

# CPATT NEWS

## SPRING & SUMMER 2018

**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

# CPATT NEWS

## SPRING & SUMMER 2018

### A MESSAGE FROM THE DIRECTOR

In September 2017, a few days after the start of my sabbatical leave, the Board of Directors of CAPTT and N.W. McLeod Chair did me the honour to approve my appointment as the new Director of the CPATT. It is certainly a great honor for me but it is also a great responsibility because I must now carry the great legacy that Ralph Haas, Gerhard Kennepohl, Carl Haas and Susan Tighe have established during almost 15 years. Without forgetting, of course, the contribution of our public and private partners, adjunct professors and research associates, students and visiting scholars who all contributed to the success that CPATT have had over the years.

I believe that the transportation system of a country has the same importance that the arteries, veins and nerves have to the human body, and the health of this system, is reflected in the development of the country. We must therefore preserve and grow these networks to support the societal, economic and ecological needs for the future, and to follow the technological advances in the transportation industry. This is why I am ecstatic to be leading a research group that played a major role that continues to contribute in making our transportation systems first-class. My vision for CPATT is to be the Canadian leader in the area of research on smart and sustainable pavement materials and structures. This objective will be possible through the collaboration with our great partners from both public and private sectors but also through the collaboration with other Canadian and international research groups.

In this newsletter, we highlight some of the various projects underway at the Centre for Pavement and Transportation Technology (CPATT). This includes: life-cycle cost analysis and crash-prediction modeling, fatigue performance of hot mix asphalt, precast concrete inlay panels (PCIP) for pavement rehabilitation, continuing research with the University of Waterloo and China and a collaboration with the Northwest Territories for a Capstone Design Project. We also highlight some events from the past few months, which includes a seminar by Dr. Orazio Baglieri, Professional Engineers of Ontario highlighting women in engineering, and a spotlight on graduate student achievements. There are also many special features on some of our current graduate students. We have also included a feature on Dr. Lynne Cowe-Falls, from the Civil Engineering Department, at the University of Calgary

Should you have any questions related to our activities please do not hesitate to contact us.

Sincerely,

**Hassan Baaj PhD, PEng**

# CPATT NEWS

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# FACULTY FEATURE

## LYNNE COWE FALLS, PhD

Lynne Cowe Falls, PhD, PEng, is a professor emerita at the University of Calgary's Schulich School of Engineering, where she taught materials and environmental engineering. Prior to joining the University of Calgary in 2001, Cowe Falls had a 20 year career in consulting with an emphasis on the design, development and implementation of pavement, asset and infrastructure management systems. As the Schulich School of Engineering's inaugural Director of Students, Cowe Falls was responsible for student success programming and developed the Maier Student Leadership Program. Cowe Falls is an award-winning teacher, prolific author, and has been elected as a Fellow of the Canadian Academy of Engineering, the Engineering Institute of Canada and the Canadian Society for Civil Engineering. In 2011, she was also awarded the Order of the University of Calgary.

On April 4, 2018 Cowe Falls delivered an entertaining and inspirational speech at the 2018 Lecture of a Lifetime. She spoke about some of her career highlights and the unique possibilities that come from a lifetime of learning. Her truly motivating speech can be found [here](#).



# STUDENT FEATURE

## MIKE AURILIO, MASc CANDIDATE



Mike Aurilio is currently the Senior Quality Control and Product Development Coordinator for Yellowline Asphalt Products Ltd. Mike completed his Bachelors of Science at the University of Toronto in 2012 with a Major in Chemistry. He joined University of Waterloo in May, 2018 in order to complete his MASc under the supervision of Professor Hassan Baaj.

As a member of Yellowline, Mike is responsible for testing and formulating asphalt cement to meet AASHTO M 320 and MTO specifications. In addition to this, Mike also spends his time working

with several industry groups. He is involved with the Ontario Asphalt Pavement Council Technical Working Group as well as the Canadian User Producer Group for Asphalt at the Canadian Technical Asphalt Association (CTAA) annual conference.

Prior to joining CPATT, Mike began working on research focusing on the inability of the Double Edge Notched Tension Test to adequately predict fatigue performance in hot mix asphalt. The initial phase of the project was published at CTAA and co-authored by Hassan Baaj and Peter Mikhailenko. The second phase of the project is currently underway at CPATT and includes work done by Ali Qubar.

## VICTORIA SPELLER, MASc CANDIDATE

Victoria Speller is from the small town of Waterford in southern Ontario. She graduated from the University of Waterloo in 2017 with a degree in civil engineering and is currently starting her third semester as a Masters Candidate under the supervision of Professor Susan Tighe. Victoria is currently researching the usage of infrared heating machinery for asphalt pavement repairs, as well as the development of hot mix asphalt for patch repairs exclusively using reclaimed asphalt pavement (RAP) materials.



# STUDENT FEATURE

## EDWARD ABREU, MASc CANDIDATE



Edward Abreu (originally from the Dominican Republic) is currently a MASc candidate working under the supervision of Professor Susan L. Tighe in the Department of Civil and Environmental Engineering at the University of Waterloo. Edward is also a graduate research assistant in the Centre for Pavement and Transportation Technology (CPATT). At the moment he is taking CIVE 740 (instructed by Professor Baaj), which is focused on innovative and sustainable materials in Civil Engineering, and Professor Bachmann's CIVE 640 course, Urban Transportation Planning, which is a topic that has significantly sparked his interest.

He obtained his bachelor's degree in Civil Engineering from the Pontifical Catholic University Mother and Master (PUCMM), Santiago de los Caballeros, at the beginning of 2017. Where he had the opportunity to develop a thesis based on a sustainable pavement practice called full-depth reclamation, using the material extracted from the Cibao's International Airport (STI). The results of the thesis called the attention of the engineers of the airport leading them to hire him as a soil laboratory tester, allowing him to work for approximately 3 months doing diverse pavement tests in order to validate the results presented in the thesis. After the laboratory tests, the airport gave him the opportunity to supervise the reconstruction of the runway, taxilanes, and taxiways, using this method. This experience led him to pursue a MASc degree in the technology of sustainable pavements, specifically related to airside.

In his spare time, he likes to play the piano and the guitar. As well as, practice sports such as soccer, swimming, and weightlifting.

# STUDENT FEATURE

## DAHLIA MALEK, MASc CANDIDATE



Dahlia Malek is a Masters candidate under the supervision of Professor Susan Tighe. She joined CPATT in 2017 after completing her Bachelor's degree in Civil Engineering at the University of Waterloo. Dahlia specialized in structural engineering in her bachelor's program and developed an interest in transportation through work experience in highway design and bridge engineering.

Her research is focused on evaluating the performance of precast concrete inlay panels (PCIP) using finite element modelling. PCIP are a new application of precast concrete pavement, for performing long-lasting, rapid rehabilitations of high-traffic volume asphalt highways exhibiting deep-seated rutting problems. PCIP can be installed overnight to minimize traffic impacts, including traffic congestion, road-user delays, and safety risks.



Pictured on the left is **PCIP overnight trial installation.**

Finite element modelling will be used to understand the behaviour of this unique type of pavement and to predict its long-term performance. This research will help to establish its expected performance, determine life-cycle costs, provide design and construction recommendations, and contribute to developing guidelines for implementing PCIP.

# STUDENT FEATURE

## MICHELLE LIU, MASc CANDIDATE



Michelle graduated from Honours Civil Engineering at the University of Waterloo with a certificate in Structural Engineering in June 2018, and is a registered Engineer-in-Training (EIT) with the Professional Engineers of Ontario. Throughout her six undergrad co-op terms, Michelle has worked with SNC-Lavalin, MTO, C3 Group, Hatch Infrastructure, and Red Peak Group. Michelle joined CPATT as a Master of Applied Science candidate under the supervision of Prof. Susan Tighe just 12 days after completing her last undergraduate exam.

During undergrad, Michelle held a total of eighteen (18) different leadership positions on campus, fourteen (14) of which she fulfilled for two or more consecutive semesters. Within the Department (CEE), Michelle held the positions of Vice President (F2015 to F2016) and President (W2017 to W2018) of the Civil, Environmental and Geological Engineering Society (CEGES), for which Prof. Tighe was the faculty advisor at the time. It was in these capacities that Michelle came into contact with Prof. Tighe and went on to complete her fourth-year design project (capstone project) under the supervision of Prof. Tighe (S2017 to W2018). The project focused on the detailed design of three road sections and one bridge structure along the future Tlichio All-Season Road in Northwest Territories, where permafrost and the remote location pose great challenges to both design and constructability. Michelle is continuing her work on permafrost as her master's research and is also involved in a project with Prof. Hassan Baaj related to hemp-substituted concrete.

Originally from Montreal (Westmount), Quebec, Michelle relocated to Niagara-on-the-Lake, Ontario in 2010 and completed high school in 2012. In high school, Michelle worked two jobs simultaneously, was a committed member of several school councils and clubs, and was a volunteer with the Niagara Health System, Canadian Cancer Society, and Amnesty International. Michelle continued her passion for extracurricular activities in university, always holding three or four leadership roles in any given semester as noted above. She is currently the Vice President Events of the Civil & Environmental Graduate Associate (CE2GA), Secretary of the PEO Grand River Chapter, chemotherapy suite volunteer at the Grand River Hospital Cancer Centre, and clinic volunteer with the Canadian Blood Services.

Michelle is an avid camper, kayaker/canoer, stock investor, animal lover and automotive enthusiast. She also considers herself a bit of a craft beer connoisseur and has contributed to numerous DIY craft brewing systems on Kickstarter.

# STUDENT FEATURE

## REMI OYEDIJI, MASc CANDIDATE



Remi was born and raised in Oyo State, Nigeria. He completed a Bachelor of Technology Degree in Civil Engineering at Ladoke Akintola University of Technology (LAUTECH), Nigeria in 2014. Upon completion of his program, Remi worked with the Federal Ministry of Works and the Federal Roads Maintenance Agency in Nigeria as a Graduate Civil Engineer. He was also part of the team that pioneered the collection of Pavement Maintenance and Management System (PMMS) Data on Nigerian federal roads under the World Bank/Federal Government of Nigeria (FGN), where he worked as a Research Assistant under Road Sector Development Team (RSMT), Nigeria.

Remi joined the CPATT team in September, 2017 as a master's research student under Professor Susan Tighe. His current research interest is on the Impact of climate change (flooding) on concrete pavements.

Additionally, Remi serves as the Vice President, External Affairs – Civil and Environmental Engineering Graduate Student Association (CE2GA) and as a Council Member of the Graduate Student Association Executive Council, University of Waterloo.

Remi finds joy implementing social intervention programs aimed at improving the well-being of marginalized persons in the society. He also loves networking, travelling and learning.

# STUDENT FEATURE

## **GUANGYUAN (LUKE) ZHAO, POSTDOCTORAL FELLOW**

Luke Zhao joined the CPATT team in March 2018 as a Postdoc Fellow under the supervision of Professor Susan L. Tighe. Before that, Luke graduated from Chang'an University, China with a B.Eng. in Highway Engineering in 2010. He completed his MASc in 2012 and Ph.D. in 2017 in Construction Management Technology, Purdue University in the United States.

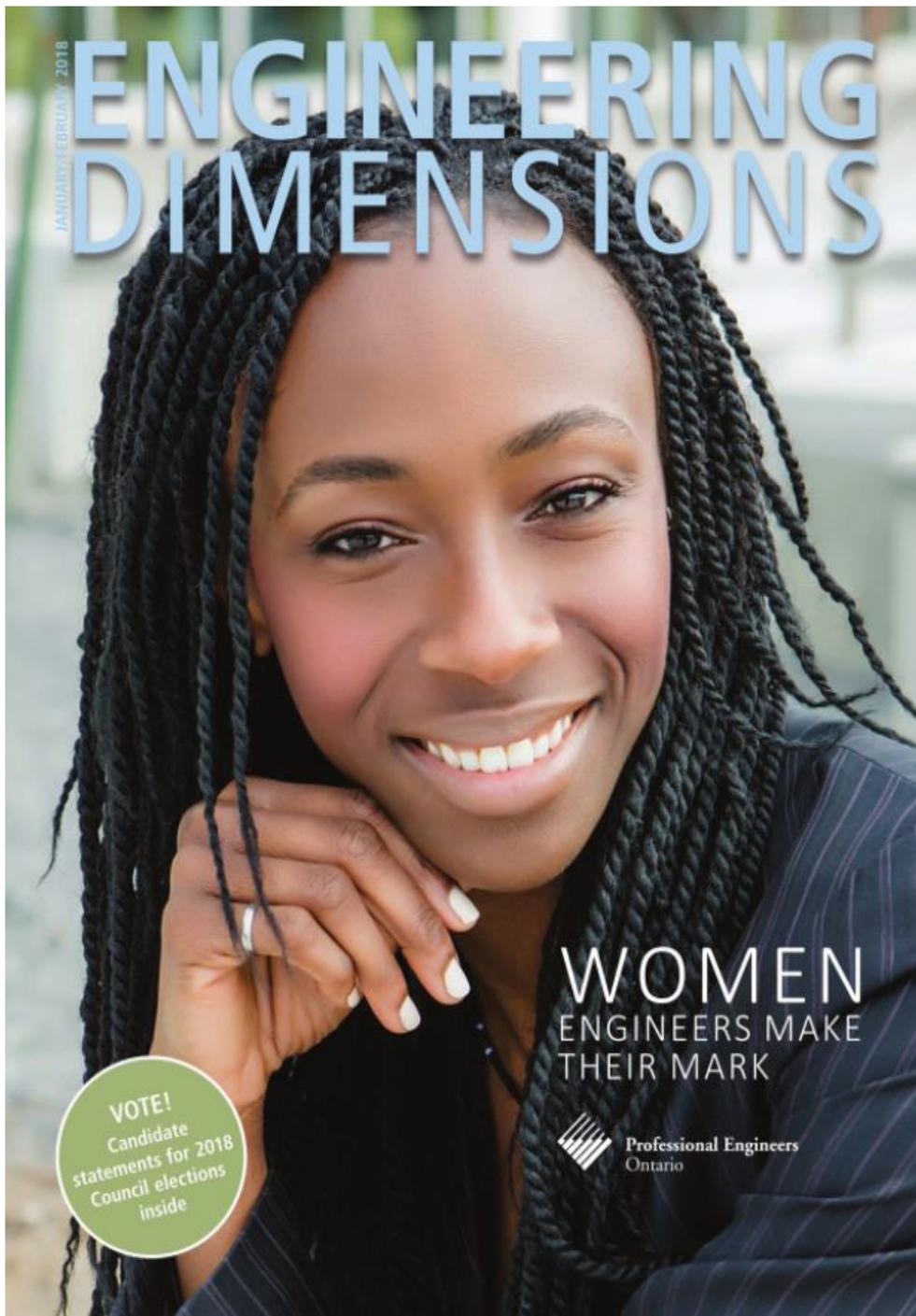
Luke's research topics focus on life-cycle cost analysis and crash-prediction modeling. He has participated and completed multiple research projects sponsored by the Indiana Department of Transportation (INDOT), such as “An Economic Analysis Methodology for Project Evaluation and Programming”, “Friction Surface Treatment Selection”, “Safety and Cost Performance of Intersection Lighting”, “Maximum Allowable Deflection by Light Weight Deflectometer and Its Calibration and Verification”, and “Quality Assurance Procedures for Chip Seal Operations Using Macrotecture Metrics”.

Luke obtained the certificate in Applied Statistics from Purdue University and three SAS certificates in programming and modeling. In addition, Guangyuan also earned certificates from Project Management Institute and U.S. Green Building Council.



# HIGHLIGHTS & EVENTS

## A CHANGE IS COMING: WOMEN IN ENGINEERING



University of Waterloo PhD candidate Amma Wakefield (supervised by Professor Susan Tighe) takes center stage as the cover photo for Engineering Dimensions, the January/February edition of the Professional Engineers of Ontario magazine. This edition highlights women making their mark in the field of engineering. Amma's article in particular, can be found on page 30. Also included in this article is Mary Wells, UW's former Associate Dean of Outreach, Professor of Mechanical and Mechatronics Engineering and co-author of Women of Impact, a book about the lives of 18 women who work in mining, metallurgy and materials.

Please click [here](#) for a digital copy of the magazine.

# HIGHLIGHTS & EVENTS

## CPATT FOOTBALL TEAM

Team CPATT, an all-star football team made up of students from the CPATT group, played semi-competitive intramurals this spring, and were able to successfully make it to the quarterfinals. Congratulations, team!

**Photo:** From top left to right, Edward Abreu, Taher Baghaee Moghaddam, Ali Qabur, Dahlia Malek, a friend of the CPATT group and Eskedil Melese. From bottom left to right, Remi Oyediji, Peter Mikhailenko, Ataa Nahidi and Sergey Averyanov.



# STUDENT SPOTLIGHT

- **Donghui Lu** presented a paper at the Federation of Canadian Municipalities (FCM) Conference (shown below), published 1 journal publication and received a Civil Engineering Graduate Scholarship. Great work, Donghui!
- **Jessica Achebe** has successfully completed her PhD Comprehensive Exam entitled “Innovating Pavement Management through Environmental Sustainability” on March 28, 2018. Congratulations, Jessica! Jessica has also, published a journal paper and has a conference paper accepted for June 2018.
- **Dahlia Malek** has been awarded a CGS-M and a Presidents Graduate Scholarship. Additionally, she has 2 accepted journal publications. Great work, Dahlia!
- **Haya Almutairi** has successfully completed her PhD Comprehensive Exam entitled “Investigating Solutions for Self-Healing and Crack Mitigation of Flexible Pavements” on September 5, 2017. Congratulations, Haya!
- **Zaid Alyami** has successfully completed his PhD Defense entitled “Asset Valuation: A Performance Measure for a Comprehensive Infrastructure Asset Management” on November 17, 2017. Congratulations, Zaid!
- **Hanaa Al-Bayati** has published 1 journal paper, 2 conference papers, and has won a Faculty of Engineering Award for Excellence & Scholarly contributions. Excellent work, Hanaa!
- Our **Winter 2018 Co-op** was Timothy Wang from Environmental Engineering.
- **Taher Baghaee Moghaddam, Hawraa Kadhim and Dan Pickel** received the Irene Marguerite McLeod Postgraduate Scholarship
- Our **Spring 2018 Co-ops** are Sabrina Renna (URA), Jinjing (Janice) Zhang (URA), Ya Ting, (Victoria) Yang, Azka Aqib and Yiran Liu (URA) all from Civil Engineering.



# SEMINAR FEATURE

## ORAZIO BAGLIERI, PhD



CPATT and the Norman W. McLeod Chair in Sustainable Pavement Engineering hosted an asset management seminar on Thursday, May 24, 2018, presented by Dr. Orazio Baglieri. Dr. Baglieri is an associate professor at the Politecnico di Torino, where he teaches Road Design and Construction in the Master's degree program in Civil Engineering. He graduated from the Politecnico di Torino in 2001, and in 2005, he obtained his PhD degree cum laude at the University of Marche, Ancona. From 2005 to 2011, he served as assistant professor at the University of Genoa. He was a visiting scholar at the University of Wisconsin-Madison (WI) in 2007 and he is currently a visiting professor at the Lyles School of Civil Engineering at Purdue University-West Lafayette (IN). Additionally, he has been senior lecturer at the TTPU University of Tashkent (Uzbekistan) since 2013. Dr. Baglieri currently serves as secretary of the RILEM Technical Committee TC 278-CHA (Crack-Healing of Asphalt pavement materials) and is the team co-leader of Task Group TG2 (Laboratory experimentation).

**Abstract** The capability to recover stiffness and strength after being damaged under loading represents a peculiar property of bituminous materials used in road paving applications, commonly referred to as healing. Healing is generally associated to phenomena of micro-crack repair that take place within the material when external loading is removed and sufficient rest time is given. Mechanisms driving micro-damage healing, however, are not yet fully understood and a number of methods have been proposed in order to evaluate healing properties of bituminous binders and mixtures.

In the seminar, some recent experimental studies carried out at the Politecnico di Torino on this topic were presented. In particular, the presentation focused on a proposed test procedure consisting of continuous shear loading interrupted by single rest periods under different testing conditions. Several healing indexes to be used in discriminating and ranking the healing potential of bituminous binders are also introduced.

The seminar was preceded by a brief overview of current research activities at the Politecnico di Torino in the area of pavement engineering.

# RESEARCH FEATURE

## FULBRIGHT SPECIALIST PROGRAM



The Bureau of Educational and Cultural Affairs of the U.S. Department of State announced on April 24, 2017 that Dr. John H. Daly III was awarded a Fulbright Specialist Program grant to study and to conduct further research in the area of public infrastructure asset management within the academic area of engineering education at the University of Waterloo in Canada, specifically in collaboration with Professor Susan Tighe. In the execution of this study effort, Dr. Daly worked in conjunction with the Ontario Good Roads Association (OGRA).

In November 2017, Dr. Daly completed the Fulbright Specialist visit with the University of Waterloo. The following were questions asked to UW by the program in response to the success of the visit:

**1.** What specific project activities did the Fulbright Specialist complete during their grant?

**a)** John participated in a five-day workshop on the Financing of Public Infrastructure; he conducted research and completed a guidebook for asset management students to use in preparing the Capstone Project associated with the OGRA Accredited Asset Manager certification program.

**2.** What do you believe were the most important outcomes of the project (i.e. what results were achieved)?

**a)** The most important outcome was the initiation of a dialog between the Province of Ontario and the State of Michigan concerning the effective long-term management and financing of public infrastructure.

**3.** Did you encounter any challenges in collaborating with the Fulbright Specialist that prevented the successful completion of any project activities or achieving any outcomes?

**a)** There were no significant difficulties encountered during either of the two visits John had at the University of Waterloo.

# RESEARCH FEATURE

## FULBRIGHT SPECIALIST PROGRAM (CONT'D)

**4.** Do you intend to continue to collaborate with your Fulbright Specialist in the future?

**a)** Yes, a dialog involving both the University of Waterloo and the Ontario Good Roads Association with Dr. Daly has been established and is expected to continue.

**5.** Do you intend to establish a linkage (formal or informal) between your institution and the Fulbright Specialist's institution/employer in the U.S.?

**a)** Yes, a linkage between the University of Waterloo and Saginaw Valley State University has already been initiated and is expected to continue.

**6.** As a result of your experience with the Fulbright Specialist Program, would you consider applying to have another Specialist participate in a project at your institution in the future?

**a)** Yes, we would consider having another Fulbright Specialist at our university for future collaborations.

**7.** Would you like to provide any additional information about your experience with the Fulbright Specialist Program?

**a)** As a result of research conducted on the two visits to the University of Waterloo, Dr. Daly has presented a paper comparing infrastructure asset management strategies in Ontario and Michigan, at the Canadian Asset Management Association's Annual Meeting in Windsor.

More information about Fulbright can be found on their website [www.fulbright.ca](http://www.fulbright.ca)



# RESEARCH FEATURE

## CPATT COLLABORATES WITH NORTHWEST TERRITORIES FOR CAPSTONE PROJECT



**Photo:** from left to right, Prof. Susan Tighe, Bailey Humphrey, Michelle Liu, Siva Tharmabala, Kurtis Hubert, Binay Yadav, and Kamran Ata; taken on March 22, 2018.

The Centre for Pavement and Transportation Technology (CPATT) recently collaborated with the Government of Northwest Territories (GNWT) on an undergraduate Fourth-Year Capstone Design Project (FYDP) focusing on sustainable design solutions for the future Tlicho All-Season Road (TASR). This specific project allowed the students to complete the required capstone design courses while taking part in a real-life, ongoing project that involved working with a large group of industry professionals and a funded trip to Northwest Territories.

The project team was supervised by Prof. Susan Tighe, PhD, P.Eng. and comprised of four undergraduate students: Michelle Liu (project management and road design), Kurtis Hubert (substructure design and 3D renderings), Siva Tharmabala (superstructure design), and Bailey Humphrey (superstructure design). The FYDP was administered and evaluated by Prof. David Brush, PhD, LEL (W2018) and Prof. Wayne Parker, PhD, P.Eng. (S2017) in the Department of Civil and Environmental Engineering (CEE).

# RESEARCH FEATURE

## NORTHWEST TERRITORIES (CONT'D)

### Acknowledgement

This collaboration was made possible by Mr. Kevin McLeod, P.Eng., Director of Highways and Marine Division of the Department of Transportation (DOT) in Northwest Territories. Throughout the project, the students were supported Mr. Binay Yadav, P.Eng., Mr. Kamran Ata P.Eng., Mr. Ziaur Rahman, P.Eng., Mr. Stewart Gibson, and Mr. Muhammad Abu Bakar, among other staff members of GNWT Department of Infrastructure (DOI). The team also received assistance from an external consultant, Dr. Bala Tharmabala, P.Eng., PhD who is Head of the McIntosh Perry Bridge Engineering Office in Burlington and former Bridge Office Manager at the Ministry of Transportation (MTO). Dr. Tharmabala assisted the team by providing both verbal and written guidance in structural design.

### Project Timeline

The FYDP was carried out between May 2017 and March 2018. Preliminary design work took place between May 1st, 2017 and July 24th, 2017 (S2017). Detailed design work took place between January 8th, 2018 and March 26th (W2018). During their co-op work term (F2017) between the two phases, the students continued to work on the project by consistently following up on data transfer, learning relevant design software, and so on.

Prof. Tighe and the four students travelled to Northwest Territories for site visit between August 8th, 2017 and August 11th, 2017. Mr. Yadav and Mr. Ata travelled from Northwest Territories to the University of Waterloo on March 22nd, 2018 to deliver a guest lecture, tour CPATT labs, and participate in the Capstone Symposium.

In this ten-month period, the four students logged a combined time of 1,231 hours in project-related work, which exceeds the FYDP requirement (800 hours) by over 50%.

### Site Visit (August 2017)

The collaboration between CPATT and GNWT allowed for a site visit which took place following the preliminary design phase. On August 8th, 2017, the students travelled from Toronto to Yellowknife and met with Mr. Yadav, Mr. Ata, and Mr. Gibson the day of for general project discussions.

On August 9th, the students met with Mr. Gibson in the morning for a short briefing, then embarked on a three-hour flyover aboard a Summit Air seaplane with Mr. Gibson. During the flyover, the team conducted aerial observation of terrain type and density of vegetation along the approved alignment of TASR (and alignment of existing access road), as well as the approximate location of the bridge to be designed (La Martre River crossing). The team noted extensive signs of a recent forest fire near the start of the alignment, and a high density of esker and pond formations midway into the alignment. Also observed was the shallow and rocky nature of the pre-determined crossing location at La Martre River, a narrowing point in the river where velocity is increased and where ice buildups can occur in the winter.

# RESEARCH FEATURE

## NORTHWEST TERRITORIES (CONT'D)



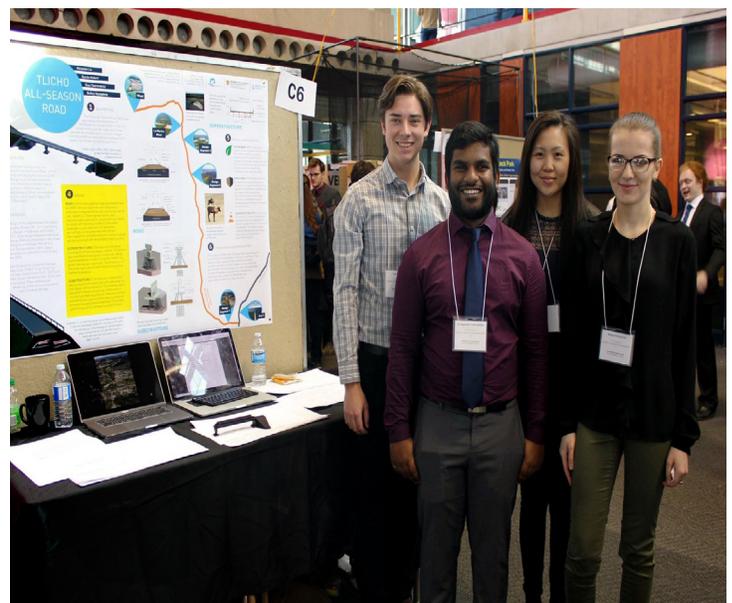
On August 10th, the students were joined by Prof. Tighe and the team proceeded with more project discussions with Mr. McLeod, Mr. Yadav, Mr. Ata, and Mr. Gibson, including the feasibility of some of the preliminary design results. The team was also given the opportunity to explore Yellowknife, including visiting the farmer's market and kayaking in the Great Slave Lake.

**Photo:** the project team with the seaplane used for site investigation; from left to right, Siva Tharmabala, Bailey Humphrey, Michelle Liu, Kurtis Hubert, and Summit Air pilot.

### Capstone Symposium (March 22, 2018)

On March 22nd, the day of the CEE Capstone Symposium, Mr. Yadav and Mr. Ata travelled from Yellowknife to the University of Waterloo. In the morning, Mr. Ata delivered a well-attended presentation in the Needles Hall Senate Room on some of the current projects in Northwest Territories and the unique challenges they face. Potential employment opportunities with GNWT were also discussed and were of interest to many.

The four students joined their class Capstone Symposium in the Davis Centre (DC) atrium from noon to 5pm where they presented their project poster and 3D-printed model to various faculty members, industry professionals, and fellow students.



# RESEARCH FEATURE

## NORTHWEST TERRITORIES (CONT'D)



While the four students were at the Symposium, Mr. Yadav and Mr. Ata were taken on a tour by Dr. Peter Mikhailenko, PhD, EIT, and Drew Dutton, a MASc candidate with CPATT. The highlights of the tour included the CPATT mixture and binder labs, where they were introduced to various equipment and talked about NWT labs. A number of CPATT projects were discussed, with the work on Hydraulic Road Binders of Shenglin Wang (CPATT PhD candidate) being of particular interest.

**Photo:** CPATT lab tour, from left to right, Dr. Mikhailenko, Binay Yadav, and Kamran Ata.

### Technical Summary

Whatì is an indigenous community of around 525 people in the North Slave Region of Northwest Territories. The only existing vehicular access to the community of Whatì is the Tlichó Winter Road, which operates on deeply frozen portions of the Great Slave Lake during wintertime. However, climate change has caused a decrease in the reliability of winter roads, and an all-season road was deemed necessary in 2013 by the Department of Infrastructure of Northwest Territories and the Tlichó Government. Challenges faced by the future TASR include permafrost, presence of weak subgrade, and proximity to caribou habitats.

The project was carried out in two phases: preliminary design and detailed design. In the preliminary design phase, a post-tensioned concrete bridge, a steel I-girder bridge, and a timber arch bridge were developed as alternatives for the bridge structure. The concrete bridge consists of a concrete superstructure tensioned by continuous steel cables within circular voids. The steel bridge has a concrete deck supported by longitudinal steel I-girders. The timber bridge is made up of twin glulam arches connected to transverse steel ribs that support a timber deck structure. Conceptual design was conducted for the bridge alternatives, taking into account major constraints such as the presence of discontinuous permafrost, flooding events, and erosion.

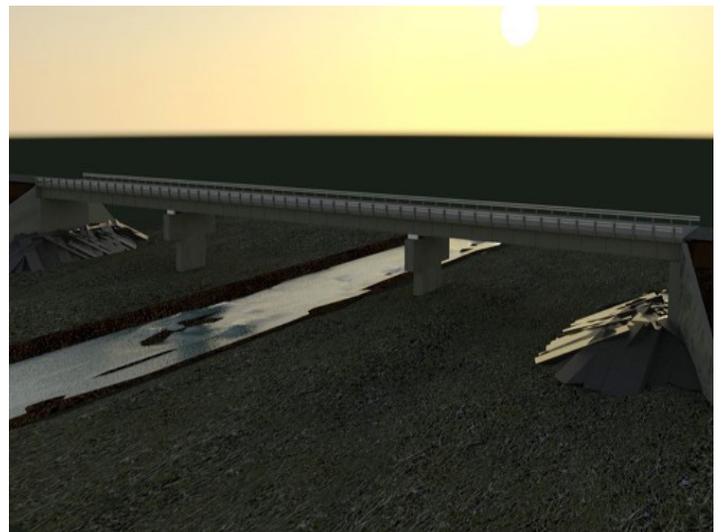
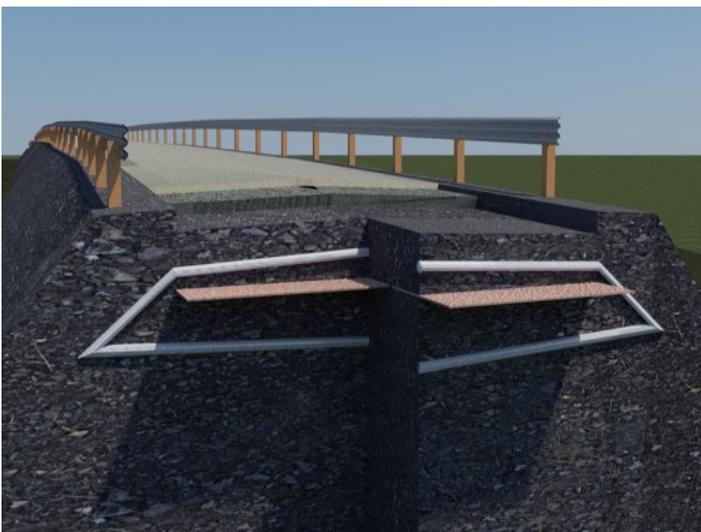
Each alternative was then evaluated against the criteria of environmental impacts, resiliency, and cost. The post-tensioned concrete bridge received the highest score in the comparative analysis and was selected to be carried forward for detailed design. However, in August 2017, the GNWT team revealed that the equipment and skill required for post-tensioning is not readily available in NWT and recommended that the team proceed with a steel structure.

# RESEARCH FEATURE

## NORTHWEST TERRITORIES (CONT'D)

The scope of this detailed design included three representative road segments and the bridge crossing at La Martre River, which is the longest crossing on the pre-determined alignment. Three representative road segments were selected, each with an identified problem related to resiliency, environmental impact, and constructability. Three main solutions were thus proposed: geotextiles, hairpin thermosyphons, and designated caribou crossing zones.

The pre-approved horizontal alignment was used to determine the vertical alignment that would require minimal fill while still meeting all design criteria. Some criteria are sourced from Geometric Design



**Photo:** 3D renderings of design results; on the left is the proposed solution for road segments over permafrost, and on the right is the 100-metre steel bridge design located at La Martre River.

Guide for Canadian Roads while others are NWT-specific parameters. Following geometric design, the Gravel Road Thickness Design Methods were used to calculate the most economical combination of granular layers. Both the superstructure and substructure of the steel bridge were designed using the Canadian Highway Bridge Design Code. Superstructure elements designed include guardrails, deck reinforcement, girders (flanges, and webs), stiffeners and diaphragms. The substructure was designed to resist overturning moment and sliding action while not exceeding the bearing capacity of the subgrade.

# RESEARCH FEATURE

## CPATT LAB FOCUS

The CPATT lab has started the 2018 year continuing the numerous projects continuing from the year before. The progress would not be possible without the help of Winter 2018 Co-op Timothy Wang, who we said goodbye to recently. Beside this, there have been a number of projects started including projects looking at the development of better polymer modified asphalt mixtures and asphalt.



CPATT has recently said goodbye to Timothy Wang, who worked in the CPATT lab as a co-op research technician. Timothy will be returning to his studies for the 2nd year of the Environmental Engineering program at UW. Timothy's help and management of the lab was a key to the work and he will be missed by everyone. For the Spring term, the CPATT will have Victoria Yang and Azka Aqib, two first year Civil students, helping out as the lab technicians.

**Photo:** CPATT Team wishing farewell to Timothy at the Grad House.

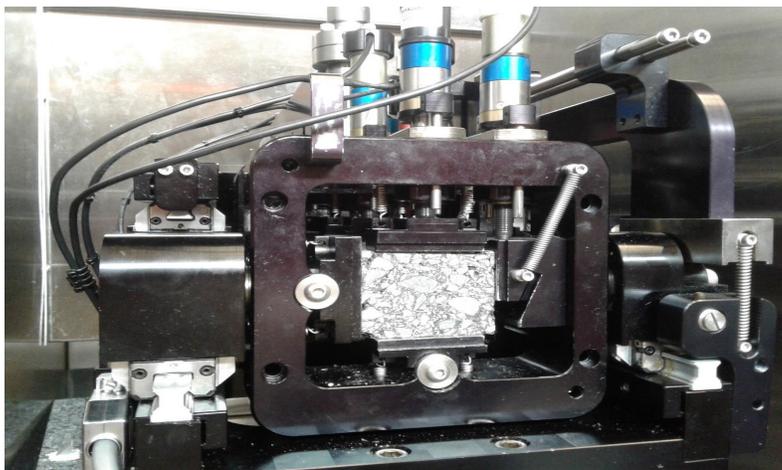
### **Better polymer modified mixtures for fatigue performance**

Polymer modified asphalts (PMAs) have been shown to improve asphalt mixture properties. However, PMA developers, such as Canada's Yellowline Asphalt Products Ltd. (Yellowline), are challenged to tailor their asphalt formulations for maximum fatigue resistance. The primary issue is a lack of consistent performance testing methods at the binder and mixture levels, and the relationship between binder properties and mixture performance is not fully understood. The proposed project brings together Yellowline and asphalt pavement expertise at CPATT, to address these issues and, ultimately, help spur the use of PMAs in Canada, in a beneficial way.

Through the two year project, CPATT will work closely with Yellowline to evaluate the binder and mixture performance of several PMA formulations with varied polymer content using the Double Edge Notched Tension (DENT), the Multiple Stress Creep Recovery (MSCR) test and Bending Beam Rheology (BBR) techniques, looking specifically at their repeatability across different base binders, PMAs and contents.

# RESEARCH FEATURE

## CPATT LAB FOCUS (CONT'D)



These results will be correlated to the performance of corresponding PMA mixtures, using both the AASHTO 4-point beam (shown below) and homogenous tension-compression fatigue testing methods. The tests will be compared and evaluation methods will be developed to provide the most accurate view of asphalt mixture fatigue performance. The PMAs will be further evaluated via chemical and microstructural analysis through Environmental Electron Scanning Microscopy (ESEM) for the binder microstructure, Fourier Transform Infrared

Spectrometry (FTIR) for chemical analysis. This project will provide key insights into the performance and optimization of PMAs, as well as the strategies needed to accurately test them.

**Photo (top):** 4-Point Fatigue Test Setup at CPATT

### Developing safer extraction solvent

In another project, Kersol Inc. and CPATT aim to develop an improved solvent for the extraction of asphalt binder, which is safer for the user and the environment than the solvents currently used in the industry in Ontario. The solvents currently used in the industry present a number of challenges in terms of user safety and there is an issue with effectiveness for certain types of asphalt binders. Given the availability of solvents from other industries, as well as the development of bio-sourced chemicals that can serve as solvents, a number of candidate solvents will be chosen and compared with solvents that are used in Ontario. The project is funded by the Ontario Centres of Excellence (OCE) Shown below, are solvents being tested at the FLEX Lab.



**Photo (bottom):** Extraction solvents bitumen degradation test (BDT) in FLEX lab

# RESEARCH FEATURE

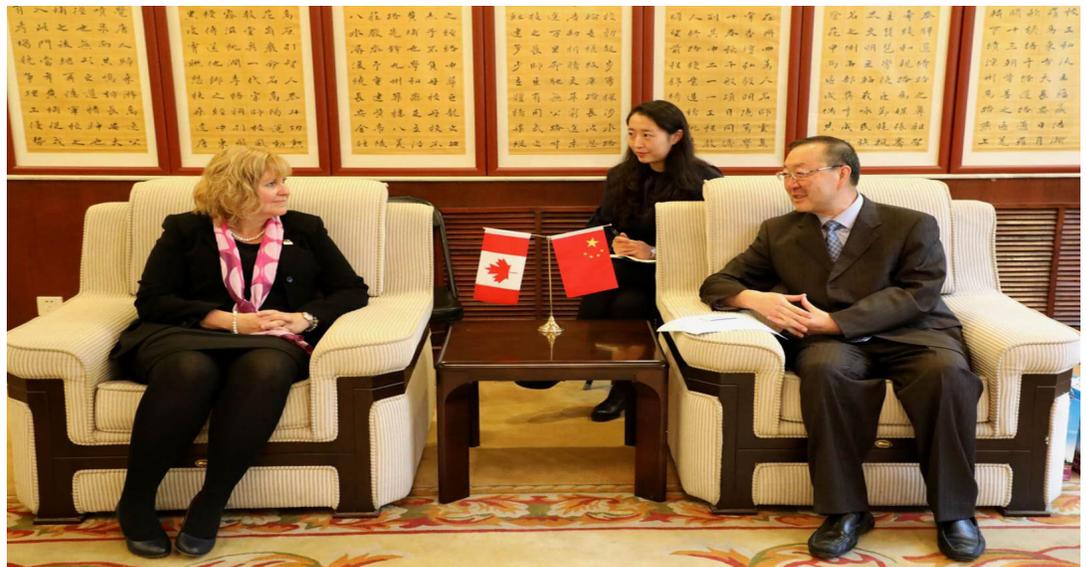
## COLLABERATION BETWEEN UW AND CHINA

Sponsored by the University of Waterloo's International Research Partnership Grants - China (IRPG China), Professor Susan Tighe and Professor Hassan Baaj have been working together with their research team in CPATT and Chinese partners on the proposed project Implementing Sustainable Transport Infrastructure Maintenance Programs for Special Regions in China. Over the course of a year, the project has progressed significantly in terms of research activities, partnership developments, research projects, budget allocations, and research activity plans, this included a recent trip to China, which we will speak briefly about here.

For the second half of the year, a team of 4 people (including Professors Tighe and Baaj) traveled to China for a total of 10 days visiting Changan University, Shenzhen University, as well as, Changsha University of Science and Technology for expanded partnership developments. Two people stayed at Chang'an University for about 4 weeks as visiting scholars (postdoctoral fellowship) conducted a series of lab tests related research work, while the other two individuals went to workshops and meetings to discuss ongoing partnership research projects, as well as, potential projects. Additionally, the Chinese Alliance of Pavement Recycling Industrials sent a 10-person study group to Ontario to attend a week long training session and visits to field construction projects on pavement recycling. Chang'an University is also expected to send visiting graduates and professors to the University of Waterloo for a short term visiting exchange program.

A special thanks must go out to CRH, Rotomill, Steed and Evans, Capital Paving and Miller Paving who helped with the tour and the many CPATT students who volunteered their time.

During the first day of travel Professor Tighe met with President Feng Chen at Chang'an University to discuss partnership developments between Chang'an University and the University of Waterloo.



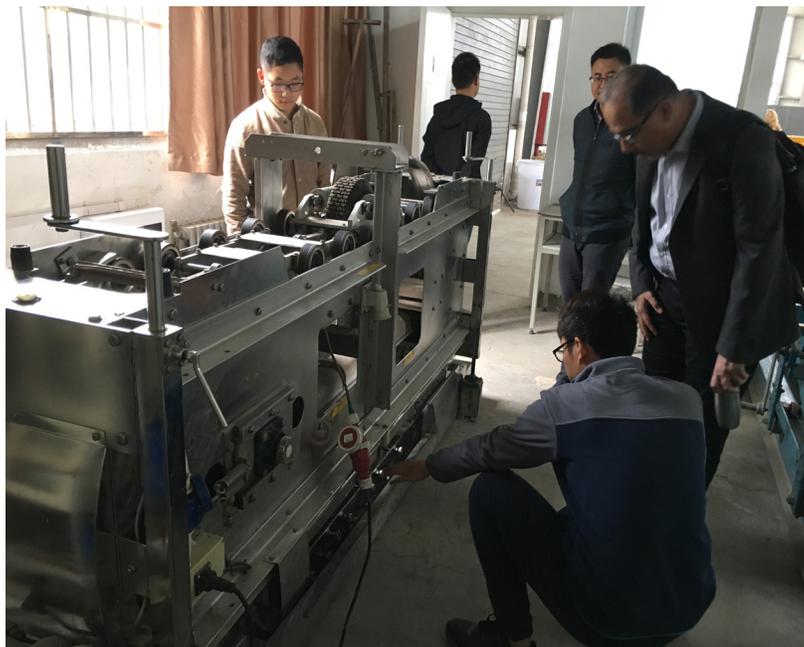
# RESEARCH FEATURE

## COLLABERATION BETWEEN UW AND CHINA (CONT'D)

After introductions and formal discussion, Professor Baaj gave a presentation, “Towards More Sustainable and Innovative Pavement Materials”, at the School of Highway, Chang’an University.



During the latter half of the visit to China, (as seen in the pictures below) the UW delegation visited Road Testing Labs and an Autonomous Vehicle Testing Track in Weishui Campus, Chang’an University.



# RESEARCH FEATURE

## COLLABERATION BETWEEN UW AND CHINA (CONT'D)



Vice-president Xiangmo Zhao awarded Professor Tighe the title of Distinguished Professor of the School of Information Engineering, at Chang’an University. Followed by a presentation by Professor Tighe on “Innovative Technologies of Image Processing Applied at Pavement Crack Detecting and Monitoring”.



The UW delegation met with the Vice-president of Changsha University of Science and Technology and the School of Traffic and Transportation Engineering. Professors Tighe and Baaj discussed future collaborations in both education and research between the University of Waterloo and Changsha University of Science and Technology

# RESEARCH FEATURE

## COLLABERATION BETWEEN UW AND CHINA (CONT'D)

Professor Baaj gave a presentation on “Development of High Modulus Asphalt Concrete Mix Design Technology for Use on Ontario’s Highways”, at the School of Traffic and Transportation Engineering. Followed by a visit to the pavement testing labs in Changsha University of Science and Technology.



Afterwards, the UW delegation met with the Vice-President of Shenzhen University and various directors from other universities in the region. Professors Tighe and Baaj provided suggestions on future collaborations, co-supervising students and research topics to be considered between the universities.

The trip ended with a presentation on high-modulus asphalt concrete by Professor Baaj, who also participated in the Technical Forum of Asphalt Industrial Development in Shanghai.

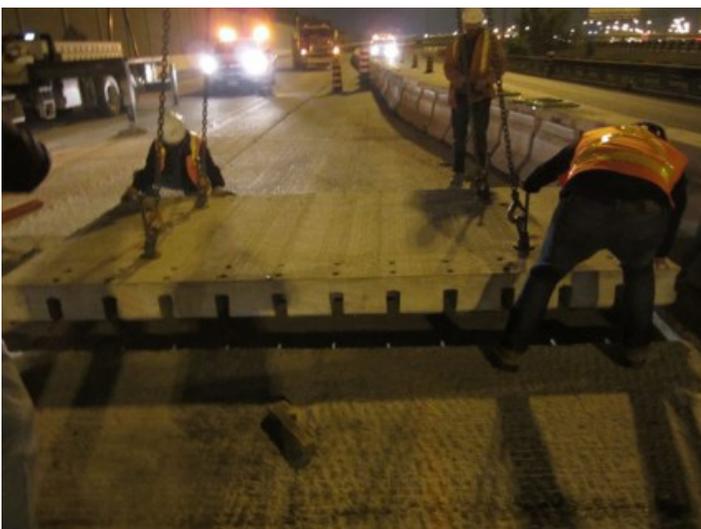


# RESEARCH FEATURE

## ONGOING AND RECENTLY COMPLETED CPATT RESEARCH PROJECTS

- Development of High Modulus Asphalt (or EME) mix design technology for use on Ontario's Highways
- Improving Durability of HMA Produced With (RAP) By Enhancing Binder Blending
- Safety and Throughput Evaluation of High-volume Highways in Ontario, Canada
- Extraction and Recovery of Asphalt Binder
- DENT and MSCR as Fatigue Predictors in HMA
- High Performance Asphalt Mixture Applied in Airfield Pavement
- Field Full Scale Instrumentation and Finite Element Simulation of Pavement Structural Layer Coefficients with the Use of CEMATRIX Lightweight Cellular Concrete
- Development of a Framework to Evaluate AC Properties in Plant Produced HMA With and Without RAP
- Deterioration Mechanism and Diagnostic Approaches for Cement Stabilized Base (CSB) Underneath Asphalt Concrete (AC) Layers
- Evaluation of Using Lean Oil Sands (LOS) and Asphaltenes as Materials on Gravel Roads
- Assessment and Improvement of MTO's Imaging Processing Systems for Usage in Pavement Management
- Pavement Crack Survey Visualization System Based on 3D Image Technology

For more information about any of our current or past projects, sponsors or partners, graduate students or research assistants, please contact Professor Hassan Baaj (see contact page for details).



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