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JUNE/JULY 2019

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June/July 2019
Volume 60, No. 4

Cover: The City of Calgary integrates the country's first diverging diamond interchange.
See page 10

See page 14

features

departments

Next issue:
Testing of fire and life safety systems, energy micro grids and more.

on topic

Transform the Future

In case you didn't already know, June 23rd is International Women in Engineering Day (INWED), part of a global awareness campaign designed to raise the profile of women in engineering and focus attention on the career opportunities available to women and girls in this industry.

This is only the third year of this worldwide initiative, but the fact that it exists at all is a testament to the fact that attracting and retaining women in engineering is indeed a global phenomenon, not an issue isolated to Canada or North America.

Before going global three years ago, the June 23rd celebration was being held only in the UK. It originated five years ago as a National Women in Engineering day, launched to celebrate the 95th anniversary of the UK's Women's Engineering Society (WES). The Society started in 1919 after WWI, when women who had worked in technical jobs during the war were unable to continue doing that work because of a law designed to revert the country back to its pre-war state. So that meant these women were no longer required to take on the engineering roles that belonged to their male counterparts.

Some pioneering female leaders set up the WES to fight for equality for women, and the Society is still fighting today with its appeal now reaching around the world.

2019 marks 100 years since the formation of WES, so the originators are aiming to broadcast to a wider audience this year, promoting the International Women in Engineering Day with the theme #transformthefuture. This column is my part in helping to spread the word.

I feel part of the challenge for the engineering industry as a whole is that many people, both young and old, still don't understand the profession and its role in society. I know when I was in high school I didn't understand what engineers do, and I'm not certain my kids really understand what a civil engineer is either. I suppose I'm partly to blame for that.

As part of our year-long Point of View series where we've been exploring the topic of diversity in the industry, in this issue we speak with professor Sheryl Staub-French from UBC. She admits that she didn't know what engineering was when she entered university, and now a large part of her mission is to educate school-age kids, K-thru-12, about what the profession is and ensure no child, boy or girl, graduates without knowing what engineers do.

It's this grassroots outreach that will help to build a stronger foundation for the profession and ultimately reach a much broader and diverse constituency.

So celebrate June 23rd to recognize the long-overdue role of women in engineering, and then do your part every other day of the year to spread the word to people of all ages about the great work engineers of all genders and nationalies around the world are doing to make ours a better society.

Doug Picklyk

FOR PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE

CANADIAN CONSULTING engineer

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UL LISTED

Source: Providence Health Care

Rendering of St. Paul's Hospital site.

COMPANIES

SNC-Lavalin's CEO retires

SNC-Lavalin has announced that Ian Edwards will step in to become interim president and CEO succeeding Neil Bruce who has announced that he is retiring as president/CEO and from the board of directors in order to return to his family in the UK.

BUILDINGS

RFQ Issued for Vancouver's new St. Paul's Hospital

The new St. Paul's Hospital in Vancouver is one step closer to starting construction. Providence Health Care has issued a request for qualifications (RFQ) inviting teams present their qualifications for, designing, building and partially financing the new St. Paul's.

The new hospital—to be constructed 3km from the current hospital site—will have capacity for up to 548 beds and will house several leading provincial programs and referral centres.

The RFQ process is expected to be finalized—with a shortlist of three teams selected—by this fall. The subsequent request for proposal (RFP) process will be initiated shortly after that and is expected to take up to one year to finalize.

Design elements include:

- Access to natural light & views
- Single patient rooms with overnight space for support persons.
- Seniors-friendly campus layout
- New technologies including digital way-finding, automated patient check-ins and online patient scheduling
- Outdoor and other spaces for wellness & rejuvenation
- Sacred spaces (All Nations Sacred Space, meditation spaces, chapel)
- Public art. Incorporating Indigenous perspectives into campus design.

The RFQ is at: www.bcbid.gov.bc.ca

Source: Canada Infrastructure Bank

TRANSPORTATION

Infrastructure Bank commits $2B to GO expansion

The Canada Infrastructure Bank (CIB) likes trains, as the crown corporation created to invest up to $35 billion into new infrastructure has made its second mass transit commitment with an investment of up to $2 billion in financing for Ontario's GO Expansion—On Corridor project.

CIB's partnership with Infrastructure Ontario and Metrolinx will add to the transformation of the GO rail network in the Greater Toronto and Hamilton Area.

CIB's first investment and only previous investment was its $1.28 billion backing of Montreal's Réseau express métropolitain (REM) light

COMPANIES

HH Angus' New president

HH Angus has named Paul Keenan, P.Eng., as president, replacing Harry Angus who remains CEO and Board Chair. Keenan, with the firm for 25 years, becomes the fourth president of the century-old firm (see more on page 26).

Promotions at TMP

TMP (The Mitchell Partnership) welcomes Mitch Kooistra, P.Eng., as a senior associate, bringing eight years of design experience leading a range of projects from sports facilities and shopping centres to luxury hotels.

Mitch Kooistra

Carlo Giancola

The firm's new associates include: Carlo Giancola, P.Eng., experienced with base building and tenant fit out projects in retail, healthcare, residential and more; Joe Kunkel who collaborates with clients on a variety of projects, including data centres, casinos, and commercial; and Sam Waterman, P.Eng., who has developed a strong mechanical building services design background in commercial, residential, mixed-use, data centre, transit, and institutional.

Joe Kunkel

Sam Waterman

rail project.

The CIB's role in GO Expansion is a financing partner and advisor to Metrolinx and Infrastructure Ontario. Infrastructure Ontario and Metrolinx are the co-sponsors and are leading the competitive procurement process including announcing the preferred proponent.

CIB financing will be offered in the form of a standardized debt financing package to all proponents during the request for proposals open period. CIB will finalize a credit agreement with the preferred proponent selected when the project reaches financial close.

The four teams prequalified to bid on the On-Corridor Works project include: EnTransit (led by SNC-Lavalin, Siemens and Keolis); MTR Kiewit Partners; ONcore Transit (ACS); and ONxpress Transportation Partners (Aecon, John Holland, Meridiam Infrastructure and Alstom).

AWARDS

Grands Prix of consulting engineering in Quebec

Source: AFG

Visionary Award winners: (l-r) Réal Laporte, president of Hydro-Québec (presenter); Jean Gauthier, Tetra Tech; Marc Chrétien, Tetra Tech; Ghyslain Pitre, City of Percé.

Winners of the 2019 Quebec Association of Consulting Engineering Grands Prix were honoured at a gala held on Monday, May 27th in Montreal.

The theme of the 17th annual gala was "Innovation in our nature," and the top prize, the Visionary Award, winner, was presented to Tetra Tech and the City of Percé for a protection and rehabilitation project on the South Cove shoreline of Percé.

Other project awards winners included: SNC-Lavalin/Bouthillette Parizeau (mechanical/electrical); Tetra Tech (structural, energy & industrial); BBA (environmental) WSP (project management); Norda Stelo/SNC-Lavalin (transportation); AXOR Experts-Conseils (urban infrastructure); AECOM (international); and SDK and Associates (SME consulting firm).

The Mentor of the Year was presented to Hélène Brisebois, ing., of SDK and Associates, and the Young Professional award went to Charles Ormsby, ing., Arup.

More details & photos: afg.quebec

Smart Cities Challenge Winners

The four winners of Canada's first-ever Smart Cities Challenge, a competition that encouraged communities of all sizes to harness the potential of connected technology and data to improve the lives of Canadians, were announced in May.

The winners are: Town of Bridgewater, Nova Scotia ($5 million prize for its proposal to reduce energy poverty); Nunavut Communities, Nunavut ($10 million prize for its proposal to use a life promotion approach to suicide prevention); City of Guelph and Wellington County, Ont. ($10 million prize for its proposal to create a Circular Food Economy); and the City of Montréal ($50 million prize for its proposal to improve mobility and access to food).

The four winners will implement their smart cities approaches over the next five years. Updates on their progress will be posted on Infrastructure Canada's website, where their proposal summaries are currently posted to

CANstruction Toronto, Best original design winner, "MÖBIUS" by WSP & Architecture49.

Source:

Honourable mention winner at CANstruction Toronto charity event, Hunger CAN "Gogh" sculpture by Gensler.

inspire communities across the country on their own smart cities journeys. www.infrastructure.gc.ca

Engineers Shine in Toronto's 2019 'CANstruction' Competition

Teams of professional engineers, designers, architects and students took part in Toronto's 20th Annual Canstruction Toronto Competition in mid-May. The Best Original Design was awarded to the team of WSP and Architecture49 for their MÖBIUS structure. An honourable mention went to a portrait of Vincent Van Gogh made out of canned beans, constructed by Gensler and called 'Hunger CAN "Gogh". There were 25 structures in total on display.

In all 68,785 pounds non-perishable food were sculpted into structures and then donated to the Daily Bread Food Bank.

"Canstruction is an engaging and creative way for the design and construction community to work together in support of Daily Bread Food Bank," says Christina Facey, co-chair of Canstruction Toronto.

Other award winning teams included: EllisDon & Zeilder Partnership Architects (structural ingenuity); RJC Engineers (best use of labels); Aercoustics Engineering (best meal); and Entuitive & PCL Construction (people's choice).

2019 Green Building Excellence Awards Results

Canadian green building projects and innovators were honoured at the Canada Green Building Council (CaGBC) Leadership Awards Gala held in Vancouver on May 29th.

The Green Building Champion Award was presented to Lisa Westerhoff, Integral Group, who been instrumental in the development of numerous green building policies including the BC Energy Step Code, the CaGBC Zero Carbon Building standard, Better Buildings BC incentive program, and The Toronto Zero Emissions Building Plan.

Roland Charneux, of Pageau Morel was given the Green Building Pioneer Award. Charneux has helped design of millions of square feet of green and efficient buildings and has spent 40-plus years leading by example, advocating for green buildings, and investing in the next generation of leaders.

The Emerging Green Leader Award went to Afaf Azzouz, buildings performance engineer with Stantec, whose recent projects include carbon neutral studies for commercial buildings, Evolv1 and the UBC Brock Commons building.

In the buildings categories, a Zero Carbon Award went to École Curé-Paquin, the first project in Quebec—and the first grade-school in Canada—to receive the Zero Carbon Building Design certification. In the category of new construction, the winner was the Western University Engineering Building (also known as ThreeC Plus) the 13th LEED certified project at Western. And in the existing building category, 4711 Yonge, located in the North York area of Toronto, demonstrated an improved ENERGY STAR score, significantly reduced water use, and a higher level of LEED certification.

A complete list of award winners can be found at cagbc.org.

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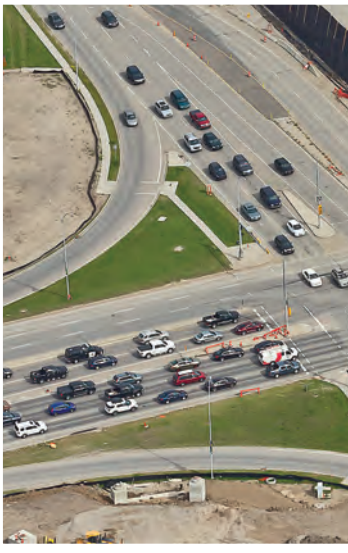
By ISL Engineering and Land Services

The City of Calgary commits to the unique interchange design to improve traffic flow with fewer construction disruptions.



DIVERGING DIAMOND COMES TO CANADA

Transportation infrastructure serves a critical role in the development and improvement of the growing City of Calgary, which since 2011 has dedicated itself to constant improvement—that is, improvement that makes the life of its citizens better.

This commitment to traffic infrastructure was clear when it came to the need for a new interchange at the high-traffic junction of Macleod Trail and 162 Avenue SE. Located in southeast Calgary, the interchange provides access to major shopping and business centres and the surrounding residential communities. Macleod Trail serves approximately 60,000 vehicles/day, connecting south Calgary to and from the downtown core, while 162 Avenue/Sun Valley Blvd. carries an additional 35,000 vehicles/day.

The former signalized intersection had become a major bottleneck, creating long queues and frustrating delays for drivers who often had to wait several signal cycles to get through the intersection.

Pedestrians and cyclists shared in these delays, waiting long periods of time to cross multiple lanes of high speed and high volume traffic.

In 2014, Calgary's City Council approved funding for a new interchange, and the City enlisted the help of ISL Engineering and Land Services (ISL) to plan, design and construct the most suitable configuration.

From prior planning dating back to the 1980s, land had historically been reserved at this location for a partial cloverleaf interchange. However, ISL took Calgary's desire for constant improvement to heart by focusing on innovation. Following a rigorous evaluation and community engagement process, the diverging diamond interchange (DDI) configuration was selected as the functional design for this location because it would enhance mobility for commuters, transit users and cyclists; increase access to surrounding businesses and services; and allow for innovative construction staging that would avoid major detours and accommodate active modes of transportation.

What is the DDI?

The DDI concept originated in France, which has had three in service since the 1970s. Since 2009, the DDI has evolved primarily in the U.S. as retrofits to existing interchange structures where there are now over 80 in service and many others in various stages of planning, design or construction.

The unique design of the DDI enabled construction with minimal traffic disruption.

The operation of the interchange follows its namesake by "diverging" traffic on the minor street to the left-hand side of the road through two crossover intersections. This enables left-turning traffic to access the major thoroughfare without waiting for a signal or crossing oncoming traffic, nearly halving the number of conflict points compared to a typical diamond interchange. Right-turning vehicles use slip lanes away from the intersection to bypass the crossovers.

With turning movements removed from the crossover intersections, the traffic signals can operate on a short two-phase cycle, improving safety and efficiency.

As with any road innovation, the risk of driver confusion was top of mind for the designers. While an aerial view of the DDI can lead to some apprehension, once at street level, the roadway configuration, approach angles, placement of curb lines and islands, strategic use of signage and clear road markings significantly aid drivers' understanding of the interchange configuration.

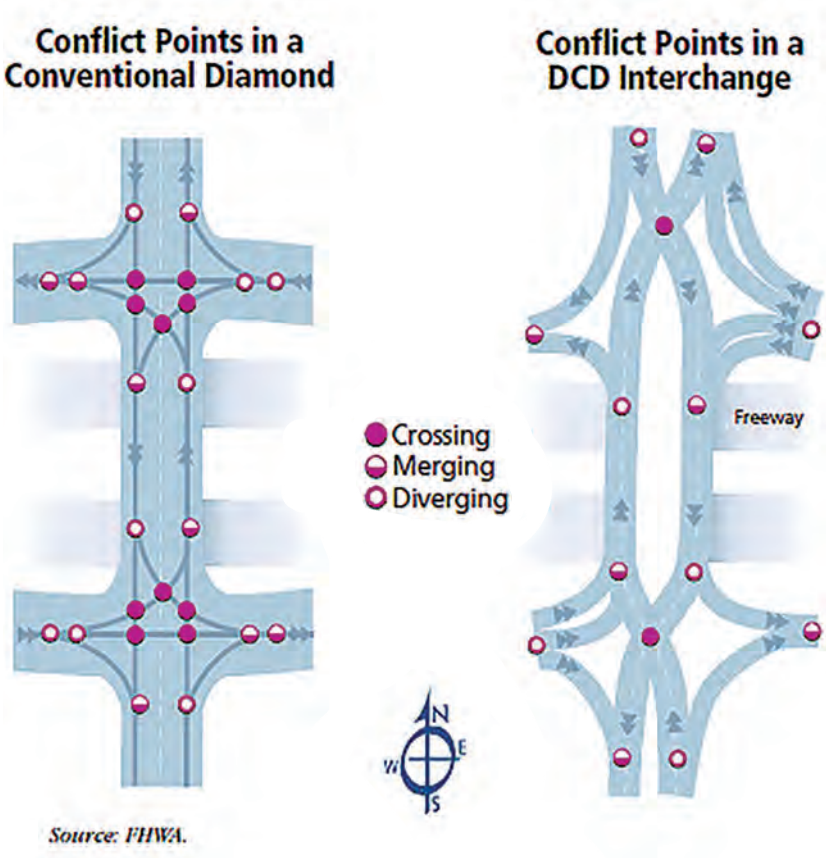
New Standards

Since most of the prior U.S. applications were retrofits of existing diamonds, there are no fixed standards for the greenfield construction of new DDI interchanges. The U.S. Federal Highway Administration published an informational guide for DDIs in 2014, and guidelines are available from various state-level Departments of Transportation. As one of the few relatively greenfield DDIs to be implemented to date, ISL found a number of opportunities to innovate and improve on existing geometric design practices while also reducing construction time and cost. The knowledge gained in Calgary can now be of benefit to other jurisdictions in the future.

Enhanced Mobility

The Macleod Trail DDI includes three bridge structures: one carrying each direction of 162 Avenue over Macleod Trail and a third basketweave structure to accommodate local access ramps to the adjacent shopping centre.

Design of the DDI put pedestrians, cyclists and transit users at the forefront. Pedestrians and cyclists are also uniquely accommodated by converging the exterior pathways from all quadrants of the interchange into the centre of the overpass. This approach reduces the total number of road and lane crossings for pedestrians, and



A U.S. Federal Highway Administration (FHWA) illustration showing the potential conflict points in a Diverging Diamond Interchange.

where crosswalks are placed, they cross only one direction of traffic at a time. By allowing all users to cross "kitty corner" through the centre of the interchange, travel times are reduced.

It was a better option for transit priority accommodations compared to other interchange configurations and provided a better balance across all transportation modes.

Safety

The roadway curves of the DDI encourage lower vehicular speeds, have fewer conflict points overall with the turning movements separated from the crossover intersections.

Road crossings pass a single direction of vehicular traffic, and the walking distances at crosswalks are reduced by allowing all four quadrants to be accessed from the single central pathway.

Increased Efficiency

The DDI design differs from traditional diamond interchanges because the two directions of traffic on 162 Avenue briefly cross to the opposite side of each other on bridges over Macleod Trail. This allows more effective traffic flow at the signalized intersections within the interchange and enables left-turning vehicles to proceed without crossing opposing traffic.

Construction Approach

Constructing an interchange over an existing active intersection is no easy feat. Additionally, being that the interchange was located in an established area, ISL faced the challenge of constructing the new interchange without limiting access to the nearby residences, schools, businesses and services.

The traditional approach is to construct a major detour road. The split bridge design of the DDI, however, offered a unique construction sequencing opportunity by splitting the opposing directions of travel on two bridges and constructing the first of the two structures offset from the existing intersection. This allowed the project to proceed with bridge construction without major detours.

Using wireframe retaining walls that were ultimately buried in the interchange fills, the entire south half of the interchange was constructed in the first nine months of 2016. Once completed in October 2016, traffic was shifted onto the new bridge and it became, in effect, an "interchange detour" that opened Macleod Trail up to free-flow traffic a full year ahead of construction completion.

The major congestion issues in the area that had originally driven the need for the project were resolved in the middle of the construction period, providing significant relief to all users.

The north DDI bridge and connecting ramps were completed in August 2017, allowing the detour interchange to be permanently changed over to the DDI configuration.

First, But Not Last

The DDI was completed on schedule and on budget and Calgarians received a higher quality outcome, at lower cost and in less time than a traditional interchange.

Canada's first DDI involved the close collaboration among the City, ISL and Graham Infrastructure. The interchange has attracted national and international attention to Calgary for its forward-thinking approach to transportation design. CCE

Diverging Diamond Interchange, Calgary	
Owner:	Calgary
Prime consultant:	ISL Engineering and Land Services
Subconsultants:	AECOM Canada Tetra Tech Canada Canadian Highways Institute Perkins + Will
Contractor:	Graham Infrastructure

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By CIMA+

New headworks building overlooking the new plant

PETROLIA WWTP RENEWAL

The new wastewater treatment plant upgrades in the Town of Petrolia provide a more efficient and sustainable solution for the community.

New disk filters.

New high-efficiency turbo blowers.

The Petrolia Wastewater Treatment Plant (WWTP) infrastructure was deteriorating after 40 years of service. The Town of Petrolia, a community of 5,500 in southwestern Ontario near Sarnia, was aware of the need for expansion at their WWTP to meet current and future flows while also reducing maintenance costs of its aging equipment. Emergency shutdowns and bypasses at the plant were a detriment to the Town's limited wastewater expenditure budget.

The Town retained CIMA+ to provide a comprehensive engineering and project management solution, including an innovative approach to upgrade and retrofit the existing plant while also providing the capacity to treat the Town's local landfill leachate. The project resulted in a state-of-the-art plant that has reduced the Town's emergency wastewater expenditures and supports the community's ongoing development and growth plans.

CIMA+ also assisted the Town in their application for provincial and federal grant funding for the majority of the project. Together the governments supplied two-thirds of the project funding, approximately $13.5M dollars.

Existing Site

The upgraded Petrolia WWTP is an extended aeration facility with tertiary filtration and an ultraviolet (UV) disinfection system which discharges treated effluent into Bear Creek.

The expansion project increased the plant's rated capacity by 39% to accommodate current flows (which frequently approached or exceeded previous rated capacity), and future growth in the area within the next 25 years.

CIMA+ undertook the task of upgrading and expanding the WWTP at its existing site while the facility remained in operation. Construction

and start-up of the upgraded plant was planned so that once the new facility was built, the old plant was sequentially decommissioned; the existing secondary clarifiers were retrofitted to aerobic digesters, and the existing aeration tanks were converted to a maintenance storage facility.

The design to provide reliable capacity, redundancy, and performance for the expansion, included:

- construction of new headworks, including two fine, mechanically-cleaned bar screens, channel aeration system including positive displacement blower, and vortex grit removal
- construction of two new extended aeration tanks, each with anoxic and aerobic zones and full floor fine bubble diffusers
- construction of two new chain-and-flight secondary clarifiers
- construction of a new blower building to house the new RAS/WAS and scum pumps, high-efficiency turbo blowers, and an alum dosing system
- new administration building, including new control and electrical rooms, laboratory, and offices
- construction of new integrated tertiary filtration and UV disinfection facility designed for peak flows, including two disk filters, energy-efficient UV disinfection, and chlorinated plant water supply
- automation upgrades to provide monitoring and control of most process equipment and instrumentation in the upgraded WWTP to match the plant's design flow
- upgraded WWTP Inlet pumping station
- repurposing of existing WWTP secondary clarifiers as two aerobic digesters for the upgraded WWTP
- construction of lagoon pumping station to return bypass lagoon supernatant to the headworks for treatment.
- standby power equipment for all major components of the plant.

CIMA+ designed the upgraded WWTP on the expectation that leachate from the local landfill could be treated there. This new capability is expected to eliminate leachate haulage operations once the local landfill completes a 1 km connection to the Petrolia collection system.

Aeration Tanks Repurposed

Petrolia's new WWTP facility combines new buildings with retrofit/repurposed existing structures. The new headworks building provides power to all major components of the plant, and the inlet pumping station which is functionally positioned to overlook the plant.

The existing aeration tanks were covered with a roof structure, externally cladded and repurposed into a maintenance and storage facility that also houses the blowers for the aerobic digesters.

Two overhead entrance doors and separate access doors were cut in through the existing concrete walls to allow for equipment and machinery access.

Electrical and mechanical including lights, overhead door openers, and HVAC were installed in the repurposed

Overhead view of plant showing aeration tanks, secondary clarifiers, tertiary treatment building and proximity of adjacent residential development.

tanks. The design incorporated site grading, and front and rear driveway entrances to the overhead doors.

Half of the existing tanks will be repurposed into a training facility for the Petrolia & North Enniskillen Fire Department.

Residential Proximity

The proximity of the residential area (slightly more than 100m clearance) around the facility's site was a significant constraint during the design and construction. The architecture of the facility was improved to be more visually appealing.

As discussed, the new plant was constructed while the existing plant remained in operation. The new facility was designed with the site's constraints in mind, eliminating larger sand filters in favour of compact tertiary treatment disk filters to meet effluent criteria, and using common walls between many different process, administration and storage areas.

The project also converted the existing secondary clarifiers into aerobic digesters to further reduce the new plant's footprint and the project's capital expenditure.

The design included a pumping station to service the existing lagoons adjacent to the facility, which were previously used for bypass flow and for digested sludge storage with seasonal discharge directly to Bear Creek.

The pumping station will be used to transfer lagoon supernatant to the headworks of the new plant for full treatment and disinfection. This is possible due to the new plant's expanded capacity.

Energy efficiency

The upgraded WWTP provides many economic and social benefits to the residents of Petrolia and the surrounding communities.

It was developed in the most cost-effective way possible, and its compact layout and shared-walls design provides improvements from an energy efficiency perspective by reducing heat loss from the buildings. The Town's unexpected expenditure on equipment malfunctions for the facility have also decreased.

Tanks were designed with high efficiency aeration blowers capable of providing significant savings over the previous inefficient and obsolete mechanical aerators. Additionally, deeper tanks and fine-bubble diffusers provide further energy savings.

As another cost saving measure, every effort was made to reuse existing tanks and buildings, where they are still structurally sound, to minimize the overall project cost. Reliable equipment will ensure that the residents of Petrolia are not burdened with emergency expenditure costs in the coming years.

The aesthetics of each of the new buildings at the facility (headworks, blower/pump, and filter/ UV) incorporate Petrolia's Victorian heritage with 19th Century Victorian industrial style of the brick detailing, window placement, flat roof and brick parapet. The building's design and surrounding landscaping offer a pleasing view for local residents.

Improved operations

The Petrolia WWTP experienced 50 days of bypasses between 2008 and 2011 due to equipment malfunctions and insufficient capacity. One of the major objectives of the upgrades project was to allow the plant to handle current and future flows and protect the Bear Creek receiving body.

The resulting solution incorporated safeguarding against treatment plant bypasses by allowing storage in the lagoons during extreme flow events. In addition, a new pumping station will transfer lagoon supernatant to the new plant headworks for full treatment during low flows.

Handling leachate

The Petrolia Landfill is located less than 1km from the Petrolia wastewater collection system and approximately 2.5km from the Petrolia WWTP, and an opportunity was identified to direct leachate through the wastewater collection system.

The Town will also have the ability to reduce or eliminate trucking of the solid waste leachate to external disposal facilities by treating the leachate at the new plant upon completion of connecting a landfill leachate forcemain to the Town's collection system. This will further increase the Town's sustainability.

Fit for Growth

The new Petrolia WWTP now suits the Town's needs with increased redundancy in case of required maintenance, and the new facility's capacity provides room for growth which supports the Town's development plans.

The design approach also provides operational flexibility with component redundancy of all major equipment, allowing buffering during high flow events without compromising effluent quality or causing wash out of the plant's biomass. CCE

EMBRACING MODULAR & PREFAB

Complex projects when time and space are tight are a perfect fit for off-site prefabrication and modular construction

CAMH Phase 1C in Toronto began construction in 2014, and the facilities are scheduled to open in mid-2020.

The Centre for Addiction and Mental Health in Toronto. Roughly 60% of the total building envelope is prefabricated.

Photos: Courtesy of Plenary Group, PCL Constructors Canada, Stantec Architecture

By Shawn Maley, Ronald Mar, and Anu Sabherwal

How much of a building can we build offsite? How granular can modularity be? In today's fast-paced construction market, modular construction offers versatility and advantages that have designers thinking bigger, and smaller, about the possibilities for incorporating prefab components. We're confident that modular and prefabrication methods will continue to bloom in coming years. Modularity has a lot of advantages, but with a few caveats.

Modular building is expected to rise 6% globally by 2022, with countries like Sweden (where 84% of detached homes use pre-fab timber) and Japan leading the way. A January 2017 report from the Modular Building Institute (MDI) predicts that modular construction which currently accounts for 3% of all new commercial construction in North America will grow to over 5% over the next five years. In North America, the commercial sector leads adoption of modular methods followed by industrial, healthcare, and education sectors.

Three modular approaches

Cancer Centre at Guy's Hospital: Building on an active urban healthcare campus can be tricky. On the Guy's Cancer Center project in central London, UK, prefabrication was a must. The compact project site, and hard-to-reach setting in central London, dictated that 60% of the project was prefabricated off-site.

Stantec led clinical planning and interior design at the Cancer Center with design partner Rogers Stirk Harbour + Partners (RSH+P). Our contractor partner, Laing O'Rourke saw the opportunity to use the Cancer Center as a demonstration project to show its ability to manufacture custom prefab components in its in-house "Explore" facility.

The key aspect of the Guy's modular approach was a prefabricated internal partition called a "smart wall." The smart wall is assembled off-site with fire and acoustic performance features, electrics, plumbing, and openings preinstalled.

The Stantec team worked closely Laing O'Rourke during design to develop digital models that facilitated

Design for Manufacture and Assembly (DfMA) of the smart walls, reinforced concrete lattice slabs, columns, and interior fit-out packages with integrated service conduits.

The external façade was comprised of unitized curtain walling, built off-site and craned into place. RSH+P designed extended balconies for the "villages" in the Cancer Center and these were prefabricated.

The mechanicals were prefabricated. The servicing modules were manufactured offsite and brought in and interconnected.

With a prefabricated lattice slab, the lower section of slab and rebar was precast before being lowered on the site, with the rest poured on site. This avoided any temporary structure.

As every floor slab went up, they craned in the smart walls, constructed offsite and precision-cut with robotic arms enabling tight design quality control and significant savings in construction time.

Photo: Morley von Sternberg

The Cancer Centre at Guy's Hospital in London features a frame made up of 3,756 off-site manufactured concrete elements. Architect of Record: RSHP | Healthcare Architecture & Interior Design: Stantec.

Yale Science Building:

Science research changes at a rapid clip and today's science buildings must be built for flexibility and expansion. Because they're so complex, laboratories provide a perfect opportunity to explore modular and prefabricated construction technologies.

Yale University's new Science Building (which Stantec designed in association with Pelli Clarke Pelli) is an example of modular approaches employed for future-ready design thinking. The majority of the building's labs are open flexible biology labs, ideal candidates for repetitive modular design.

For Yale, we embraced multi-trade prefabrication rack modules for the mechanical and plumbing corridor mains on the lab floors. This approach provides a modular structural frame in which the mechanical, plumbing, telecom, and other laboratory components are installed offsite.

The completed assembly is delivered and installed as a unit. This approach allowed the delivery of a high-level of organization and consistency in the main laboratory services, including valve locations and future piped system expansion. This consistent, repetitive approach helps the building services to remain relevant as research needs evolve.

The main vertical steam and chilled water building risers also used prefabrication. The 90-foot assemblies were constructed off-site and craned into the building as single structural elements.

Modular thinking at Yale resulted in a more direct path to project completion, increased project quality control, and a significant boost to construction safety.

Centre For Addiction and Mental Health (CAMH):

Prefabricated elements are a significant aspect of construction at the CAMH Phase 1C project, a pair of hospital buildings located in Toronto's urban core.

The new buildings will allow patients to move with more freedom within and around their hospital units, choose more private settings when receiving treatment and support, and enjoy more natural "home-like" settings—all designed to increase self-efficacy and promote recovery.

Roughly 60% of the total building envelope (the exterior building envelope whole-wall panel construction for all the non-curtainwall cladding) is prefabricated.

On this P3 project it was sensible to prefabricate certain elements offsite, such as the building's rainscreen wall. As design-builder, PCL Constructors

Benefits of Modular

SPEED: Prefabrication increases speed of construction by simultaneous construction of project elements that typically follow a linear schedule. At Yale, the riser components, which would have taken a crew seven weeks to construct on-site, were installed in two days—a savings of 960 person hours on-site.

SAFETY: Prefabrication takes place in a controlled environment where the benefits of temperature control, ergonomics, and standard safety protocols are present, and that means a more consistent product, with much lower potential for harm to workers.

SUSTAINABILITY: With prefabricated components, there's far less waste produced. In a shop environment, the cuttings from making smart walls for Guy's, for example, can be re-used or properly recycled whereas on-site, those cuttings are typically sent to landfill.

QUALITY: Modular design approaches and the idea of architectural achievement are not always thought of synonymously—but perceptions are shifting thanks to projects like Guy's and Yale.

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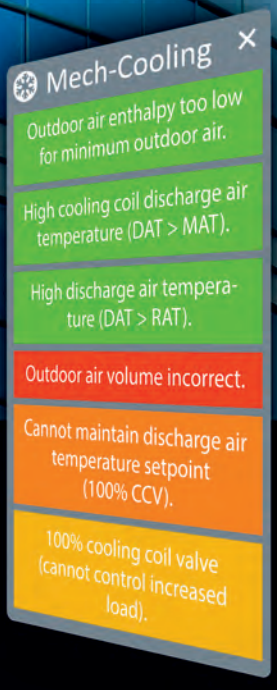

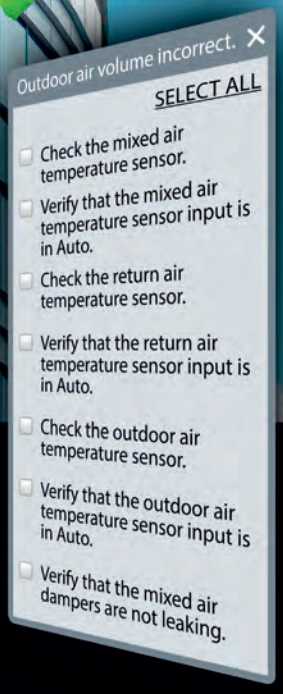

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Canada worked collaboratively with the team to identify elements of the project that could benefit from design for manufacture and assembly principles in efforts to enhance quality, improve cost certainty and accelerate speed to market.

The modular wall panels were comprised of the envelope's interior back-up wall assembly (metal studs, G90 metal exterior sheathing & air-vapor barrier) and the windows.

This includes the walls for approximately 225 mental health patient bedrooms, each outfitted with a super-size window, operable vent, a complicated window with an interior sash for security, and integrated roller blinds. The panels were approximately 3.65m high x ~2 to 3m wide depending if including a window element.

In total, 1,775 prefabricated exterior wall panels were manufactured at PCL's Agile offsite manufacturing facility in Etobicoke. The modular elements were shipped in volumes to keep the install crews well stocked. The panels were installed between concrete floor slabs similar to curtain-wall panels. Due to tight urban job site constraints the "just in time delivery/ install" schedule was aided by the modular panel system.

As installed the walls were ready for Blueskin AV Barrier tie-in on the exterior between individual modular panels and steel shelf-angles at floor slabs for veneer brick masonry installation.

When is modular a good call?

When repetition is necessary:
Modularity is a great match for repetition, where it can achieve efficiencies in manufacturing. Therefore, in the education, residential, and healthcare sectors where room types repeat, modularity has benefits. At CAMH Phase 1C, hundreds of patient room walls are being replicated.

When controlling finishing details:
A modular/prefab process makes it more likely that critical details (say the placement of service connections for a laboratory) can be executed to exacting standards in a workshop.

Photo: Stantec/Pelli Clarke Pelli

The Yale Science Building in Connecticut, where prefabrication was used for mechanical and plumbing on the lab floors. Architect and Engineer of Record and laboratory planner: Stantec | Design Architect: Pelli Clarke Pelli Architects.

Guy's in London features a great deal of exposed concrete, which is unusual in hospitals. Through modularity, we were able to achieve a much higher quality finish on the concrete surfaces to meet Guy's infection control standards.

On tight urban sites:
At CAMH Phase 1C there are very tight constraints with the rest of the urban hospital campus, which remains active during construction, and only a modest staging area available for construction. Prefabricating the wall panels means fewer hands on-site and less staging space needed.

What approaches can help get the most out of modular?

See it as a process:
At Yale, an interdisciplinary team analyzed the project for opportunities to apply prefab and tweaked the design. This design thinking led to a layout of eight repeating lab modules per floor, each with a repeating single trade prefabrication that brought together mechanical/electrical/plumbing systems with future capacity and routing built into the design, an excellent fit for shop-based fabrication.

Understand that it requires intense coordination:
Achieving the benefits of modularity requires early and intense collaboration. And that collaboration extends beyond the design team to the contractor and sub-trades.

Digital model to fabrication:
With Guy's, it was to our advantage to develop the clinical and architecture database and develop finished details on rooms and equipment in a 3D model environment. The engineers modeled everything in BIM. It was crucial that we delivered in a digital model because that model, once translated, became the blueprint for fabrication.

Where is modular going?
Currently, there are limitations to the application of modular building. At Guy's, erecting smart walls as the building was going up created an unusual, albeit temporary, situation: exposed interior walls during construction. But, keeping this in mind and challenging ourselves and clients to use their imagination, means that prefabrication and modular construction is one wave of the future that's already arrived. CCE

(This article originally appeared in Stantec's Design Quarterly, issue 5)

Shawn Maley AIA, LEED AP, is an architect and designer at Stantec's Butler, Pennsylvania, office; Ronald Mar is an exterior envelope/core and shell architect based in Toronto; and Anuradha Sabherwal is Stantec's lead environmental architect in the UK.

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Throughout 2019 Canadian Consulting Engineer explores the topic of diversity in the industry through a series of articles called Point of View; stories designed to get readers thinking about their profession, their day-to-day workplace and maybe seeing their surroundings through a new lens.

Empowering the Next GENERATION

Sheryl Staub-French, P.Eng., PhD, is a professor of civil engineering and recently named as the associate dean of equity, diversity and inclusion in Applied Science at the University of British Columbia. Dr. Staub-French received her BS in civil engineering from Santa Clara University and her MS and PhD from Stanford. She is Director of the BIM TOPiCS Lab where she leads research focused on understanding and improving best practices for the delivery of sustainable building construction projects through effective and collaborative use of building information modeling (BIM).
She has published over 75 journal and conference papers and has won numerous awards, including the 2018 Engineers and Geoscientists of British Columbia D.C. Lambert Professional Service Award.

What attracted you to engineering?
I actually did not know what engineering was when I started at university. My father recommended that I study engineering because I liked math and, thankfully, I found that I really enjoyed civil engineering. I love how you can see the work of civil engineers in the world all around us: on the roads and bridges we travel on, in the buildings we live and work in, and in the clean water we drink. I am particularly interested in green buildings and how we can design and construct buildings that have a positive impact on the environment.

Have you worked in industry?
One of my first jobs after university was at a large consulting firm in Los Angeles. I worked there in more of a project manager role, helping with the schedule management and documentation of construction projects. I have also worked extensively with consulting engineers over the past 20 years in my research on sustainable buildings. I really enjoy the diversity of the work and getting to meet different people involved in the design and construction of our civil infrastructure. It has helped me see the importance of communication and collaboration in our work as engineers.

Have you had female mentors or role models?
During most of my early career, I did not have female mentors, which made it more difficult to feel like I belonged in engineering. I did, however, have many male mentors who helped me through different stages of my career.

They had a significant positive impact on my life by helping me believe in myself and supporting my professional development. I think role models and mentors are absolutely critical, particularly for people who are part of an underrepresented group. It is difficult when you do not see yourself represented in the people you work with or in the leadership of your organization, and mentors and role models can help bridge that gap.

But I also think that we have to go beyond mentorship and engage all members of our community as allies in our work to create a more inclusive engineering profession. Being an ally means taking on the struggle as your own, standing up to discrimination and biased behaviors, and transferring the benefit of your privilege to others. We must all take responsibility for making our workplaces inclusive and welcoming to everyone.

What have you learned as an advisor on equity, diversity and inclusion?
I have learned that providing opportunities for girls and other underrepresented communities to explore engineering in a safe, fun, and meaningful way is critical. We have found that exposing kids to the exciting opportunities that engineering has to offer and showing them that they will 'fit' in engineering makes

them much more interested in pursuing a career in engineering.

At UBC, we have witnessed this firsthand. Over the past 10 years we have increased female enrolment in engineering from 18% to 32% simply by providing these types of outreach events (and without making any changes to our admissions process).

I believe the single most significant thing we can do to increase diversity in engineering is to embed engineering within the K-12 curriculum. All students should graduate high school knowing what engineering is and how the work of engineers is critical to the well-being of society.

UBC set a goal of 50-50 male/female representation in engineering—how has that been going?

We set the goal of 50% women in engineering because we believe the engineering profession should reflect the society it serves. In many respects, we are doing incredibly well. At 32% we're well above the national average of 21%. We accomplished this through a comprehensive approach that engages the whole ecosystem—parents, teachers, counsellors, and kids. Last year alone, our engineering outreach program Geering Up reached nearly 25,000 youth, including 12,000 girls, 5,500 inner-city youth, and 2,200 Indigenous youth.

We recognize that we still have a long way to go to reach parity, but if we all work together, including education, government, industry, and academia, then we will get there.

What's being done at the university level to create a more inclusive engineering culture?

At UBC, our goal is to embed equity, diversity and inclusion (EDI) into all of our systems and structures. In the first year of our engineering curriculum, students learn about bias and the importance of inter-cultural understanding and perspective taking.

In 2014, the Engineering Undergraduate Society created the Iron Pin Ceremony as a way to mark a student's entry into the UBC Vancouver Engineering community. Upon completion of their first year, students publicly adopt these community values and pledge to uphold expectations of equity, integrity, respect and professionalism.

We have a very active Women in Engineering student club and a new club for Indigenous students in STEM. We are also starting to educate students about EDI in our co-op and professional development programs, and are exploring ways to incorporate Indigenous ways of knowing into our curriculum. We want our students to be change agents when they graduate from UBC, leading the transformation toward an inclusive engineering profession.

How can we address gender bias and the lack of diversity in industry today?

Education is critical to disrupt the impacts of implicit gender bias and to create inclusive and equitable environments and workplaces. The reality is that everyone is biased and everyone must do the hard work of understanding how they may be exhibiting biased behaviors.

It requires leadership from the top in terms of setting the tone and expectations for the culture, and also establishing policies that are supportive of diverse needs (e.g., flexible work and work-life balance programs).

Research shows that more inclusive policies lead to more organizational commitment for men and women, and that positive workplace culture is a key predictor of better organizational performance.

We also know that inclusive teams make better business decisions. So making our profession more inclusive is not just the right thing to do, it is the smart thing to do.

Are you seeing a greater diversity in the progressive BIM segment of the construction field?

Anecdotally, I have noticed that BIM roles do tend to have greater diversity, as I think BIM may provide an alternative pathway for people to establish themselves in the construction sector. Although I think this is positive, I also believe we have to ensure that all pathways are equally available to everyone in the profession.

Are you optimistic that we'll see greater diversity in the engineering industry?

I am very optimistic! I am seeing much more attention, leadership, and engagement within all sectors of our profession to increase diversity and create more welcoming and inclusive environments. The challenge now is to take that interest and translate it into concrete action and real change.

What gives me the most hope is that young people today not only expect diverse representation, they are already helping to lead the transformation. **CCE**

We want our students to be change agents when they graduate from UBC, leading the transformation toward an inclusive engineering profession.

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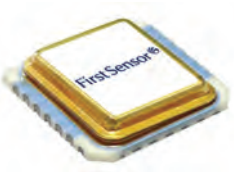

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Keeping the Momentum

Toronto-based HH Angus and Associates is celebrating its 100th anniversary in 2019, and at the end of May the company announced that Paul Keenan, formerly director of its health division has been named president.

Keenan replaces Harry Angus, the third generation of the Angus family to lead the privately owned firm. Angus remains on as CEO and Chair of the Board.

A Queen's University grad, Keenan has been with the firm for 25 years and served as director for the past decade. Also, within the past year, HH Angus was selected among Canada's Best Managed Companies for 2019, an achievement received in its first year applying to the Deloitte program. And last fall the firm captured the Schreyer Award at the 2018 Canadian Consulting Engineering Awards for its work on the CHUM hospital in Montreal.

We spoke with Keenan to discuss HH Angus and where it goes from here.

You're the firm's first president not named Angus. What does that mean for the company?
I think it in part means we're maturing. The firm has grown to over 250 people, and I think that as a bigger company you need inputs from different areas. The family legacy is important and it continues—Megan Angus, Harry's daughter, is one of the senior leaders in the organization—and although I'm not part of the family. I've grown up in the HH Angus way, so we're maintaining some of that family connection and we're enhancing it as we go forward.

Describe the HH Angus culture?
We try to maintain the family feel of the business, and with that comes a responsibility to the staff and a social responsibility to the community. Our turnover has been historically very low—we have 40 or 50 employees with over 25 years service—and that longevity and feeling part of a group is important for us.

What is your leadership style?
My experience here has always felt like a series of careers within one career. I started on small projects, gaining skills and transitioning naturally from project to project with larger challenges and increasing levels of responsibility.

I want to create those opportunities for our people. We've got to give them the opportunity to succeed or fail and go from there. At some point we all make decisions, and we need to believe in our decision making process based on the experiences we've had. Trust yourself, trust your team, make your decision and then move forward.

It's important not to get stuck; we need to keep our momentum going.

How does a consulting firm foster creativity & innovation among its employees?
I think that's a challenge for the entire industry, and we need to move more quickly now, to get from ideas to execution. One of the things we've done this year is create an Innovation Hub, which is a forum and a place to gather a range of ideas and have our people practice making presentations and share ideas, and then flesh them out, incubate them and then execute.

How has the firm changed over the years?
Traditionally, mechanical/electrical consulting engineering-led projects had been half of our business, and then the world changed. We did a lot of healthcare-related work in the '90s and have become recognized as healthcare experts. As that market has matured we've responded and entered different areas, for example transit, data centres, and more commercial work. Our energy group, that traditionally has done a lot of industrial work, is focused on more low-carbon, sustainable energy projects.

We also have some sub-specialities, such as vertical transportation, lighting design, and our ICAT group that does communications and consulting around smart buildings. You need to be diversified enough to respond to what the market is telling you.

How will you measure your success?
One of our primary objectives is to continue to be an independent firm. That comes with its challenges, but it also comes with its rewards.

We've been on a steady trajectory of growth and fundamentally we need to continue to grow; growth is important to create opportunities for our employees and for the underlying strength of our business. We need to be strong enough to resist whatever economic forces come along; we need to grow geographically; and we need to grow our share of the market and do the kind of interesting work that motivates our people.

Which HH Angus project has impressed you the most?
There are many projects in the history of the firm that are impressive and set us on the path of wanting to continue doing projects that are special and iconic. Personally, the Sick Kids research tower, a 750,000 sq. ft. research building, is iconic in the City of Toronto and more fundamentally is a place where important things happen for the future of this community and this country. **CCE**

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