ENGINEERING
NEWSLETTER
JANUARY, 2017

Telling Our Stories, Telling *Your* Stories

Welcome to the first issue of the Faculty of Engineering newsletter at Lakehead University! We are delighted to share our faculty's news and achievements with our many alumni and friends. I sincerely hope that you find this newsletter interesting and engaging.

We feel your connection with Lakehead University and our Faculty shouldn't end at graduation. Keeping in touch with our Alumni is an important part of our program. That includes keeping you informed of what's happening at Lakehead as well as learning about your achievements and activities. That's why we want to hear from you: your stories, your successes, and your news about how Lakehead University experience has made a difference in your life.

We know that in our forty-plus years of offering accredited degrees, there are many stories out there. Our enrolments continue to climb with roughly 1,150 undergraduates and 150 graduate students attending our world-class programs each year. We have added several new graduate programs in the past few years including Master's level Civil Engineering and Mechanical Engineering programs, and a new PhD program in Electrical and Computer Engineering. As you'll see in this newsletter, the growth in graduate students has helped promote research and other educational activities within the Faculty.

Since the Faculty of Engineering opened its doors in 1974, we have also offered a unique and valuable pathway for college students who choose to continue their education at a university level. Today, our summer transition program has grown to nearly 300 students. Our Orillia Campus is continuing that tradition in their development of a partnership with Georgian College in Barrie to launch a new electrical engineering program in Fall 2017.

While college transfers continue to make up the majority of students, we have experienced an increase in Year-1 entry of local and national students as well as a growing number of international students. We are pleased to welcome so many new and talented students to our Lakehead University family.

In closing, I would like to extend my sincerest best wishes in the hopes that you will enjoy reading our first Faculty of Engineering newsletter and remember to keep in touch! Our contact information is on the back page.

Yours sincerely,

David W. Barnett, D.Sc., P.Eng.
Dean, Faculty of Engineering
Lakehead University

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Lakehead UNIVERSITY | Faculty of Engineering

LAKEHEAD'S UNIQUE FIRE TESTING AND RESEARCH LABORATORY

Extending Our Structural Fire Engineering Knowledge

Every year in Canada, there are about 24,000 house fires resulting in 377 deaths and over 3,000 injuries on average – and that's not including industrial or commercial fires.

Structural fire resistance design is helping reduce these numbers. Changes to the National Building Code of Canada (NBCC) as well as different provincial building and fire codes have had a significant impact over the last decade. However, more documentation, experimental data, design tools, and experienced personnel are needed to give us a better understanding of structural fire engineering.

The new Fire Testing & Research Laboratory, completed this past summer at Lakehead's Thunder Bay Campus, will greatly contribute to our growing body of knowledge. Dr. Sam Salem, Professional Engineer and Associate Professor in the Department of Civil Engineering oversaw the construction and now the operation of this state-of-the-art lab. This world-class facility will allow researchers and engineering students get a better understanding of how structural building systems respond to fire in different scenarios under controlled laboratory conditions.

"Outcomes of advanced research in this crucial area will allow structural engineers to account for a more realistic response of different structural members and assemblies when exposed to fire environment, resulting in more cost-effective structural designs," Dr. Salem said.

Lakehead' Fire Testing & Research Laboratory is the only one of its kind at a Canadian university, and one of the very few in the world. The lab itself is a one-storey, high-ceiling building that houses a large, custom-designed fire testing furnace. This unique facility allows researchers to study the structural behaviour and fire resistance of large building components such as beams, columns, and floor and wall assemblies subjected to applied design loads and elevated temperatures of standard or realistic fire scenarios.

The main structure of the furnace is an insulated reinforced-steel chamber with internal clear dimensions of 3.4m x 1.8m x 1.6m high. The chamber has a main opening on the top and a large movable front door, both of which can be used to set up large test assemblies. A 1.0-ton jib crane was installed in the new facility to help move and place the heavy test assemblies inside.

The furnace is equipped with a state-of-the-art control panel including an advanced Human Machine Interface (HMI) system to provide precisely-controlled fire exposure to the different test assemblies under investigation. Several logic and safeguard circuits and devices are installed and attached to the furnace to provide protection for personnel and equipment, as well as to control the operation of the furnace up to 1,300°C.

The lab also features a control room that is equipped with computer workstations and logic control units to monitor and analyze the outcomes of the various fire resistance tests. In addition, a few finite element computer modelling software installed on the computer workstations in the control room are being used to simulate the structural fire behaviour of the building assemblies tested in the facility.

"More fire resistance testing of different building components and assemblies under performance-based structural design is also needed. This is due to the relatively

BEFORE

AFTER

new trend of adopting objective-based codes that promote performance objectives rather than prescribe specific building design parameters, construction methods, or materials," Dr. Salem said.

This unique infrastructure project started in 2013 when the Canada Foundation for Innovation (CFI) awarded Dr. Salem with the John R. Evans' Leaders Fund to help finance the project. In total, Dr. Salem secured more than $1.4 million in research grants from the CFI, the Ontario Ministry of Research and Innovation (OMRI), the Northern Ontario Heritage Fund Corporation (NOHFC), the Natural Sciences and Engineering Research Council of Canada (NSERC – Discovery Grant), and Lakehead University as well as from the private sector.

Dr. Sam Salem – On the "Fire Front" of Structural Fire Engineering

Dr. Sam Salem, an Associate Professor of Structural Fire Engineering in the Lakehead University Department of Civil Engineering, is one of the leading experts in this fast-developing area of research in Canada. After earning degrees in civil and structural engineering in his home country of Egypt, he came to Canada to complete his PhD work in civil engineering at Carleton University in Ottawa. He also worked as a structural engineer for six years, gaining a broad experience in the structural design and construction of numerous structures including industrial steel buildings, hangers, multi-storey residential buildings, and steel bridges.

Today, Dr. Salem oversees the operation of the Fire Testing and Research Laboratory at Lakehead – the only university in Canada with such a lab. The new facilities, installed in the summer of 2016, allow him to continue his investigations into the structural fire performance of innovative steel-wood hybrid building systems. In particular, he is researching the moment-resisting capacity of glue-laminated timber (Glulam) frame connections and the flexural bending behaviour of composite systems, such as composite beam sections made of cross-laminated timber (CLT) slabs or concrete slabs supported by Glulam beam sections. His research could help to prove that the fire resistance of such structures are much higher than first thought.

Dr. Salem has been recognized with numerous awards and grants including a Society of Fire Protection Engineers Award, an NSERC Discovery Grant, a CFI Leaders Fund (which contributed to the construction of his Fire Testing and Research Laboratory), and several teaching awards including the Contribution to Teaching Award (CTA) and Merit Award for Excellence in Teaching and Research both from Lakehead University in 2014.

A BRIGHT IDEA GROWS On Northern Communities

"I'd like to become an engineer reminiscent of the Apollo Generation. Short time frame, complex problem, elegant solution," said Andreas Zailo, a fourth year student in Lakehead University's mechanical engineering program.

And Zailo is not waiting until graduation to begin solving one of Canada's most pressing issues – high rates of food insecurity in northern communities, particularly amongst Canada's Indigenous populations.

"Over a year ago, I was reading about Canada's food security issues and couldn't wrap my head around the fact that so little has been done to address this," said Zailo.

Zailo defines 'food insecurity' as the state of being without reliable access to a sufficient quantity of affordable, nutritious food. According to Zailo's research, remote communities tend to face the highest rates of food insecurity. There are 292 remote communities in Canada – 38 of which are in Ontario. Of those 38, 25 are First Nations. With food insecurity rates ranging from a Canadian average of 28% to as high as 45% in Nunavut, Zailo became inspired to develop a solution: a net-zero hybrid solar/geothermal greenhouse for isolated communities.

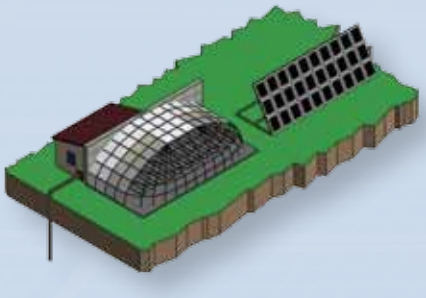
Applying principles of thermodynamics, heat transfer, and renewable energies as taught by Lakehead professor Dr. Basel Ismail, P.Eng., Zailo, with peers Tyler Beckie, Alex Coulson and Evan Oulahen, developed an optimized greenhouse that would allow communities in Northern Ontario to grow their own consistent and affordable natural food supply.

The proposed solution has the potential to address a number of the causes for high rates of food insecurity in remote communities, including:

- The inability to grow food locally due to short growing seasons of less than 100 days
- A lack of local food availability due to small population numbers, which restricts order capacities
- A lack of education on what constitutes a healthy, balanced diet
- High food prices, resulting from elevated costs of living and high operational costs

"When routes to remote locations are particularly difficult to traverse as a result of impediments like ice roads, journeys of the same distance can cost as much as ten times the amount," said Zailo.

The high financial and environmental costs directly associated with long-distance transportation are compounded by a number of indirect transportation costs, such as elevated rates of shrinkage. This means that the theft of a chocolate bar, for example, from a local northern business translates to a greater loss in transportation costs per unit than the same theft from a business in a more accessible community. The food must also spend more time in transit, which leads to higher rates of spoilage and lesser saleability. Food products headed to a local grocery store in Toronto or Ottawa go through about five points of contact before they are purchased by a consumer, whereas products heading to fly-in communities can go through as many as eleven.



Enter the optimized greenhouse. Selecting Whitesand First Nations as their case study point of reference, Zailo and team used the last five years' worth of data on temperature, wind speed and solar radiation from a Canadian weather station less than two kilometres away from Whitesand to inform their calculations and simulations.

A combination of external solar panels, internal LED lighting and a hydroponic growing system – where plants grow in a nutrient-rich liquid solution instead of soil – allows plants within the optimized greenhouse to grow larger and more efficiently than in a standard greenhouse. Rather than planting and harvesting crops every three months, the optimized design follows a three-week growing cycle, allowing for more comprehensive year-round food production in remote areas.

The model uses solar photovoltaic technology for energy, passive solar design for additional solar gain and optimized geometry to maximize solar radiation. The optimized greenhouse features curved angles that drastically reduce the surface area of the greenhouse, preventing the collection of snow and ensuring solar radiation is at an optimal 90-degree angle throughout the day.

Having a smaller surface area also significantly reduces the amount of heat transfer. "Our optimized design has half of the heat loss of a commercial greenhouse," explained Zailo. "But, due to the Greenhouse Effect, a large cooling load for greenhouses is required during the summer. Fans run all day and are powerful enough to remove the entire volume of air from inside the greenhouse in one minute."

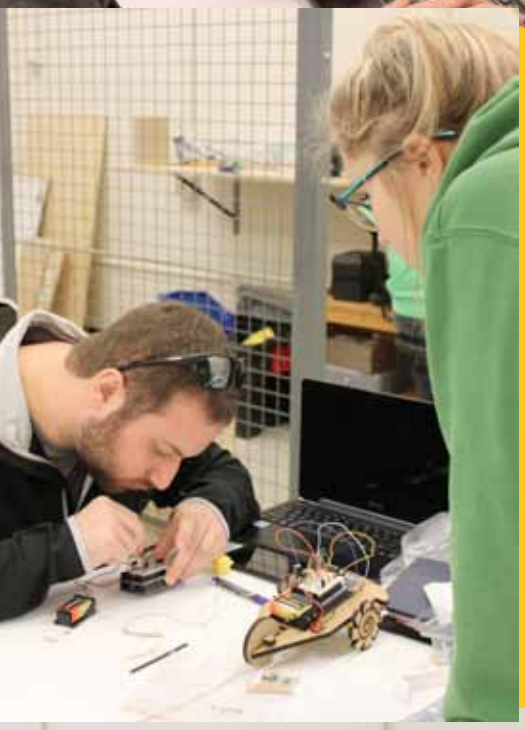
Zailo and team thus incorporated a geothermal loop into their design, where a working fluid is used to absorb heat from within the greenhouse while pumping it into the earth. Operating at net-zero, the greenhouse is not only producing the energy it requires, but it is also energy positive, supplying the grid with slightly more energy than it uses over the course of a year.

According to a 2014 national audit of a food subsidy program called Nutrition North Canada (NNC), savings from subsidized food transportation costs do not appear to be reaching the consumers they are intended to help.

As a result, Zailo is actively seeking partnerships for the funding required to make the greenhouse project a reality. With Food Matters Manitoba, the Ministry of Natural Resources and Forestry and several First Nations chiefs already on board, Zailo is confident that each partnership is a validation that the optimized greenhouse has the potential to make a positive difference.

ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

This article was written by Stephanie Harden, Communications Coordinator at the Ontario Society of Professional Engineers (OSPE). It was originally featured in the association's quarterly magazine The Voice, and on OSPE's Society Notes blog (blog.ospe.on.ca). If you have an engineering story to tell, or would like to become a member of the Society that represents the voice of the engineering community in Ontario, contact us at stories@ospe.on.ca or visit ospe.on.ca/join.



"WOLF LABS" ENGINEERING MAKERSPACE OFFICIALLY OPEN

Is there a way for Lakehead to help engineering students learn better AND improve their performance at national or international competitions?

Creativity is a key element in all engineering projects – using science to turn that spark of an idea into a living, breathing invention. But until recently, the latest high-tech tools used to create prototypes were a long snail mail away. Students could design their inventions at Lakehead, but they would have to send their specs out of town and wait up to couple of days or weeks to receive their models.

Now, that waiting time has changed into hours or even minutes thanks to a new engineering lab in Centennial Building (CB) 1004.

The Engineering ***Makerspace*** – unofficially called "Wolf Labs" by students – opened this fall as the first invent-build-play space for engineering students at Lakehead University. The Makerspace features much of the equipment students need to bring their idea to reality by building prototypes of their inventions including three 3D printers (two Dremel Idea Builders and one Makergear M2), a Sense 3D scanner, and an Epilog Mini 24CO2 laser, as well as hand tools, testing instruments, and all other related parts and equipment.

However, the Engineering Makerspace is more than just equipment; it's also a community. It's a creative environment that allows all engineering students the freedom to try new things and develop their ideas in an informal setting with like-minded classmates. With these high-tech tools and equipment, students can design, test, and build any personal or school project. The space can also host tutorials, safety training on different equipment, presentations, workshops, engineering hackathons, and other competitions.

For example, 2016 saw Lakehead's first Fall Design Challenge. Ten teams had full use of the Makerspace for three weeks to design and build either a line-following robot or a ping pong siege weapon out of laser-cut parts. The civil team of Matt Olinski, Ben Degroot, Mack Barber, and Kevin Langdon won the ping pong siege while mechanical engineering students Urvish Valand, Peter Negru, and Madeleine Becke won the robot competition. The challenge's great success is a harbinger of what's to come – the lab will also help Lakehead engineering students compete better in provincial, national, or even international competitions.

The Engineering Makerspace is funded by the Engineering Equipment Endowment Fund (E3F) and Lakehead University, and operated jointly by the Engineering Student Society (ESS) and the Faculty of Engineering. Dr. Siamak Elyasi, Assistant Professor of Chemical Engineering, is the Faculty representative and an enthusiastic supporter of the lab. He works closely with ESS, the Faculty of Engineering, and the E3F Committee to help oversee this student-led initiative.

Currently the Makerspace is only available to engineering students, though plans are in the works to open it up to all Lakehead students and faculty members for a membership fee.

New Electrical Engineering Program Offers the Best of Both Worlds

University? College? A new partnership between Lakehead University's Orillia Campus and Georgian College in Barrie will offer electrical engineers the best of both worlds.

Electrical engineers are involved in all stages of product and system development including design, manufacturing, testing, maintenance, and troubleshooting in the field. Over the course of a career, the typical electrical engineer's CV includes a combination of roles which require strong theoretical foundations and capabilities such as design, development, consulting, etc. and hands-on fieldwork.

That's what makes this new program so valuable. The BEng (Electrical Engineering) Lakehead-Georgian Partnership offers both a Bachelor of Engineering Degree *and* an Electrical Engineering Technology Advanced Diploma. The four-year program at Georgian College's Barrie campus provides students with a solid foundation across all areas of electrical engineering, preparing them with valuable theoretical knowledge, practical engineering experience, and applied technology skills. Specific course offerings will focus on subfields such as digital and analog micro-electronics, power electronics, communication systems, computer networks, power systems, and electrical machinery.

Successful graduates will exit the program with a well-rounded education in academic and practical electrical engineering for a wider range of career opportunities including future specialization.

The inaugural program is currently accepting applications from Year-1 students for Fall 2017.

Can Drones Have Situational Awareness?

First used in the military, unmanned aerial vehicles (UAVs) or "drones" have exploded in popularity in commercial applications and among hobbyists over the last several years. Most popular are the quadrotor drones due to their vertical takeoff and landing capabilities, agile flight, and portable size. Commercially, they are used for many videography applications including land surveying, aerial crop inventory, and forest fire monitoring.

Obviously, these types of activities require precision flight systems, especially during computer-guided flight. However, today's commercially available technologies are far from perfect. Dynamic uncertainties can reduce stability (sometimes to total failure) and imprecise position control can cause the drone to collide with an obstacle.

Drs. Abdelhamid Tayebi and Xiaoping Liu of the Department of Electrical Engineering and a team of graduate students are developing nonlinear control systems for quadrotor drones. Their goal is to find algorithms that will be able to monitor real-time position tracking while maintaining stable flight.

The research team is investigating several possible solutions with promising results so far. One of these is an adaptive control system that can react to dynamic uncertainties – literally on the fly. Other possibilities include position control using GPS, and another using optical flow sensor technology. Future research may include developing an image processing technique for navigation and obstacle avoidance, allowing the drone to "see" its flight path and react to situations much as pilots do.

NEWS & NOTES

Dr. Fatehi Wins Innovation Award

Dr. Pedram Fatehi of Lakehead's Biorefining Research Institute and the Department of Chemical Engineering won the 2016 Innovation Hero of the Year Award from the Northwestern Ontario Innovation Centre (NOIC). According to NOIC, "Dr. Fatehi's … research and commercialization efforts into green and environmentally friendly pulp and paper solutions make him deserving of this award."

Currently, some industrial processes use toxic oil-based chemicals as flocculants and dispersants. Dr. Fatehi's team is investigating how to use waste biomass instead, reducing environmental impact as well as cost.

Dr. Liao Wins NSERC Distinguished Researcher Award

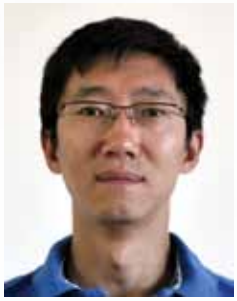
Dr. Baoqiang Liao of the Department of Chemical Engineering received an NSERC Distinguished Researcher Award in 2016 for his research into membrane bioreactors (MBR). This process promises a cheaper and more environmentally friendly way to treat wastewater than conventional activated sludge treatment. Dr. Liao's research program has attracted $1.6 million in external funding for research and for graduate student and postdoctoral fellow training.

Dr. Liao has published approximately 50 peer-reviewed papers and book chapters since joining Lakehead in 2002.

Chemical Engineering Welcomes Dr. Ebrahim Rezaei

Dr. Ebrahim Rezaei joined the Department of Chemical Engineering as an Assistant Professor in August 2016. A graduate of the Chemical Engineering program at the University of Saskatchewan, Dr. Rezaei's research interests including catalytic total oxidation of organic pollutants, synthesis of novel adsorbents, catalytic conversion of CO2 to value-added products, and modelling, simulation, and optimization of chemical engineering processes.

Dr. Yushi Zhou New Electrical Engineering Professor



Dr. Yushi Zhou joined the Department of Electrical Engineering as an Assistant Professor in August 2016. After completing his undergraduate work in China, Dr. Zhou received his PhD in Electrical and Computer Engineering from Ryerson University. His research interests include CMOS analog and mixed-signal circuits, design and modelling of clock generation circuits, ultra-low power transceivers design, and design methodologies for Gbps wireline transceivers.

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