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CANADIAN CIVIL ENGINEER
L'INGÉNIEUR CIVIL CANADIEN

2014 | WINTER/HIVER

- Fused grid neighbourhoods
- Lessons of the Panama Canal
- Award-winning West Don Lands
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contents

WINTER 2014/HIVER 2014 | VOLUME 31.5

IN VIEW: PROJECTS

Cover: Rendering of West Don Lands redevelopment, Toronto, courtesy of Waterfront Toronto

TECHNICAL: OPERATIONALIZING AND IMPLEMENTING SUSTAINABILITY GUIDELINES
TECHNIQUE: OPÉRATIONALISATION ET MISE EN OEUVRE DE DIRECTIVES EN MATIÈRE DE DURABILITÉ

FORUM ON SUSTAINABILE INFRASTRUCTURE/ FORUM SUR L'INFRASTRUCTURE DURABLE

NEWS, VIEWS & DEPARTMENTS
NOUVELLES, POINTS DE VUE ET DÉPARTEMENTS

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L'INGÉNIEUR CIVIL CANADIEN

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Annual Subscription Rates/Abonnement annuel
Canada & U.S./E.U. $35.00, Other countries/Autres pays $45.00; Single copy/Un numéro $7.50; Agency discount/Rabais au distributeurs 10%

PUBLICATION ISSN 9825-7515

RETURN ADDRESS/ADRESSE DE RETOUR :
The Canadian Society for Civil Engineering
La Société Canadienne de Génie Civil
4877 Sherbrooke St. W., Westmount, Quebec H3Z 1G9

Canadian Civil Engineer (CCE) is published five times per year by the Canadian Society for Civil Engineering (CSCE). L'ingénieur Civil Canadien (ICC) est publié cinq fois par année par la Société Canadienne de Génie Civil (SCGC).

CIVIL Magazine is produced by the publishers of Canadian Consulting Engineer Magazine, published by BIG Magazines LP, a division of Glacier BIG Holdings Ltd. Le magazine Civil est produit par l'editeur de la publication Canadian Consulting Engineer qui est publie par BIG Magazines LP, une division de Glacier BIG Holdings Ltd.

CANADIAN CONSULTING engineer

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Toronto, Ontario M3B 2S9
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PUBLICATIONS MAIL AGREEMENT/POSTES CANADA ENREGISTREMENT #40069240

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Panama Canal – A Lesson in Sustainability

I had the privilege of attending the recent ASCE annual meeting in Panama City, Panama. In addition to the appeal of nurturing CSCE's relationship with our sister organization and southern neighbour, the location of the meeting was intriguing to say the least. The canal itself has many notable attributes that would naturally attract a civil engineer. To list a few: the significant civil engineering accomplishment of conceiving, planning, designing and constructing this infrastructure mega-project; the centennial celebration of the original canal construction completed in 1914; the strategic importance of the Panama Canal in the global economy in moving goods between the Pacific and the Atlantic; the current construction project for an additional set of locks to increase capacity nearing completion.

After taking in a number of presentations on the planning, engineering and construction of the canal, I had the opportunity to tour the site of the new, third set of channel locks currently under construction and the visitor's centre for the original canal. In the end, I must say I was awed and inspired. Considered to be one of the seven modern wonders of the world, the Panama Canal has lasted 100 years while servicing some 5% of world trade today.

There are so many stories one could tell about the canal, the process of its construction and the process of creating and nurturing a vision for such an undertaking until it saw final completion in 1914. While the technical data itself is impressive (e.g. 268 million cubic yards of excavation to complete), the focus of my personal inspiration turns to the visionaries facing the challenges (e.g. technical and political debates on funding and route selection) and the setbacks (e.g. more than 25,000 workers died due to malaria, yellow fever and landslides). These visionaries, through belief in, and tenacity for, the vision, achieved final success.

In the late 18th century and early 19th century several unsuccessful efforts to launch contracts to build a canal resulted in an offshoot – the construction of a railway in 1855. In the next 50 years, political, financial, technical and medical challenges dominated the concept before the task became a project owned, funded and constructed by the U.S. government under President Theodore Roosevelt. The canal became a reality with construction taking place between 1904 and 1914.

Existing locks at Miraflores (October 9, 2014). / Écluses actuelles de Miraflores (9 octobre 2014).

The story of the 50 years required to overcome political, financing and technical hurdles for such a mega project seems no different than the current

Current construction of the Panama Canal locks at the Pacific Ocean side of the canal (October 9, 2014). / Construction en cours des écluses du canal de Panama du côté de l'océan Pacifique (9 octobre 2014).

challenges of creating infrastructure in today's environment. It would not have been successfully completed without the passion, vision and leadership of individuals to push forward in spite of challenges and setbacks.

The canal is an inspirational example of the concept of staying the course when it comes to "sustainable infrastructure." It can and should provide the motivation for civil engineers to have the kind of impact on society the canal has had on a global scale, now for more than 100 years. The Panama Canal brings to life CSCE's vision statement on leadership in sustainable infrastructure. ■

Reg Andres is vice-president of R.V. Anderson Associates Limited in Toronto.

La canal de Panama – Une leçon en matière de durabilité

J'ai eu le privilège d'assister à la dernière assemblée annuelle de l'ASCE dans la ville de Panama, au Panama. En plus de l'intérêt à resserrer les relations de la SCGC avec notre société sœur et notre voisin du Sud, le lieu de la réunion était pour le moins intrigant. Le canal à lui seul possède plusieurs caractéristiques qui devraient naturellement attirer un ingénieur civil. Pour n'en nommer que quelques-unes : l'importante réalisation en génie civil sur le plan de la conception, de la planification et de la construction de ce mégaprojet en infrastructure; la célébration du centenaire de la construction du canal d'origine qui s'est terminée en 1914; l'importance stratégique du canal de Panama dans l'économie mondiale pour le transport de marchandises entre le Pacifique et l'Atlantique; le projet de construction actuel en cours d'achèvement pour l'ajout de nouvelles écluses afin d'augmenter la capacité du canal.

Après avoir assisté à un grand nombre de présentations sur la planification, l'ingénierie et la construction du canal, j'ai eu l'occasion de visiter le chantier d'une troisième série d'écluses présentement en construction ainsi que le centre des visiteurs du canal d'origine. En fin de compte, je peux vous dire que j'étais émerveillé et inspiré. Considéré comme l'une des sept merveilles modernes du monde, le canal de Panama est en service depuis 100 ans et dessert aujourd'hui 5 % du commerce mondial.

Il y a encore tellement à dire sur le canal – le procédé de construction et la façon d'avoir créé et promu une vision pour un tel projet jusqu'à son achèvement en 1914. Alors que les données techniques elles-mêmes sont impressionnantes (par ex. 268 millions de mètres cubes à creuser), ce sont les visionnaires qui ont fait face aux défis (par ex. les débats techniques et politiques sur le financement et le choix du tracé du canal) et aux échecs (par ex. plus de 25 000 travailleurs sont morts à cause de la malaria, de la fièvre jaune et de glissements de terrain) qui sont la source de mon inspiration personnelle. C'est grâce à leur croyance en cette vision et leur ténacité qu'ils ont atteint le succès final.

À la fin du 18e siècle et au début du 19e siècle, plusieurs tentatives infructueuses pour lancer des contrats pour la construction d'un canal ont résulté en la construction d'une voie ferrée en 1855. Durant les 50 années suivantes, les défis politiques, financiers, techniques et médicaux ont dominé le débat sur le concept de canal avant que le gouvernement américain sous le président Theodore Roosevelt s'approprie le projet, le finance et le construise. Ce canal devint une réalité avec sa construction entre 1904 et 1914.

L'histoire des 50 années qui ont été requises pour surmonter les obstacles politiques, financiers et techniques pour un tel projet d'envergure ne semble pas différente des défis rencontrés de nos jours dans la création d'infrastructures. Ce projet n'aurait pas pu être mené à bien sans la passion, la vision et le leadership des personnes qui l'ont fait avancer malgré les défis et les échecs.

Le canal est un exemple inspirant pour maintenir le cap lorsqu'il s'agit d'« infrastructures durables ». Il peut et devrait motiver les ingénieurs civils pour qu'ils aient le même impact sur la société que le canal a eu à l'échelle mondiale, et ce, depuis maintenant plus de 100 ans. Le canal de Panama est une illustration concrète de l'énoncé de vision de la SCGC sur le leadership en matière d'infrastructures durables. ■

Reg Andres est le vice-président de R.V. Anderson Associates Limited à Toronto.

Ontario Region: Growing with Youth

Adrian Munteanu, MCSCE, P.Eng.
VICE-PRESIDENT, ONTARIO REGION, CSCE

The Ontario Region CSCE team comprises the chairs of the six sections existing in the province: Ben Hunter, Hamilton-Niagara; Gerry Buckrell, Northwestern Ontario; Robbie Larocque, Durham-Northumberland; Patricia Wilbur, London and District; Kevin Alemany, National Capital Section; and Nigel Parker, Toronto; plus the regional treasurer Andrew Turnbull and the regional vice-president Adrian Munteanu.

We all work together to guide our organization to the vision we share for the future of the CSCE. A specific strength for our region is the large number of students in the universities scattered over the province, and "Growing with Youth" is one of our strategic directions to build and sustain a stronger CSCE. We are present in 11 universities where we have active student chapters or sustaining members: Carleton University, University of Ottawa, Royal Military College, Queen's University, Ryerson University, University of Toronto, McMaster University, University of Waterloo, University of Western Ontario, University of Windsor and Lakehead University.

I am pleased to see the excitement and the dynamics of the activities put together by our students as well as the continuous effort of the sections, the student affairs and young professionals (YP) committees, and our sustaining members to support those activities. Due to that effort, some of the student chapters have been re-activated after a period of "hibernation." Growing with Youth also embraces the young professionals who are at the beginning of their professional careers, for whom our YP program is fashioned to provide support and guidance. In 2014, our students and young professionals counted 425 members, approximately 40% of our Ontario Region members; a good number, which we are working to increase so that ultimately we are serving all Ontario civil engineering and civil technology programs, and all civil students and young professionals are welcomed into the CSCE family.

Ontario Region sections are responsible for an exciting array of lunch and dinner meetings, as well as hosting CSCE professional development workshops and supporting the student chapters mentioned above.

In terms of news from the sections, I am pleased to welcome Patricia Wilbur, the new chair for the London & District Section, and Kevin Alemany, who has stepped into the chair position for the National Capital Section. Check out the csce.ca website for links to Section websites and contact information for the section chairs. Come out to an event near you or volunteer to organize one. Participation is very rewarding and lots of fun. ■

At the CSCE ceremony for the Graduate Student Poster Competition, University of Ottawa, in March 2014, are: (from left) Sai Vanapalli, chair, Civil Engineering Dept., University of Ottawa; James Garland, former CSCE vice-president, Ontario Region; Zhong Han, winner, structural design; Adrian Munteanu, former chair, CSCE National Capital Section; Claude Laguë, dean of the Faculty of Engineering, University of Ottawa. Other winners: Marta Lopez Egea, environment and sustainable development (next page) and Asmaa Shehata, mechanics/materials (not shown).

La région de l'Ontario : Croître avec les juenes

Adrian Munteanu, MCSCE, P.Eng.
VICE-PRESIDENT ONTARIO REGION, SGCG

L'équipe de la SCGC de la région de l'Ontario est composée des présidents des six sections de la province : Ben Hunter, Hamilton-Niagara; Gerry Buckrell, nord-ouest de l'Ontario; Robbie Larocque, Durham-Northumberland; Patricia Wilbur, London et District; Kevin Alemany, section de la capitale nationale et Nigel Parker, Toronto; ainsi que du trésorier régional, Andrew Turnbull et du vice-président régional, Adrian Munteanu.

Nous travaillons tous ensemble pour guider notre organisation vers la vision que nous partageons pour l'avenir de la SCGC. Un point fort de notre région est le grand nombre d'étudiants fréquentant les universités de la province, et « Croître avec les jeunes » est une de nos orientations stratégiques pour bâtir et maintenir une SCGC plus forte. Nous avons des chapitres étudiants ou des membres actifs dans chacune des 11 universités où nous sommes présents : L'Université Carleton, l'Université d'Ottawa, le Collège militaire royal, l'Université Queen's, l'Université Ryerson, l'Université de Toronto, l'Université McMaster, l'Université de Waterloo, l'Université Western, l'Université de Windsor et l'Université Lakehead.

Je suis heureux de voir l'enthousiasme et la dynamique de groupe entourant les activités mises en place par nos étudiants ainsi que les efforts soutenus déployés par les sections, le comité des affaires étudiantes, le comité des jeunes professionnels (JP) et nos membres actifs pour soutenir ces activités. Grâce à ces efforts, certains chapitres étudiants sont à nouveau devenus actifs après une période d'« hibernation ». Croître avec les jeunes englobe aussi les jeunes professionnels qui sont au début de leur carrière et pour lesquels notre programme des JP est façonné pour leur fournir appui et conseils. En 2014, le nombre total de membres étudiants et de jeunes professionnels s'élevait à 425, ce qui représente environ 40 % de nos membres dans la région de l'Ontario. C'est un bon nombre que nous cherchons tout de même à augmenter afin de servir tous les programmes de génie civil et de technologies du génie civil de l'Ontario. Tous les étudiants en génie et les jeunes professionnels sont les bienvenus dans la famille de la SCGC.

Les sections de la région de l'Ontario ont organisé une série de dîners et de soupers-conférences, co-organisé des activités de formation continue de la SCGC et apporté leur appui aux chapitres étudiants mentionnés précédemment.

Pour ce qui est des sections, je suis heureux d'accueillir Patricia Wilbur, la nouvelle présidente de la section London et District ainsi que Kevin Alemany, qui a fait ses premiers pas comme président de la section de la capitale nationale. Consultez le site Web csce.ca pour des liens vers les sites Web des sections et pour obtenir les coordonnées des présidents des sections. Venez assister à un événement qui vous touche de près ou portez-vous volontaire pour en organiser un. Y participer est très enrichissant et amusant. ■

La cérémonie des prix de la SCGC pour le Concours d'affiches pour étudiants diplômés à l'Université d'Ottawa en mars 2014 – à partir de la gauche : Sai Vanapalli, président du département de génie civil, Université d'Ottawa; James Garland, ancien vice-président de la SCGC, Région de l'Ontario; Martha Lopez Egea, lauréat, environnement et développement durable; Adrian Munteanu, ancien président de la section de la capitale nationale de la SCGC; Claude Laguë, doyen de la Faculté de génie, Université d'Ottawa. Les autres gagnants sont : Asmaa Shehata, mécanique technique/matériaux (absente sur la photo) et Zhong Han, conception structurelle (à la page précédente) .

Beyond the Walls of the Classroom – Laval's Experience

Véronique Chabot
VICE-PRESIDENT, COMMUNICATIONS, CIVIL ENGINEERING STUDENTS ASSOCIATION, LAVAL UNIVERSITY

Last October, myself and eight fellow Laval University students attended the annual conference of the American Society of Civil Engineers (ASCE) in Panama. One of the objectives of our adventure was to experience a different point of view than what we see from inside the walls of our school.

During the conference, learning about various technical aspects of civil engineering was enhanced by the personal experiences shared by some presenters.

Of course, we were also excited about visiting Panama, student style. We found a youth hostel near the conference site and planned to cook meals together and share dorm rooms. Within the city of Panama, we didn't have all our usual landmarks, the streets seemed less secure at night, and the language was unfamiliar. In this way, we were pushing ourselves by going beyond our personal comfort zone. In our future career, we may have opportunities to work in foreign countries, but that option doesn't appeal to everyone. So this experience gave each of us a chance to know ourselves a little better.

I didn't expect to meet many other youths at the conference, but I was wrong. The next generation was out in force. As soon as we arrived, we met, among others, two other groups like ours, of 7 and 9 students. I also had an opportunity to speak with several students from Engineers Without Borders USA who attended intensive courses all week in addition to the conference presentations.

I have come to believe business cards will soon be out of style, because we all just became friends on Facebook. ■

Our visit to the site of the Panama canal expansion./Photo prise lors de la visite du chantier d'agrandissement du Canal de Panama. From left to right/De gauche à droite : Valérie Potvin, Chaher Toybou, Stéphanie Carrier, Mélissa Tremblay, Laurence Simard, Sophie Roy-Painchaud, Véronique Chabot, Audrey Gauvin-Bherer, Pier-Olivier Labbé.

Au-delà les salles de cour – L'àventure des étudiants de Laval!

Véronique Chabot
VICE-PRÉSIDENTE AUX COMMUNICATIONS À L'ASSOCIATION DES ÉTUDIANTS EN GÉNIE CIVIL DE L'UNIVERSITÉ LAVAL

En octobre dernier, huit de mes camarades de l'Université Laval et moi-même, avons assisté au congrès annuel de l'American Society of Civil Engineers (ASCE) au Panama. Un des objectifs de notre aventure était d'aller chercher un point de vue différent de celui qu'on a à partir de l'intérieur des murs de l'école. Pendant les conférences, nous avons appris sur divers aspects techniques du génie civil, en plus de s'enrichir des expériences personnelles que certains conférenciers ont partagées avec nous.

Bien sûr, nous étions aussi excités à l'idée de visiter le Panama en style sac à dos. Nous avons trouvé une auberge de jeunesse près du lieu du congrès et on allait cuisiner nos repas ensemble et partager le dortoir. Dans la grande ville de Panama nous n'avions pas nos points de repère habituels, les rues nous semblaient peu sécures le soir, et la langue était différente de la nôtre. À ce niveau, nous avons repoussé nos propres limites personnelles en sortant de notre zone de confort. Dans notre future carrière, nous aurons peut-être des opportunités de travail à l'étranger et ces choix ne conviennent pas nécessairement à tout le monde. Alors, cette expérience nous aura permis à chacun se connaitre mieux soi-même.

Je croyais qu'on ne rencontrerait pas beaucoup d'autres jeunes au congrès, mais non, il y avait de la relève en masse! Dès notre arrivée, nous avons fait connaissance, entre autres, avec deux autres groupes comme nous, respectivement de 7 et 9 étudiants. Aussi, j'ai eu l'opportunité de discuter avec quelques étudiants de Engineers Without Border-USA qui eux, avaient des cours intensifs toute la semaine en plus des conférences. Je suis portée à croire que les cartes d'affaires seront bientôt démodées... parce que nous sommes simplement tous devenus amis facebook! ■

UNIVERSITY OF VICTORIA
ASSISTANT OR ASSOCIATE PROFESSOR POSITION IN CIVIL ENGINEERING

The Faculty of Engineering, at the University of Victoria, invites applications for two tenure-track faculty positions in Civil Engineering at the level of Assistant or Associate Professor in the areas of structural (with expertise in timber and/or steel design), environmental and geotechnical engineering. Candidates for the position must have a PhD in Civil and/or Environmental Engineering, or a related field, together with demonstrated excellence in teaching, research, graduate student supervision, verbal and written communication, and collaboration with colleagues with engineering and non-engineering backgrounds. Candidates must be registered as a professional engineer or be eligible for and committed to registration. The successful applicant will be expected to teach at the undergraduate and graduate levels, supervise graduate students, establish an active research program, and participate in the academic affairs of the university.

The Civil Engineering Program was established in 2013 and has currently about 90 undergraduate students in the first two years. The Program presently has 5 faculty members and an Acting Director. The development of its graduate programs is under way. The successful applicants will have the opportunity to contribute further to the growing Civil Engineering Program at UVic.

The Civil Engineering Program, until it becomes an independent academic unit, is being temporarily housed within the Department of Mechanical Engineering, which offers B.Eng., M.Eng., M.A.Sc., and Ph.D. degrees, and has presently 22 faculty members, 4 Canada Research Chairs, and 150 graduate students. With an excellent collegial atmosphere and active research, the Department attracts outstanding faculty and staff as well as first-rate graduate and undergraduate students. Further information on the Department can be found at http://www.uvic.ca/engineering/mechanical/.

The University of Victoria (http://www.uvic.ca/) is situated in the City of Victoria, the capital of British Columbia, at the southeast tip of Vancouver Island. Founded in 1963, the University is ranked as one of the leading universities in Canada with a reputation for excellence in research and teaching. Victoria is one of the most scenic locales in Canada with a pleasant climate year round.

Applications should include curriculum vitae, a statement of teaching and research objectives and interests, and the names, addresses, telephone number, and email addresses of at least four referees. Applications can be sent electronically by 6 February 2015 in PDF or MS Word formats to CIVErole1@uvic.ca addressed to:

University of Victoria

Dr. Sadik Dost, Professor and Acting Director of Civil Program
Department of Mechanical Engineering, University of Victoria
PO Box 1700, Victoria, BC, Canada, V8W 2Y2

The University of Victoria is an equity employer and encourages applications from women, persons with disabilities, visible minorities, Aboriginal Peoples, people of all sexual orientations and genders, and others who may contribute to the further diversification of the university. In accordance with Canadian Immigration requirements, Canadians and permanent residents will be given priority. Canadian citizens or permanent residents of Canada are requested to self-identify themselves in their application.

CSA-S-06 Canadian Highway Bridge Design Code: New edition

CSCE will be offering a one-day course on the new edition of the Canadian Highway Bridge Design Code. Authors of the code will present and explain the major changes made to four main sections of the code: Section 4: Seismic Design, Section 5: Methods of Analysis, Section 6: Foundations and Geotechnical Systems and Section 12: Barriers and Highway Accessory.

The course will be presented throughout Canada starting in the spring of 2015.

The 11th edition of CSA-S-06 Canadian Highway Bridge Design Code applies to the design, evaluation and structural rehabilitation design of fixed and movable highway bridges. ■

CSA-S-06 Code canadien sur le calcul des ponts routiers: Nouvelle édition

La SCGC présentera une formation d'une journée sur la nouvelle édition du Code canadien sur le calcul des ponts routiers. Les auteurs du code présenteront les modifications importantes apportées à quatre principaux chapitres du code : Chapitre 4 : Conception parasismique; Chapitre 5 : Méthodes d'analyse; Chapitre 6 : Fondations et systèmes géotechniques et Chapitre 12 : Dispositifs de retenue et supports d'équipements routiers. La formation sera offerte dans tout le Canada à compter du printemps 2015.

La 11e édition du CSA-S-06 Code canadien sur le calcul des ponts routiers couvre la conception, l'évaluation et la conception de réhabilitation de la structure des ponts routiers fixes et mobiles. ■

Barres en polymères renforcés de fibre (PRF) et renforcements externes pour structures en béton: propriétés, spécifications et conception

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• CSA-S807 (2010) Polymères renforcés de fibre (PRF),

• CSA-S808 (2014) Spécifications pour les matériaux en polymères renforcés de fibre pour structures renforcées extérieurement.

This course will be presented in French. ■

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www.csce2015.ca

Young professionals Across Canada: Atlantic Region

Jérémie Aubé, EIT, AMCSCE

East New Brunswick and Price Edward Island

As discussed at our recent local section AGM, one of our main goals for the upcoming months is to increase the membership of young professionals in our section. We plan to achieve this by reaching out to colleagues and various firms and institutions of the region. We will also organize, in collaboration with our student chapter, a transition session at the end of the university year in order to maintain our student members as associate members following graduation.

Once the young professional numbers are up, our plan is to organize monthly networking events targeting this group. These events will provide an opportunity to meet fellow young engineers and exchange ideas on various topics in an informal setting.

As usual, we are working closely with the student chapter to support activities such as a half-day job shadowing and a wine and cheese evening, where students get the chance to have discussions with local professional engineers.

If you are interested in getting involved, please get in touch at ja@crandallengineering.ca.

Sara Rankohi, B.Sc., M.Sc., EIT

West New Brunswick Section

The West New Brunswick YP section has a very active student chapter at the University of New Brunswick (UNB). The focus of the UNB YP program has been geared towards providing young professionals in New Brunswick with continuous support and networking opportunities to enhance their professional career development.

UNB was recently recognized as Canada's Most Entrepreneurial University by Startup Canada. Our young professionals are achieving some incredible successes in entrepreneurism and innovation. The UNB student chapter and YP group has also hosted professional and social events such as the Spring and Fall 2014 Career Fairs, a lunch and learn series, the graduate poster competition, Mitacs Steps workshops, lectures and guest speaker events. We also sent more than five representatives to this year's annual CSCE Conference in Halifax. ■

Les jeunes professionnels au Canada: région de l'Atlantique

Jérémie Aubé, EIT, AMCSCE

Nouveau-Brunswick-Est et Île-du-Prince-Édouard

Tel que discuté lors de la dernière AGA de notre section locale, un de nos objectifs principaux pour les prochains mois est d'accroître le nombre de jeunes professionnels dans notre section. Nous comptons atteindre cet objectif en communiquant avec des collègues ainsi qu'avec différentes entreprises et divers établissements de la région. De plus, avec l'aide de notre chapitre étudiant, nous organiserons une session de transition au terme de l'année universitaire afin de garder nos membres étudiants à titre d'associés une fois leur diplôme obtenu.

Lorsque le nombre de jeunes professionnels aura augmenté, nous envisageons d'organiser des événements de réseautage mensuels qui ciblent ce groupe. Ces événements seraient l'occasion de rencontrer de jeunes membres ingénieurs et permettraient d'échanger des idées sur divers sujets dans un cadre informel. Comme d'habitude, nous travaillons étroitement avec le chapitre étudiant pour soutenir des activités telles qu'une demi-journée d'observation en milieu de travail ainsi qu'une soirée vins et fromages où les étudiants ont l'occasion de discuter avec des ingénieurs professionnels de la région.

Si vous souhaitez vous impliquer, n'hésitez pas à nous contacter au courriel suivant: ja@crandallengineering.ca.

Sara Rankohi, B.Sc., M.Sc., EIT

La section du Nouveau-Brunswick-Ouest

La section des JP de l'ouest du Nouveau-Brunswick comprend un chapitre étudiant très actif à l'Université du Nouveau-Brunswick (UNB). L'objectif du programme des JP offert aux jeunes professionnels à l'UNB est axé sur l'offre d'un appui continu et sur les possibilités de réseautage dans le but d'améliorer le perfectionnement professionnel des jeunes.

Récemment, l'UNB a été reconnue par Startup Canada comme étant l'université la plus entrepreneuriale du Canada. Nos jeunes professionnels accumulent d'incroyables réussites en entrepreneuriat et en innovation. Le chapitre étudiant de l'UNB et le groupe des JP ont aussi organisé des événements professionnels et sociaux tels que les salons de l'emploi au printemps et à l'automne 2014, les dîners-causeries, le concours d'affiches pour diplômés, les ateliers Étapes de Mitacs, ainsi que des événements comprenant des conférences et des conférenciers. Nous avons également envoyé plus de cinq représentants au Congrès annuel de la SCGC de cette année qui s'est déroulé à Halifax. ■

Curitiba: Transformation into Sustainability

Curibita in Brazil has gone from a city in crisis to a city that is a showcase in sustainability, thanks to strong leadership and sustainable civil engineering.

By Dr. Gord Lovegrove, UBC OKANAGAN & UBC SUSTAINABLE TRANSPORT SAFETY RESEARCH LABORATORY

Coincidentally, I am writing this while on sabbatical in the Netherlands at the Technical University of Delft (TU Delft). The Netherlands exemplifies many of the traits that make communities sustainable, which is why we asked Dr. Fred Wegman, Professor of Civil Engineering at TU Delft to write a case study for us on the Netherlands. And to check my inherent biases (yes, I have been known to hug a tree or two in my time), I have asked two experts to help me stay balanced in this case study. First, my biggest fan, my

Bus rapid transit (BRT) station. Engineers in Curitiba have put in place a fully-integrated system of neighbourhood, city and BRT routes. The system penetrates to all neighbourhoods using spine and ring transit routing.

spouse, a registered nurse and parent, who has travelled the world with me, knows me better than I know myself and enjoys being my biggest reality check. Without saying what I was writing about, I asked what sets apart communities like the Netherlands (or Curitiba) from our home town of Kelowna, B.C. The instant response: "Sense of Community," defined as: "Everything is so close, you don't need to drive, you can walk, bike and bus everywhere in your own community. The pace of life seems to slow down, so you experience your neighbourhood differently than from behind a windshield – smell, sight, hearing – as you bike and walk. You get to recognize people – your neighbours, your neighbour's kids, your fellow cyclists and shoppers and shopkeepers. Shops are smaller and integrated into the neighbourhoods, so you can get everything you need closer to home, and at prices that seem no higher than in Canada. Yet driving at higher speeds back home seems to take way longer to get anywhere because of congestion, if we don't get into a jam due to an accident." In my humble opinion, my non-engineering, non-urban planner spouse has a pretty good grip on community living that perhaps we should all aspire to, and which is further discussed in Curitiba's sense of community below.

My second guest expert is a UBCO civil engineering exchange student who grew up in Curitiba, Brazil. I asked him to compare and contrast Kelowna with Curitiba. His answers provide the next generation's reality check on how well our generation has done for our kids – listen up and learn! I appreciate their bluntly honest and keenly practical insights.

Context and growing pains

Curitiba is located in southern Brazil (25° South, 49° West), 100 km inland from the Atlantic Ocean and at 900 metres elevation. It is a provincial capital city, home to nearly 2 million people, and has received numerous sustainability awards, most recently the Global Sustainable City Award in 2010, given to cities and municipalities that excel in sustainable urban development. This is a long way from the Curitiba of the 1960s, a city in social, economic and environmental crisis, with no-one stepping up to take a leadership role to address its problems. It had high unemployment, poverty, squalor, burgeoning population growth, overflowing landfills, poor air quality, shrinking civic budgets, and rising traffic congestion – many of the same problems faced by Canadian cities.

Unsure of what to do, Brazilian leaders appointed a young applied scientist, architect and planner, Jamie Lerner, as Curitiba's mayor. Over the next 20 years, Mr. Lerner and his team of civil engineers, urban planners, social planners and architects addressed these problems, individually, and in an integrated system-based approach that has reversed Curitiba's fortunes and made it into a leading global city. Curitiba is proof that retrofitting our cities to be more sustainable through strong leadership and sustainable engineering is possible.

There are several critical success factors for engineering community sustainability that worked in Curitiba. As you scan through them, note how many touch on civil engineering.

1. Strong, Inclusive and Transparent Leadership. Young and inexperienced, Mr. Lerner sought help from his professional colleagues and from residents. His colleagues provided theoretical

expertise, while residents provided community expertise. Working together with no budget, they bridged the gap between bureaucracy and community to provide creative, low-budget, and system-based solutions that were unheard of but incredibly simple to implement. Mr. Lerner became so popular that he was re-elected as mayor three times; check out his TED talks – his self-depreciating humour and charming meekness are disarming and inspiring.

The city uses old buses that travel around providing a location for neighbourhood night schools and libraries.

2. Sense of Community and Social License. Unless everyone pitches in and takes ownership of solving community problems, progress is limited if not impossible. Mr. Lerner and his team launched a barter system to enlist help in transforming the city. With a limited budget, they instead gave what they could afford and what residents told them were needed – cheaper transport for everyone to get to badly needed jobs. They gave bus passes to adults and toy/candy vouchers to children for picking up litter and garbage off the streets.

As public support grew for his innovative social programs that promoted city cleanliness and cheap mobility, Lerner and his team grew bolder. They banned cars in the downtown by physically placing planters, barriers, and trees on the major arterial roads over one weekend, and invested what budget they had in a new state-of-the-art, all rubber-tired bus rapid transit system. Warned that the driving lobby planned a mass protest and "drive-in" on the following Friday afternoon, the week after he implemented the traffic calming measures, Lerner got the word out to all his young waste pick-up recruits to come and play in the streets with free toys and candy at the exact same time and location as the auto-owner protest. Out-manoeuvred and face-to-face with their own children enjoying the car-free downtown, the auto lobby backed down. Today Curitiba has the largest car-free downtown pedestrianized shopping area in the world. Lerner won grudging support from his opponents for his unorthodox but effective leadership style. Doubters and opponents have all come around. People are proud to call Curitiba their home, where polls show that 99% of inhabitants are happy to live there.

3. Promoted Environment. Curitiba has regularly held tree planting events, again recruiting local residents and litter crews. They now have many beautiful trees, and parks which perform double duty as flood control

drainage basins to accommodate the sub-tropical climate rainfall. To maintain a safe and proper height of grass and other vegetation growth in these new drainage basins, they use sheep instead of lawnmowers, reducing both energy costs and an emission burden on air quality.

4. Renewable Energy Sources and Reduced Emissions. Ideally, energy sources need to be from renewable sources – solar, wind, hydro, with minimal fossil fuel use. Brazil has access to offshore oil, but at a price that Curitiba could not easily afford. Moreover, their air quality was sickening and among the poorest in Brazil; hence, they were forced to consider other more creative solutions to reduce their reliance on fossil fuels and improve the air quality. Curitiba is blessed with plentiful solar energy and rain, thus they had no need for costly irrigation systems to maintain parks and to grow food locally. Cutting traffic, improving transit, and increasing green space have greatly impacted the air quality. It has gone from the worst to the best in Brazil.

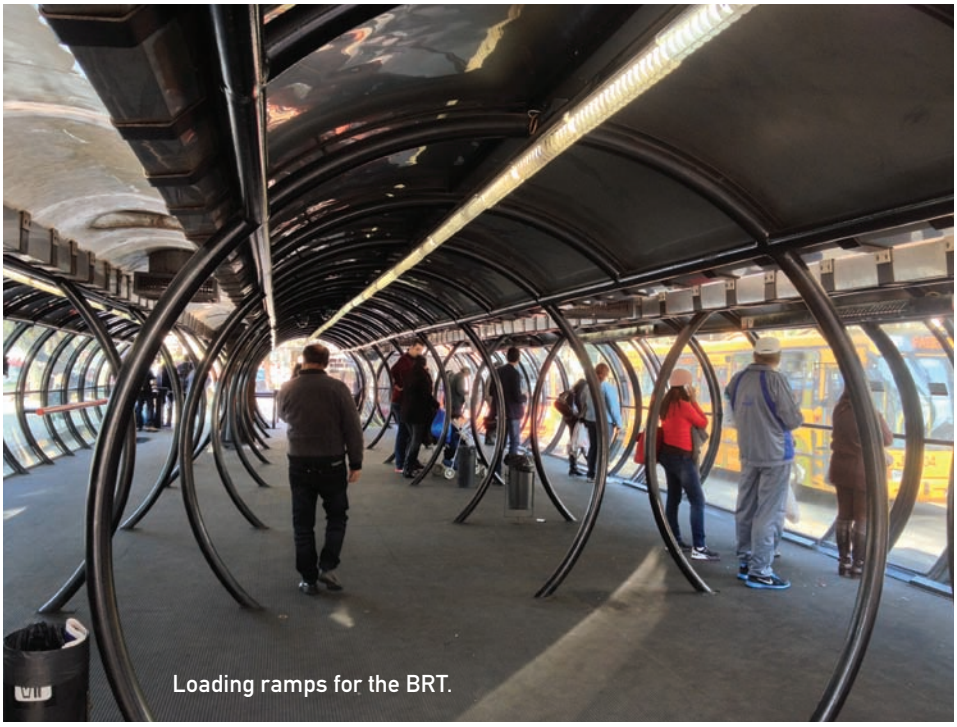
5. Net Zero Waste Management. Their waste barter system has grown from not just litter and waste pick-up, but also to having an effective recycling program. Curitiba has the highest recycling rate in the world – 70%. Our Brazilian engineering student adds that "Another great thing, is that since birth you are taught in how to separate the garbage and, therefore, selective waste collection is really a thing." The city is also recycling its old buses, distributing them around the city to be used for neighbourhood night schools to educate illiterate parents, and as libraries for everyone to enjoy.

6. Economic Prosperity. Providing improved transit and public education systems has created opportunities in all neighborhoods – improved job skills, local economic growth, and access to better paying jobs. Moreover, public transit has made mobility affordable for everyone, and made auto-ownership an optional luxury, thus freeing up personal income for other uses to improve personal quality of life. Curitiba's average income per person has gone from less than the Brazilian average in the 1970s, to 66% greater than the Brazilian average.

7. Accessible, High-Capacity Transport System. Engineers in Curitiba have put in place a fully-integrated system of neighbourhood, city and bus-rapid-transit (BRT) routes, with fare paid zones allowing for high capacity (un)loading at the heavily used BRT stops downtown. Transit penetrates to all neighbourhoods in the city, using spine and ring transit routing. The bus system is so good that even though the civic population has trebled, car traffic has decreased by a third. The BRT now carries well over 75% of daily city trips.

This world class transport system is echoed in my young friend's comment that "there are some things that I miss from Curitiba, such as its public transportation system – Kelowna is a medium sized city, therefore it doesn't have lots of interconnectivity between the bus lines and they also have a really low frequency when compared to those in Curitiba. In Curitiba, it is possible to go from north to south, east to west paying only one fare, which is not possible in Kelowna. On the other hand, Curitiba doesn't have U-Pass, which is really useful for students at UBCO." (For more about U-Pass transportation passes, go to www.trek.ubc.ca.) Note the word "system" – it is NOT all about buses. Integration with walking and bicycling routes, as well as goods movement routes is also needed. For example, our young Curitiban adds that "It's quite hard to get around some areas in Kelowna due to the lack of sidewalks, mainly in places such as supermarkets and shopping mall areas that are planned and built strictly towards cars. This makes urban mobility really difficult for pedestrians and if you have a car probably you will use it. In Curitiba, it is quite different since most of the city is planned and built to increase pedestrian activity, even by making some areas car free zones."

Pedestrian mall in Curitiba.


Loading ramps for the BRT.

8. Integrated, Dense and Complete Neighbourhoods. To sustain local living, transit to jobs, and businesses across the city, it is important to promote moderate residential and job density with a balanced mix of services in each neighbourhood – schools, parks, shopping, public health, churches and day care. Curitiba has planned its neighbourhood land use mix and locations to have a residential density of 4,062/km^2 (10,523/sq mi) within its city boundaries (population 1,764,540), and 210.9/km^2 (546.2/sq mi) in the Greater Curitiba metropolitan area (population 3,209,980). Curitiba has municipal health, education and daycare networks, neighbourhood libraries shared by schools and citizens and Citizenship Streets, where buildings provide essential public services, sports and cultural facilities near transportation terminals. At the Open University, residents can take courses in subjects such as mechanics, hair styling and environmental protection for a small fee. Moreover, my Brazilian student notes that "Curitiba has a large number of parks and green areas per inhabitant. Kelowna and Curitiba, both, are concerned about public health investing in active transportation – cycling and walking paths along the city. In Curitiba, it is also possible to exercise at public gyms located at some parks and squares free of charge."

So as you have read this, what has your inner voice been saying? Do you aspire to what you have read, and/or have concerns about it being possible in Canada? Our cities in Canada need help, they need your help. That's what civil engineers do: help to solve problems and promote a civil society – ideally, to sustain our way of life, right? So did Jamie Lerner and his team in Curitiba. They provided strong, inclusive and transparent leadership. They began by building a sense of community that gave them social licence to make what even today in our communities would be considered pretty radical infrastructure investments in car-free downtowns and BRT, in efforts to promote environmental stewardship, improved air quality, social welfare, and less reliance on costly fossil fuels. They engaged and enlisted local efforts through a bartering system towards net zero waste generation. All the while, they controlled land use and transportation planning decisions to ensure integrated, dense, and complete neighbourhoods. And the results were award-winning economic success and sustainability acclaim for Mayor Lerner and his team.

If nothing else, I hope this article has stimulated you to think again about your role in operationalizing more sustainable civil engineering practises. You have all the tools – theory, creativity, practical know-how. An architect, together with a bunch of planners and civil engineers did it in Brazil with arguably bigger pressures and less money. Why can't we? Our built communities, limited budgets, driving public – and our local experts – necessitate local solutions. I suggest that more sustainable communities must begin by first building our sense of community, by engaging and enlisting all the experts – and keeping them engaged. Civil engineers have always been part of community plans and decision-making in Canada; this will not change. What will your role be? ■

References

Some sustainability performance measures came from www.cities-forpeople.net.

Other statistics on climate and population density came from Wikipedia.

Photos were all provided from civil engineering students living and studying in Curitiba, with releases fully granted to CIVIL magazine.

Dr. Gord Lovegrove is an Associate Professor of Civil Engineering, UBC Okanagan, and, Principal Investigator, UBC Sustainable Transport Safety Research Laboratory. He is a member of the CSCE SD Committee, and has worked to engineer sustainable communities since obtaining his BASc in 1982. He obtained his PhD from UBC in 2006 in Sustainable Transport Safety. www.ubc.ca/okanagan/engineering/faculty/gordonlovegrove.html

Sustainable Communities: the Dutch Example

Since the 1960s and 70s, planning in the Netherlands has favoured controlled growth with an emphasis on public transit, bicycles and walkable communities.

By Fred Wegman, TU Delft, NETHERLANDS

The Netherlands, a flat country with almost 17 million inhabitants in the Northwestern EU (latitude 53° N), has had a longstanding, historic and special interest in engineering sustainable land use and transportation systems. The Low Countries (the Netherlands) flourished in the 17th century, and cities such as Amsterdam, Delft, Haarlem and Leiden grew under this economic prosperity from trade in Europe, but also from trade with the Far East. Community growth was a planned growth, as can be seen for example from the orderly, concentric shape of the Amsterdam canal system. Moreover, well-planned urban land use and transportation development is a long and strong Dutch tradition, as can be seen, for example, from the 1934 General Expansion Plan for Amsterdam (see p.18) in which the famous Dutch architect Berlage designed a new extension for Amsterdam.

When mass-motorization arrived in the Netherlands in the 1960s and 70s, initial ideas were developed to bring more motorized cars as comfortably and quickly as possible to Dutch inner cities to support economic developments. The American traffic engineer David Jokinen was invited to give his views on solving this "modern traffic" problem in Amsterdam. His proposal (Give the City a Chance) was major demolition and reconstruction projects, and highways throughout the city, which necessarily would mean massive removal of (historic) buildings. In response, our community leaders at that time, primarily architects but also a few civil engineers, acknowledged their cultural and architectural appreciation of historical inner cities, and the conclusion was: Dutch historic cities don't match well

Photo: Thinkstock

with large amounts of motorized vehicles. Instead, they decided in favour of transport policies that gave better opportunities for public transport and the use of the bicycle. And civil (transportation) engineers have played a large role in planning and designing Dutch public transport and bicycle systems. Furthermore, Dutch cities and villages have always been very walkable, with everyday land uses – home, work, school, shopping – planned in close proximity (i.e. walkable and bikeable) to each other, with deliberate traffic calming in residential areas (i.e. woonerfs). For example, cars could enter historical inner cities, but travelling by car was and is expensive (parking) and is complicated by certain routes being blocked and one-way systems. At the same time travel by public transport, walking, and cycling is made relatively easy, cheap and comfortable.

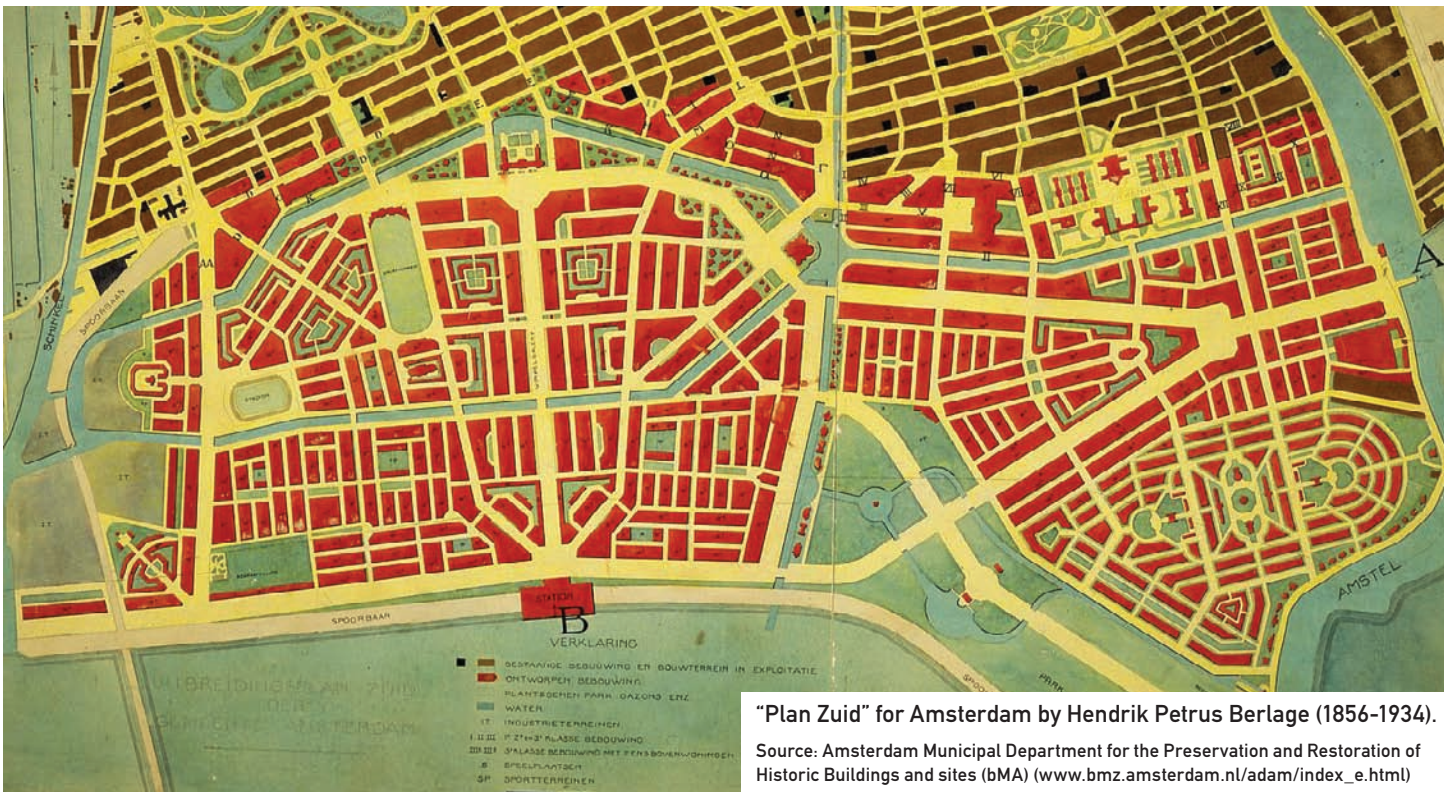
Public transport, bicycling and cars "tolerated"

Over the years this planned land use and transportation approach was adopted by community planners and engineers in almost all Dutch cities and villages. The backbone of urban transportation became public transport and bicycling, with cars "tolerated" but given relatively low priority in the inner cities. Car-related traffic was concentrated alongside major ring roads and by-passes of Dutch cities and villages. Major offices were moved from inner cities to the external borders of cities. As a modern growth management strategy, several Dutch New Towns were built as satellites of major Dutch cities to house families that could not find (large) enough homes in the historic cities. Hundreds of thousands of Dutch urban citizens found their new homes in satellite cities such as Houten (near Utrecht), Zoetermeer (near The Hague), and Purmerend, Almere and Lelystad (near Amsterdam).

Given its highly-planned and growth-managed communities, the Netherlands generally is a community of communities. It has relatively high population densities (400 inhabitants per square kilometre) located in communities dispersed among rural parkland and agriculturally productive hinterlands. While this dispersion of communities lends itself to a high quality of life and healthy living, it also naturally can result in travel demand between these urban areas, for example resulting in a high density of motorway road length per square kilometre – one of the highest in the world. As a result, a high proportion of interurban trips are made on motorways. A high density of activities can result in high emissions and noise pollution problems due to traffic. For that reason, to comply with prevailing EU environmental legislation on air quality and traffic, noise requirements are in place to manage traffic volumes and speeds, especially in and around urban settlements, as well as providing for world class cycling and rail networks criss-crossing the country.

Sustainable Safety approach

From a road safety perspective, policies in Dutch cities and villages are dominated by Sustainable Safety, one of the world's pre-eminent examples of the "Safe System" approach. Sustainable Safety tries to eliminate traffic conditions that could result in serious crashes, and if these conditions cannot be eliminated fully, it tries to reduce the severity of injuries as much as possible. This can be achieved by a pro-



"Plan Zuid" for Amsterdam by Hendrik Petrus Berlage (1856-1934).

Source: Amsterdam Municipal Department for the Preservation and Restoration of Historic Buildings and sites (bMA) (www.bmz.amsterdam.nl/adam/index_e.html)

Photo: Thinkstock

active approach in which human characteristics are used as a starting point: a user-centric approach. These characteristics refer on the one hand to the physical vulnerability, and on the other hand to the human (cognitive) capacities and limitations. A Functional Classification of the Road Network forms one of the principles of Sustainable Safety. This principle is based on the U.K. "Traffic in Towns" philosophy of the 1970s. A second, the Homogeneity principle, deals with human vulnerability and basically tries to manage kinetic energy in a crash by speed reduction. The third principle, Forgivingness, tries to ensure that errors by road users remain limited when vehicles leave the road and enter the road side. Fourth, the Predictability principle concerns preventing human error by safe road design.

Sustainable Safety, with a strong emphasis on land use and transportation planning and road design, has been implemented over the years. While I will not say that civil engineers led decision-making in the historic progress toward sustainable and safe communities, I do know that civil engineers were key members in building what today supports a high quality of life for residents and an inviting and safer experience for visitors to the Netherlands. Peer-reviewed evaluation studies have demonstrated positive road safety effects, in both rural and urban settings.

Strong leadership required

It is remarkable that the Netherlands embarked on sustainable transportation – a cornerstone of sustainable development, as well as a critical factor in healthy communities – far before the concept of sustainable development was introduced into our civil engineering profession in the 1987 UN report on Our Common Future (so "avant la lettre"). Perhaps it was our historic human scale of development, with moderately dense and walkable communities, that facilitated our remarkable decision making in support of controlled growth and public transit rather than sprawling communities. Regardless, these decisions required strong leadership, which included civil engineers, to value and preserve the history, culture, and built form of our cities for future generations. As a result, in Dutch cities today we don't think twice about taking the tram, bus, or bike – it is the natural and healthy thing to do. And everywhere, whether travelling by car or bike, Sustainable Safety is the logical completion to our transportation policies that rank the Netherlands among the safest countries in the world. ■

Fred Wegman is Professor Emeritus of Civil Engineering at the Technical University of Delft (TU Delft), Netherlands and former director of the Dutch Road Safety Research Institute (SWOV.nl)

Renderings showing the West Don Lands in east downtown Toronto at full build-out.

Waterfront Toronto

Waterfront Toronto Redevelopment Project Wins CSCE Award

By James Garland, P.Eng., FCSCE
NLT (NATIONAL LECTURE TOUR) COORDINATOR, CSCE

At the CSCE Awards Banquet in Halifax on May 30, 2014, Waterfront Toronto was named 2014 winner of the CSCE Governmental Leadership in Sustainable Infrastructure Award. This award recognizes leadership by governments and government bodies in demonstrating better ways of creating and renewing Canada's infrastructure. Waterfront Toronto was recognized for the work they are doing to transform the waterfront of Canada's largest city.

When 10,000 athletes and officials come to Toronto in 2015 for the Pan/Parapan American Games, they will be staying in what is arguably Canada's most sustainable neighbourhood. The tri-government agency Waterfront Toronto is reshaping Toronto's under-utilized industrial waterfront with a 21st-century approach, integrating sustainability and innovation to create a modern "blue edge" for Toronto.

Temporary Athletes' Village

One of the most dramatic redevelopment areas is the West Don Lands, a 32-hectare (80-acre) precinct located west of the Don River just north of the GO Rail corridor on former derelict industrial land previously susceptible to flooding. A 14-hectare (35-acre) portion of this precinct will be the home of the Athletes' Village for the 2015 Pan/Parapan American Games, providing temporary accommodations for the athletes and officials. After the games, an amazing new mixed-use community will welcome residents when the buildings are converted for permanent

occupancy in early 2016. With a focus on pedestrian-friendly high density development, the West Don Lands will allow residents to live within walking and cycling distance of their day-to-day destinations, including parks, shopping, and community services. The community was designed to knit into surrounding neighbourhoods and the rest of the city with an extensive network of pedestrian and cyclist connections, light rail, and roads.

The West Don Lands is one of four waterfront precincts, totaling 800 hectares (almost 2,000 acres), that will be developed over the next decade. The entire Waterfront Toronto project is one of the largest waterfront redevelopment initiatives in the world. The project goals are to transform the brownfield lands into dynamic mixed-use communities that will enable Toronto to compete on the world stage for investment, talent and residents who will want to live and work in sustainable, high-density, transit- and active transportation-friendly neighbourhoods with superior public spaces. The two-decade-long project began with a $1.5-billion public investment to create Waterfront Toronto. The remainder of the estimated $35-billion cost will be borne by private sector investment.

Stormwater drainage was key

The West Don Lands previously hosted industries and created jobs for an earlier Toronto. Once industry moved out, the lands were left derelict and contaminated. In 2001, when Waterfront Toronto was created, the area was identified as one of four waterfront revitalization priorities. Waterfront Toronto's award-winning precinct plan provided the roadmap; soil remediation, design of a flood protection scheme and a sustainable stormwater drainage system were key elements of the area's transformation.

Soil remediation was based on a risk assessment/risk management approach that achieved the correct level of clean-up required for the future land use of the area.

The entire precinct and about 200 hectares of adjacent neighbourhoods, extending into Toronto's financial district, were exposed to regional flood risk because of the limited capacity of the adjacent Don River. The solution for this site was to increase channel capacity in the river and create a large flood protection landform along the river's western frontage, which would act as a flood control berm but also serve as the foundation for the signature park – Corktown Common, a 7.3-hectare (18-acre) year-round facility. The accompanying photograph shows the water play area within the park.

After addressing the soil contamination and flood risk challenges, the third big challenge to creating the revitalized West Don Lands precinct was stormwater management. Toronto's Wet Weather Flow Management Guidelines, developed to reduce the problems of poor water quality in Lake Ontario forcing beach closures after summer storm events, require 80% removal of total suspended solids and less than 100 E.coli/100 ml during the swimming season. Waterfront Toronto has achieved this with a multi-step treatment system starting with Canada's largest oil-grit separator and ballasted flocculation, then ultraviolet disinfection of all minor system flows. Using proven, commercially available technologies for water and wastewater treatment on stormwater is innovative and cost effective.

The West Don Lands precinct naturally drained to the Don River, a route now cut off by the flood protection landform. The technical solution selected was to regrade the entire site to route major and minor (piped) stormwater flows to the west and under the adjacent railway corridor at the existing Cherry Street underpass. The roadway has a low point south of the underpass and a major system inlet was positioned here to prevent roadway flooding during all events. The major and minor system piped sections had to cross under the Gardiner Expressway, Lakeshore Boulevard, underground high voltage hydro lines and a gas main. Tunneling through the deeper shale rock was more cost effective when the risk of dealing with contaminated soil and groundwater in the old lake fill overburden was considered. Using a single access shaft for three component tunnels, and then reusing the shaft and the minor system tunnel under the railway lands for storage to minimize peak flows to the treatment system is an additional example of innovation. This approach lowered the capital and operating costs.

Neighbourhood planned with sustainability in mind

Similar to the CSCE's Guidelines for Sustainable Development, Waterfront Toronto's Sustainability Framework has been used to guide the creation of the West Don Lands. In addition to the engineering innovation de-

Corktown Common, West Don Lands on official opening day, July 10, 2014.

Waterfront Toronto

scribed above, Waterfront Toronto has also incorporated sustainability principles into the planning and building of this new neighbourhood. The process followed a LEED ND (Neighbourhood Development) Gold certified plan (Stage 1 US Pilot Version). They have maintained regular consultation with the public and other stakeholders, including the City of Toronto and the Toronto Region Conservation Authority throughout the planning phases. Waterfront Toronto also conducted extensive public consultation throughout the design and construction of the area, and held a design charrette in the early stages to assist with the development of the West Don Lands Precinct Plan.

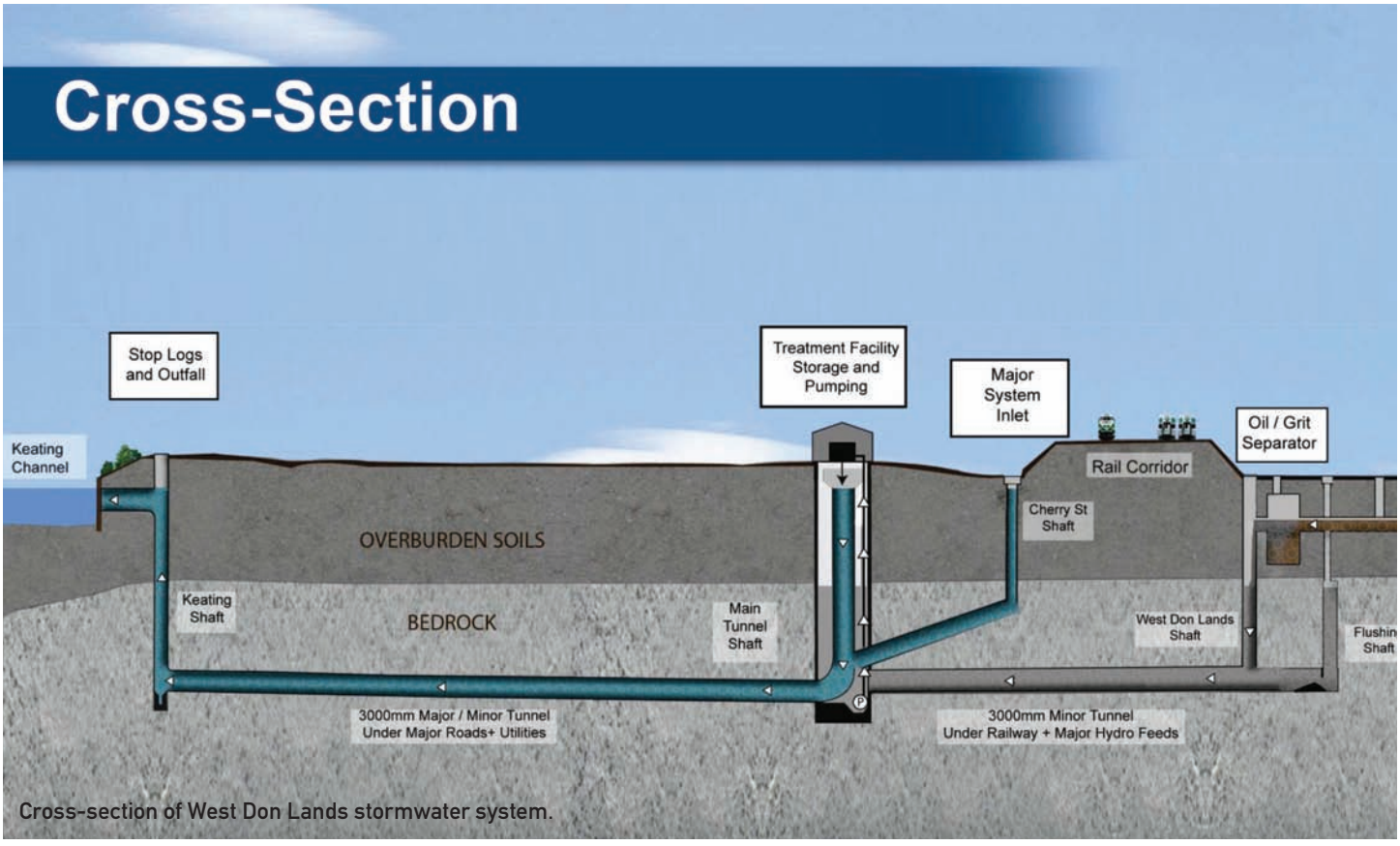
As part of Waterfront Toronto's broader leadership and accountability approach, the corporation published its first Corporate Social Responsibility and Sustainability Report (CSRSR) in 2013 (available at www.sr.waterfrontoronto.ca). The CSRSR documents their progress on 23 measures of sustainability, including energy and water conservation, LEED Gold certification, waste diversion, aquatic habitat creation, design excellence, and economic performance.

Sustainable infrastructure isn't just about being well designed and well built; it also must meet the needs of the community in harmony with the natural environment. These measures are met in the West Don Lands in many ways. The stormwater system in Corktown Common is recycled through a wetland to provide irrigation water. The wetland sustains waterfowl and water plants, creating a natural oasis in a high density urban environment. More than 80% of residences and workspaces are within a 400 metre walk to public transit and a multi-use trail, and 20% of the residential units in the West Don Lands will be affordable housing, ensuring a representative community.

The West Don Lands have been created by a tri-government agency and provide an example of how sustainable communities can be achieved. Creating the precinct plan and readying the area for development was the first step. Visitors to the area can now see the transformation underway: residents have begun moving in, the Village is almost complete, and Corktown Common and Underpass Park have become local and regional destinations. After the Games, when the fences are down and the buildings are home to permanent residents, the derelict post-industrial landscape will be a distant memory.

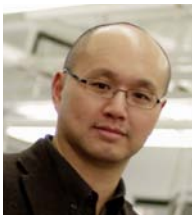
Congratulations and thank you to Waterfront Toronto! ■

James H. Garland is project manager, Rapid Transit Office, Region of Durham Works Department.



Cross-section of West Don Lands stormwater system.

Sustainability and Civil Engineering



Edwin Tam, Ph.D., PEng
CHAIR, CSCE, SUSTAINABLE DEVELOPMENT COMMITTEE

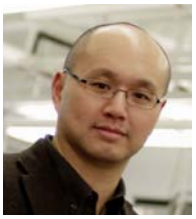
Gord Lovegrove, Ph.D., PEng., MBA
ASSOCIATE PROFESSOR, SCHOOL OF ENGINEERING, FACULTY OF APPLIED SCIENCE, UBC

What does it mean to be sustainable in the context of civil engineering? In 2012, the CSCE put forth its Vision 2020 which promotes three strategic directions, one of which is to provide leadership in sustainable infrastructure. Clearly, the emphasis is on infrastructure, but even this refinement leaves a very broad interpretation of sustainability. Earlier, in 2006, the CSCE updated its Guidelines for Sustainable Development in response to the changing needs of civil engineering, but the landscape for civil engineering with respect to sustainability continues to evolve.

We, the human species, are largely responsible for the rapid and sometimes drastic changes to our environment; as civil engineers, we likely effect more change to our environs than most others. The vast majority of new undergraduate civil engineering students were born seven years after the landmark Brundtland Report in 1987 which defined the modern concept of sustainable development. Sustainability is now taught to new engineering students, but understanding and achieving sustainability for many civil engineers remains elusive: how do we know if we have achieved sustainability in a new bridge, roadway, or building?

At the 2014 CSCE Annual Conference, the CSCE Sustainable Development Committee put forth a paper discussing the concept of sustainability and providing guidance on how to operationalize sustainability: how does a civil engineer put into practice the diverse and sometimes overwhelming information about sustainability? The sustainability articles in this issue of CIVIL draw from this paper but also present new case studies and perspectives on what sustainability means for our profession. ■

La durabilitié et le génie civil



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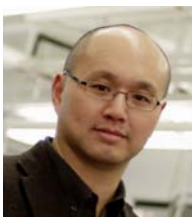
Que signifie être « durable » en génie civil? En 2012, la SCGC a présenté sa Vision 2020 qui met de l'avant trois orientations stratégiques dont l'une a pour but de fournir du leadership en matière d'infrastructures durables. Il est clair que l'accent est mis sur les infrastructures, mais même ce détail laisse place à une très large interprétation de ce qu'est la durabilité. En 2006, la SCGC a mis à jour ses directives sur le développement durable en réponse aux besoins changeants en génie civil, mais le paysage de la durabilité en génie civil continue d'évoluer.

En tant qu'espèce humaine, nous sommes en grande partie responsables des changements rapides et parfois drastiques qui surviennent dans notre environnement. En tant qu'ingénieurs civils, nous influençons probablement davantage notre climat que la plupart des gens. La grande majorité des nouveaux étudiants de premier cycle en génie civil sont nés sept ans après l'important Rapport Brundtland, paru en 1987, qui définit le concept moderne du développement durable. À présent, on enseigne ce qu'est la durabilité aux nouveaux étudiants en génie civil. Toutefois, pour bien des ingénieurs civils, comprendre et parvenir à la durabilité reste une chose difficile à réaliser : comment savoir si nous avons atteint la durabilité dans un nouveau pont, une chaussée ou un immeuble ?

Lors du Congrès annuel 2014 de la SCGC, le comité du développement durable de la SCGC a proposé une communication qui traite du concept de la durabilité et qui donne des directives sur la façon de la concrétiser: comment un ingénieur civil peut-il mettre en pratique cette énorme masse d'informations si variée sur la durabilité ? Les articles sur la durabilité publiés dans ce numéro de CIVIL sont tirés de cette communication, mais ils présentent également de nouvelles études de cas et d'autres points de vue sur ce que la durabilité signifie pour notre profession. ■

Guidelines for Operationalizing Sustainability in Civil Engineering Practice



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This article is excerpted and modified from the paper presented at the CSCE 2014 General Conference (Perks et al. 2014).

It would be very difficult to prescribe how every civil engineering project should embrace sustainability; however, a methodical, rational approach to incorporating sustainability principles into practice should significantly help. Sustainability is about triple-bottom line, life-cycle thinking in all we do, while considering future generations. This includes environmental and resource stewardship, sustaining quality of life, and developing impact-neutral, productive infrastructure systems. To help facilitate this thinking, CSCE and other engineering societies have developed sustainability guidelines. The rapid evolution of related research and information technologies means more information than ever is available to civil engineers. Guidelines are not the only tools for incorporating sustainability into engineering practice, but they do serve as useful frameworks.

The following table compares the current CSCE guidelines against other notable sustainability guidelines from: (1) Practice, Education and Research for Sustainable Infrastructure (PERSI) Task Committee on Planning for Sustainable Infrastructure (hosted by the American Society for Civil Engineers); (2) Transport for New South Wales; and (3) the Association of Professional Engineers and Geoscientists of British Columbia. The categories used are based approximately on the latest CSCE sustainability guidelines. Within the table are our summaries of what appear to be the defining aspects of each organization's guidelines with respect to the relevant CSCE category. This comparison provides insight into alternative perspectives on operationalizing sustainability, and reveals, to some degree, the differences in thinking with respect to different aspects comprising sustainability. Of course, not all civil engineering societies have the same mandate, and Transport for New South Wales focuses on transportation projects. Nevertheless, given the dominance of civil engineering in the transportation sector, reviewing their guidelines is still instructive.

The table also helps identify areas of potential improvement for the CSCE guidelines. Within the matrix, cells highlighted in green in any one category represent the most defined guideline across all four organizations examined. This implies that users of that particular guideline would have the most detail and guidance in operationalizing that aspect of sustainability.

As an example, three out of four organizations address the Natural Environment category in relatively broad, holistic terms. Transport for NSW, however, provides very specific examples with respect to assessing and managing impacts regarding the natural environment. At first glance, more defined guidelines appear better formulated and thus provide a better starting direction on how to understand and implement sustainability. However, more prescriptive guidelines can limit creativity. Conversely, guidelines which are much more general can allow for creative solutions, but if they are too vague, will not provide a practical starting point to operationalize sustainability. Ideally, sustainability guidelines should provide a starting point for operationalization, but not limit those ideas to a fixed set of preconceived parameters.

Admittedly, whether or not a description in a particular cell is more useful just because it is more extensively defined is a subjective call. Nevertheless, more description provides greater commentary and therefore guidance, particularly if an engineer is unfamiliar or even uncomfortable with how to incorporate sustainability. An extensive definition can always be modified or even rejected depending on the practitioner's circumstances – the practitioner has at least specific issues to consider.

Of the four guidelines, the CSCE guidelines are the oldest, suggesting that CSCE's guidelines should be revised periodically. For example, in the beige box in the Green Construction category, the guideline "ensure use of feasibility study" is noted, which was summarized from three points outlining the basic premise of a feasibility study. Given that feasibility studies are now much more accepted as precursors to environmental assessments, what instead would be more practical is advice on how to incorporate feasibility information into sustainability decision-making. As a result, the squares highlighted in beige only pertain to the CSCE guidelines and represent sections that could be considered vague or outdated, and may need to be revised given that our collective understanding of sustainability continues to evolve.

Since the creation of the guidelines, the sustainability field has made significant advancements, and some specific guidelines are now provided through legislation. Merging the "best" characteristics of these notable guidelines (the green boxes) into a single, comprehensive framework could provide the basis for a revised sustainable civil engineering best practice guide for the next generation of civil engineers. ■

References

Association of Professional Engineers and Geoscientists of British Columbia (APEGBC)

Continued on page 27

CSCE Guideline Categories	**CSCE** Canadian Society for Civil Engineering	**PERSI (ASCE - US)**	**Transport for NSW (AU)** New South Wales	**APEGBC** Association of Professional Engineers and Geoscientists of BC
Natural Environment	Be aware of, protect and enhance the natural environment affected by the project	Natural infrastructure should be preserved and used to compliment new infrastructure	Undertake water balance study Retain natural hydrological features and install surface treatment. (plant grassland species to assist with treatment) All heritage items to be protected or reused during construction and project life span 95% of all construction/ demolition waste is diverted from landfill Ensure the project stays within a prescribed greenhouse gas emission level	Consider long and short term effects of a project
Financial and Economic Stability	Include all environmental costs during assessment stages (const., maintenance, disposal, environmental protection) Value environmental assets and capital assets fairly when performing asset analysis	Users should pay for both capital investment and on a pay-per-use basis to assist with maintenance costs Include costs to local economy and community networks in addition to project costs during decision making stage	Consider the whole life cycle of a project when selecting materials, technologies and scope Purchase 25% of site-based electricity needs from green energy sources	Consider full life cycle costs of a project
Green Construction	Promote energy efficiency Ensure use of feasibility study Negative environmental, social, economic impacts are to be minimized Promote green materials and minimize land use	New infrastructure should require less maintenance and be able to handle risks better Strive to maximize the service life of a structure	Ensure crime prevention through environmental design (CCTV cameras, minimizing narrow corridors and tight corners, and adequate lighting) Include on-site water reuse, and non-potable water use All fixtures to be water efficient fixtures up to specified efficiencies Reuse all spoil on site or nearby offsite (spoil – excavated soil, rock, etc.) Reduce Portland cement by 30% on average across all concrete mixes by substituting in supplementary cementitious materials that are waste materials from other industries Optimize building orientation and form to provide maximum amount of natural lighting	
Human Resources	Stay informed with regard to sustainability trends, protective practices, and impacts Promote public consultation and training and continuing improvement	Work with a wide range of professionals to better define sustainability		The engineer should be up-to-date with sustainable practices Advocate for new standards where existing ones are not sustainable

Continued on page 26

CSCE Guideline Categories	**CSCE** Canadian Society for Civil Engineering	**PERSI (ASCE - US)**	**Transport for NSW (AU)** New South Wales	**APEGBC** Association of Professional Engineers and Geoscientists of BC
Social, Regulatory, Health	Meet basic human needs of current and future generations Comply with legislation and report inadequate conditions Concerns outside of legislation should also be addressed where evidence exists	Locate residential, employment, and shopping areas closer together and install alternative transportation between these Use modeling software to analyze, simulate and visualize planning decisions. This helps identify long-term effects	Comply with noise pollution regulations Perform a "Climate Change Impact Assessment" for projects >$10M using current scientific predictions Risks from extreme, high, and medium climate impacts as identified in above report to be accounted for in design	
Ethics	Adopt and suggest new practices of sustainable development Show commitment to public's physical, economic, and environmental wellbeing Inform clients, colleagues and the public of improvements in sustainable civil engineering Lead in developing sustainability-based best practices Do not associate with clients unwilling to comply with regulations or that will not mitigate environmental harm	Project effectiveness should be measured using economic, environmental, and social benefits as well as energy efficiency levels, not just by investments that produce immediate benefits Award contracts based partially on the sustainability and not on cost alone Have owners stipulate the final outcomes they wish to achieve thereby allowing designers more freedom to incorporate sustainable practices into the design	Actively engage with stakeholders	Sustainability should be incorporated into infrastructure projects, since it is implied to be in the public's best interest Provide a clear justification for the implementation of sustainable solutions (allows for transparency in the decision making process)
Participation	Involve other professionals in assessments and support their initiatives Involve public in the decision-making process and value their input	Develop solutions for infrastructure using an integrated, cross-disciplinary approach Involve life and earth scientists in planning stage	Achieve interpretation of heritage items through public and heritage interpretation committee Ensure design projects take existing planning strategies into consideration	Work in multi-disciplinary teams to achieve more comprehensive solutions
Implementation	Establish operational goals to: conserve energy and resources, minimize solid and gaseous waste, and protect surface and ground water Ensure communication between design and build stages Advocate sustainable funding for O & M during project	Distribute electricity generation, water and treatment plants in a fashion which reduces distribution lines Distribute electricity generation using renewable sources which provides increased capacity and local heating effects Balance 10-20 year budgets to include deferred maintenance		Assess sustainability performance, specifically ways to improve knowledge and professional practice
Technology Use	Use appropriate technology for the project's purpose	Use modeling software and building information modeling to reduce costs and time	Install sensors to reduce water from inefficient use	
Monitoring Initiatives	Monitor environmental change and adjust systems	Sensors and controllers should be used to improve traffic management before deciding to add additional lanes Install sensors to indicate maintenance on buildings	Monitor and record all water usage during construction Report carbon footprint every six months using standard values	

Fused Grid: Engineering a More Sustainable Community

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Adam Lee, UBC
Farhad Faghihi, PhD, UBC

A new neighborhood design is seeking to overcome problems associated with living and driving in the two most common street patterns seen in North American cities: (1) the traditional grid or grid-iron, and, (2) the cul-de-sac or loops and lolly-pop pattern. The more recently employed cul-de-sac pattern sought to overcome problems associated with the traditional grid pattern by calming through vehicle traffic and thus providing quieter safer living spaces. However, it has proved disorienting to navigate, increased driving, decreased bicycling, and caused safety problems at intersections with perimeter main roads. To increase safety and to balance the needs of driving, biking and walking, a new street pattern has emerged, the Fused Grid (FG).

The Fused Grid was developed by the Canada Mortgage and Housing Corporation (CMHC) to provide a more liveable and sustainable community development pattern for residents, by fusing the best aspects of mobility, accessibility, green, and living spaces in a human scale, walkable 80 metre grid pattern (Grammenos et al. 2008). This fused grid pattern of 400-metre square neighborhoods contains five 80-metre blocks per side (a distance walkable in 1 minute), and 25 blocks per 16 hectare neighborhood module. Perimeter roads provide through traffic mobility according to standard 400 metre (collector), 800 metre (minor arterial), and 1600 metre (arterial) spacing, although this can be varied as needed, depending on the density of planned land use activities. Major services are contained along the perimeter roads within one-way couplets, which allow for safer access by pedestrians, bicyclists, and vehicles. Local roads connect to perimeter roads via roundabouts and three-way intersections. The internal local street pattern focuses on access only, with no through-vehicle connectivity due to a car-free central green space. This central green is supplemented by a continuous grid network of off-road paths and local parks to provide full walk/bike connectivity and restorative green spaces, such that all residents live within a one minute walk of a park without crossing any streets.

Grammenos et al (2008) suggest that the FG model offers practical connectivity for vehicles, and full connectivity for people. This increases the odds of walking/cycling in the community, and is correlated with increased incidence of physical activity. Lack of physical activity has become a main challenge for public health across Canada, as it increases the possibility of many health problems, such as hypertension, diabetes, obesity and heart diseases. Moreover, a lot of research evidence suggests that with proper planning and engineering, a neighborhood built using FG design principles would be a sustainable model community. It would result in reduced pollution emissions and less public exposure to pollutants, due to both the compactness of the community and reduced vehicular use. The convenient walkable access to local green space would improve mental and physical health. Controlling speed and volume of vehicles on local streets would not only reduce emissions, but also reduce traffic noise, fuel consumption, and the safety risk for children.

This case study assesses the FG neighborhood from a civil engineering perspective using two sustainability-oriented frameworks that have not yet widely been applied in Canada, but that represent perhaps the

Continued from page 24

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most proactive ways to assess development patterns and promote more sustainable communities for Canadian civil engineers. The first, known as the Healthy Development Index (HDI) (Dunn et al. 2009) is an innovative tool developed by public health and community planning experts in the Peel Region of Ontario, and focuses primarily on the planned land use design of a community. It has also been reviewed for civil engineering applications by researchers at UBC. The second evaluation tool focuses on evaluating the planned transportation design of a community. It is a collection of Sustainable Transport Safety (STS) principles that was developed by civil engineers and researchers at the Dutch Road Safety Research Institute (SWOV) (Wegman et al, 2008), and applied country wide over the past 20 years. Serious road crashes in the Netherlands have declined by more than 70%, making it one of the safest countries in the world. More background information on each is available in references cited. Taken together these two tools can provide a holistic evaluation of the planned land use and transportation infrastructure designs of any community. This case study demonstrates how to use them, and in particular, the theoretical strengths of the FG neighborhood design. Again, success in sustainable community infrastructure design would depend on the actual site application, together with the engineer's professional judgement and final design decisions.

Land use design evaluation: Health Development Index (HDI)

There are seven evaluation criteria of the HDI: density, connectivity, proximity to services, land use mix, road and sidewalk networks, parking, and aesthetics and human scale. Each is discussed below in terms of how the FG neighborhood design would score 100 points out of a total possible of 100 points (= 100% perfect score).

Density

The average assumed density in this analysis was 85 units/ha, higher near the perimeter arterial corridors to provide a higher level of proximity to services. For the Floor Area Ratio (FAR), the intensified commercial zones in the arterial corridors nearby high residential and employment density ensures that the FG neighbourhood will have a FAR value greater than 2.5.

Connectivity

Connectivity relates to the ease of access between housing, jobs, and services by neighborhood residents using Active Transport (AT) networks to walk and bike inside the neighborhood, and to ease of vehicular mobility outside the neighborhood for transit and driving across cities. By definition, the FG has very high connectivity; FG AT connectivity is 1.29 compared to 1.54 for vehicle connectivity.

Proximity to services

The FG design, with perimeter arterial roads and services, would allow the residents to

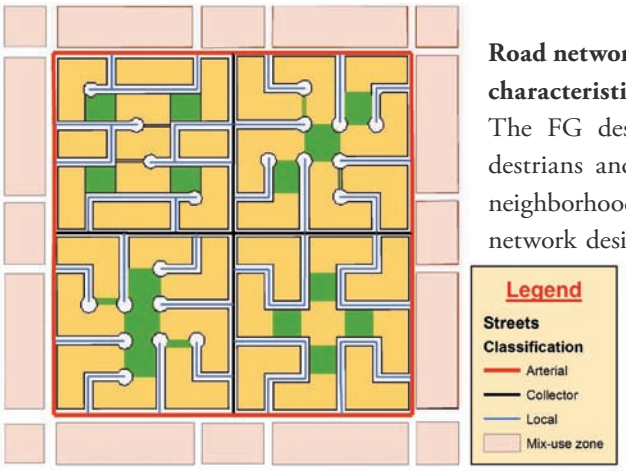

Figure 1: The typical four-quadrant FG community under evaluation

conveniently walk and bike to services in all four directions of the neighbourhood within minutes. Thus proximity to jobs and services within the neighborhood is assured, as is proximity to transit stops and routes taking residents outside the neighborhood. This would score very high on the HDI, which encourages developers to develop as close as possible to activity centres in order to decrease urban sprawl effects, and to thereby make it more appealing for residents to use alternative modes of transport. Thus, it can be said that in theory, all FG neighborhoods provide for sub-30-minute transit service to all jobs.

Land use mix

The FG community provides at least 8% of the community land as outdoor public spaces. In addition, as discussed earlier, the variety of services the community provides and the mix of housing types allow the FG to easily achieve the heterogeneity of Land Use Mix criteria. The following FG design features would receive a maximum HDI score:

- ≥ 60% of commercial buildings include a ground floor pedestrian use.
- 100% of mixed-use buildings and ≥50% of multifamily residential buildings include ground floor retail, live/work spaces, and/or residential dwellings.

Road network and sidewalk characteristics

The FG design is based on giving pedestrians and cyclists first priority inside neighborhoods, which is reflected in the network design and characteristics. In addition, the FG incorporates traffic calming measures to ensure the safety of pedestrian and cyclists from severe collisions due to high speed such as roundabouts, three way intersections, and raised cross walks on arterials, which would be designed to 50 km/h speed limits and one-way arterial standards. Local roads in neighborhoods would be designed to speeds limit of 15km/h, with pedestrian and bicycle priority.

Sidewalks would exceed 2.5 m width, with

buffer strips and curb side parking added along collector and arterial roads. Separated bikeways would be designed on major roads, with colored bike lanes on collectors. Off-road AT paths would complement on-road routes and sidewalks, such that it would be more convenient, and quicker to walk/bike than to drive across a neighborhood. High-level and pedestrian level street lighting (solar and/or wind powered if possible) would be provided on both sides of all roads, as well as low-level pathway lighting for personal security.

Parking

To reduce automobile dependency, FG design would ideally restrict the location, supply and price of parking, as follows:

- All units would have unbundled parking.
- Shared parking would be provided in commercial zones.
- Metered parking would be enforced in all commercial zones, with the price of all parking increasing (i.e. NOT decreasing) with the length of the stay.
- All on-road parking in each neighborhood would be restricted to a 2-hour maximum.
- Driveways for loading/unloading in residential and commercial areas would have a maximum width of 3 metres to minimize pedestrian and bicycle crossing distance and safety risks, with long term residential parking accessed via rear alleys.

Aesthetics and human scale

The buildings within the FG neighborhood by definition are massed to achieve a minimum average building height to street width ratio of 1:1. In addition, to provide a pleasant environment for pedestrians, commercial buildings provide a nice pedestrian scale with the following characteristics:

- No setbacks from property lines, which allows for convenient walk-in access,
- Clear glass on more than 60% of their facades, giving a more inclusive look and feel to walkers,
- No blank walls longer than 40%, or 15m, of the facade facing the sidewalk.
- Trees planted every 10m on street sidewalks abutting the facade.

To most practising civil engineers, the above design (and policy) features of a FG neighborhood are not unfamiliar. Perhaps more difficult to implement would be the parking policies related to pricing, time limits, and supply. However, with strong leadership, implementing these design and policy measures as a system would garner a very favorable Healthy Development Index rating, in support of sustainability.

Transportation design evaluation: sustainable transport safety

To complete the community design evaluation, the design can also be described from a transportation design perspective. Sustainable transport safety principles follow from two goals (Wegman et al, 2008):

(1) To prevent road crashes by decreasing the risk of human errors, and,

(2) Recognizing that human error is bound to happen, to reduce the severity of any crashes that do occur to a level that the human body can tolerate.

Towards these goals, the five STS principles include: functionality, predictability, homogeneity, forgivingness, and driver state awareness.

Functionality

In the sustainable safety vision, a road should fulfil only a single function, either to provide for local access, or to provide for through traffic flows. In the FG design, road functionalities are absolutely clear and multifunctional roads cannot be found. Local roads are designed to provide only access functions to residences within neighborhoods. Between and surrounding neighborhood modules, collector and arterial roads provide traffic flow functions.

Predictability

The predictability principle specifies that the road design should create a driving environment that educates road users on expected operation, and on potentially unsafe actions of other users, such that dangerous consequences are limited. The use of T- intersections in the FG model reduces conflict points in comparison with four-way intersections. Additionally, the consistency and modularity of the FG design allows road users to easily become familiar with its structure. Internal local roads are low speed, narrow, two-way, with reduced setbacks to buildings, while perimeter major roads are wider, direction separated, and behind parking from buildings. Finally, separation of AT paths from vehicle roads provides all users with predictable locations for vehicles, for bicycles, and for walking, with internal greens precluding street crossings.

Homogeneity

Homogeneity refers to separation of road

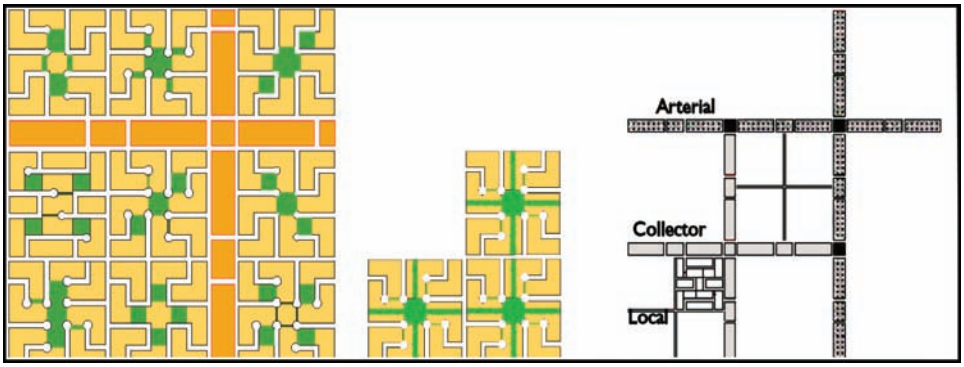

Figure 2: Hierarchy of roads in the Fused Grid network (Grammenos et al. 2008)

users with differences in mass, speed and direction, or, where separation is impossible (e.g. at most urban intersections), to reduction in speeds to reduce the severity of crashes that do occur. The FG design includes separate, dedicated paths for pedestrians and cyclists in neighborhoods. Additionally, the creation of one way arterial and major distributor corridors serve to separate traffic by direction.

Forgivingness

Forgivingness recognizes that despite the road designer and the driver's best efforts, mistakes will be made by drivers and other road users (research has shown that 96% of all crashes occur due at least in part to driver error). Therefore, the FG employs the STS principle of using lowest speeds in highest risk areas, such that if a collision occurs, it is survivable with minimal damage and injury. For example, internal local roads employ 15 km/h limits, which research shows is a survivable speed for pedestrians struck by vehicles. Speed limits on the perimeter roads would be 50 km/h to minimize damage and injury between vehicles that crash at intersections.

Driver state awareness

Driver state awareness pertains to two things: (**1)** The driver's perception of his or her mental and physical ability to properly and safely conduct all required road use tasks (e.g. car drivers must perceive, react, and yield to other cars at intersections, and to vulnerable road users at driveways; cyclists must avoid bollards and pedestrians; etc); and, (**2)** The driving task burden placed by the road system on the driver. Ideally, driver state awareness will always be optimal such that driver capability will exceed driving task difficulty. To minimize driving task difficulty the FG neighborhood design relies on T-intersections and separated AT paths to reduce potential traffic conflicts, with perimeter roads using one-way couplets, T-intersections, and roundabouts to also remove dangerous left turn tasks.

Summarizing from a transportation perspective, the Fused Grid neighborhood design promotes a sustainably safer system in compliance with the leading Dutch road safety principles. It minimizes conflicts among road users of differing mass, speeds, and trip purposes. Moreover, it provides a smooth flow for all road users. Consequently, dangerous collisions can be diminished. Recent research by Sun et al (2013) suggests that, compared to cul-de-sac and grid neighborhood road systems, the FG would result in 60% fewer road collisions.

Summary and conclusions

This case study assessed the FG neighborhood from a civil engineering perspective using two sustainability-oriented frameworks that have not yet widely been applied in Canada, but that represent perhaps the most proactive ways to assess development patterns and promote more sustainable communities for Canadian civil engineers. The first, known as the Healthy Development Index (HDI) (Dunn et al. 2009), was used to demonstrate the FG as a successful model for building sustainably healthy communities. A key provision is its differential connectivity between the AT and road networks. Other design strengths relate to the community providing dedicated bike facilities, or creating policies such as unbundled parking. The second framework, known as the Sustainable Transport Safety Principles (Wegman et al, 2008), was used to show how the FG design would meet the requirements of a sustainably safer road system. It seeks to minimize conflicts among road users, and to control speed in locations where frequent driver errors occur, such that risks of dangerous collisions and serious injuries are minimized.

Healthier, safer, and more sustainable community design is possible and is moving from theory to practise in Canada using Fused Grid neighborhood design principles. Several residential developments are underway and will be the subject of future reports and case studies (Grammenos et al, 2014). ■

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Sustainability: My Journey in Civil Engineering

Craig Hostland, P. Eng., MBA, PhD candidate

Photo: Thinkstock

I graduated in 1982 as a civil structural engineer and commenced my engineering career in building construction. From the onset, in the construction world I entered, I was amazed at the amount of waste in time, energy, and materials existing in a business environment that relied on people-to-people communication to complete tasks.

On local projects in Yellowknife that I was involved with from 1982 to 1987, waste and inefficient waste utilization were everywhere in the process: inadequate soils; partially reusable formwork; double labour to build and tear down formwork and scaffolding; identifying and removing damaged product and product coverings; cutting good lumber into small pieces later burned in fires or buried in waste sites; and the waste in materials and labour associated with fitting other products into the matrix of a building. And then there were the remnants after construction was complete, likely due to imprecise estimation or measurement. Waste was evident everywhere, including labour productivity and repetition of tasks due to misunderstandings and poor training, or the inefficient use of manpower. To make matters worse, our means and methods appeared superior to our competitors.

Advance planning can make a difference

Conversely, our remote (high Arctic) building projects took on a cohesiveness, thoroughness, and level of carefulness that was commendable. The process of material and labour waste reduction was financially driven, as the cost of shipping materials and transporting the workforce was a significant part of the project costs. Nonetheless, the end result was, comparatively, a greatly reduced waste output, more careful construction procedures, increased emphasis on skills training based on efficiency of manpower and a reduction in waste material. To make matters more demanding, the disposal of construction waste materials, including plastics, chemicals, etc., in the frozen tundra of the high Arctic was complicated and expensive. Efforts made in advance of project mobilization culminated in better use of materials, lower material purchase costs, lower waste removal costs, better labour productivity, and more labour efficiency due to preplanning.

The most profitable job we had done to that point was one that was bid significantly lower than the nearest competitor. It was in a remote region with limited accessibility. The intensity of scrutiny in material takeoff, project logistics, management planning, and focus on key project members drove the project to be the most profitable large-side construction project for the company at that time. I didn't think of measuring the amount of project material and labour waste at that time, but the profits I know came from savings in materials purchased, labour, and project overhead costs. So, although I cannot say for certain, it seems it was not stewardship or a holistic view of the environment that drove these efficiencies, but fear and economic benefit.

I drew from this and other early experiences that: (1) humans are naturally inefficient and financially driven; (2), things are not necessarily done for the right reasons; and (3), the right results don't necessarily mean things were done for the right reasons. In short, the viability of a project, or a corporation for that matter, in the form of efficient systems and economic well-being, was not viability in the true sense of the word if a broader perspective was taken. That broader perspective, sustainability, was yet to form in my conscience.

Lessons from the North

I drew many lessons from my Northern construction and consulting experience but, I would say, the greatest things I learned are: 1) a passion for material and labour waste reduction, and, 2) a First Nations appreciation of the land as a gift. There wasn't a word for it then. At least I didn't know it if there was, but the image of doing much more with less, whether materials or labour, had struck me in a primary way and that now forms the basis for my impression of the "sustainability" movement.

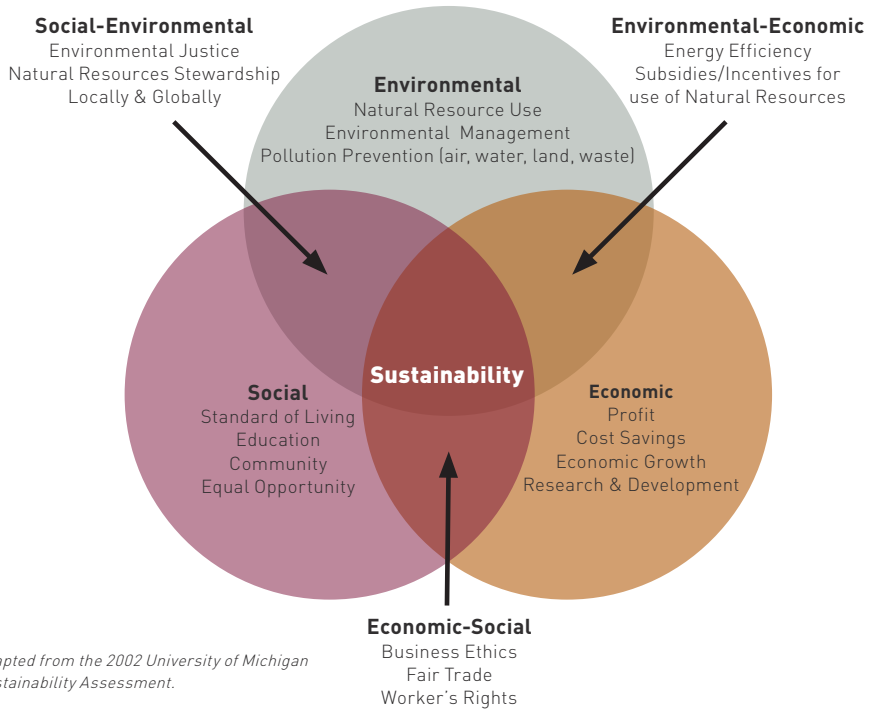
The North can be seen in stark contrast to the colourful and plentiful south, but within that starkness is an appreciation for what nature provides in small quantities and a realization that those offerings must be nurtured and put to efficient use. The scarcity principle abounds in the North, but so does the recognition of the sensitivity of the environment to human interaction and the richness of the insignificant (from a human perspective). The term "sustainability" might mean life or death in this environment, or from a corporate perspective, life or death of a business. For me, it was yet to mean what it means now.

Most recently, my journey has included pursuing my PhD as another way to improve the world using my civil engineering expertise. I soon realized that whatever civil engineering principle I was seeking to advance, getting it adopted and operationalized by the wider practitioner community would be a challenge. It became apparent that a method was necessary to ensure that my addition would contribute to improving our civil society for decades to come, a method that would in a sense 'sustain' the effectiveness of my new civil engineering technology.

At this point, let me confess that I had not ever known nor been referred to the CSCE Sustainability Guidelines (CSCE, 2006) at any point in my journey as a civil engineer. My first formal referral was during my graduate civil engineering studies at UBC, wherein reference was made to the Brundtland Report on "Our Common Future" (UN, 1987), and the definition of sustainable development (on which our CSCE guidelines are based). As all students do, I internalized and assimilated that learning into my personal and professional life lessons. I now discuss sustainability as: (1) the endurance of systems and processes from an organizational perspective; and, (2) a term that defines at what point there is a balance between sufficient resources and the requirements of those systems from a stewardship perspective.

This holistic approach is echoed by the U.S. Environmental Protection Agency (EPA, 2014), with its mandate to provide water, materials, and resources of sufficient quality to protect human health and the environment. This does assume that we engineers will always be able to draw on the earth's resources and change them into whatever outputs our society needs to survive. I see no concept of replenishment in this, which I think the environmental lobby believes should happen. As an engineer, I look at the extraction of the earth's resources as inevitable for our continued well-being, but how to do that sustainably is my focus. I recognize that there is an ultimate carrying capacity, and do not wish to see annihilation as an end result (e.g. an ultimate effect of global warming), so I seek ways to improve processes and to significantly diminish that risk with new processes.

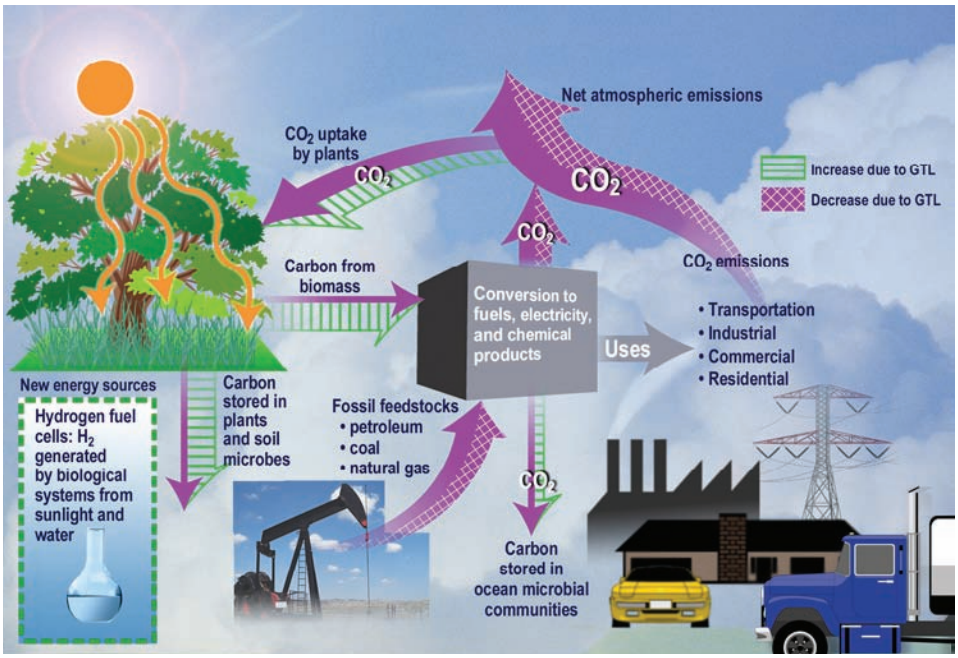
The Three Spheres of Sustainability



Adapted from the 2002 University of Michigan Sustainability Assessment.

Sustainability from a systems perspective

This background and perspective led me to expand my PhD research and potential contributions, not only to advance civil engineering practice and human health, but also to analyse and demonstrate related economic benefits to practitioners, governments, and society. In doing so, I hope to effect change in systems that would render my efforts sustainable. So sustainability, if I look at it selfishly, helps to ensure my work will not end up in the dust bin as have so many good initiatives in the past (Hostland, 2014). Initiatives are dismantled for a number of reasons, many of them good, i.e. due to obsolescence, or failure to achieve the goals set out. But others just fall out of favour with the champion losing interest, or are dismantled as a result of indis-



"Genomics GTL Program Payoffs". Licensed under Public domain via Wikimedia Commons

An example of system sustainability.

criminate cost-cutting measures. I don't want that. As well, an argument for approving an initiative is stronger, I believe, if the proponent proves a cost benefit method that also benefits the managers of the system. That forms part of the sustainability aspect – will the program remain when the champion leaves? That was my sustainability concern.

By focusing on the subject of sustainability, from a systems as well as a viability perspective, I determined that there had to be sufficient economic benefit to render the program free from typical cost cutting measures. If so, my contributions could remain a permanent part of civil engineering practice, and promote human health and civil societies for generations to come. This is not just tree-hugging environmental thinking; rather it is sound civil engineering and a system sustainability perspective. It provides tangible quality of life benefits to individuals, businesses, and governments, together with economic and environmental benefits that accrue to 'system' sustainability.

So what have I learned in this rambling 30-year civil engineering journey, which has taken me from being driven to succeed by economic reality, to recognition of the more holistic system sustainability perspective? I have learned that sustainability of our way of life, systems, companies, and ideas requires a specific focus and intent – initially with champions, but sustained over the long term with a systems approach. I have learned that a systems approach includes economic benefits to more than just myself, my companies, and my clients. I have learned that short-term economic benefits cannot be taken at the expense of longer-term environmental or social impacts – we will all pay for this short-sightedness, so resource extraction needs to be balanced with carrying capacity. Most importantly, I have learned that my journey has re-defined who I am as a person, in a good way, such that sustainable civil engineering is an integral part of my professional life focus, my personal passion, and my civil engineering service provided to my community. This was a most pleasant surprise that I now cherish.

And what takeaways can I offer you from my lessons? Regardless of whether you are a newly minted EIT just starting out in your civil engineering career, or a nearly demented grey beard like myself facing the sunset of my civil engineering career, take to heart the following:

• It is never too late to learn. If an old dog like me can learn new tricks, so can you learn about sustainable civil engineering. Grab a book; take a course; visit csce.ca; get involved!

• Live life as you see it, as it comes to you, but with a jaundiced eye towards the fast and furious, and a passion to leave more behind than you took.

• Carve a niche with that passion you developed into a specific role to play in this world; name it, and share it. You would be surprised how many will warm by its fire.

• Leave a legacy. Make it bold. It will be a lasting legacy that contributes positively to your family, your community, your world. In that moment, you will fully understand the word sustainability. ■

Craig Hostland is president of Pillar to Post, Kelowna, B.C., which specializes in professional engineering inspection and remediation of residential and commercial building indoor environments.

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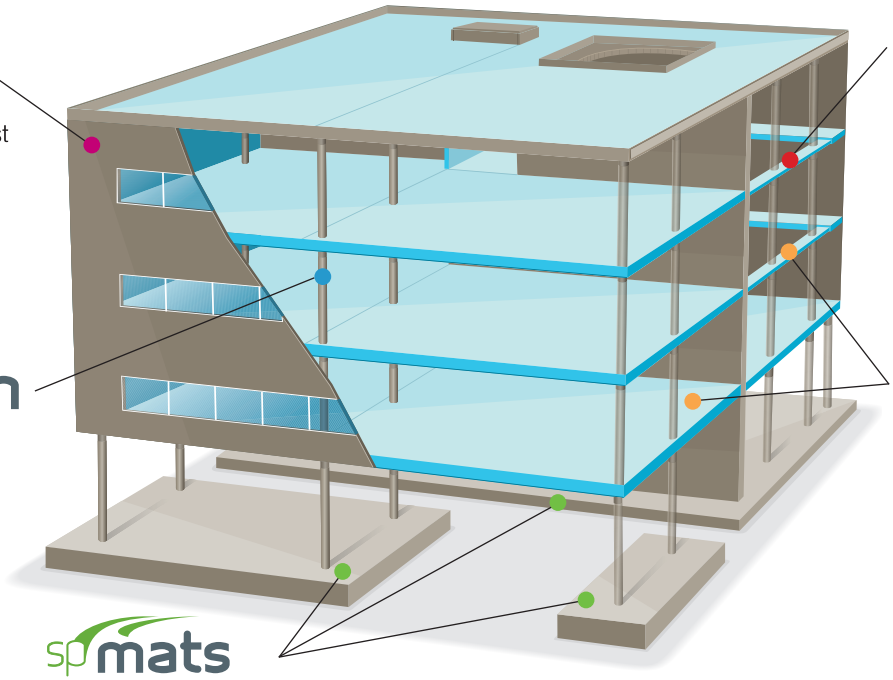

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