EXCELLENCE IN EXECUTION

The Ontario Association of Certified Engineering Technicians and Technologists (OACETT) is the certifying body for more than 25,000 engineering technology professionals in Ontario.

OACETT is dedicated to excellence in the engineering and applied science technology profession in a manner that serves and protects the public interest.

OACETT is a self-governing professional association that functions under the OACETT Act for the purpose of protecting public safety, governing its members and providing a wide range of member benefits and services.

Certified members of OACETT hold one of the following designations:

• Certified Engineering Technologist (C.E.T.)
• Applied Science Technologist (A.Sc.T.)*
• Certified Technician (C.Tech.)

Members may also hold one of these designations after qualifying:

• Road construction contract administrator (rcca)
• Road construction senior inspector (rcsi)
• Road construction junior inspector (rcji)

*No longer awarded
The Technical Program consists of technical presentations and poster displays that provide technology transfer and promote member engagement. There are three oral presenters and 10 poster presentations, all selected by the Association's Peer Review Committee, a multifaceted group of volunteers from a cross-section of disciplines.

This year OACETT received 38 abstracts from members across Ontario. The abstract submissions revealed the emerging technologies, dynamic projects and the unique skills of those working in the profession. The five Peer Review Committee members participated in the review process and accepted 10 abstracts for the Technical Program. These abstracts presented some of the most practical and promising technical topics in engineering technology, and offer a wide range of perspectives, practices and technical expertise to our conference attendees.

In this program, you will see the technical projects and applied research of the OACETT members selected for this year’s Technical Program profiled – clear evidence that engineering technicians and technologists are shaping the future.

We hope you learn more about what our members are doing in the marketplace and encourage you to visit the various poster displays in the South/West Ballroom.

Peer Review Committee

A special thank you to members of our Peer Review Committee for the time and effort they put into reviewing, evaluating and selecting the abstracts for the Technical Program. It is through their contribution, recommendations and diligent support that the Technical Program continues to grow into a program we can all be proud of.

Eugene Stodolak, C.E.T., chair
Mark Gatenby, C.E.T.
Nick Mozzoni, C.E.T.
Nadine Rush, C.E.T.
Christopher van Dop, C.E.T.
Michelle Malcolm-Francis (staff)

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Technical Presentations
Using the cost model developed, the best options for part orientation, raster width and air gap were realized which then impacted the cost of manufacturing the part. Therefore, the users of FDM Process are able to anticipate process parameters that minimize manufacturing cost before committing to run the FDM machine. However, in some cases, other objectives such as functionality need to be considered over the minimal cost.

FDM is an additive manufacturing (AM) process that manufactures parts layer by layer by deposition of molten thermoplastic material extruded from a nozzle. The methodology for the AM process involves computer-aided design (CAD) models for the suspension arm and the articulated rod modeled using SolidWorks software. To establish consistency, we converted the CAD file into STL (.stl) format, which is the standard of the additive manufacturing industry.

We developed the total build cost as:

\[
\text{Cost Total} = 8.58 \times \text{Build Time} + 3.967 \times \text{Part Volume} + 3.967 \times \text{Support Volume} \quad (1)
\]

Based on the results, it was concluded that the optimal build orientation for manufacturing the parts using AM is at the 0° orientation, minimum raster width and maximum air gap. While these optimal conditions are valid for the objective of minimum manufacturing cost, the situations may vary if functionality is to be maximized. In this case, minimum air gap would give maximum functionality.

The FDM model experiment did not consider pre-processing and post-processing costs, which may slightly increase the overall cost.

Further work includes using the cost model and process parameter to realize a predictive model using advanced modeling methods. We know this cost analysis will assist AM users in selecting the best process parameters of the part and create optimal process planning which will assist in reducing work and the total cost required for manufacturers using AM technology.
INTELLIGENT RAIL SYSTEMS AND SIGNAL DESIGN

Today, most engineers and designers who design systems and signals for railways use software that is far from ideal, which has presented many opportunities for improvement. Often a rail systems designer must work from a template created in standard computer-aided designing (CAD) software (MicroStation or AutoCAD). However, using templates is still time-consuming, tedious, extremely limited and has no automated controls.

As part of the wider Hatch building information modeling (BIM) initiative, the rail systems group chose to invest in the development of a new design methodology that would bring intelligence into rail systems and signal design never seen before in the industry. This solution has an intelligent three-dimensional (3D) model which is linked in real time to the schematics required for design.

The traditional CAD platform is replaced with the help of Promis.e, which is used as the core software for designers to create new intelligent projects enriched with data. A Microsoft SQL Server allows multiple users to share a single database stored on a central network, while utilizing ProjectWise for the drawing collaboration, which is integrated through the Promis.e project manager. Microsoft SQL Server is a relational database management system with the primary function of storing and retrieving data as requested by other software applications, in this case Promis.e. ProjectWise is a software suite developed by Bentley Systems which is used for engineering project collaboration. It helps our project teams manage, share and distribute engineering project content in a single platform across multiple offices within North America.

The return on investment has been proven in three different areas:

1. Quality. Application of this technology allows designers to drive our already high level of quality to a level that cannot be matched by anyone using previously available standards.

2. Flexibility. In its finished state, the system is flexible enough to react to scope and design changes with relative ease.

3. Interdisciplinary operability. By integrating the rail systems design with the 3D model-based civil design, rail systems design is moving towards the goal of multidisciplinary design in a 3D framework and ultimately to a five-dimensional framework, incorporating time and cost.

This new system allows designers to become more efficient through automation and the single database allows for designs to be performed with greater accuracy. It includes features to automate drawing and bill of materials creation and to streamline basic checking processes. The automated creation of site-specific projects, drawings, schematics and 3D layouts combined with the capability of dynamic changes throughout each phase of a project will immensely reduce design costs.

In November of 2014, the use of intelligent rail design was recognized by Bentley Systems at its Be Inspired Awards, winning the award for Innovation in Rail and Transit in London, England. In addition, the project also won Hatch Global’s Design Excellence Award recognizing the creation of innovative methodologies or technologies to solve a complex design problem.

ROBERT HENDERSON, C.TECH.
Signal Designer/Technology Co-ordinator, Hatch Limited
THE GORE ROAD SOLUTION: BRINGING THE CORRIDOR BACK INTO A COMMUNITY

The Region of Peel’s long range transportation plan (LRTP) identified the need to widen a section of The Gore Road in the City of Brampton to six lanes by 2020. The region is growing rapidly and has become attractive to many because of its vibrant economy, high quality of life and strong transportation system. Knowing the population growth of Peel would reach at least two million people by 2014, the region prepared an ambitious capital program valued at $1.4 billion over the next 10 years.

To ensure necessary infrastructure is in place as Peel grows, the region initiated an environmental assessment (EA) study for The Gore Road between Queen Street and Castlemore Road. The EA study examined the need to widen the corridor from four to six lanes.

The study area for this four-kilometre road section includes two secondary schools, an elementary school, multiple places of worship, nine signalized intersections, two cemeteries, a posted speed of 60/70 kilometres per hour and is truck restricted.

The LRTP traffic modelling and forecasting showed a need to widen the road to address congestion. However, the project team observed that there is a divergence between local travel patterns and through travel patterns. The southbound double left turn lanes are predicted to be at capacity at key intersections. About 57 per cent of the total traffic volume will be turning left, creating a major capacity constraint. However, through traffic needs will be met with the current four-lane road section.

The LRTP modelled road network and zone connectors were refined to better reflect existing conditions and to support more realistic loading of traffic along the corridor. The modelled traffic demand up until 2031 indicates heavy left turn volumes at selected intersections like the link to Highway 427’s future extension. Adding extra through lanes would not provide a long-term traffic solution and could have a negative impact on a unique corridor.

The study area’s conditions show no accommodation for cyclists, two cemeteries that front the roadway, a heritage structure that constrains the roadway, a community-oriented corridor and a need for increased transit ridership.

The findings changed the widening project to a showcase of design innovation using a “Complete Streets” approach that encompasses the programs and services delivered to the Peel community, embracing the region’s new philosophy in road design as espoused in the region’s 2013 roads characterization study.

The project team recognized the complexity of the corridor and came up with a design solution that includes transit bus bays and queue jump lanes; lower speed limits; maintains the existing bridge structures; provides cycling and pedestrian infrastructure; provides dual left turn lanes at intersections providing access to the highway 427 extension; and improves stormwater management features that utilize low impact development principles. The project team plans to implement these design solutions by 2020.
Poster Presentations
A radioactive, colourless and odourless gas, radon (and its radioactive progeny, polonium, bismuth and lead) is the byproduct of the radioactive decay of uranium which is distributed in rock and soil. Once uranium decays to radon gas it is mobilized by pressure and concentration gradients and moves through rock and soil pore spaces. Stack effect draws radon into buildings where it can accumulate and expose occupants to elevated levels.

In March 2012, Health Canada completed a random, cross-Canada survey of radon concentrations in nearly 14,000 homes. The results from this two-year study concluded that 6.9 per cent of Canadian homes have radon levels above the current radon “actionable level” of 200 becquerel per cubic metre of air. Subsequent efforts including, risk communication strategies, public education and changes to building codes have been and are continually implemented to protect Canadians from radon exposure.

Evidence shows conventional building construction methods do not adequately control its ingress and that additional measures to mitigate its infiltration are warranted. There are many challenges and potential shortcomings with the minimum building code requirements that could result in elevated radon in buildings. More importantly, designers, constructors, authorities, building owners and occupants may falsely assume a prescriptive code requirement was met and the occupants are safe from radon overexposure.

Radon cannot be “sealed out” with conventional construction methods and the extreme level of quality control to do so is cost prohibitive. Simple modifications to conventional building methods can provide passive enhancements that significantly improve radon mitigation system performance and dramatically reduce operational energy costs. Although tight building envelopes provide energy reduction benefits, without purpose built ventilation (i.e. active sub-slab depressurization, dilution ventilation) an increase in indoor radon levels and subsequent risk of lung cancer for building occupants may result.

In situations where active mitigation systems must be implemented to adequately control radon levels, favouring active sub-slab depressurization methods over general dilution ventilation will further control energy consumption and associated heating ventilation and air conditioning operation and maintenance costs.

Although dilution ventilation is a viable option for radon control, building occupants are still at risk of greater radon exposure than active sub-slab depressurization. In large-scale buildings with dynamic monitoring and ventilation systems and active sub-slab depressurization or dilution ventilation, indoor radon levels are often effectively controlled and energy expenditure requirements are reduced up to 94 per cent.

In 2012, the Canadian Nuclear Safety Commission reported radiation exposure from inhaled radon gas impacts the health of all types of building occupants across Canada, and is the largest contributor to an individual’s annual radiation exposure. They also shared with Canadians that recent efforts to investigate the direct association between indoor radon and lung cancer have provided convincing evidence of increased lung cancer risk at levels commonly found in buildings and recognized radon as the second-leading cause of lung cancer, after smoking, in the general population.
Characterized by extensive seasonal development along the shoreline and widespread agricultural use inland, the township experiences algal blooms and beach closures as the result of high nutrient levels and E. coli levels. Private, on-site septic systems within the township are suspected as a potential source of some contaminates. However, the township found the records and information on the age, condition, and location of approximately 3,000 systems within the municipality were lacking. With the assistance of a local engineering and planning firm, B.M. Ross and Associates Limited, the township developed an innovative program for re-inspecting all septic systems in the municipality that investigated the conditions and collected, managed and tracked data related to these systems.

To evaluate and monitor the condition of the septic systems in the municipality, the township enacted the Huron-Kinloss Community Septic Inspection (HKCSI) Program – a mandatory program that ensures inspections were completed by a qualified on-site sewage systems inspector and is overseen by the chief building official. At every property serviced by an on-site septic system, including privies and tertiary systems, the inspector completed a visual inspection of the system. A hand-held Trimble unit collected the data gathered during the inspection process, including the geographic coordinates of the components of the septic system. Data, photographs and geographic coordinates for each inspected septic system are transferred to a geographic information system database, designed to manage the quantity of data collected.

The database stores the information for every septic system, allowing for analysis of required repairs, completed repairs, pump-out frequency and spatial analysis of risk ratings and system ages. In the database, permits can be linked to existing septic systems, as can records relating to new installations, including applications, permits and constructed drawings.

During the first eight years of the HKCSI program, 2,940 properties had a septic inspection completed. The data collected from these inspections revealed that five per cent of the systems inspected are considered ‘high risk’, with 43 per cent given a medium-risk rating, and 52 per cent a low-risk rating. The data contained in the database also uncovered areas in the township with concentrations of high-risk systems, systems requiring repairs and the presence of a significant number of old systems possibly approaching the end of their useful life.

Since the inspection, most high-risk systems have been replaced and many other property owners have completed repairs to improve the function and extend the life of their septic system. Since then, surface water quality has improved which has been linked to the removal of high-risk systems and repairs completed by property owners. Additionally, the program has successfully been integrated with source water protection policy requirements for inspections. The HKCSI program and associated database demonstrate the capacity to effectively manage, oversee and monitor septic systems at a municipal scale.

THE HURON-KINLOSS COMMUNITY SEPTIC INSPECTION PROGRAM

The Township of Huron-Kinloss is located along the southeast shore of Lake Huron and, like many other lakeshore communities, faces issues surrounding nearshore and surface water quality.

MATT FARRELL, C.E.T., CBCO
Chief Building Official, Township of Huron-Kinloss

MATT PEARSON, B.SC., MCIP, RPP
Senior Planner, B.M. Ross and Associates Limited
These buildings are not constructed with a drainage cavity and since there is only a single wythe of masonry, the moisture storage capacity is limited. As the TTW deteriorates, water penetration into the building interior is common. Since the structural TTW is not protected by thermal insulation or an exterior cladding, it is exposed to the elements and susceptible to freeze-thaw cycling and resultant damage. TTW assemblies are typically energy inefficient as there is no thermal control layer over the brick and floor assemblies which load the brick, creating thermal bridges.

At Building A, the client determined that it was time to repair, renew and/or upgrade the building envelope to address ongoing masonry deterioration and improve the building envelope by better controlling air/moisture and heat flow and improving the overall building aesthetics. The project was to include an assessment of 10 overcladding options, each with varying insulation thickness, and included heat transfer analysis (THERM Beta 7), hygrothermal analysis (WUFI) and an energy savings analysis (RETScreen). It was determined that a four inch exterior insulated finish system (EIFS) overcladding was the optimum solution to remediate the building’s lack of continuous secondary moisture barrier and drainage plane, limited moisture storage capacity and uninsulated structure.

A specification was prepared which included a detailed drawings package. As is the case with multi-component/hand applied systems, EIFS is sensitive to the experience and quality of the workmanship. Quality control is necessary to assure the various components are properly applied and that they effectively work together to provide the desired performance. Construction at Building A was completed in 2014 and was registered with the EIFS quality assurance program (EQI), created by the EIFS Council of Canada, which required periodic third-party inspections of the application.

While there is no universal solution for deteriorating building envelopes, the case for EIFS overcladding is compelling. EIFS retrofit over existing masonry buildings has been a standard practice in the industry for almost 50 years in North America and even longer in Europe. When compared with other overcladding systems, the simple pay period for the EIFS could not be outperformed. The system also offers endless aesthetic possibilities, from traditional to ultra-modern specialty finishes, which appeals to most building owners.

EIFS also has its limitations, requires careful consideration of the details during the design phase and the keen eye of inspectors on-site during construction to ensure proper installation. Even the most experienced installers can fall victim to oversights and installation errors. Programs like EQI aim to raise the bar for installers and inspectors alike and can provide an additional layer of protection for owners considering major EIFS projects.
To investigate the effectiveness of HDR-I, video data of the gas metal arc welding (GMAW) process, including free flight metal transfer and cold metal transfer (CMT®), was collected and reviewed to determine if the camera could visualize weld details in real time. Attempts were made to identify droplet size and pattern, weld pool/arc relative position, direction of the weld with respect to the seam, weld pool/arc size, and shape and colour. Additionally, video data was reviewed to determine if defects, or sources which cause defects, could be repeatedly detected. Weld conditions were optimized, defect production and identification methods were developed and a video library was created.

Results showed that the aforementioned weld details could be clearly identified. Defects such as porosity, torch and joint misalignment, undercut, burn through and lack of fusion were also reliably observed. This visual information would be advantageous to allow rapid identification of (and adjustments to) critical welding parameters while the weld is in progress which could lead to diminished rework rates and increased productivity. Knowledge gained in this investigation may be used to implement the camera in welding automation where remote, detailed observation of the welding process and/or weld defect prevention through machine vision could be possible.

CMT® is an adaptation of the GMAW process that involves very low heat input, a short-circuiting pulse and a rapid push-pull wire feeder, allowing welding on very thin and advanced materials to be achieved. Interestingly, research determined the camera reliably identified CMT® wire retraction, weld details and offered stable arc recognition at points on the short-circuiting CMT® pulse. The opportunity to witness such welding details in real-time may permit a better understanding of this specific welding process.

Creating a safe and healthy work environment is crucial and the HDR-I welding camera studied is a tool that may someday allow elimination of some workplace hazards while improving a company’s overall productivity. The application of this technology could permit workers in welding environments to distance themselves from the arc and hazardous work environments by allowing real-time remote visualization of the welding process and identification of weld defects and their sources. Viewing these unique details may hasten the learning process of welding industry personnel, increase understanding of the welding processes studied and, in turn, promote and improve the growing welding industry.
TRENCHLESS REPAIR OF A 675mm SANITARY SEWER IN THE CITY OF LONDON

In 2015, the City of London decided to rehabilitate a sanitary sewer in conjunction with a subdivision development in the Chelsea Green area of the city. The pipe under rehabilitation, a 675 millimetre trunk sanitary sewer, was constructed in 1924 and is the outlet for the new subdivision. The pipe also serves a large area upstream of the development, and runs under a railway and through a closed road allowance which is now part of a warehouse yard.

The city decided it would structurally line the existing sewer under the railway to a maintenance hole in the warehouse yard in an easement. The pipe to be lined had no major defects but had significant debris buildup as well as mineral encrustation caused by years of infiltration.

One of the challenges the city faced with lining the sewer was finding a way to bypass the existing flows. They decided the best plan-of-action was to send the bypass piping through the new subdivision, through a city park, along a multi-use pathway beside the Thames River and under the rail bridge over the river with pipes ending at a discharge maintenance hole over 600 metres away. To successfully do this, the bypass piping would require a two lane multi-use pathway closure.

The city put out a tender for the CIPP (Cast in Place Pipe) lining of the existing 675 millimetre sewer. CIPP is a method for repairing a pipe without excavation. A resin-impregnated felt tube is inserted into the existing pipe and inflated. The inflated tube fits tightly to the pipe walls and heat is added. The resin in the tube hardens creating a new pipe within the existing pipe.

Insituform Technologies won the bid. Over a period of two weeks, Insituform worked closely with their bypass pumping and cleaning subcontractors (Atlas Pumps and Empipe), the developer, his contractor, the consultant and the London Parks department.

Insituform and the developer decided how the lining/bypass would be separated from other subdivision construction work. Next, the bypass pumps and piping were installed with help from the developer who created an access ramp, and the Parks department who supplied signs for the multi-use pathway lane closure as well as some brush clearing.

Once the bypass piping and pumps were installed, tested and in use, Empipe began cleaning the sewer. Cleaning went smoothly and within days lining began. There were no problems during the installation of the liner. Existing abandoned lateral connections were lined over to prevent future infiltration and encrustation issues.

Insituform noted to the city that the remaining downstream length of pipe was dirty and since the flows were removed from the pipe this would be an ideal time to clean it up.

By the end of the project, the lining, bypass and cleaning were successful, increasing the sewer’s life expectancy significantly. The new and improved sewer, lined and cleaned, has also increased in capacity – something not seen for many years. The city completed the rehabilitation project on time and within budget. The city will continue to use trenchless repairs as a method to save money and avoid citizen frustration associated with conventional dig and replace.

2016 Annual General Meeting & Conference
THE OPTIMUM ELECTRIC RAILWAY TECHNOLOGY FOR GO TRANSIT’S FUTURE GROWTH

In a 2013 report titled GTHA Regional Rapid Rail, research was undertaken following the Metrolinx-commissioned electrification study conducted in 2010, in which some of the modeling methodology was contested by Transport Action Ontario, for whom the work was prepared. If electric multiple units (EMUs) are as commonplace as they are on European and Asian railways, they should also be cost-effective for the future of the GO Transit network, yet the 2010 Metrolinx study did not arrive at this conclusion.

The Metrolinx-commissioned electrification study favoured electric locomotives in its development. However, the modeling methodology had a number of issues that included inappropriate scheduling assumptions, a lack of fleet optimization and equipment cycling, and an absence of labour differentials between railway vehicle technologies, all of which offer different average operating speeds.

In this report, an extensive set of assumptions for the entire GO Transit rail network was described and assessed for its expansion and operation with three different vehicle technologies. The three technologies were the existing diesel locomotive-hauled trains, the system GO Transit operates with currently; the electric locomotive-hauled trains based on a model in operation on the New Jersey Transit network, as from the Metrolinx-commissioned study; and electric multiple-units, assumed to be an electrified version of the existing bi-level coaches, somewhat similar to the electric multiple units in operation on the METRA electric service in Chicago, Illinois.

Operating schedules of each technology were developed in a manner that would provide the same level of service, but optimized the equipment cycling to attain the smallest fleet size for providing that level of service. After accounting for spare ratios and comparing against what proportion of the existing fleet can be reused (where applicable), capital costs and operating and maintenance costs were determined for each technology’s fleet, including fuel, servicing, labour, and, where applicable, differences in the “train-bus” services that GO Transit currently provides. The incremental long-term costs of each technology were compared, at 2021 and 2031 horizons.

Capital costs were also developed for additional tracks, expanded stations, new grade separations at level roadway crossings and signal system upgrades. The basis of the infrastructure expansion used a combination of the infrastructure index provided in the Metrolinx-commissioned electrification study and considerations of local context to accommodate the needs of neighbourhoods in which the infrastructure would be located.

Annual operating cost savings from an EMU-operated GO rail service over a diesel-operated service is estimated at over $465 million by 2031. Therefore, electrification with EMUs could serve as a means to avoid sharp increases in operating budgets for GO rail service over the long term. On a basis of passenger capacity per dollar of capital investment, the GO EMU approach is highly cost effective.

EMUs would clearly be the soundest option for the future fleet of the GO rail system. Since the time this work was completed, Metrolinx has begun moving towards an EMU-based system very similar to that analyzed in this work.
The membrane is very sensitive to differential pressure fluctuations on sides between the hydrogen and chlorine gas headers, so one of the most important process variables is controlling the gas pressure in both headers to maintain a desirable differential pressure across the cathode and anode. This must be maintained at all times to maximize membrane life and to avoid any potential process safety incidents such as an explosion.

Rapid start-ups or shutdowns of hydrochloric acid (HCl) burner units create pressure disturbances in the header which is capable of tripping alarms and causing the process to shut down in seconds. Consequently, it is essential to control and maintain not only the pressure of the chlorine and hydrogen headers feeding the burner units, but also differential pressure across the electrolyzer membranes. Units with multiple burners increase the level of complexity.

The flow diversion concept is a way to minimize pressure disturbances. If a burner shuts down, diverting the exact amount of gas being used by that burner to some other destination, typically the emergency vent scrubber for chlorine and atmospheric vent stack for hydrogen, can mitigate or eliminate pressure disturbances in the headers.

A new design developed by Neelesh Shah, P.Eng., C.E.T. uses the flow measurement of gas to the burner and positions a throttling control valve on a line to a safe area. This ensures the flow through the control valve (which is partially open) matches the flow to the burner. Flow through to the throttling valve is prevented by a second upstream fail-closed on-off valve. The on-off valve is electrically connected to the burner safety shut-off valves, so that when the burner trips and the burner safety shut-off valves close, the on-off valve on the diversion line opens. After the flow is diverted and stabilizes, the throttling valve closes slowly, giving the normal pressure control systems time to adjust to the new flow rates.

This design has helped engineering communities and chemicals plants all around the world including Molycorp Inc. in California. Since implementing the design, the company has run, started, stopped and regulated production capacities of two HCl units independently without affecting electrolyzers’ productions.

Molycorp has saved over $2 million per year, increased personal and equipment safety and has reduced the risk of environmental emission through the safe diversion scheme of chlorine to the emergency vent scrubber. The company has also benefited from higher reliability and extended life of membrane and electrolyzer components, and has better product quality which has increased customer satisfaction.