs projets d'envergure ont été entamés durant la dernière année. Notons par exemple la construction du nouveau pont Champlain qui s'inscrit parmi les plus importants au Canada. À cet effet, la section de Montréal a contacté le consortium Signature sur le St-Laurent afin d'organiser des visites de chantier qui permettront à plus de 250 membres étudiants de la SCGC de visiter l'ampleur de ces travaux colossaux et pour le moins uniques. Cet événement a suscité un intérêt marqué pour les six chapitres étudiants de la Région du Québec.

En mai dernier, la première édition du Concours national canadien de pont d'acier de la SCGC s'est tenue à Montréal. Elle était organisée conjointement avec le Concours national canadien de canoë de béton de la SCGC à l'Université McGill. Cette initiative de la section de Montréal fut un succès. Une deuxième édition se déroulera à l'Université de Laval en mai 2017. Toutes les universités canadiennes sont invitées à y participer.

D'autre part, la section de Montréal a programmé six conférences qui se dérouleront le dernier lundi de chaque mois. Afin d'attirer un maximum de participants, les conférences seront axées sur des sujets touchant les différentes sphères du génie civil, sans pour au-

tant être d'un niveau technique trop avancé. Par exemple, deux de nos conférences traiteront du rôle de l'ingénieur à l'international, mais seront présentées par des conférencières œuvrant dans des entreprises actives dans des domaines différents. En effet, la directrice générale d'Ingénieurs sans frontières Québec sera invitée à promouvoir l'aide internationale, alors que les différentes perspectives du travail à l'étranger nous seront présentées par une ingénieure qui a travaillé à l'extérieur du pays durant plusieurs années. Finalement, nous tiendrons la troisième édition de notre forum carrière à laquelle une centaine d'étudiants et de professionnels prendront part.

La section de Montréal termine actuellement la conception d'un nouveau site web dans le but de moderniser et d'uniformiser l'image des sections de la région du Québec. En plus de centraliser l'information et d'accroître la visibilité de nos partenaires, cette initiative permet de faciliter la mise en ligne des événements sur les différents réseaux sociaux.

Si vous avez des suggestions ou vous souhaitez recevoir plus d'informations sur nos activités et nos événements, n'hésitez pas à me contacter: [president@scgcmontreal.ca](mailto:president@scgcmontreal.ca). ■

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## Insight into 10 years of successful student chapter activity

Spencer Behn, Riley Brown and Brett Cheek  
CO-PRESIDENTS, CSCE STUDENT CHAPTER, BCIT

The 2016/2017 school year is a milestone at the British Columbia Institute of Technology as it marks both the 10th year of graduating students from the school's civil engineering degree program, as well as the 10th anniversary of the formation of our CSCE student chapter.

Since forming the chapter in 2006, BCIT has been home to one of the most active chapters in Canada. This chapter often achieves 100 per cent membership. Student members at BCIT have enjoyed a high participation rate in technical seminars, professional networking and social events. One of the highlights of each school year is our annual BCIT CSCE Professional Night, which is attended by hundreds of students and local practitioners.

This combination of participation and activity has already earned our relatively young chapter the CSCE President's Award for Best Student Chapter three times, most recently in 2016. As the current co-presidents, here is our insight into what has contributed to establishing such

a successful chapter.

A strong sense of camaraderie exists amongst BCIT civil engineering students, faculty and staff. Having a relatively small number of students organized into a cohort model gives our student chapter the opportunity to enhance this community. Also, a high magnitude of faculty support is critical to our success and continuity. Planning for each academic year begins during the summer break, when our chapter's incoming leadership and faculty advisors meet to organize events and goals for the year to come.

In summary, we encourage other chapters to start early, engage with their own student body and advocate for faculty support to help achieve their chapter goals. We look forward to meeting other chapter leaders and CSCE members during the upcoming annual conference and AGM being held in Vancouver May 31 to June 3, 2017, where you can be sure you'll see our members volunteering. ■

## 10 années de succès pour notre chapitre étudiant

Spencer Behn, Riley Brown et Brett Cheek  
COPRÉSIDENTS, CHAPITRE ÉTUDIANT DE LA SCGC, BCIT

L'année universitaire 2016-2017 est une étape clé pour le British Columbia Institute of Technology. Il s'agit de la 10e année de la remise de diplômes aux étudiants du programme de baccalauréat de génie civil de l'Institut, ainsi que le 10e anniversaire de la formation de notre chapitre étudiant de la SCGC.

Depuis qu'il a créé le chapitre en 2006, le BCIT a abrité l'un des chapitres étudiants les plus actifs au Canada. Souvent, la totalité des étudiants en sont membres. Leur participation aux séminaires techniques, aux activités de réseautage professionnel et aux événements de nature sociale est toujours élevée. Chaque année, un des faits marquants est notre Soirée annuelle des professionnels de la SCGC à laquelle participent des centaines d'étudiants et de professionnels de la région.

Cette combinaison de participation et d'événements renommés a déjà permis à notre chapitre relativement jeune de remporter trois fois le Prix du président du meilleur chapitre étudiant de la SCGC. Le prix le plus récent nous a été remis en 2016. En tant que coprésidents actuels, voici les raisons qui, selon nous, ont contribué au succès de notre chapitre

étudiant.

Il existe un fort sens de la camaraderie entre les étudiants en génie civil, le personnel enseignant et le personnel de soutien du BCIT. Le fait d'avoir un nombre relativement limité d'étudiants organisés en cohortes procure à notre chapitre étudiant l'occasion de mettre en valeur cette communauté. Par ailleurs, un soutien fort de la faculté est extrêmement important pour notre succès et notre pérennité. La planification de chaque année universitaire débute durant la pause estivale, lorsque les nouveaux dirigeants du chapitre et les conseillers du département se rencontrent pour organiser les événements et établir les objectifs pour l'année à venir.

En terminant, nous encourageons les autres chapitres à s'organiser tôt, à s'impliquer auprès de leur propre association étudiante et à chercher le soutien de la faculté afin de contribuer à la réalisation de leurs objectifs. Nous avons bien hâte de rencontrer d'autres dirigeants de chapitres étudiants et les membres de la SCGC lors du prochain congrès annuel et l'AGA qui se tiendront à Vancouver, du 31 mai au 3 juin 2017. Il est certain que nos membres y participeront comme bénévoles. ■





## Shaping the young professionals program at CSCE 2017 Vancouver

**Stanley A. Chan, M.Eng., EIT**  
 CSCE 2017 VANCOUVER CONFERENCE,  
 YOUNG PROFESSIONALS COORDINATOR

It is an exciting yet challenging time to be young professional engineers, as we are expected to take on greater responsibilities and step into leadership roles faster than ever before. Engineers Canada has predicted a significant shortage of experienced engineers over the next two decades, as 95,000 professional engineers will retire by 2020.

This shortage is addressed by one of CSCE's Vision 2020 goals – growing with youth. CSCE has several initiatives at the national level aimed at assisting our young professionals in accelerating their career growth and development. These initiatives include the recently launched mentorship

program and the active Young Professional Committee with representatives across Canada.

CSCE's commitment to our young professionals will also be reflected at the CSCE 2017 Conference in Vancouver. The young professionals program at the conference will feature workshops and networking events which cater specially to young professionals.

I am honoured to be able to serve as the young professionals coordinator at the CSCE 2017 Vancouver conference. I call upon our young professionals to step forward and take on leadership roles in the planning and execution of these events at the conference. I encourage you to contact me with ideas on how to shape our young professionals program at the CSCE 2017 conference ([stanleyachan@gmail.com](mailto:stanleyachan@gmail.com)). ■

## Élaboration du programme des Jeunes professionnels de la SCGC pour Vancouver 2017

**Stanley A. Chan, M.Eng., EIT**  
 COORDONNATEUR DES JEUNES PROFESSIONNELS,  
 CONGRÈS DE LA SCGC, VANCOUVER 2017

Nous sommes dans une période passionnante et stimulante pour les jeunes ingénieurs professionnels, d'autant plus que nous nous attendons à prendre de plus en plus de responsabilités et à obtenir plus rapidement que jamais des rôles de dirigeants au sein de la profession. Ingénieurs Canada a prédit une importante pénurie d'ingénieurs d'expérience au cours des deux prochaines décennies, alors que 95 000 ingénieurs professionnels prendront leur retraite d'ici 2020.

Cette pénurie est abordée par l'un des objectifs de Vision 2020 de la SCGC : Croître avec les jeunes. La SCGC peut compter sur plusieurs initiatives au niveau national visant à aider nos jeunes professionnels à accélérer leur croissance professionnelle et leur développement de carrière. Ces initiatives incluent le programme de mentorat récemment mis sur pied ainsi que le Comité des jeunes professionnels, très actif et représenté partout au Canada.

L'engagement de la SCGC envers nos jeunes professionnels se reflétera également lors du

congrès 2017 de la SCGC qui se tiendra dans la ville de Vancouver. Le programme des jeunes professionnels à ce congrès comportera des ateliers et des événements de réseautage s'adressant tout particulièrement aux jeunes professionnels.

Je suis honoré d'occuper la fonction de coordonnateur des Jeunes professionnels lors du congrès de Vancouver 2017 de la SCGC. J'encourage nos jeunes professionnels afin qu'ils assument des rôles de leaders dans la planification et de la tenue de ces événements. Je vous encourage à me contacter pour me faire part de vos idées sur la façon de structurer notre programme à ce congrès ([stanleyachan@gmail.com](mailto:stanleyachan@gmail.com)). ■

### Flood Control in Residential Neighbourhoods



The West Thornhill Flood Control Program includes the construction of new large diameter storm sewers in mature residential neighborhoods with limited working space available. RVA was retained by the City of Markham to provide design services for the program. Construction was successfully completed on Phases 1A and 1B in the fall of 2015 and 2016, respectively. Phases 1C and 2A are currently under construction.



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# Barriers and solutions to achieving sustainable infrastructure

By Doug Salloum,

EXECUTIVE DIRECTOR, CSCE

People have been talking about sustainability and sustainable development for a generation, at least since the 1987 Brundtland Commission Report, but for many engineers these terms are overused and rather vague. Design challenges call for practical tools and the Brundtland Commission did not provide these.

Developments in the last 10 years, however, make it possible for civil engineers to contribute in a meaningful way to the sustainability conversation. This article is about two of these recent developments: infrastructure sustainability assessments and economic evaluation of social and environmental benefits.

## The role of CSCE

The Canadian Society for Civil Engineering is committed to leading our profession from the vision of the Brundtland Commission to something more practical.

1. Since civil engineers design, build, operate and maintain infrastructure, CSCE decided that our contribution to the sustainability conversation should be to focus on making infrastructure more sustainable;
2. We initiated the CSCE Award for Governmental Leadership in Sustainable Infrastructure to recognize public sector leaders whose decisions lead to better infrastructure. We have awarded this prize five times since 2012 and the prize winners have informed our understanding of what is possible;
3. CSCE also studied failing or failed infrastructure. The Gardiner Expressway in Toronto and the Turcot Interchange and the Champlain bridge in Montreal provided lessons in what not to do;
4. Combining what we learned from the best and worst of contemporary infrastructure led us to a working definition of sustainable infrastructure, and;
5. CSCE identified the remaining barriers to sustainable infrastructure. We survey the world for solutions to these barriers and we are committed to sharing lessons learned with our members and the Canadian public.

## A working definition of sustainable infrastructure

Our definition of sustainable infrastructure is evolving but here it is, in two parts:

1. Sustainable infrastructure must last — a service life of 200 years is not unrealistic, and;
2. Sustainable infrastructure must deliver economic, social and envi-

ronmental benefit throughout its operating life.

The first part of this definition is the home turf of civil engineers. We have the experience and technical knowledge to build infrastructure that lasts by using the best materials, designs and construction techniques.

The second part of the definition is trickier. According to our definition sustainable infrastructure doesn't just avoid doing social and environmental harm, it actually creates positive social and environmental impacts.

This two-part definition leads to the conclusion that if civil engineers want to fully participate in the development of sustainable infrastructure we will have to leave our technical comfort zone as designers of someone else's project and engage in the larger conversation on why we build infrastructure in the first place and how we can create not only economic benefits but also social and environmental benefits. This is a new and uncomfortable perspective for civil engineers. It is also highly political... which leads to a discussion of the remaining barriers to building more sustainable infrastructure.

## Barriers to sustainable infrastructure

The challenges that remain to the design and construction of more sustainable infrastructure can be organized as follows:

- Design challenge — now that we know what it is, how do we design sustainable infrastructure?
- Procurement challenge — how do we get sustainable designs into project specifications?
- Political challenge — how do we overcome lowest capital cost tendering requirements?

I will deal with the first two challenges together, because there is a common answer to these questions, and that answer is infrastructure sustainability assessment. The answer to the third challenge is triple-bottom-line economic modelling.

## Infrastructure sustainability assessment

The best known assessment process, at least in North America, is Envision, a template developed in the U.S. by the Institute for Sustainable Infrastructure. Several hundred engineers and non-engineers across Canada are trained in Envision and carry the designation ENV SP (Envision Sustainability Professional). As of the date of this article at least a dozen projects in this country have been assessed or are being assessed





The Victoria Bridge - constructed in the 1860s, modified and rebuilt several times - is still providing benefits to Montreal and the region.



Photo: Doug Kerr via Wikimedia Commons.

The Champlain Bridge - also serving Montreal, constructed in 1960s, soon to be replaced and torn down - is not an example of sustainable infrastructure.



Photo: CapturaCamera via Wikimedia Commons.

using Envision, and two have received Platinum Awards.

Following the Envision template, under the leadership of an ENV SP, project proponents at the local community level assess the value of the proposed infrastructure, including asking whether the project should even be built. If the team determines the project should go ahead they are encouraged to improve the project, by adding new features that will deliver incremental economic, social and environmental benefits to the community.

The application of a well-designed infrastructure sustainability assessment process results in infrastructure that is more sustainable from the concept stage. Sustainable elements can then be incorporated into the project design specifications and tendered for construction.

## Economic analysis

Whereas the application of an assessment process like Envision will result in a more sustainable design, how does the local politician justify spending taxpayers' money on incremental social or environmental benefits, if the more sustainable option is also more expensive than the basic solution? A cost benefit analysis (CBA) can help, but when it comes to infrastructure decisions CBA tends to overlook a project's social and environmental benefits. What is needed is a true triple-bottom-line (TBL) analysis. Triple-bottom-line as a phrase is almost as overworked as "sustainable development," but there are practical developments to report here also.

Models that can calculate the value of social or environmental benefits have until recently been expensive and proprietary. Open source, cloud-based economic modelling has broken down these barriers. Simulations that might once have cost \$200,000 can now be run for a cost in the range of \$5,000 per scenario, and;

Empirical research has progressed to the point where there is broad academic agreement on the economic value of a range of environmental and social benefits, for example: an acre of wetland or forest, a ton

of carbon dioxide, etc.

Combining cheap analytical tools with standard social and environmental input values means TBL analysis is now feasible for most infrastructure projects. The economic value of the social and environmental elements of the project can now be correctly factored into the analysis. This means that infrastructure options can be ranked in terms of full net present value or return on investment. If the net present value of a sustainable project is higher than that of a more basic design, local politicians will find it much easier to champion the sustainable option.

## Bottom line

CSCE believes the application of infrastructure sustainability assessments makes projects more sustainable, starting from conception through to the design, tendering and construction stages of the project.

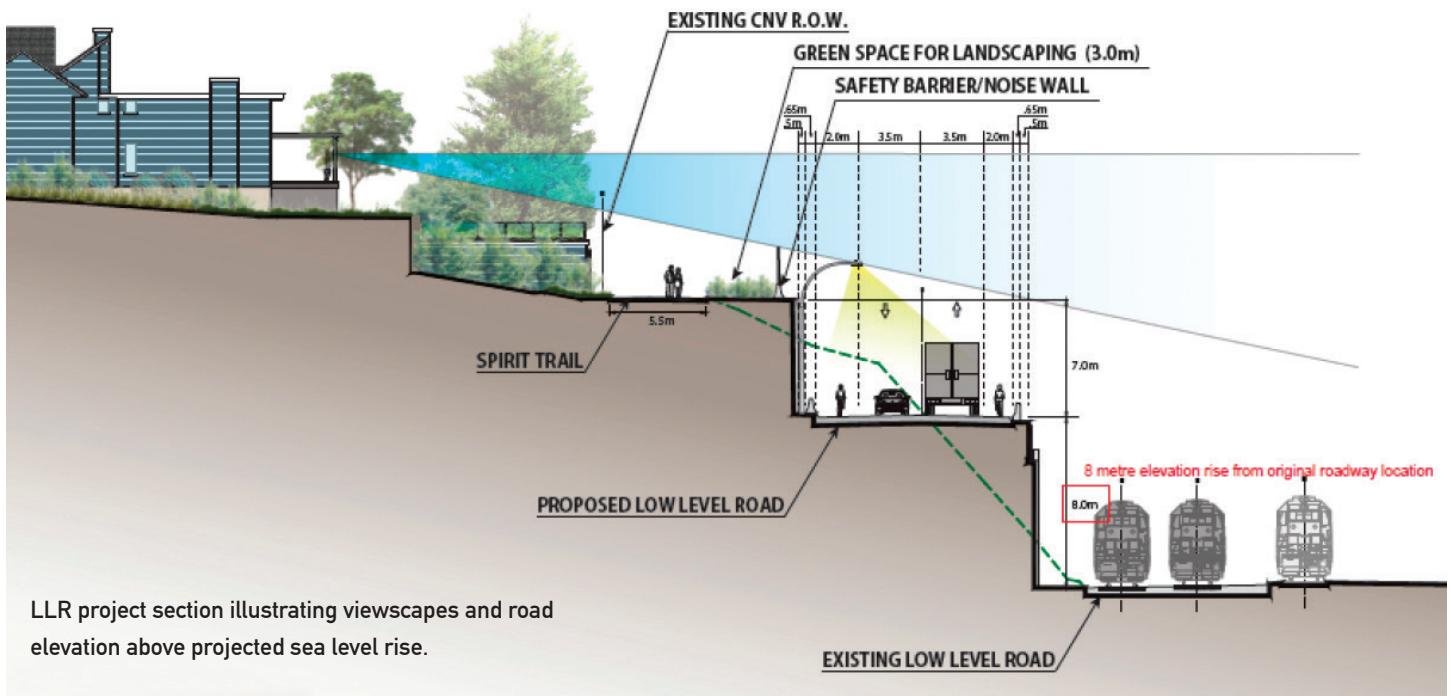
With the addition of cloud-based open-source economic modelling and standard accepted values for environmental and social benefits, analysts can use TBL analysis to rank infrastructure investment options and politicians can allocate public funds to infrastructure projects, starting with the projects that have the highest NPV.

## Ongoing work

CSCE is committed to developing a Canadian infrastructure sustainability assessment process that incorporates TBL analysis. The Canadian Construction Association and Canadian Construction Innovation are partners with CSCE in this work.

Articles on sustainable infrastructure will be posted on the CSCE website and Facebook page. Winners of past CSCE Awards for Governmental Leadership in Sustainable Infrastructure, as well as the criteria for nominations, are also on the CSCE website, under the section called Sustainable Infrastructure.

I welcome contributions to and comments on this important civil engineering theme. ■



LLR project section illustrating viewscales and road elevation above projected sea level rise.

Stantec

# Low Level Road Project – Envision Platinum

**The Low Level Project in North Vancouver was the first transportation infrastructure project to receive an Envision award from the Institute for Sustainable Infrastructure.**

By Lourette Swanepoel, RPP, ENV SP and Eric Dunford, ENV SP, Stantec

Public infrastructure is the critical backbone of our cities and communities — yet it is too often constrained by a “satisfy the need at the lowest cost” mentality. While cost concerns for public infrastructure are crucial, they can no longer be considered the sole driving force for defining a “good” project. Modern public infrastructure assets are expected to do more than their core function. A good project will integrate with the local context, provide aesthetic beauty, contribute to biodiversity, and it must be resilient to climate risks and other hazards and threats. So how do we

achieve these shared value benefits?

## History of the project

Stantec designed the Low Level Road project in the City of North Vancouver, B.C., which arose from the need to expand rail capacity to support more efficient goods movement. The project required the realignment of 2.6 kilometres of arterial road to enable the rail expansion. At the same time, the City of North Vancouver had identified the need to address transportation improvements and historical safety concerns associated with an unstable hillside slope running parallel to the existing roadway.

The planning process began in 2008. Following the completion of an Environmental

Impact Assessment by Port Metro Vancouver, the design was presented to the City of North Vancouver in June 2011. Despite the commercial urgency of this project, the design was not supported by city residents and was subsequently rejected by the city council. During the following redesign process, the Port undertook deeper community engagement and sought out a more comprehensive tool to help assess and guide the project.

## Envision – incorporating and assessing sustainability

The concept of a consistent standard for sustainable performance has been a part of the buildings industry for some time, most notably represented by the LEED system. In 2012, the Envision framework and rating system were released, offering a resource for civil infrastructure professionals. Similar to LEED, Envision



projects must demonstrate achievement and innovation beyond industry standards or regulatory requirements to earn credit. Projects are reviewed by independent third party verifiers; and they must meet scoring thresholds to be recognized with an Envision award.

The Envision framework was applied late in the design phase for the Low Level Road project. It subsequently earned the Envision Platinum award from the Institute for Sustainable Infrastructure (ISI). It was also the first transportation infrastructure project to receive an Envision award.

Envision assesses the sustainability of infrastructure projects against 60 criteria organized in five areas: Quality of Life, Leadership, Natural World, Resource Allocation, and Climate and Risk.



Photos: Stantec

## Recognized in five categories

Ultimately, the Low Level Road earned achievement scores across all five categories of the Envision framework, excelling in the Quality of Life and Climate and Risk categories. Below are some of the project features that were recognized in each category.

### 1. QUALITY OF LIFE

- Close collaboration between stakeholders and community leaders, including the Government of Canada, Canadian National Railway, Translink, Canadian Pacific Railway, terminal operators, the City of North Vancouver, etc.
- Economic benefits generated are expected to support an additional 5,000 jobs and contribute more than \$7.9 billion annually for B.C.
- Demonstrated efforts to reduce impacts on local residents, including the addition of noise reduction walls, maintaining and enhancing viewscales, and reducing lighting impacts.

### 2. LEADERSHIP

- A holistic stakeholder engagement program and interactive website platform (PortTalk.ca) that were used during the design process to ensure that the final design appropriately

Artwork on retaining walls.



Pedestrian overpass at E 3rd Street

OWNER/CLIENT: City of North Vancouver, Port of Vancouver  
 PRIME CONSULTANT: Stantec  
 CONTRACTOR: B&B Heavy Civil  
 PROJECT MANAGEMENT: MMM/WSP  
 OTHER KEY PLAYERS: Delcan/Parsons (traffic management), Morrison Hershfield (woodland bridges design check), De Leur (road safety audit), Levelton (concrete testing), ME2 Transportation Data (traffic analysis), Protech Surveys (field surveying), Arbortech /ACL (arborist)



reflected community needs and priorities.

- “Walking the talk” through a demonstrated alignment between project objectives and broader corporate sustainability policies and objectives.
- A value-engineering study and a one-day workshop that explored potential cost-saving measures and possible design changes, resulting in an estimated \$40.5 million savings in construction costs.

**3. RESOURCE ALLOCATION**

- LED streetlight fixtures used in the project that led to 42 per cent annual energy reductions.
- Reusing 50 per cent of excavated materials on-site, thereby reducing import costs, as well as truck traffic and its associated emissions during construction.
- Sourcing more than 60 per cent regional and local materials for aggregate and sands, concrete, landscaping, and soils and mulches.

**4. NATURAL WORLD**

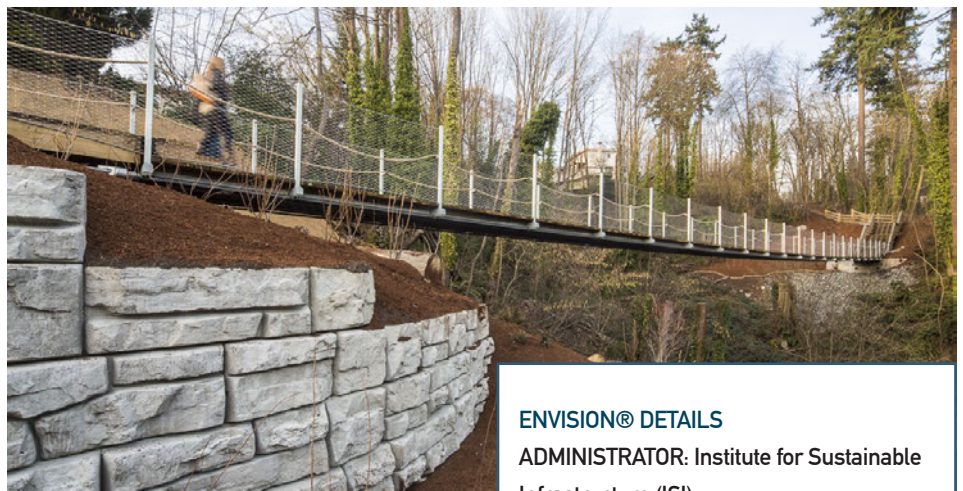
- Preservation of trees colonized by bald eagles mid-way through site construction. The port hired eagle experts to provide recommendations on how to minimize impacts on the birds’ health and wellbeing. The project also included the installation of two artificial nesting sites for eagles.
- Specification of native, xeriscape landscape species, and establishing a program for the removal and ongoing management of invasive plant species.

**5. CLIMATE AND RISK**

- Enhancement of long-term adaptability and resilience by aligning the design with the city’s adaptation plan. The road profile was raised above the projected 200-year Flood Construction Level – accommodating a two-metre rise in the sea level.
- Complementing road improvements with improvements to alternative modes, such as a dedicated cycling lane, enhanced transit facilities, and expansion of the city’s Spirit Trail.



New overpass at Neptune/Cargill terminal entrance.



Suspension Spirit Trail bridge.

- Stabilizing the eroding embankment that had been putting residential properties at risk from landslides.

**What is next for the industry?**

In September 2015, the Low Level Road became the first transportation sector project and only the second in Canada to achieve an Envision award. Since that time, the number of certified projects has grown to 21 across North America. With a growing number of public agencies indicating their interest in requiring or incentivizing the use of Envision for public infrastructure, both in Canada and beyond, Envision is quickly joining LEED as one of the key tools available to public agencies to advance the sustainability of not just their buildings, but now also their civil infrastructure. Every civil infrastructure could — and should — use a comprehensive framework like Envision to

**ENVISION® DETAILS**  
**ADMINISTRATOR:** Institute for Sustainable Infrastructure (ISI)  
**WEBSITE:** [sustainableinfrastructure.org](http://sustainableinfrastructure.org)  
**SINCE:** 2010  
**ORIGINAL PARTNERS:** APWA, ASCE, ACEC, Harvard University  
**PROJECTS CERTIFIED as of September 2016:** 21  
**ACCREDITED PROFESSIONALS as of September 2016:** About 4,800 ENV SP

prompt design teams and project owners to think more holistically.

View more about the project and watch the video at [www.stantec.com/our-work/low-level-road](http://www.stantec.com/our-work/low-level-road) ■

*Lourette Swanepoel is a Registered Professional Planner and accredited Envision Sustainability Professional (ENV SP) and ISI trainer with Stantec in Vancouver. Eric Dunford is an accredited Envision Sustainability Professional (ENV SP) and trainer with Stantec in Toronto.*



Value engineering led to the construction of fewer but heavier segments for the bridge.

Photos: Hong Kong Engineer.



# Overcoming a viaduct challenge through innovation

**Engineers in Hong Kong used the “beam and winch” method of precast segmental construction to build a viaduct in the MTR South Island Line (East) railway.**

By Angela Tam, Editor,  
Hong Kong Engineer

Challenges and innovation are, as engineers know, closely connected. Without challenges, there would be no innovation. If engineers could always build on bare, greenfield sites, there would be no need to devise new types of structures or construction techniques.

The construction of the MTR South Island Line (East) (SIL(E)) is a good example of how diverse challenges can spur the adoption of innovative solutions, particularly on the viaduct section under Contract 903.

SIL(E) is a 7-km long medium-capacity

railway designed to run from Admiralty to South Horizons in Ap Lei Chau. The detailed design of Contract 903, which involves the construction of Ocean Park Station, Wong Chuk Hang Station, 2 km of viaducts and a new Aberdeen Channel Bridge, was carried out by Atkins. The consultant also redesigned some elements of the project following the award of the target cost contract to Leighton Contractor (Asia) Ltd.

There are three viaduct sections on Contract 903. Emerging from the tunnel under Aberdeen Country Park, the first viaduct



Works on the Aberdeen Channel Bridge.

Photos: Hong Kong Engineer.

section crosses the approach roads of the Aberdeen Tunnel to reach Ocean Park Station. The second section runs between Ocean Park and Wong Chuk Hang Stations, and the third section runs from Wong Chuk Hang Station to the Aberdeen Channel Bridge. About 800 metres of the last two sections of viaducts had to be built on top of the nullah<sup>1</sup> that runs to the south of Heung Yip Road.

### Beam-and-winch

Traditionally, launching gantries are used to place precast concrete segments for viaducts to eliminate the need to erect falsework for in-situ construction, which was not a viable option where the SIL(E) viaduct crosses the Aberdeen Tunnel approach roads due to the amount of traffic that would have to be diverted. However, launching gantries also posed their own challenges for this project.

“A traditional launching gantry is quite big, about 60-70 m long, and spans two piers. It would need a big site for assembly but we have limited works area. Even the assembly of such a gantry over two piers would require a long period of road closures, which

was not possible. Furthermore the viaduct alignment’s tight curve also imposes another difficulty for using launching gantries,” said Ir Jimmy K K Poon, construction manager - SIL civil.

This challenge spurred the adoption, for the first time in Hong Kong, of the “beam-and-winch” method of precast segmental construction. Developed in Italy but more often used in the U.S., the method involves the use of small gantries about one-tenth the size of a traditional launching gantry to lift precast concrete segments next to the pier. The process began with the erection of four pier segments by mobile crane, followed by the lifting in place of a pair of small gantries to winch successive segments up from the ground for balanced cantilever erection. The segments were winched during night-time road closures and prestressed, then the gantries would travel out over the erected segment and repeat the process until it met up with the last segment erected from the next pier.

The gantries, which are about 8 m long, are much smaller than traditional launching gantries, which are approximately 100

m in length. For this reason, they also took much less time (one week vs. one month) to assemble. The method was used to erect the viaduct from the Aberdeen Tunnel to the nullah. Gantry cranes were used to erect the segments in the other sections, where space was available for manoeuvring the cranes.

“Mobile cranes are cheaper where there is space but where there [is] lots of live traffic then mobile cranes become more expensive. The beam-and-winch method minimized disruption to the public as well as mobilization cost,” said Ir Poon.

The viaducts required 628 segments that weighed 22-55 tonnes each. They were precast in Dongguan and brought to site by two routes. Initially they were transported to site by trucks via the Aberdeen Tunnel; later they were brought by sea to a barging point in Sai Wan then taken to site via Pokfulam Road as there is no suitable barging point on the south side of Hong Kong Island. Due to the shortage of storage space, the segment production rate at the precasting factory and the erection rate on site were closely coordinated, allowing 20-30 segments to be temporarily

<sup>1</sup> Nullah – a stream, or watercourse, in a steep narrow valley. In Hong Kong, the term generally refers to a concrete-lined channel designed to allow rapid runoff of storm water from high ground.



stored on site at a time.

According to Ir Poon, work over the nullah was dependent on the season. As its flow capacity must be maintained at all times, work within the 18-m wide nullah was restricted to the dry season between November and April. Since the construction inside the nullah of the foundation for Wong Chuk Hang Station would affect its capacity, compensatory widening of the channel was carried out by demolishing the nullah's south wall in order to extend its width by 4-6 m. A deck was also added, turning the nullah into a box culvert, to provide more space to accommodate the public road widening.

To minimise the impact of potential noise from railway operation on neighbouring residences, noise barriers that have been designed to blend in with Southern District's green environment as well as integrate with the overhead line are provided as necessary on the viaducts. Traditional MTR noise barriers feature a separate support system for the overhead line masts, which require more headroom. On the SIL(E) viaducts, the green noise mitigation panels are supported by arch beams that also carry the overhead line. This streamlined design optimises the height of the noise barriers to 6 m, compared with 9 m for those on West Rail Line.

## Aberdeen Channel Bridge

The new Aberdeen Channel Bridge was cast in-situ with a form traveller using the balanced cantilever method. The 250-m long bridge has a 115-m span over the marine channel. To construct the bridge's intermediate supports, a tower crane was set up on the marine pier and two form travellers were lifted in place to construct the segments, one on either side of the pier, until the section reached the middle of the channel. A tower crane was then set up on the onshore pier on the opposite side and form travellers were again lifted in place to cast the segments. A mid-span stitch tied the two sections together while end stitches anchored the bridge to their end span support on both sides. In total 24 pairs of segments weighing up to 160 tons

were cast for the bridge. By using modular form travellers to cast the segments in-situ, traffic through the marine channel was maintained throughout the construction period.

As there is a small, 5-m separation between the new bridge and the existing road bridge, care had to be taken to ensure the safety of traffic on the latter. The movement of the tower crane was therefore restricted to within the boundary of the new bridge. As a 40-m wide navigation channel had to be maintained, a small barge was used for the construction of the pier foundation and pile cap within a silt curtain to protect the marine environment.

During the works about 7 cu. m of contaminated sediments were dredged from the channel. The conventional approach towards the disposal of contaminated mud is to dispose of it at an approved pit in East Sha Chau. However, a more environmentally friendly solution was developed whereby the marine sediment, which was contaminated with heavy metals, was stabilised by combining it with cement and granite and used as backfill elsewhere on the project. The innovative approach secured the approval of the Environmental Protection Department under a Variation of Environmental Permit (VEP) and won a Bronze Award at MTR's in-house Projects Innovation Conference 2014.

## Target cost benefits

According to Ir Poon, the project has benefited from the target cost contracting approach, which helped in the early planning of the seasonal work over the nullah. After the first stage of the two-stage tendering process, two contractors were selected out of several bidders for stage two tendering, during which both were paid to share their construction methods and value-engineered alternative designs with MTR. The discussion over several months with both contractors facilitated planning of the contract and gave the contractors time to familiarize themselves with the project's requirements, thus reducing set-up time when construction commenced. After completion of the assessment of the

technical and commercial tender submissions, the contractor was selected based on the tender providing the lowest outturn cost to MTR.

One example of the benefit derived from using value engineering solutions involves the use of a single, 2.8-m diameter bored pile to replace three small diameter piles to support a pier on Wong Chuk Hang Road, thus significantly reducing the works area required and therefore its impact on road traffic. A similar approach was adopted for the stretch of viaduct over the nullah, where smaller diameter piles were replaced with larger diameter piles supporting the portals. This reduced the construction time as well as conflict with existing utilities.

Through value engineering, the design and construction method for the Aberdeen Channel Bridge were also fine-tuned, resulting in the construction of fewer but heavier segments.

Civil construction of the viaducts and the Aberdeen Channel Bridge have been completed. Installation of overhead lines and trackside auxiliaries on the viaduct section has also been completed except for a section near Ocean Park Station. SIL(E) will run three-car trains that will offer a unique experience as the rail line will adopt fully automatic operations and the driver's cabin has been removed, allowing passengers to take in the view from the front of the aquatically-themed trains. It is a win-win solution to serving the relatively small catchment on the South Side of Hong Kong Island, providing a rail service that could be fully controlled from MTR's Operations Control Centre.

Completion of SIL(E) is targeted for the end of 2016. ■

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# There's much to be learned from engineering in Asia

**Brian Burrell**

VICE-PRESIDENT, INTERNATIONAL, CSCE

Common to the articles in this issue is the recognition of Asia's re-emergence as a major contributor to the development of civil engineering. Many of the world's greatest civil engineering works have taken place in Asia during the past 30 years. It is easy to think of examples: tall structures such as Taipei 101, Shanghai Tower, and the Burj Khalifa; massive water projects such as China's Three Gorges Dam and South-North water diversion project; and major transportation projects such as the Eurasia tunnel in Turkey.

A market for specialized Canadian engineering services still exists in Asia. The article "Persistence pays in South Asia" reminds firms to be determined and patient when entering changed Asia markets.

In this issue, we are fortunate to have two examples of engineering accomplishments in Hong Kong. The article on a viaduct challenge highlights how innovation can be used to overcome the complexity of working in a densely populated urban environment. The article on HKIA's Midfield Concourse demonstrates how environmentally beneficial features and building information modeling (BIM) can be used

for better planning and construction of complex structures.

The article on China's Belt and Road Initiative describes a visionary and progressive concept, demonstrating China's desire to obtain the resources necessary to maintain its vast economy and its influence in Asia during this century. Canada also needs an integrated plan for sustainable infrastructure development that incorporates not only the replacement of aging infrastructure but also a vision of new infrastructure that will enrich Canada's economic future. Canadian governments should adopt the visionary approach of China and cooperatively work together to make projects of national scope and importance a reality.

## Acknowledgements

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I thank the Hong Kong Institution of Engineers and Ms. Angela Tam, Editor of *Hong Kong Engineer*, for their assistance and all the authors for their contributions. Gratitude is also expressed to Ms. Jerman Cheung, Arup (Hong Kong), and Ms. Samantha Siu, MTR Corporation Ltd. ■

# Il y a beaucoup à apprendre de l'ingénierie provenant de l'Asie

**Brian Burrell**

VICE-PRÉSIDENT, INTERNATIONALE, SCGC

Un aspect commun aux articles de ce numéro est la reconnaissance de la réémergence de l'Asie comme une contributrice majeure au développement du génie civil. Plusieurs des plus importants travaux de génie civil du monde ont été effectués en Asie au cours des 30 dernières années. Des exemples nous viennent aisément à l'esprit: de hautes structures telles Taipei 101, la Shanghai Tower et Burj Khalifa; d'immenses projets hydrauliques tels que le barrage Three Gorges en Chine et le projet de dérivation Sud-Nord, ainsi que d'importants projets en transports tels que le tunnel Eurasia en Turquie.

Il existe toujours un marché pour des services d'ingénierie spécialisés en Asie. L'article « Persistence pays in South Asia » rappelle aux firmes canadiennes qu'elles doivent être déterminées et patientes lorsqu'elles décident d'entrer sur les marchés asiatiques en pleine évolution.

Dans ce numéro, nous avons la chance d'avoir deux exemples de réalisations en ingénierie à Hong Kong. L'article sur le défi qu'a posé la construction d'un viaduc met en évidence la manière dont l'innovation peut être utilisée pour surmonter la complexité du travail dans un environnement urbain densément peuplé. L'article sur le Midfield Concourse de l'aéroport international de Hong Kong démontre comment les caractéristiques environnementales et la modélisation de l'information du bâtiment (BIM) peuvent être utilisées pour mieux plani-

fier et construire des structures complexes.

L'article sur « L'initiative de la Ceinture et la Route » (ou « Nouvelle route de la soie ») de la Chine décrit un concept visionnaire et progressiste. Elle démontre la volonté de la Chine d'obtenir les ressources nécessaires pour maintenir sa vaste économie et son influence en Asie au cours de ce siècle. Le Canada aussi a besoin d'un plan intégré pour la construction d'infrastructures durables incorporant non seulement le remplacement des infrastructures vétustes, mais aussi la vision de nouvelles infrastructures assurant un avenir économique prospère du pays. Les gouvernements canadiens devraient adopter l'approche visionnaire de la Chine et travailler ensemble afin de faire des projets d'importance et d'envergure nationale une réalité.

## Remerciements

Cet article fait partie d'une d'articles parrainés par le Comité des affaires internationales de la SCGC (CAI). Le Dr. Rishi Gupta est le président du CAI.

Je remercie la Hong Kong Institution of Engineers et Mme Angela Tam, directrice de *Hong Kong Engineer* pour leur aide, ainsi que tous les auteurs pour leurs contributions. J'exprime aussi ma gratitude à Mme Jerman Cheung d'Arup (Hong Kong) et Mme Samantha Siu de MTR Corporation Ltd. ■

# China's Belt and Road Initiative

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China has embarked on the “Belt and Road” strategic initiative to link Asia, Europe and other parts of the world with diverse forms of transportation, including high-speed rail. The strategy underlines the country’s push to enhance its geopolitical profile, export capacity and construction engineering capabilities. It aims to increase China’s capital investments in infrastructure to the Belt and Road initiative and to increase the export of engineering and construction expertise. Once infrastructure is completed, China will be able to utilize it to import resources and export Chinese products and services.

The word “road” alludes to a 21st century version of the ancient Silk Road that provided a trade route from China to Persia and beyond to the Mediterranean Sea (Elisseeff 2001), whereas “belt” implies a wide economic corridor around this road.

The Belt and Road initiative consists of two main components: the land-based Silk Road Economic Belt and oceangoing Maritime Silk Road (The State Council of China 2015). The Silk Road Economic Belt component calls for the countries situated along the original Silk Road to form a cohesive economic area through building infrastructure, increasing cultural and technical exchanges, and broadening trade. A large-capacity, standardized, high-speed rail system connecting Central and East Asia is a key component of the Belt and Road initiative. China also plans to build an economic corridor – pipeline, rail, roads, bridges and more – through Pakistan.

The complementary Maritime Silk Road, also referred to as the “21st Century Maritime Silk Road,” is aimed at investing and fostering collaboration in countries bordering the Indian Ocean, the South China Sea and the Pacific Ocean, thereby extending the concept to South Asia and Southeast Asia. Under this initiative, China could facilitate regional economic and trade cooperation, the marine industry, and maritime training bases, and create impetus for industrial parks and hinterland development.

A potential for an economic transformation within the countries along the Belt and Road transportation routes exists. Partner nations

Photo: Atlas catalan. Wikipedia Commons



Mid-14th century illustration of a caravan on the Silk Road, from Atlas catalan.

will benefit from increased Chinese economic connections.

Canadian civil engineers should be aware of the potential for rapid advancement of Chinese engineering, particularly as it relates to the Belt and Road strategic plan. The purpose of this article is to inform Canadian civil engineers of the ramifications of China’s Belt and Road initiative on international infrastructure development.

## Implications

The publicity associated with the Belt and Road initiative, as expressed by the Chinese leadership, is one of beneficial international cooperation and a common destiny offering peace and security. The initiative is not intended to extend China’s sphere of influence or dominance over other countries, or to interfere with the internal affairs of other nations (Cheung and Lee 2015). A reality is that China would be increasing its political, economic and technological influence throughout Asia if the Belt and Road initiative is successful.

The proposed initiative would benefit China’s economy. Exports from industries with major overcapacity such as steel, cement and aluminum would likely result in improvements to China’s domestic economy (Cheung and Lee 2015). For example, the railways, pipelines, power stations and other projects of the Belt and Road plan could boost demand for China’s steel as much as five per cent per year (Zhu 2015) and for China’s cement (Leung 2015). Furthermore,



Chinese engineering and construction firms hope to win many of the infrastructure projects – roads, railways, ports and pipelines – that the new “connectivity” will demand (The Economist 2015).

If the Belt and Road initiative is successful and Asian designers and contractors are participants, it will greatly enhance their experience on multiphase, joint-venture projects. Based on these assumptions and the magnitude of a successful Belt and Road initiative, this experience would likely influence construction sector practices in many other countries.

The Chinese construction industry, like much of Chinese society, has embraced the rush for profit and this has led to poor design and construction in some cases. To address issues concerning quality of design and construction, new Chinese standards are being rapidly developed that would be crucial to the initiative’s success. These standards may be adopted by nations along the Belt and Road, and eventually find their way into accepted international standards.

Large infrastructure projects and initiatives require large amounts of money. Many of the countries that are part of the Silk Road belt are also members of the China-led Asian Infrastructure Investment Bank. China recently pledged US\$40 billion to a Silk Road Fund that Chinese President Xi Jinping says will be used to support the development of the Belt and Road initiative (Caixin Online 2014). Even if China is able to attract foreign investors to the Belt and Road projects, these partners will likely require significant guarantees. Whether China finances the projects directly or guarantees significant project risks, it can only afford to do so as long as it has abundant foreign reserves created from strong export performance.

Much of the Belt and Road system is envisaged as a way to bring an increased supply of foreign raw materials into China in order to satisfy growing Chinese domestic needs and the demands of Chinese export-oriented industries. A slow or weak world economy could dramatically reduce the need for imported raw material and thereby affect the financial viability of some Belt and Road infrastructure. Building infrastructure that responds to present and near-future needs may provide the best chance of economic viability. As is the case elsewhere, money spent within China to reduce or eliminate foreign resource dependency may in the long term be a better investment.

Future economic and societal needs are very difficult to anticipate with respect to infrastructure. Determination of the future need for Belt and Road infrastructure requires risk analysis, and the major risks associated with the Belt and Road initiative may be economic and political, not the technical ones that civil engineers are trained to handle. The poorer countries along the Belt and Road routes can either strengthen the long-term stability of supply and distribution sys-

**If China invests heavily in an effort that falters or fails, the rest of the world will be fundamentally shaken. If the initiative is successful, China is likely to become an even greater supplier of engineering and construction expertise worldwide.**

tems, or destabilize infrastructure development and economic relations, depending upon the fairness of benefit distribution along the route and within the nation’s society.

### Potential for Canadian involvement

At the end of the Cultural Revolution, China had to draw on foreign institutions and foreign engineering expertise, but the situation is much different now. Now the high standards of Chinese engineering are being re-established and China is emerging as a major international force in engineering. Several Chinese engineering schools are high calibre, with three universities in mainland China and four in Hong Kong SAR ranked among the top 50 civil and structural engineering universities, compared to two Canadian universities (QS World University Rankings

by Subject 2015). China is the second highest producer of scientific and engineering papers, and the average citation count per Chinese paper has increased greatly (Xie et al. 2014). China has 2.4 million engineers (Xie et al. 2014), including a skilled complement of civil engineers experienced on major engineering projects. Furthermore, China has been successful in attaining foreign expertise from academic exchanges and hosting of international conferences. A university alliance centered at Xi’an Jiaotong University aims to support the Belt and Road initiative with research and engineering, and to foster understanding and academic exchange. Expertise from outside Asia generally is not needed, although Canadian consulting engineers may still be able to find niche opportunities; if not in China, then in other countries along the proposed transportation routes.

Most of the proposed construction will take place outside of China, in countries where few governmental controls exist over environmental or social impacts. Quality control in remote areas of Kazakhstan, Uzbekistan, Afghanistan, and other developing countries along the historic Silk Road will be a major challenge. There may be opportunities to supply Canadian project management expertise to ensure that the infrastructure is constructed to acceptable standards on budget and schedule.

As claimed by the vice-premier of China, Zhang Gaoli, China attempts to “build the Belt and Road in a green, harmonious and reciprocal way” (Song 2016). Some ongoing efforts are being made, such as promoting cooperation in environmental protection, and in increasing investment in eco-friendly technologies and climate change adaptation plans. Canadian civil engineers are capable of sharing experience and knowledge on sustainable infrastructure with, and benefiting from technical exchanges in, China and the countries along the Belt and Road routes. China hopes to attract private sector involvement in building and operating the Belt and Road infrastructure. Considering the scale and complexity of these projects, some form of

public-private-partnership (PPP) may make sense. Experience with PPPs may be a contribution that Canadian civil engineers can bring to China and other nations along the transportation corridors, as they wrestle with how to design, build, finance, operate and maintain Belt and Road facilities.

Some major variations in long-term durability and quality along the Belt and Road system may exist, unless the civil engineers involved can implement sustainability rating systems and transparent quality controls for the proposed infrastructure. Canadian civil engineers may assist engineers in China and elsewhere along the Belt and Road with respect to sustainability rating systems, and as a result advance sustainability within the countries involved. Canadian firms may market their expertise with respect to these rating systems and this may lead to other opportunities.

Canadian consulting firms face many challenges working in China. Although the Chinese market looks attractive due to its rapid economic growth and tremendous spending on infrastructure, Canadian consulting firms are faced with challenges posed by design licensure, cultural differences and lack of local connections (Dai 2013). Canadian consulting firms may overcome some of these barriers by opening local offices in China or forming partnerships with Chinese design institutes (Dai 2013).

Although the Belt and Road initiative may create some new opportunities for Canadian consulting engineers and construction specialists, its long-term effect on Canadian engineering may be more profound. The international emergence of Chinese “design institutes” fed by recent engineering graduates from Chinese universities, as well as foreign-trained Chinese engineers, could eventually have major effects on the global market for Canadian engineering expertise.

## Concluding remarks

The Belt and Road initiative is of worldwide importance and influence. Although the initiative seeks to benefit China, presently the world's second greatest economy, and the countries along the routes, the potential impact of the initiative will have economic and political consequences for all of us. If China invests heavily in an effort that falters or fails, the rest of the world will be fundamentally shaken. If the initiative is successful, China is likely to become an even greater supplier of engineering and construction expertise worldwide.

Civil engineers around the world should monitor this unprecedented infrastructure initiative. Given its scale and potential impact, the initiative is actually a global initiative that has implications that affect the scientific, geopolitical and economic environments in which civil engineering operates. The challenges in linking vast distances with a wide variance of conditions will result in new technological approaches and engineering progress. The Belt and Road initiative has the potential to be one of the most important influences on the civil engineering profession during the next few decades. Although it is likely Asian engineers will perform much of the engineering work for

infrastructure projects under the Belt and Road initiative, opportunities are arising to apply Canadian expertise in sustainable infrastructure and environmental management.

## Acknowledgement

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# Persistence Pays in South Asia

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This article captures some of the authors' key lessons learned from an unusual 25-year track record of project experience in South Asia, and especially India. R.V. Anderson (RVA) is a major Canadian engineering consultant, and the Canada-India Centre for Excellence (C-ICE) is an agency established to promote training and business partnerships between Canada and India. RVA's first involvement was actually brought about, after several unsuccessful forays, through the Focus India Connection sponsored by the then Department of Foreign Affairs and International Trade (DFAIT). The program introduced RVA to key Canadian agencies including Ontario Exports, CIDA-INC, and the DFAIT Trade Commissioner Service, and their role in promoting trade for small and medium sized Canadian firms.

With that understanding in place, a continuous stream of projects ensued from those initial efforts in 1992-94, the most significant being a related sequence in the City of Mumbai; (a) a report on wastewater O&M that led to (b) the 25-year Wastewater Master Plan for the city, followed by (c) full implementation of the Priority Works identified in the Master Plan. Smaller assignments were completed in Vapi, Bangalore, Mysore, Ludhiana, Delhi and Lucknow, and other cities.

According to the C-ICE's latest research, today's India is experiencing an economic transition unparalleled anywhere else in the world. Regardless of the measures used to describe the country's growth rate or its increasing GDP, it is sobering to take a moment to consider the scale of the transformation. More than 65 per cent of India's population is under the age of 35, approximately 650 million people; and the annual per capita income in India is presently estimated at CDN \$2,600. As many economists expected, meeting this threshold has led to a more consuming and aspirational population – an average Indian's propensity to consume non-necessity goods and services has become significantly higher. This represents an opportunity that Canada cannot afford to miss.

## A true partnership

Canadian firms, especially professional service firms, must demonstrate a desire to forge a true partnership with India, and not just establish a "seller-buyer arrangement." As any business person or scholar who has worked in India can attest, building trust and credibility is the first, and

arguably the hardest, step toward partnering with India. It is important to invest in building human capacity as well as business models that are specifically designed to build trust with India. Small businesses and start-ups, for example, must be encouraged to learn about Indian realities: cultural sensitivities, business practices, regulatory environments, government incentives, and above all, consumer behaviour. An example in the infrastructure sector is RVA's continuous record of project experience in India since 1994. The firm has been involved in all aspects of infrastructure in India - planning, design, construction and operations and maintenance.

Canada's exports to India account for roughly 0.8 per cent of our total exports, and an annual bilateral trade of approximately \$8 billion, only \$1 billion more than our trade with the Netherlands, which has a population equal to that of New Delhi. It is unfair to make this comparison, of course, given that per capita income is significantly higher in the Netherlands than in India, yet it is helpful for conveying the trade growth potential with India. The C-ICE at Carleton University is developing specialized courses, in partnership with Indian partners, to provide exposure and training for Canadian businesses and policy makers. The C-ICE also continues to support policy research to identify the best ways to engage with India that will lead to a robust partnership.

The initial roadblocks any Canadian team faces in entering the South Asia market, RVA included, are not always appreciated in advance. Foremost would certainly include significant cross-cultural differences that take time and effort to understand. Probably the most important attributes to learn would be patience and listening, as Canadian approaches to planning and organizing may not always be appropriate or effective in the South Asia business market.

Intense foreign competition and the high cost of marketing can also be expected in working in such a far-flung market. After the year 2000, it became evident that there was a growing local/regional technical capacity emerging, especially in India. In the earlier years (1990-2000), the ratio of foreign "expats" to local engineering staff was 1:4. Now, it is closer to 1:15, requiring a completely different approach to engineering service delivery and profitability. This is a widespread phenomenon across developing markets and can potentially lessen the employment opportunities of Canadian civil engineers in the international consulting industry.

Topping these concerns is the use of increasingly complex and costly competition/selection criteria and procedures at the local government level, here again made more difficult by the cross-cultural and business challenges of working in such an intense and crowded business environment. In the Mumbai traffic, for example, two meetings in different parts of town may be all that can be accomplished in one day.

## Be export-ready

The Canadian values that Indian agencies come to like and respect do



Photos courtesy of Alan Perks.



**Left:** Humayun's Tomb in Delhi, built in 1570, is of particular cultural significance as it was the first garden-tomb on the Indian subcontinent. **Right:** The Taj Mahal, a mausoleum built in the mid-1600s. Both buildings are UNESCO World Heritage sites.

help in the long term. Small and medium-sized Canadian firms are often more flexible and adaptable than larger U.S. and European firms. This provides leverage in adapting to the inevitable changes that occur in South Asia, on almost a daily or weekly basis, and can translate into a very client focused and value-added approach, and more cost-effective services that clients quickly learn to appreciate.

The Export Ready Firm is a term used frequently by Canadian Trade Commissioner Services to denote firms that have relevant corporate and staff experience, and have demonstrated initial efforts to develop local partnerships.

Our experience demonstrates the need to reply to enquiries and to follow up leads that may present themselves either on trade missions or through regular trade commissioner communication channels. However, for smaller firms, it does become extremely important to carefully choose one's opportunities, and then focus on those value-added services.

Most Canadian small to medium enterprises (SMEs) have very little international experience or understanding of "on the ground" conditions for business in South Asia. Therefore, they have to rely upon local partnerships and advice. By far, the best partner, from an infrastructure engineering point of view, is a local company doing similar business, with real clients in the same field. It is critical to ensure that the potential partner is a real business, and not an agent simply wanting to generate commissions.

Such a partner would likely be similar in size, with common business interests and a record of service with similar clients. Such a firm would contribute effectively to proposals and marketing efforts, have real business and technical resources, and be willing to commit to risk/reward sharing. With such a partnership, both parties are committed to protecting the team's interests and in supporting each other to the benefit of the project and the client. Agency and/or commission-based relationships simply do not offer those assurances.

The only way a Canadian SME can identify and build such partner-

ships is to network and seek reliable advice, especially from the Canadian Trade Commissioner Service in the city or country of interest. Participation on trade missions is useful only when followed by meaningful and focused dialogue with an experienced trade commissioner. Many Canadian firms simply rely upon trade commissioners as travel agents. Instead, they need to consider working in partnership with the local trade missions and its experienced Canadian trade commissioners.

While Canada likes to think of itself, at least politically, as a significant global player who is "here to help," Canada is in fact only a relatively small player on the international stage. On a trip to South Asia, often the only times a traveler will hear Canada being discussed is in the airports of Toronto, Montreal or Vancouver. More has to be done to promote Canadian engineering in that part of the world.

The scale and complexity of cities, towns and villages in south Asia, and India in particular, is simply huge. The enormous population places strains on municipalities to provide sustainable infrastructure; a small town in India may have a population of 150,000 or more. Consequently, the infrastructure is often much larger than one might experience in Canada. The John Street pumping station in Toronto has a capacity of about 12,000 l/s, whereas Mumbai has pump stations exceeding 30,000 l/s capacity. The Municipal Corporation of Greater Mumbai also has approximately 120,000 employees – more than the entire Canadian armed forces. To further complicate the process of infrastructure design, the detailed and reliable data and information that a Canadian firm relies upon for planning and design may simply not exist in south Asia.

In summary, with persistence and experience, a Canadian SME can learn to survive and grow in South Asia. But if one expects matters to evolve in a predictable and step-wise fashion much like in Canada, opportunities will quickly scatter and disappear, just like those street monkeys that inhabit many urban neighbourhoods in South Asian cities. Perhaps the best advice is contained in an old Indian saying heard frequently on the streets of Mumbai: "You must learn to slowly, slowly catch the monkey." ■

# A Triumph of Total Design: HKIA Midfield Concourse

Arup

The Midfield Concourse (MFC) enables the Hong Kong International Airport (HKIA) to cater to more than 10 million additional passengers a year, strengthening the city's competitiveness as a regional and international aviation hub.

Located to the west of Terminal 1 and between the two existing runways, the 105,000-m<sup>2</sup> MFC provides 19 contact aircraft parking stands (two of which can accommodate Code F aircraft, such as the Airbus A380).

The five-storey complex features an architectural style that complements Terminal 1 with a large, clear, open span steel truss roof, high headroom and extensive use of glass to create a sense of openness.

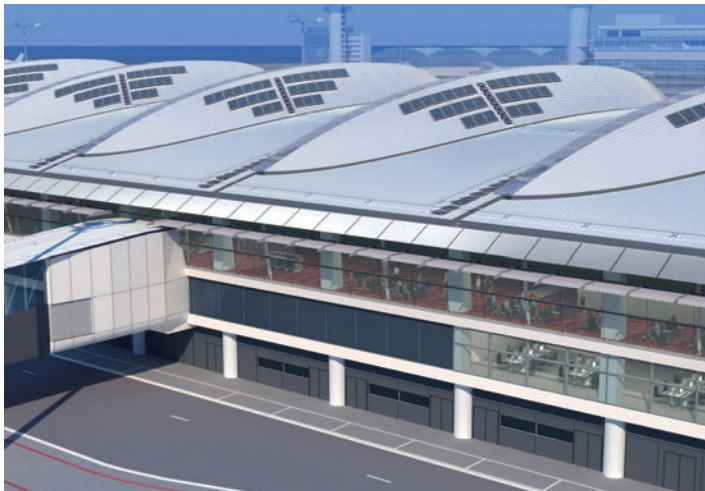


Photo: AAHK

PV panels on the skylight structures.



Photo: Marcel Lam Photography

Air conditioning is provided via binnacles.

Arup, in joint venture with Mott MacDonald, provided full multi-disciplinary design and construction support for this project.

## Environmentally responsive design

To maximize efficiency and sustainability, Arup introduced 35 environmentally beneficial features to the concourse design including high-performance glazed panels, more than 1,200-m<sup>2</sup> of solar panels to harness renewable energy, and regenerative power for both the automated people mover (APM) and vertical transport systems.

Arup recommended a building orientation along the north-south axis to avoid the large solar gain from the south. The distinctively shaped building was also developed based on sustainability requirements: the glass façade on the west side is minimized to reduce heat gain from the hot afternoon sun, while the glass façade on the east side is maximized to admit more daylight to the space.

To maximize daylighting, north-facing roof skylights were introduced to bring natural light deep into the heart of the building to reduce artificial lighting and improve user comfort and experience.

Air conditioning is provided via binnacles. The cooled air delivered from the top of the binnacles sinks and forms a 'blanket' above the floor, enabling efficient local cooling for the occupied zones only. All systems are variable in terms of volume and speed, allowing the building to react to different occupant capacities.

Locally sourced materials, both recycled and renewable, were used throughout design and construction, and construction waste was recycled. Furthermore, the MFC was designed for flexibility so that the space could be adapted and changed in the future requiring minimal structural works or re-strengthening.

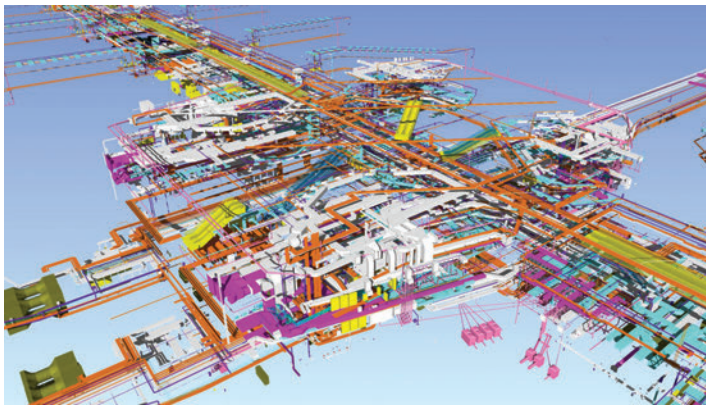
Water conservation strategies were also adopted, including the recycling of A/C condensate water and grey water from restrooms and kitchens, to be used as make-up water for the cooling towers. These measures have successfully achieved a total potable water reduction well beyond our initial baseline.

The MFC has already received a BEAM Plus Provisional Gold rating and is currently undergoing final assessment.

## APM: creating safe and seamless connectivity

The MFC is connected to Terminal 1 via an extension of the existing APM system. The one-kilometre extension also provides a new station at the MFC, a route recovery line and a light maintenance area.





AAHK

3D model of the integrated building services and airport systems.

Arup was responsible for the upgrade of the existing APM signalling system from a fixed block system to a communications-based train control (CBTC) system. While the traditional fixed block system only allows one train to enter a block after the previous train has cleared, the CBTC moving block system uses bidirectional train-to-wayside data communications to continuously monitor and calculate the train status so that the trains can automatically adjust their speed while maintaining a safe distance from the preceding train. As a result, trains can travel at a closer distance, thus reducing the headway and increasing the system capacity.

To ensure continuous APM operations, installation of the new signalling system on the APM vehicles and along the tracks was performed as an overlay in parallel with the existing system: the fixed block system remained functional during daytime operations, and the APM then switched over to the CBTC system at night for testing. All train-side and wayside works and equipment installation were also carried out during maintenance hours (between midnight and 6 a.m.). The fixed block signalling system will be removed within a year of the new CBTC system being confirmed to work properly.

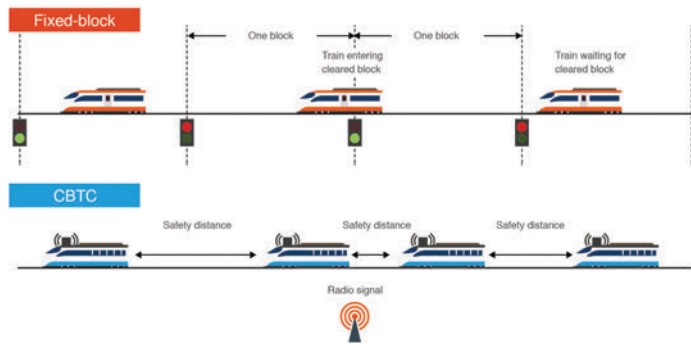
This is Hong Kong's first CBTC overlay project. The whole process, including testing and commissioning, took four years to complete. The process designed by Arup helped to avoid disruption of the APM operations and allowed seamless transition to the new signalling system. Arup is currently working on the Terminal 2 line upgrade to CBTC to match the signalling system on the Terminal 1 line.

### Mission critical: integrating the systems

The APM system expansion also required modification of the existing airport systems in the Terminal 1 West Hall, due to the construction of the new APM platform and route recovery line.

New cameras, cables, access control doors, and leaky cables were provisioned, while some existing devices were either retained, dismantled or relocated. All new equipment was integrated into the existing system to operate seamlessly as a single unit.

Arup also formulated the strategy to divert the existing communication cable containment in order to spare the space for the new plat-



Arup

Schematic diagram of fixed block system vs. CBTC system.

form. Since these cables support various airport and mission-critical systems used in the air traffic control tower, this diversion work was extremely critical to the operation of the whole airport.

The cable containment design was verified using the BIM model to ensure that the new design has a shorter route distance and there was sufficient slack to relocate the existing cables, thereby avoiding the need to splice and reconnect the cables. Cable diversion risk assessment was also developed to identify the risks, the possible failure effect and migration methods.

Equipment and cables in the existing West Hall Radio Room were relocated for the construction of the new APM platform. Arup prepared a methodology for the relocations of the operators' radio equipment without disrupting the service, and worked closely with the mobile operators during construction to ensure a smooth implementation.

### An optimum solution using BIM

The Mott MacDonald-Arup Joint Venture, in conjunction with architect Aedas and sub-consultant Atkins, deployed multiple software platforms to deliver the design. Software integration through the BIM workflow enhanced project-wide collaboration, allowing rapid information exchange and helping to significantly improve inter-disciplinary coordination.

Opened in December 2015, the MFC is now in full operation. ■

*This article was originally published in Arup FIRST magazine.*

**CLIENT:** Airport Authority Hong Kong (AAHK)

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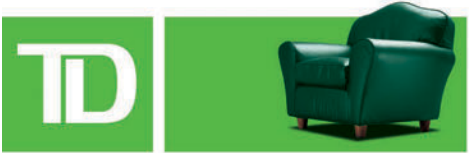
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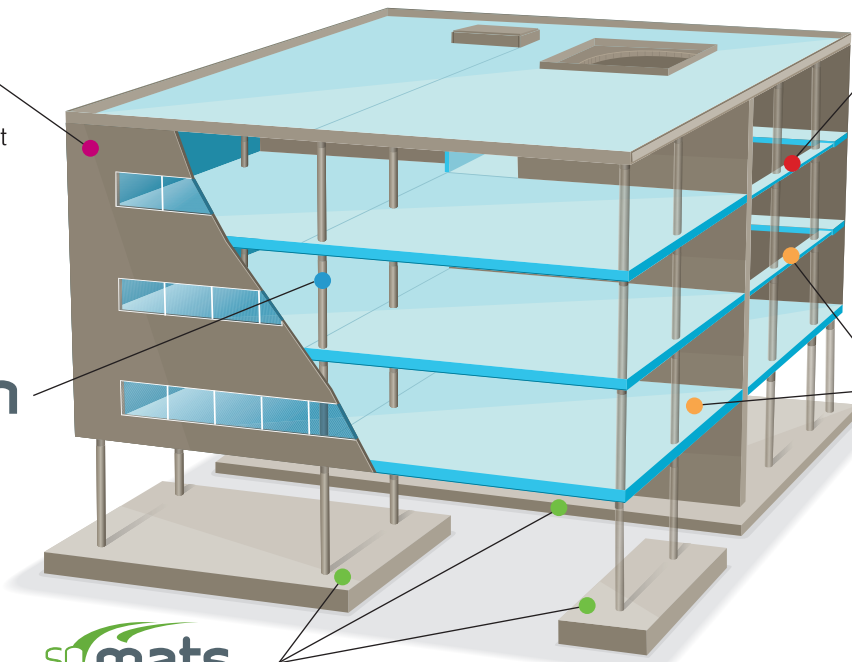
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