

NORMAN W. MCLEOD CHAIR IN SUSTAINABLE PAVEMENT ENGINEERING

2016 ANNUAL REPORT

NORMAN W. MCLEOD

CHAIR IN SUSTAINABLE PAVEMENT ENGINEERING

CPATT

CENTRE FOR PAVEMENT AND
TRANSPORTATION TECHNOLOGY



UNIVERSITY OF WATERLOO
FACULTY OF ENGINEERING
Department of Civil &
Environmental Engineering

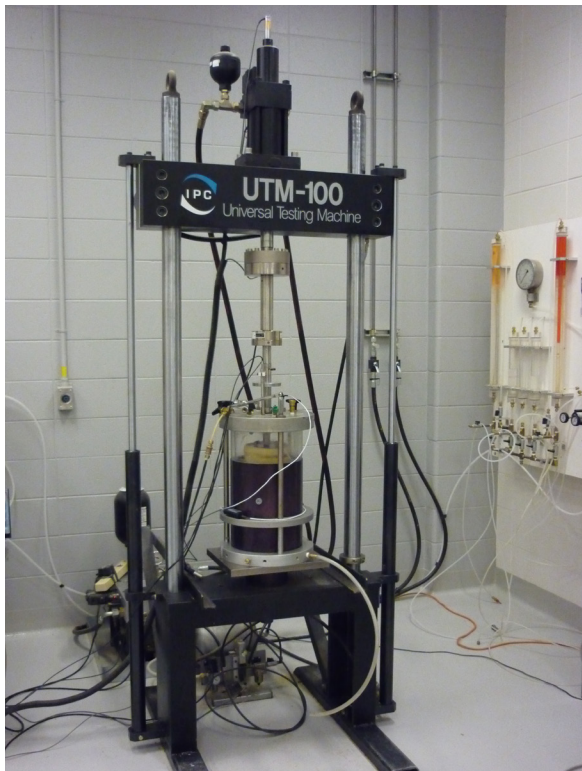
SCOPE & OBJECTIVE OF THE CHAIR

The scope of the Chair focuses on emerging and innovative pavement technology, state-of-the-art research infrastructure in areas of design, materials, construction, preservation, safety, and management for tackling specific problems, developing new technologies and training skilled people.

The objective of the Chair is to:

- Provide cutting-edge sustainable pavement engineering research
- Develop sustainable and cost-effective materials, designs, construction and management tools
- Collaborate with government, industry and academia
- Teach and supervise students
- Disseminate findings through seminars, newsletters, papers and reports

One main objective of the Chair is to provide specialized training needed to meet the challenges of transportation engineering in the 21st century. The research and teaching program is designed to develop future leaders and to advance critical partnerships between universities, government, and the private sector.



The Norman W. McLeod Chair in Sustainable Pavement Engineering is in support of the Centre for Pavement and Transportation Technology (CPATT). CPATT has been at the forefront of exceptional research, training and professional activities. This success is rooted in both the experienced and skilled faculty members, as well as the state-of-the-art facilities such as the John J. Carrick Pavement Laboratory at the University of Waterloo, the CPATT Test Track at Waterloo Region's Waste Management Facility and several satellite test sites located across Canada. All of these facilities support the state-of-the-art research program. The current and future research will continue to advance key research needs but will also provide strategic training for the industrial partners and the broader community at large. Development of national and international partnerships will also facilitate technology transfer.

PARTNERS



We greatly appreciate the continued support of our partners in the Norman W. McLeod Chair in Sustainable Pavement Engineering. Our industry partners are key industry stakeholders and are knowledgeable in the areas of research in which the Chair will pursue. The resources and expertise they provide is extremely beneficial as we move forward on various research initiatives. Below is a list of our partners:

- Canadian Asphalt Industries Ltd.
- Capital Paving Inc.
- CRH Canada
- DBA Engineering Ltd.
- EnGlobe
- Golder Associates Ltd.
- McLeod Endowment
- McAsphalt Industries Limited
- Miller Paving Limited
- Ministry of Transportation Ontario
- Ontario Good Roads Association
- Ontario Hot Mix Producers Association
- Concrete Ontario
- Roto-Mill Inc.
- Shiloh CanConstruct Ltd.
- Stantec Consulting Limited
- Steed and Evans Limited

OUTREACH SYMPOSIUM



GRADUATE POSTER SYMPOSIUM

On Friday, October 28, 2016 CPATT and the Norman W. McLeod Chair in Sustainable Engineering held the 6th annual Graduate Student Poster Symposium in the E5 Sedra Student Design Centre, at the University of Waterloo.

A total of 34 Graduate students from all areas of Civil and Environmental Engineering were able to showcase their current research to industry members, faculty, staff and fellow students. The symposium allowed students to not only present their work, but also practice their public speaking and network with other faculty and industry personnel.

Thank you to all the students that participated in this event, the industry members who attended, and all the staff and faculty that came out to support our graduate students and their research.

OUTREACH SEMINARS

CURTIS BERTHELOT, PhD

On May 27, 2016, the Norman W. McLeod Chair and CPATT co-hosted a seminar for students on the application of applied mechanics.

The invited speaker, Dr. Curtis Berthelot is the president, owner, and chief technical officer of PSI Technologies and provides overall technical leadership, as well as operations management for the company. As a professional engineer, Dr. Berthelot has over 25 years of experience in research, design, construction, and project management



related to roadway construction, road recycling, material stabilization, transportation infrastructure management, intelligent transportation systems, and the trucking industry. He served as an assistant professor in the Department of Civil and Geological Engineering at the University of Saskatchewan from 1998 to 2009 and a tenured professor from 2009 to 2014.

The presentation from this seminar can be found here:

<https://uwaterloo.ca/centre-pavement-transportation-technology/related-links>

We greatly appreciate Dr. Berthelot for taking the time to visit the University of Waterloo.

OUTREACH SEMINARS



MARCELO GONZALEZ, PhD

On July 8, 2016, the Norman W. McLeod Chair and CPATT co-hosted a seminar for students on enhancing the sustainability of Portland Cement Concrete (PCC) in Chile.

The invited speaker, Dr. Marcelo Gonzalez is an Assistant Professor at the Pontificia Universidad Católica de Chile (PUC). He received his PhD from the University of Waterloo in 2014, his Master of Science from the PUC in 2006 and his Bachelor of Civil Engineering from the Universidad de Santiago de Chile in 2002. Before his PhD, he was a researcher and consultant for 6 years at DICTUC (a branch of the PUC). He has held consultant jobs in countries such as Chile, Argentina, Peru and Panama.

Dr. Gonzalez is a member of the Basic Research and Emerging Technologies Related to Concrete, AFN10 Transportation Research Board. He is also an associate researcher at the Research Center for Nanotechnology and Advance Materials CIEN-UC. Finally, he is leading the creation of the first Center of Concrete Innovation in Chile, which will be located at PUC.

The presentation from this seminar can be found here:

<https://uwaterloo.ca/centre-pavement-transportation-technology/related-links>

We greatly appreciate Dr. Gonzalez for taking the time to visit the University of Waterloo.

OUTREACH SEMINARS



JAMES TSAI, PhD

Dr. James Tsai is a Professor in Transportation Systems Engineering, Smart Cities and Sustainable Communities at Georgia Tech in Atlanta, GA. Before joining the faculty at Georgia Tech, Dr. Tsai worked as a senior research scientist in the GIS center at Georgia Tech. Since 1997, he has led a research team and worked with GDOT pavement engineers, successfully implementing a large-scale Oracle GIS-based pavement preservation and management system for GDOT to effectively preserve and manage its 18,000-centerline miles of highway.

A series of models and programs developed by Dr. Tsai, including field pavement condition data acquisition, the annual pavement preservation project prioritization and program development, treatment determination model, cost model, and performance forecasting model, and long-term system performance simulation and optimization, have been successfully implemented by the Office of Maintenance of the GDOT. They have resulted very positive impact on GDOT's operations.

Dr. Tsai came to the University of Waterloo in the Fall term to give a talk on "A sensor-based and spatially-enabled system for next generation Intelligent and sustainable pavement/infrastructure asset management", hosted by CPATT and the Norman W. McLeod Chair.

ABSTRACT Roadway infrastructures, including pavements, bridges, and signs are deteriorating rapidly due to material aging, improper usage, harsh environments, and damages resulting from natural or man-made hazards. With the advancement of sensor technologies, it become feasible to collect the large-scale in-field detailed infrastructure data, such as 3D pavement surface data, using high-performance cameras, lasers, LiDARs, and Inertial Navigation System (INS) to gain better insight understanding of the large-scale in-field infrastructure behavior. An intelligent sensing system will be presented, using 2D Imaging, 3D Laser, LiDAR, and GPS/GIS Technologies with artificial intelligent and pattern recognition to automatically detect and diagnose pavement surface distress, including rutting, cracking, raveling, etc., using an innovative crack fundamental element (CFE) model that is a topological representation of cracks to support crack classification, diagnosis, and intelligent pavement management. Cases of automatic roadway health condition assessment and innovative pavement preservation technology development using 3D technology will also be presented.

OUTREACH SEMINARS



CHRISTIANE RAAB, PhD

Dr. Christiane Raab is a Senior scientist and leader of the Road Materials and Pavements team at the Road Engineering/Sealing Components Lab - EMPA Swiss Federal Laboratories for Materials Science and Technology (Switzerland), and an Adjunct Research Professor at Carleton University, in Ottawa, Canada.

Dr. Raab came to the University of Waterloo on October 3rd, 2016 to give a seminar on the “Ageing Behavior of Energy Reduced Pavement”, hosted by CPATT and the Norman W. McLeod Chair.

ABSTRACT Nowadays, pavement construction is expected to be more energy efficient and road pavements to be more environmentally and socially friendly. In this context the Swiss Federal Office of Transport FOT, has established a road research program under the title of “Sustainable transport” in order to investigate energy reduced pavements, warm or semi warm pavements concepts allowing to significantly reduce the installation temperature in order to save CO₂ emissions. Although first experiences with these pavement concepts show promising results, there are no long term performance data available and the durability and long term resistance has still to be established. This paper presents results from investigating the ageing behaviour of different energy reduced pavement mixtures. The mixtures were either prepared in the laboratory or taken directly from mixing plant. The study compares the rutting and fatigue behaviour of unaged material in comparison to long term aged material. In order to conduct the long term ageing a special ageing protocol with different heating, cooling and watering cycles had been developed. The investigation revealed a quite controversial rutting behaviour with most aged pavements showing increased rutting while for others reduced rut depths could be found. As opposed to this finding, fatigue and stiffness of all aged pavement samples compared to unaged samples improved significantly. The overall results lead to the conclusion that the ageing of energy reduced pavement concepts is not very critical and that the application of such pavements therefore provide a good solution for saving CO₂ emissions and prolonging the installation season.

OUTREACH UNB & WESTERN

UNIVERSITY OF NEW BRUNSWICK AND WESTERN UNIVERSITY LECTURE SERIES

Susan Tighe was invited to Western University and the University of New Brunswick Transportation Group Seminars as a guest lecturer. Her lectures were on resilient pavement for the sustainable future.

A key aspect to determining if a pavement design can effectively be used in Canada is that it must be resistant to harsh environmental and traffic loads. Currently, public agencies are also investigating the feasibility of incorporating sustainability and climate change impacts into transportation asset management. The potential benefits are diverse and of strategic importance as they encompass improvements to virgin material usage, alternative material usage, pavement in-service monitoring and management, noise, air quality, water quality and energy usage.



The lecture provided a framework for formally evaluating new materials and designs into pavement engineering. An evaluation of the concept of a solar road and the advanced application of SEM and CT scanning tools for evaluating and predicting performance of asphalt materials for usage on Canadian pavements was presented. Engineering tools such as Finite Element for more sustainable and climate factors into asset management programming at the network level work was also presented.

NEW ADJUNCT PROFESSOR

STEVE GOODMAN, PhD



Dr. Steve Goodman is honored to join his alma mater as an Adjunct Professor. Dr. Goodman completed his BAsC degree at the University of Waterloo in 1997 and then completed his Masters and Doctoral degrees at Carleton University under the supervision of Dr. Abd El Halim.

Between 2008 and 2015, Dr. Goodman started and successfully managed the Ottawa office of Aecon Materials Engineering to provide engineering support to Aecon operations in Eastern Ontario and internationally. In September 2015, he joined Houle Chevrier Engineering Ltd. to manage their growing pavements and materials group in Ottawa and provide technical support to their parent company GEMTEC across Atlantic Canada.

Through his 18 years of experience with a national technical association, a large municipality, a major contractor, and now a dynamic consulting firm, Dr. Goodman has gained significant experience in all aspects of pavement engineering including design, rehabilitation, management, preservation and materials. During his time, Dr. Goodman also indulged his interest in teaching by acting as a sessional lecturer at Carleton University for both graduate and undergraduate courses on numerous occasions. His passion for research has also led to the publication of over 20 technical papers.

Since 2006, Dr. Goodman has been the Editor for the Canadian Technical Asphalt Association (CTAA) and is responsible for reviewing, formatting and publishing their annual conference proceedings. As Editor and a member of the Board of Directors for CTAA, Dr. Goodman regularly interacts with pavement professionals from across Canada. His editing experience was also utilized by the Transportation Association of Canada (TAC) when he was retained to review and edit the 2013 Pavement Asset Design and Management Guide - a national effort led by Dr. Susan Tighe.

OUTREACH EVENTS

LUNCH AND LEARN

On Monday, November 21, 2016, CPATT along with the Norman W. Mcleod Chair in Sustainable Engineering, and the Miller and McAsphalt Groups, hosted a Lunch and Learn at the University of Waterloo.

The Lunch and Learn provided graduate and undergraduate students a chance to hear key note speakers from the Miller and McAsphalt groups, such as: Blair McArthur, CEO (Miller Group), Ryan Essex, Vice President (Miller Group), Trevor Moore, Corporate Technical Director (Miller Group), Nicolas Cifelli, Technical Services Manager (Miller Group) and Tony Khucharek, Corporate Technical Director (McAsphalt). The discussion was mainly focused on current projects and providing insight on what it is like working in industry, followed by a Q&A session.

Thank you to the fantastic key note speakers for inspiring our future civil engineers. We are grateful for the time and effort you took to share your thoughts and experiences with us!



CEO of the Miller Group, Blair McArthur, speaking to our graduate and undergraduate students at the 2016 Lunch and Learn.

OUTREACH CONFERENCES

TRANSPORTATION ASSOCIATION OF CANADA (TAC)



From September 25-28, 2016, The Sheraton Centre Toronto Hotel welcomed almost 1000 delegates to the 2016 Transportation Association of Canada Conference and Exhibition.

Highlights included several international guest speakers, the first-ever TAC Town Hall meeting, and well-attended events.

More than 50 technical sessions, panels and workshops covered a variety of topics, including connected and automated vehicles, applying the science of road safety, roundabout design, and more.

CPATT students also presented their work. Daniel Pickel (PhD candidate), Hanaa Al-Bayati (PhD candidate), Adam Schnieder (MAsc candidate), who won the 2016 Best Student Paper Award and Ms. Gulfam Jannat (PhD Candidate), who won the 2016 Best Student Poster Award, just to name a few. With the support of the Department of Civil and Environmental Engineering, 55 students were able to participate in the TAC Pavements, Soils and Materials Standing Committee meetings as pictured below. This was a terrific opportunity for them to network and learn about the various issues facing the Canadian Transportation Community.

Thank you to the executives of both these committees for assisting in ensuring everyone had a seat to sit on.

CURRENT PROJECTS

2016

TITLE	AGENCY	YEAR	STATUS
Evaluation of Reclaimed Concrete Material as Aggregate for OPSS Granular B Type II	Ministry of Transportation Ontario	2015-2016	Active
Effect of Extraction and Recovery Method and Solvent Type on Properties of Recovered Binder	Ministry of Transportation Ontario	2016-2016	Active
Optimisation of the use of recycled glass-base artificial lightweight aggregates in the pavement structure	Ontario Centres of Excellence and Foamyna Canada	2015-2016	Active
Effect of Oxidation Products of Iron Sulphide Minerals in Aggregate on the Chemical/Rheological Properties of Asphalt Cement	Ministry of Transportation Ontario	2015-2017	Active
Development of High Modulus Asphalt mix design technology for use on Ontario's Highways	Ministry of Transportation Ontario	2015-2017	Active
Performance Evaluation of Pre-cast Concrete Panels over Asphalt	Ministry of Transportation Ontario	2015-2017	Active
Improvement Strategies for Upstream Heavy Oil Mining Pavements	Imperial Oil	2015-2017	Active
Performance Evaluation of Coloured Asphalt Pavements and Surface Treatments for BRT Lanes in York Region	York Region	2014-2016	Active
Upgrade of U of Waterloo's primary confocal microscope for 37 users with state-of-the-art correlative microscopy	NSERC- Research Tools and Instruments - Category 1 (Co-PI), PI - David Spafford (UW)	2014-2014	Active
Sustainable Long Life Concrete Pavements	NSERC-CRD, and the Cement Association of Canada	2013-2016	Active
U-Fill Utilization of Recycled Materials	City of Toronto	2014-2016	Active

FUNDING

TOTAL EFFECTIVE FINANCIAL RESOURCES

The initial investment was \$1,500,000 and approximately \$1,750,739 as of April 2015. Some of the funding for students comes from research projects but also funding comes from scholarships and assistance as described below. In addition, it has enabled for open houses, symposiums and seminars to be hosted. The Chair program is fully utilizing the original \$10 million CPATT laboratory.

STUDENT SALARY ASSISTANCE

Total annual funding from student assistance programs is approximately \$120,000/year. The following is a list of student assistant programs that are included in this amount.

- NSERC USRA
- Ontario Graduate Scholarships, Civil and Environmental Engineering Scholarships, President's Graduate Scholarships, Dean's Incentive Program
- Ontario Centres of Excellence
- Chinese Scholarship Council
- Saudi Arabian Scholarship Funds
- Transportation Association of Canada Scholarships
- Canadian Technical Asphalt Association Scholarships
- Queen Elizabeth Scholarships
- Scholarship for Ministry of Higher Education and Scientific Research/Scholarship & Cultural Relations Directorate - Republic of Iraq
- Becas-Chile Scholarship - Chilean National Scholarship Program for Graduate Students
- Part-time students - part-time students salaries are covered by industry

AWARDS, EVENTS & MILESTONES

AWARDS

- 2016/2017 Ontario Graduate Scholarship - Dan Pickel - awarded for excellence in the graduate program
- 2016/2017 President's Graduate Scholarship - Dan Pickel - awarded to graduate students who hold major federally and provincially funded competition-based scholarships
- 2016 Irene Marguerite McLeod Postgraduate Scholarship - Hanaa Al-Bayati and Taha Younes - awarded for academic excellence and outstanding graduate research productivity in the fields of bituminous materials or flexible pavement design
- 2016 Sze Memorial Award - Dan Pickel - awarded for research in the field of experimental stress analysis
- 2016 Best Student Poster Award - Gulfam Jannat - awarded at the Transportation Association of Canada conference based on an oral presentation
- 2016 Best Student Paper Award - Adam Schneider - awarded at the Transportation Association of Canada conference based on technical and written abilities
- Dr. Susan L. Tighe, has won the medal for Research and Development. Tighe is among 10 winners to have been honoured in Mississauga on Nov. 19 at the 2016 Ontario Professional Engineers Awards (OPEA), which have been running for almost 70 years.

INDUSTRY HOSTED EVENTS

- Participation in Ontario Good Roads Association Municipal Academy
- 2016 Ontario Hot Mix Producers Association Conference
- 2016 Transportation Association of Canada Conference & Exhibition
- 61st Annual Canadian Technical Asphalt Association Conference

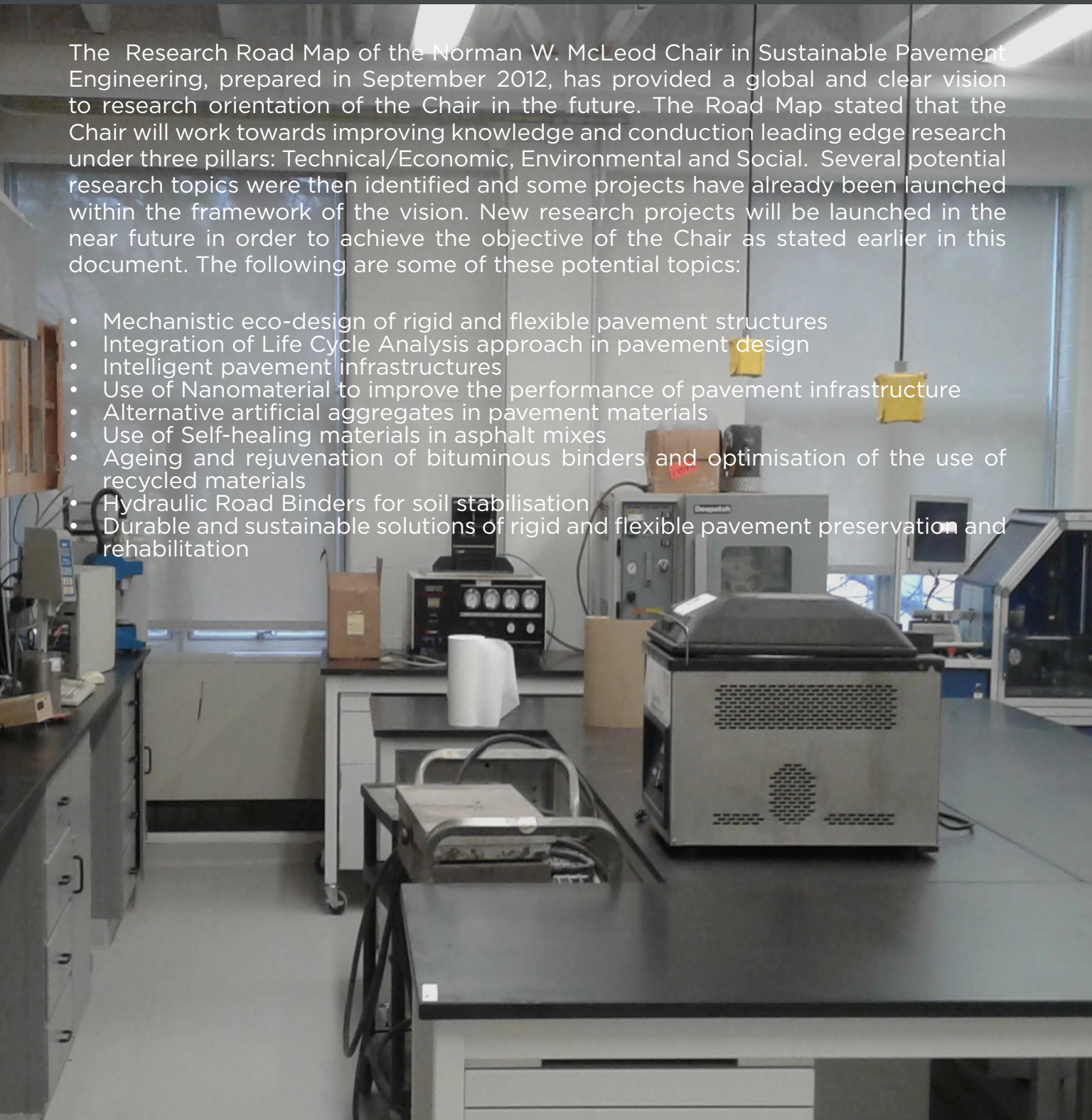
MILESTONES

- Sina Varamini, PhD., McAsphalt Industries Ltd.

FUTURE PLANS

The Research Road Map of the Norman W. McLeod Chair in Sustainable Pavement Engineering, prepared in September 2012, has provided a global and clear vision to research orientation of the Chair in the future. The Road Map stated that the Chair will work towards improving knowledge and conduction leading edge research under three pillars: Technical/Economic, Environmental and Social. Several potential research topics were then identified and some projects have already been launched within the framework of the vision. New research projects will be launched in the near future in order to achieve the objective of the Chair as stated earlier in this document. The following are some of these potential topics:

- Mechanistic eco-design of rigid and flexible pavement structures
- Integration of Life Cycle Analysis approach in pavement design
- Intelligent pavement infrastructures
- Use of Nanomaterial to improve the performance of pavement infrastructure
- Alternative artificial aggregates in pavement materials
- Use of Self-healing materials in asphalt mixes
- Ageing and rejuvenation of bituminous binders and optimisation of the use of recycled materials
- Hydraulic Road Binders for soil stabilisation
- Durable and sustainable solutions of rigid and flexible pavement preservation and rehabilitation



CONTACT US

DR. SUSAN TIGHE

Norman W. McLeod Professor in Sustainable Pavement Engineering
Office: 519-888-4567 ext. 33152
Email: sltighe@uwaterloo.ca

DR. HASSAN BAAJ

Norman W. McLeod Associate Professor in Pavement Material Engineering
Office: 519-888-4494 ext. 84494
Email: hassan.baaj@uwaterloo.ca

JESSICA ROSSI

Acting, Research Financial Administrative Assistant
Office: 519-888-4567 ext. 32289
Email: jessica.rossi@uwaterloo.ca

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