



THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE

FALL/AUTOMNE 2025

BULLETIN



SPECIAL ISSUE ON

Advances in Aerospace

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Editor's Letter

I AM PLEASED TO INTRODUCE THE FALL 2025 issue of the Canadian Society for Mechanical Engineering (CSME) *Bulletin*. This issue highlights the latest advances in aerospace made by Canadian researchers and engineers.

This is my first time serving as the Editor-in-Chief of the CSME *Bulletin*. I would like to express my sincere gratitude to Professor **Marc Secanell** (University of Alberta), our previous Editor-in-Chief, whose contributions were pivotal to the bulletin's success. Additionally, I am happy to welcome Professor **Hassan Alkomy** from the University of New Brunswick and Professor **Baafour Nyantekyi-Kwakye** from Dalhousie University, who are serving as Technical Editors for the first time in this issue.

The issue is co-edited with guest editors Professor **Dana Grecov**, Chair of the Fluid Mechanics Technical Committee (TC), and Professor **Yuping He**, Chair of the Transportation Systems TC. The goal of this issue is to keep CSME members informed about the most recent technological advances in aerospace engineering in Canada and around the world.

This issue features articles from teams led by Professor **Essel** (Concordia University), Professor **Hangan** (Ontario Tech University), Professor **Shan** (York University), Professor **Egberts** (University of Calgary), and Mr. **Brandon Robinson** (Horizon Aircraft).

Dr. Essel provides an overview of recent innovations in aerospace transport. Dr. Hangan highlights their work on analytical and numerical simulations of surface gusts and their impact on aerospace vehicles. Dr. Shan presents their research on the planning and control of unmanned aerial vehicles (UAVs) to ensure safe and precise operation under slung payloads. Dr. Egberts emphasizes the importance of collaborative training in advancing Canada's aerospace leadership. This issue of the CSME *Bulletin* also features an article by Brandon Robinson, a former Royal Canadian Air Force CF-18 pilot and now CEO of Horizon Aircraft, who shares his vision for the future of advanced air mobility in Canada.

To showcase exceptionally talented researchers, within the early years of their academic careers, working on aerospace-related research, this issue features spotlight articles from three researchers. This includes Dr. **Vaishnavi Kale** (University of Calgary), who focuses on topology optimization problems in aerospace; Dr. **Zeinab El-Sayegh** (Ontario Tech University), who develops finite element models to simulate standing waves in aircraft tires; and Dr. **Reza Faieghi**, who aims to advance aerial autonomy for UAVs.

This issue of the CSME *Bulletin* also features three Chair's Corner articles contributed by

Professor **Alighanbari** (Toronto Metropolitan University), Professor **Germain** (École de Technologie Supérieure - ÉTS Montréal), and Professor **Packirisamy** (Concordia University), in which they introduce the aerospace programs within their departments.

To keep CSME members informed, this issue also includes updates about the upcoming CSME Congress (2026), CSME news, the Student Affairs section, a list of future CSME awards and recent awardees, and a list of new CSME members.

Next issue will focus on "How Machines and Robots are Transforming and Shaping the Future World" and will be co-edited with Professor **Yang Shi**, chair of the Mechatronics, Robotics, and Control TC, and Professor **Juan Antonio Carretero**, chair of the Machines and Mechanisms TC. If you would like to suggest a topic for future issues, please let the CSME editors know your suggestions.

We hope you find this issue of the CSME *Bulletin* informative and engaging.

Sincerely,



Ali Hosseini

ALI HOSSEINI, PhD, MCSME, P.Eng.
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Yuping He

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Chair, CSME Transportation Systems TC
Professor, Department of Automotive and Mechatronics Engineering, Faculty of Engineering and Applied Science, Ontario Tech University



DGrecov

DANA GRECOV, PhD, FEC, FCSME, P.Eng.
Chair, CSME Fluid Mechanics TC
Professor, Department of Mechanical Engineering
University of British Columbia



President's Message

Message du Président

Dear CSME members,

In an era marked by rapid change and uncertainty, engineering stands at a crossroads. The CSME has a vital role to play—not only in uniting the mechanical engineering community across Canada but also in fostering international dialogue grounded in integrity and collaboration. At a time when technological progress often outpaces reflection, we must reaffirm our collective responsibility: to champion ethical, responsible, and principled engineering, and to stand firm against compromises that weaken the trust society places in our profession.

A major highlight of the year was the 2025 CSME Congress in Montreal, hosted at ÉTS, which brought together over 600 participants from academia and industry for one of our most vibrant editions yet. The event featured two industrial workshops, a wide range of technical and student presentations, and plenary and keynote lectures from world-leading experts. On behalf of the Society, I extend my deepest gratitude to the organizing team—Dr. Lucas Hof, Dr. Giuseppe Di Labbio, Dr. Sébastien Lalonde, Dr. Antoine Tahan, Dr. Marlène Sanjosé, and Dr. Nicole Demarquette—for their dedication, and to ÉTS for their warm hospitality and outstanding support.

Looking ahead, preparations are already underway for the 2026 CSME Congress, which will be hosted by the University of British Columbia and co-organized with the CFD Society of Canada and the Canadian Society of Rheology (CSR). Under the leadership of Dr. Dana Grecov, this next edition promises to build on Montreal's success, featuring world-class plenary and keynote presentations, a strong industrial program, and expanded opportunities for collaboration and dialogue across Canada's mechanical engineering community.

Let us continue to support one another, to lead with purpose, and to ensure that our profession remains both innovative and socially responsible.

The CSME thrives because of you, serves you, and truly is you.

Sincerely,

ALI AHMADI, PhD, P.Eng., MCSME

CSME President

Associate Professor, Department of Mechanical Engineering

École de Technologie Supérieure

WELCOME NEW CSME/SCGM MEMBERS

May 1, 2025 to September 30, 2025

Mr. Bilal Ahmad, *Pembina Pipeline Corporation*

Prof. Emna Helal, *École de Technologie Supérieure*

Prof. Jerin John, *Concordia University*

Prof. Ahmad Naser, *University of Manitoba*

Prof. Mathieu Olivier, *Université Laval*

Mr. Richard Renaud, *Syncrude Research and Development*

Mr. Gagandeep Singh Kajal, *Mytox (Magna international)*

Chers membres de la SCGM,

À une époque marquée par des changements rapides et une incertitude croissante, le génie mécanique se trouve à un carrefour. La Société canadienne de génie mécanique (SCGM) joue un rôle essentiel — non seulement en unissant la communauté du génie mécanique à travers le Canada, mais aussi en favorisant un dialogue international fondé sur l'intégrité et la collaboration. Alors que le progrès technologique dépasse souvent le rythme de la réflexion, nous devons réaffirmer notre responsabilité collective : promouvoir un génie éthique, responsable et fondé sur des principes solides, et demeurer fermes face aux compromis qui affaiblissent la confiance que la société accorde à notre profession.

L'un des faits marquants de l'année a été le Congrès 2025 de la SCGM à Montréal, tenu à l'ÉTS, qui a réuni plus de 600 participants issus du milieu universitaire et industriel lors de l'une de nos éditions les plus dynamiques à ce jour. L'événement comprenait deux ateliers industriels, de nombreuses présentations techniques et étudiantes, ainsi que des conférences plénières et des allocutions de sommités internationales. Au nom de la Société, j'adresse mes sincères remerciements à l'équipe organisatrice — Dr. Lucas Hof, Dr. Giuseppe Di Labbio, Dr. Sébastien Lalonde, Dr. Antoine Tahan, Dr. Marlène Sanjosé et Dr. Nicole Demarquette — pour leur dévouement exemplaire, ainsi qu'à l'ÉTS pour son accueil chaleureux et son soutien remarquable.

En regardant vers l'avenir, les préparatifs sont déjà bien entamés pour le Congrès 2026 de la SCGM, qui se tiendra à l'Université de la Colombie-Britannique et sera coorganisé avec la Société canadienne de CFD et la Société canadienne de rhéologie (SCR). Sous la direction de la Dre Dana Grecov, cette prochaine édition s'annonce prometteuse : des conférences plénières et techniques de calibre mondial, un programme industriel étoffé et de nouvelles occasions d'échanges et de collaboration à l'échelle nationale.

Continuons de nous soutenir mutuellement, de diriger avec conviction et de veiller à ce que notre profession demeure à la fois novatrice et socialement responsable.

La SCGM vit grâce à vous, vous sert et vous représente véritablement.

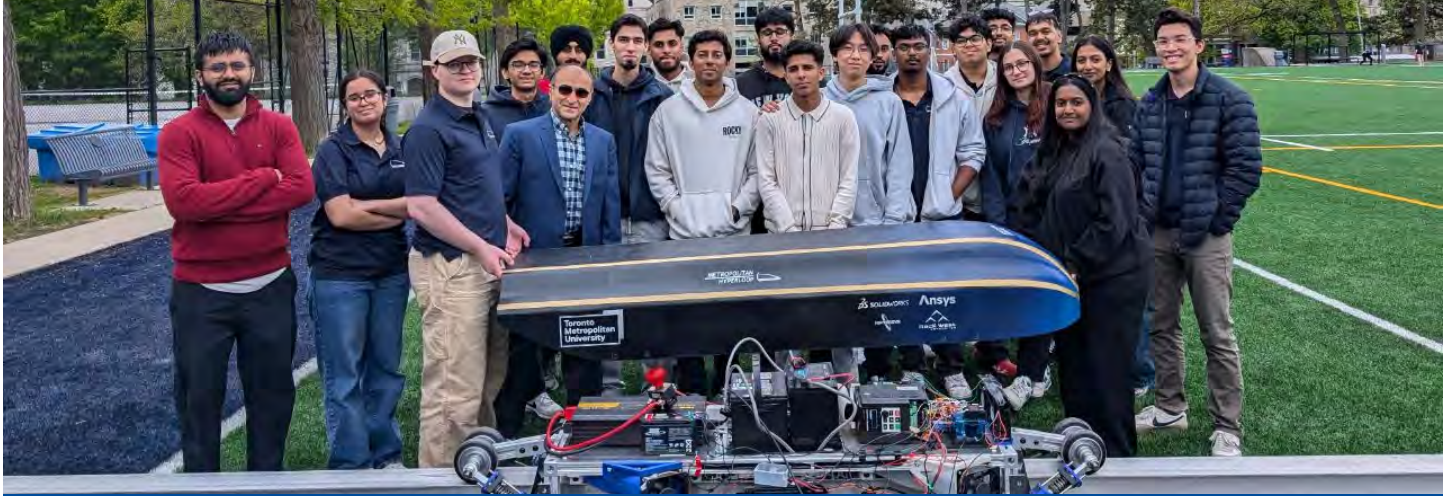
Cordialement,

ALI AHMADI, PhD, P.Eng., MCSME

Président, Société Canadienne de Génie Mécanique

Professeur agrégé, Département de génie

mécanique, École de Technologie Supérieure



Charting the course for Canada's aerospace future at Toronto Metropolitan University

FIG. 1: TMU AEROSPACE HYPERLOOP TEAM'S INNOVATIVE DESIGN SECURED THE TOP AWARDS AT NATIONAL AND INTERNATIONAL COMPETITIONS.

AS CHAIR OF THE DEPARTMENT OF AEROSPACE

Engineering at Toronto Metropolitan University (TMU), I am happy to share the academic and research advancements we are making to train the next generation of engineers who will drive Canada's aerospace sector. Our program has a long history, since it began in 1993 and became Canada's first autonomous academic unit devoted exclusively to aerospace in 2003. It continues its tradition of providing a demanding, industry-aligned education, supported by world-class research and a bold vision for the future.

ACADEMIC EXCELLENCE AND INDUSTRY COHERENCE

The department's core mission is to produce highly qualified, industry-ready graduates along the entire aerospace value chain. Our extensive curriculum, which includes a CEAB-accredited Bachelor of Engineering (BEng), alongside our advanced Master's (MEng/MASc) and PhD programs, helps us accomplish this.

The BEng curriculum is developed to provide a thorough aerospace engineering foundation before students choose to be specialized in one of three focused streams: Aircraft, Space Systems or Avionics. Our graduates develop the theoretical depth and real-world experience that today's employers require, thanks to this comprehensive curriculum and the optional co-operative internship program. The caliber of our students is consistently high, and their success is evident as our student's design teams, such as rocketry, Hyperloop and space design teams, regularly achieve high ranking in diverse competitions.

FRONTIERS OF RESEARCH AND INNOVATION

Research is the engine of innovation at TMU Aerospace Engineering. Our research is led by our 19 dedicated faculty members, four of whom hold or have held distinguished Canada Research Chairs or Industry Research Chairs, demonstrating our leadership in core aerospace domains. Our faculty and students are tackling the most significant challenges facing the industry, focusing on areas vital to Canadian competitiveness: Advanced Materials and Manufacturing (e.g., composites, additive manufacturing and nanotechnology), UAV, Propulsion and Aero-Thermal Management, Flight Dynamics and Morphing Systems, and Space Systems Engineering (including nanosatellites and robotics). Since 2015, the department has secured over \$14.5 million in external funding. This significant external support has created a robust research environment. The TMU Centre for Advancing Engineering, Research and Innovation in Aerospace (AERIAS) has been helpful to our success. AERIAS serves as a hub, connecting our top researchers and laboratories with our leading industry partners like Bombardier, Safran, Boeing, and Pratt & Whitney for high-impact R&D and student project-based learning.

FUTURE PLANS AND PRIORITIES

TMU Aerospace's top priorities going forward are:

1. Curriculum improvement: We are actively integrating emerging subjects like Advanced Materials and Manufacturing and Machine Learning into the curriculum to make sure our students understand the complexity of future aircraft and spacecraft systems.

2. Capacity Growth: A key priority is the continued upgrade and expansion of our state-of-the-art laboratories to support hands-on learning and accommodate the rising demand for our program.

3. Strategic Research: Our research efforts will increasingly target societal needs, including sustainable aviation and advancements in space and drone technologies. Furthermore, we are committed to enhancing EDI through various programs to ensure that the future of aerospace engineering reflects the diversity in Canada.

By strengthening our industry partnerships, continually evolving our academic offerings, and investing in our teaching and research infrastructure, TMU Aerospace Engineering is boldly prepared to lead the way in Canada's aerospace education.



HEKMAT ALIGHANBARI, PhD, P.Eng.

Dr. Alighanbari is a highly regarded scholar and leader in Aerospace Engineering. Currently serving as Department Chair at Toronto Metropolitan University. Prior to TMU, he worked as a Senior Engineer at Bombardier Aerospace and an Adjunct Professor at McGill University, where he earned his PhD. Dr. Alighanbari is internationally recognized for his research in nonlinear aeroelasticity and unsteady aerodynamics. His academic achievements include substantial teaching, research, and collaborative industry funding.

DO YOU HAVE AN ENGAGING ENGINEERING IMAGE?

Submit an original photograph or research-related image to be featured on the cover of the 50th Volume of TCSME in 2026! Email your image to Jocelyn (Jocelyn.Sinclair@cdnsiencepub.com) for consideration. Images are used with attribution, and the selected (engineering) artist will be provided with the high-quality image file of the fully composed cover for their use.

Criteria: Single image (no collages/composite images or AI-generated content), either .jpg/.tiff/.png format, > 2850 x 3300 pixels (9.5" x 11" at 300 DPI).



CHECK OUT OUR JUNE AND SEPTEMBER ISSUES

June 2025 (cdnsiencepub.com/toc/tcsme/49/2) – featuring a review on Microneedle arrays for brain drug delivery (Akbari et al.), and new research on spring design (Deng et al.), modelling wind turbine performance (Paraschivoiu et al.), lithium-based grease performance testing (Kiani et al.) and more!

September 2025 (cdnsiencepub.com/toc/tcsme/49/3) – featuring a review on postural stability and neuromuscular control (Rouhani et al.), and a host of new research on fault and vibrational analysis, dampening, gear drives and more.

CALL FOR PAPERS



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For general inquiries, contact TCSME's Journal Development Specialist Jocelyn Sinclair at Jocelyn.Sinclair@cdnsiencepub.com.

A New Aerospace Engineering Department at ÉTS Montréal



IN 2023, THE AEROSPACE ENGINEERING department at École de Technologie Supérieure was established by a group of experts in advanced manufacturing, materials, propulsion, aerodynamics, and on-board systems. Together with industry, they all strive to make spacecraft and airplanes lighter and more efficient. In the field of aerodynamics and propulsion, Dr. Patrick Germain, the department head, applies decades of experience in the aerodynamic integration of gas turbines and is pioneering research on unconventional aircraft configurations, including solar-electric planes for Mars. Complementing his work, Dr. Hany Moustapha leads a number of aerospace projects by combining his knowledge of Industry 5.0 and gas turbine optimization, while Dr. François Garnier investigates fluid dynamics and sustainable propulsion solutions to reduce aviation's contrail footprint. High-fidelity simulations of complex flows and turbulence are at the heart of Dr. Marlène Sanjosé's work, improving the efficiency and acoustic performance of drones and aircraft alike. Dr. Flavio Noca develops a modular fan-array wind generator for drone testing, simulating complex atmospheric conditions, including inclement weather, further expanding Canada's advanced air mobility capabilities. His research addresses gaps in testing facilities for intermediate-sized aircraft. To increase aircraft safety and efficiency, Dr. François Morency uses computational fluid dynamics to simulate aircraft icing and de-icing systems. The design and performance of next-generation aircraft vehicles are advanced by Dr. Ruxandra Botez, an expert in aerodynamics, aeroelasticity, control, structures, and optimization.

Researchers in the areas of embedded technologies and aeronautical systems are revolutionizing the functioning of satellites and airplanes. Dr. Jesús González-Llorente designs power systems and autonomous energy management solutions for small satellites, while Dr. René Landry Jr., founder of the LASSENA

laboratory, focuses on secure, intelligent embedded systems that enhance navigation, communication, and observation capabilities. Dr. Waël Jaafar applies machine learning to wireless networks and integrated terrestrial/non-terrestrial platforms, providing adaptive and secure solutions for autonomous vehicles and IoT ecosystems, while Dr. Georges Ghazi uses AI to optimize airport operations and identify anomalies in aerospace systems.

Research on materials and manufacturing is another area in which the university excels. Dr. Vincent Demers investigates powder metallurgy and additive manufacturing processes to produce complex aerospace components, while Dr. Philippe Bocher explores the optimization of metal manufacturing processes and the characterization of 3D-printed components under extreme conditions. Dr. Gelareh Momen advances sustainable surface treatments for energy and aerospace applications by creating durable coatings for corrosion protection and anti-icing. Dr. Ilyass Tabiai focuses on polymer and composite processing, combining experiments with numerical modeling to improve material performance, while Dr. Elmira Moosavi has developed recognized expertise in the thermodynamics of critical metals and their recovery from secondary sources such as end-of-life products, as well as in the production alloys for aircraft engines in a sustainable manner. Dr. Emna Helal, at ÉTS since 2025, is a specialist in polymer nanocomposites and sustainable advanced materials, with industrial experience.

These 17 professors work together to create a dynamic, multidisciplinary environment at ÉTS that incorporates state-of-the-art research in digital technologies, propulsion, systems, materials science, and aerodynamics. A new Bachelor's program in Aerospace Engineering at ÉTS has started in September 2025, with 29 students. Each course in the program includes laboratory (hands-on) activities, and the list of equipment includes wind tunnels, equipment for materi-

al characterization, manufacturing (composite material, metal forming, machining), drones, etc. The program is collocated at École Nationale d'Aérotechnique (ÉNA), and the students and teaching personnel of ÉTS have access on site to helicopters, aircraft, engines, and on-board aircraft equipment. The efforts of the new department and its members ensure that Canada and Quebec stay at the forefront of global aerospace breakthroughs by pushing the limits of aerospace innovation and developing the next generation of engineers and researchers.



PATRICK GERMAIN, PhD, P.Eng.

Dr. Germain is a professor and Director of the Aerospace Engineering department at École de Technologie Supérieure. He has 25 years of experience in the aerodynamics of gas turbine installations. While employed by Pratt & Whitney Canada from 1996-2011, he worked on the installation aerodynamics of engines for business, commercial, regional, military, general aviation, including that for helicopters and APUs. While at Bombardier Aviation between 2011-2020 he was a principal engineering specialist and section chief in the Advanced Aerodynamics department. In 2021, he joined ÉTS to create the Bachelor's program in Aerospace Engineering.

CALL FOR SUBMISSIONS: HOW MACHINES AND ROBOTS ARE TRANSFORMING AND SHAPING THE FUTURE WORLD

As the Editor of the Canadian Society for Mechanical Engineering (CSME) Bulletin, I would like to invite you to submit any of the following items for consideration for publication in the next CSME Bulletin issue. For examples of prior contributions, please see previous issues at www.csme-scm.ca/bulletin.

The next issue focuses on *How Machines and Robots are Transforming and Shaping the Future World* and will be published in May 2026. The guest editors of the issue will be Professors **Yang Shi**, chair of the Mechatronics, Robotics, and Control Technical Committee (TC), and **Juan Antonio Carretero**, chair of the Machines and Mechanisms TC.

FEATURED ARTICLES

The aim of the featured articles is to give our readers an overview of a given sub-topic of the theme (*How Machines and Robots are Transforming and Shaping the Future World*), the most recent advancements in the area, and finally, the most critical aspects for future research. The article should be 1,200 words (9,000 characters including spaces) long. If you are interested in submitting a featured article, please submit an Expression of Interest (Eoi) by sending a 300-word abstract of the article and a 50-word biography to either SayedAli.Hosseini@ontariotechu.ca or rwilling@uwo.ca by **January 12, 2026**. After abstract review, selected authors will be invited to submit a full featured article that will be due on **April 1, 2026**.

SHORT NEWS ITEMS

News of interest to the ME community prior to April 1, 2026.

RECOGNITIONS

Highlighting the achievements of ME peers (not self) prior to April 1, 2026.

IN MEMORIALS

Recognizing the passing of ME members prior to April 1, 2026.

FACULTY SPOTLIGHT

This section highlights new faculty in the Mechanical Engineering Departments across Canada within four years of their appointment, ideally working on the topic of the issue (though not essential). The aim of this section is to introduce new faculty members to the CSME community; therefore, the article should provide a short biography, an introduction to your research (what is the topic of your research? why is the research topic important?) and a description of your laboratory including past and future work. If you are eligible and interested in submitting an article, please submit an Expression of Interest (Eoi) by sending a 100-word abstract and a 50-word biography to either SayedAli.Hosseini@ontariotechu.ca or rwilling@uwo.ca by **January 12, 2026**. After abstract review, selected authors will be invited to submit a full article (500 words or 4,000 characters) that will be due on **April 1, 2026**.

Thank you for your consideration. I look forward to hearing from you soon.

Ali Hosseini, PhD, P.Eng.

Associate Professor, Department of Mechanical and Manufacturing Engineering, Ontario Tech University
Editor, Canadian Society for Mechanical Engineering (CSME) *Bulletin*

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Ryan Willing, PhD, P.Eng.

Associate Professor, Department of Mechanical & Materials Engineering, Western University
Associate Editor, Canadian Society for Mechanical Engineering (CSME) *Bulletin*

rwilling@uwo.ca



Innovation in Motion: Concordia's Aerospace Program



FIG. 1: 13-METRE LIQUID-FUEL ROCKET, DESIGNED AND BUILT BY STUDENTS OVER MANY YEARS, IS BEING INSTALLED FOR THE HISTORIC TAKE-OFF.



FIG. 2: SAE AERO DESIGN COMPETITION, MAY 2025 DALLAS, TEXAS; STUDENTS WON THE 2nd PLACE IN NORTH AMERICA.



FIG. 3: STARSAILOR, 13-METRE LIQUID-FUEL ROCKET, DESIGNED AND BUILT BY STUDENTS.



MUTHUKUMARAN PACKIRISAMY, PhD, P.Eng. FNAI (U.S.) FRSC (Chemistry, UK), FRSC, FINAE (India), FEIC, FASME, FCAE, FIE (India), FCSME
Dr. Packirisamy is a strong promoter of innovation in Canada and Chair of Mechanical, Industrial and Aerospace Engineering, Professor, Gina Cody Research and Innovation Fellow and Concordia Research Chair at Concordia University. He is the recipient of CSME Robert W. Angus Medal and CSME I.W. Smith Award, Petro Canada Young Innovator Award, ENCS Young Research Achievement Award, Distinguished Alumnus of NITT and Distinguished Research Fellow of University. As an author of around 550 articles published in journals and conference proceedings, 50 invited talks, 30 inventions, obtained grants around \$16Million and supervised more than 16 Research Associates/PDF, 33 PhDs, 54 Masters and 71 UG students in addition to teaching around 4000 students. He has also published a textbook, BioMEMS: Engineering and Science Perspectives, and 6 book chapters. His recent invention on energy harvesting from photosynthesis of blue green algae and Direct Sound Printing had more than 400 citations around the world and was covered by news media, globally.

This article was authored with support of Professors in the Department of Mechanical, Industrial and Aerospace Engineering Hang Xu, Carole El Ayoubi, Mojtaba Kheiri, Marie-Laurence Cliche and Department of Chemical and Materials Engineering Professor Pantcho Stoyanov.

GREETINGS FROM THE DEPARTMENT OF Mechanical, Industrial, and Aerospace Engineering (MIAE) at the Gina Cody School of Engineering and Computer Science (GCS), Concordia University. As the largest engineering school in Quebec, GCS brings together over 12,000 students and 260 faculty members, fostering an inclusive environment where 40% of students are international and 27% are women.

The MIAE Department, long associated with Quebec's aerospace sector, launched its Bachelor of Engineering (B.Eng.) in Aerospace Engineering in 2016. Among the few programs of its kind in Canada, it benefits from Montreal's position as the world's third-largest aerospace hub, home to major players such as Bombardier, Pratt & Whitney, CAE, Bell Textron, Airbus, and Boeing. Many faculty members possess decades of industrial experience, driving strong academic/industry collaborations, hands-on learning, and cutting-edge innovation.

The program, accredited by the Canadian Engineering Accreditation Board, allows students to specialize in Aerodynamics and Propulsion, Aerospace Structures and Materials, or Avionics and Aerospace Systems. Students gain hands-on experience through design-oriented courses, lab work, and project-based learning. Many also take part in competitions such as SAE

Aero Design (photo 2) and the Canadian Satellite Design Challenge, where they apply their skills on both national and international stages.

Concordia's Aerospace Engineering research and innovation are recognized for their strength in areas such as computational fluid dynamics, aeroelasticity, advanced and smart materials, aeroacoustics, propulsion, avionics and flight control, and sustainable aviation technologies. Supported by extensive facilities, including wind tunnels, propulsion labs, structural testing systems, and high-performance computing resources, faculty researchers lead globally recognised projects in low-carbon aviation, noise reduction, lightweight structures, and space technology development.

The Concordia Institute of Aerospace Design and Innovation (CIADI) brings together more than 70 faculty members and regional aerospace partners, helping strengthen Concordia's long-standing presence in Quebec's aerospace industry. CIADI promotes research collaboration and professional growth through industry-led competitions, site visits, seminars, and training programs. Recently, in partnership with Concordia Continuing Education, CIADI launched two new certificates: Decarbonization of Aerospace and Applications of Emerging Cybertechnologies in Aerospace.



CSME-CFDSC-CSR 2026

A joint conference of the CSME, CFD Society of Canada, and Canadian Society of Rheology
 May 24-27, 2026
 University of British Columbia (UBC), Vancouver, BC

The Canadian Society for Mechanical Engineering (CSME), the Computational Fluid Dynamics Society of Canada (CFDSC), and the Canadian Society of Rheology (CSR) will hold their joint 2026 **CSME-CFDSC-CSR** International Congress at the University of British Columbia (UBC) in Vancouver, BC, on May 24-27, 2026.

This international congress presents a unique opportunity to exchange new knowledge across various fields of engineering and to establish strong networks between academia, research, and industry, accelerating innovation.

Call for Abstracts & Papers

- Both **abstracts** (up to 400 words) and **papers** (up to 6 pages) are accepted and welcome
- Papers first-authored by students are eligible for the student paper competitions
- **Submission deadline: January 30th, 2026** (see www.csmecongress.org for updates)

Additional Information and Sponsorship

- Call for special symposia and workshops
- Sponsor? – Please contact csme2026@ubc.ca
- For any questions, inquiries, and/or proposals, please contact csme2026@ubc.ca

CSME Symposia	Advanced Energy Systems Advanced Manufacturing Biomechanics & Biomedical Engineering Computational Mechanics Engineering Analysis & Design Environmental Engineering Fluid Mechanics	Machines & Mechanisms Materials Technology Mechatronics, Robotics & Controls Microtechnology & Nanotechnology Solid Mechanics Thermal Science & Engineering Transportation Systems
CFDSC Symposia	Computational Methods & Model Development Canonical Flows, Flow Physics & Turbulence	Compressible & Multiphysics Flows Applications of CFD
CSR Symposia	Biorheology Non-Newtonian fluid mechanics Materials and polymer processing	Applied rheology and rheometry Soft Matter and Interfaces

THIS YEAR THE CSME-CFDSC-CSR 2025 International Congress was held in the vibrant downtown Montréal campus of École de technologie supérieure (ÉTS) from May 25 to 28, 2025. The congress saw a record high of nearly 800 participants, demonstrating the growing interest from the CSME, CFDSC and CSR communities. The program was full of interesting topics and discussions in the broad field of mechanical engineering, showcasing the strength and quality of our Canadian research community.

Almost 600 abstract/papers were presented in 16 parallel sessions over the three full days of the congress. The congress featured 6 plenary events, including four academic plenary speakers, one industrial perspective talk by Ansys, nine industrial spotlights, and a panel on the emerging role of AI in engineering hosted by the Engineering Institute of Canada (EIC). The insightful research contributions and vision of 20 invited keynote speakers were shared across the CSME, CFDSC, and CSR communities. In parallel to the sessions, the congress hosted seven panels/workshops on topics including equity diversity and inclusion (EDI), entrepreneurship, academic writing, artificial intelligence (AI) in academia, and research grants. During lunch, ÉTS provided guided tours of their laboratories and research infrastructure.

New this year was a stronger involvement of industrial partners in the technical program, aimed at highlighting current needs and challenges across the broad field of mechanical engineering. Indeed, the implication of our industrial partners this year has been outstanding, both in terms of their support and their contribution to the program, including 26 sponsorships, 20 exhibition booths, nine business pitches over lunch featuring their innovative activities, a strong implication in the plenary events and panels/workshops, as well as three post-congress workshops.

Social events for networking and discussion were planned throughout the congress. The welcome reception provided a perfect opportunity for participants to gather together over a cocktail after their travels to Montréal. A student mixer for students and postdoctoral fellows followed at the Brasserie Memento located along the scenic Lachine Canal, seeing about 160 participants enjoying various activities including arcade games, foosball, ping pong, and darts. The first full day of the congress ended with a networking cocktail, allowing attendees to mingle with live music by a renowned artist in the background. The traditional banquet and awards ceremony was held at Le Belvédère, located within the historic Old Port of Montréal, and saw over 350 participants (including almost 200 students) enjoy delicious local food and entertainment by a master magician!

International Congress 2025



CONGRESS VOLUNTEERS AND VENUE



In closing, the congress organizers would like to once again thank all the volunteers, support staff, and symposia chairs for all their important and hidden work that goes into organizing a memorable congress. Likewise, the organizers would like to thank all sponsors whose contributions continue to have a significant impact on what our communities can offer in this thriving annual congress.

Co-Chairs CSME-CFDSC-CSR 2025:



LUCAS A. HOF, ANTOINE TAHAN, GIUSEPPE DI LABBIO



SÉBASTIEN LALONDE, MARLÈNE SANJOSÉ, and NICOLE R. DEMARQUETTE

Advanced Energy Systems

- There were seven sessions in the Symposium on Advanced Energy Systems in the CSME International Congress 2025. We had a total of 44 talks, including a keynote presentation by Professor Gaixia Zhang from École de technologie supérieure.
- We had a hybrid TC meeting during the Congress, including both professional and student members of the TC. We discussed potential activities of interests and methods to increase the engagement among members.
- We continue to organize Advanced Energy Systems Webinars. Recent invited speakers include Dr. Ana Silva from University of Minho, Portugal and Dr. Orestes Rivada-Wheleghan from Universidad de Sevilla, Spain. – *Dr. Xiaoyu Wu, MCSME*

Environmental Engineering

- Prof. Lexuan Zhong and Prof. Ofelia Jianu serve as Chair and Vice-Chair of the TC on Environmental Engineering.
- Welcomed three new TC members: Prof. Marina Freire-Gormaly (York University), Prof. Guangming Wang (Shandong Agricultural University), and Prof. Ramona Fayazfar (Ontario Tech University).
- Supporting the Symposium on Environmental Engineering at the 2025 CSME Congress, École de technologie supérieure (ÉTS), May 25–28, 2025.
- Updated the TC Environmental Engineering webpage. — *Dr. Lexuan Zhong, MCSME*

Fluid Mechanics

- Dr. Dana Grecov from the University of British Columbia has served as the Chair, and Dr. Fabian Denner from Polytechnique Montréal has served as the Vice-Chair of this TC since July 2023.
- The TC Chair and Vice-Chair are currently serving as the Co-Chairs for the Fluid Mechanics Engineering Symposium at the CSME 2026 Congress.
- The TC continued the CSME webinar series on Fluid Mechanics. The first webinar of this year will take place on November 13, featuring Dr. Liangzhu Leon Wang from Concordia University on the topic "AI for Urban Microclimate Engineering."
- The TC chair has served as an associate editor for TCSME. — *Dr. Dana Grecov, FCSME*

Manufacturing

Current activities:

1. Serving as an associate editor for the *Transactions of the Canadian Society for Mechanical Engineering* (TCSME).

Future activities:

1. Organizing the Manufacturing symposium at the 2026 CSME Congress at the University of British Columbia (UBC)
2. Continuing to serve as an associate editor for TCSME.
3. Continuing the CSME webinar series on Manufacturing, featuring both international and national invited speakers. – *Dr. Farbod Khameneifar, MCSME*

Materials Technology

Dr. Zengtao Chen, Chair of the Technical Committee, attended the CSME International Congress in Montreal from May 25–28, 2025. During the congress, he chaired two sessions of the Symposium on Materials Technology and one session of the Symposium on Engineering Analysis and Design. Dr. Almira Moosavi chaired another session of the Symposium on Materials Technology. Additionally, Dr. Chen participated in the TCSME Editorial Board Meeting held in conjunction with the conference.

Activities Planned for 2025–26

- Host the Materials Technology (MT) Symposium at the 2026 CSME International Congress in Vancouver.
- Attend the CSME Board Meeting and TCSME Editorial Board Meeting during the 2026 CSME International Congress.
- Organize one or two online seminars before the 2026 CSME International 2026 to facilitate knowledge exchange among MT Committee members and other relevant stakeholders. – *Dr. Zengtao Chen, FCSME*

Solid Mechanics

- Prof. Akbarzadeh served as the Chair of the Solid Mechanics Symposium at the CSME-CFDSC-CSR 2025 International Congress held in Montréal in May 2025.
- The Solid Mechanics Symposium featured a strong technical program with approximately 45 presentations covering diverse topics in solid mechanics.
- Prof. Daniel Theriault from the Department of Mechanical Engineering at Polytechnique Montréal delivered the Keynote Lecture in the symposium.
- Prof. Akbarzadeh participated as one of the evaluators for the CNC-organized competition led by Prof. Liying Jiang, recognizing the best presentation by junior researchers in solid mechanics.

I hope that everyone's ever-busy fall has started off great, and summer went well. The Student Affairs Committee has been busy fielding significant interest in establishing Local Student Chapters and with the National Design Competition. While at the Annual Congress in Montreal, hosted by École de Technologie Supérieure (ÉTS), there were many great opportunities to discuss student engagement in the CSME and potential future activities. We've now grown to eight active Local Student Chapters with additions of Memorial University of Newfoundland, and University of Manitoba. In the year ahead we will look to promote local events as well as networking between chapters to increase student presence within CSME. As always, I encourage anyone interested in becoming more involved with the CSME Student Affairs Committee to reach out to me for further discussion (dromanyak@ualberta.ca).

The 2025 National Design Competition was a huge success! Thanks to efforts from Dr. Grant McSorley and the active network of our student members, we are thrilled to report that there were 42 entries, spanning 20 different schools, to this year's competition. We'd like to congratulate the following winners in the three different categories:

— **Sustainability:** TRASH-E, submitted by Elhan Iqbal, Brandon Jong, Viktor Moreno, Simone Saini, and Clark Zhang (University of British Columbia).

— **Commercial Readiness:** Auto Ergometer, submitted by Isabella Walker, Manahil Malik, Kiera Orr-Casbourne, and Sebastien Rancœur (University of Guelph)

— **Technical Excellence:** Carbon-Carbon Hybrid Rocket Fuel Mixing Plate, submitted by Caleb Assen, Pierre André Dawe, Samier Al Hattab, Juan Alvarez Ramirez, Robert Lee, and Christian Daniel Magsombol (University of Calgary)

We are already looking forward to the 2026 National Design Competition, and any interested students are encouraged to contact Dr. McSorley directly (gmsorley@upei.ca).

— *Dr. Dan Romanyak, MCSME*

- Prof. Akbarzadeh continues to serve as an Associate Editor of the *Transactions of the Canadian Society for Mechanical Engineering* for manuscripts related to solid mechanics and manufacturing. — *Dr. Hamid Akbarzadeh, FCSME*

OVERVIEW OF INNOVATION DIRECTIONS IN AEROSPACE TRANSPORT

THE AEROSPACE INDUSTRY IS RAPIDLY MOVING towards sustainability, motivated by the target for net-zero emissions by 2050, set by the International Civil Aviation Organization (ICAO) through its Long-Term Global Aspirational Goal (LTAG). As decarbonization is a critical need in aerospace, the demand for more efficient air transport continues to drive the search for innovative approaches. This article provides an overview of three innovative approaches (i.e., sustainable aviation fuel (SAF), hydrogen propulsion, and advanced air mobility (AAM)), and highlights both their potential to reshape the aerospace sector and the challenges associated with their implementation.

Currently, SAF stands out as the most commercially viable decarbonization strategy. SAF is obtained from renewable sources and operates like conventional jet fuel but with significantly lower carbon emissions. Figure 1 shows the production cycle of SAF, highlighting the stages from feedstock growth to its use in flight. The biggest advantage of SAF is its compatibility with existing systems. SAF can be blended with conventional jet fuel, often up to 100%, without requiring changes to aircraft engines¹. This drop-in quality makes it a practical bridge technology while more transformative innovations continue to mature. ICAO reports that more than 360,000 commercial flights have used SAF, with supply available in over 40 airports². Research is pushing SAF in new directions as well. Beyond conventional biofuels, the National Renewable

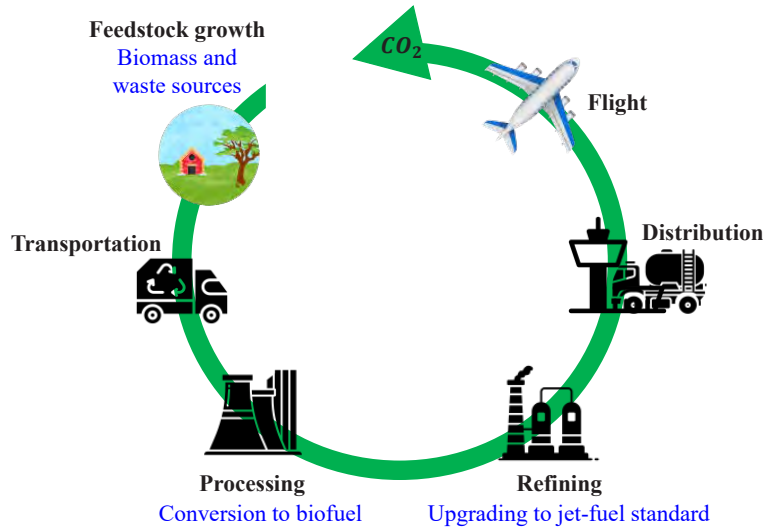


FIG. 1: PRODUCTION CYCLE OF SUSTAINABLE AVIATION FUEL (SAF).

Energy Laboratory is developing processes that use wet waste³, while the Pacific Northwest National Laboratory is exploring methods to convert carbon-rich waste gases to SAF¹. Initiatives like these suggest SAF may play a greater role in connecting aviation with circular economy principles. However, the conversation cannot stop at technical feasibility. The production of SAF raises important social and environmental questions such as where does the feedstock come from? How is it cultivated? To what extent might large-scale production compete with food systems, land use, or community resources? Ad-

ressing these concerns requires viewing SAF as part of a broader innovation cycle. As production scales, the goal is to refine processes, diversify feedstocks, and adopt cleaner energy inputs so that emission reductions are realized across the entire production cycle. Despite these challenges, SAF is currently the most deployable solution, providing a viable pathway for today's fleets to move toward a lower-carbon future. Its long-term success, however, will depend on ensuring that the social and environmental costs of its production are transparently addressed.



KEZIAH HAMMOND

Hammond is a Master of Applied Science student in the Department of Mechanical, Industrial and Aerospace Engineering at Concordia University. As a member of the Concordia Turbulence Research Laboratory (CTRL), she studies active flow control using synthetic jets for aerodynamic drag reduction and thermal management to lower carbon footprints in aerospace and mechanical applications. She has presented her work at international conferences, published in peer-reviewed high-impact journals, and serves as a teaching assistant in Fluid Mechanics. Passionate about STEM outreach, Keziah mentors young students in coding and innovation.



CAROLE EL AYOUBI, PhD, P. Eng.

Dr. El Ayoubi is a Senior Lecturer in the Department of Mechanical, Industrial, and Aerospace Engineering at Concordia University, and the Undergraduate Director of Mechanical and Aerospace programs. She also serves as Director of Education at the Concordia Institute of Aerospace Design and Innovation (CIADI) and Director of Training for the SDG Innovation Network – Advanced Air Mobility Institute (AAMI). A former Pratt & Whitney Canada engineer, her work bridges academia and industry through experiential learning, decarbonization, and digitalization. She is the creator of two professional microprograms on Decarbonization of Aerospace and Emerging Cybertechnologies in Aerospace.



EBENEZER EKOW ESSEL, PhD, P. Eng.

Dr. Essel is an Assistant Professor in the Department of Mechanical, Industrial, and Aerospace Engineering at Concordia University and Director of the Concordia Turbulence Research Laboratory (CTRL). He earned his PhD from the University of Manitoba and completed an NSERC Postdoctoral Fellowship at the University of Windsor, followed by a Mitacs Accelerate Fellowship at the University of Toronto. He is also a member of the CSME Technical Committee on Fluid Mechanics and the Scientific Committee of CIADI. Dr. Essel's research integrates experiments, computational fluid dynamics, and machine learning to develop innovative flow control strategies for aerodynamic drag reduction, thermal management, and decarbonization in aerospace and transportation.

While SAF serves as a near-term solution, hydrogen propulsion is widely viewed as the most transformative long-term pathway. Hydrogen can be used to power aircraft in two main ways: through fuel cells that generate electricity or by direct combustion in modified gas turbines. Airbus and ElringKlinger ran a 1.2 MW hydrogen fuel cell demonstrator, and the project has since attracted partners, including airports, airlines, and energy providers.⁴ ZeroAvia, H2FLY, Cranfield Aerospace Solutions, and Stralis Aircraft are also testing different hydrogen-powered aircraft designs.⁵ In spite of all these advances, significant barriers remain. First is the type of hydrogen being produced: today's supply is mostly "grey" or "blue", derived from natural gas with varying levels of carbon capture, while true climate benefits demand scaling "green" hydrogen produced from renewable electricity.⁵ Infrastructure is one of the biggest hurdles for hydrogen aviation as well. The fuel has to be stored at extremely low temperatures, which means tanks, pumps, pipelines, and fueling systems all need to be redesigned. Airports would have to rethink fueling logistics, turnaround procedures, and even gate assignments to handle hydrogen safely. On the aircraft, engines would need redesigns, and material limits have to be addressed. Burning green hydrogen produces no carbon, but it can still create nitrogen oxides (NO_x) when flames get hot. The high flame speed and low ignition threshold of hydrogen also raise concerns about knock and flashback in both gas turbines and piston engines, requiring improved cooling strategies and innovative combustor designs.⁶ There are also environmental questions. While water vapor is the main by-product of hydrogen combustion, studies suggest contrails at cruising altitudes could still contribute to climate effects.³ Though these challenges exist, hydrogen stands out as the most promising long-term route to decarbonization in aviation, provided that its production and deployment are managed in ways that uphold both environmental and social standards.

Advanced Air Mobility (AAM) is both a technological advancement and the emergence of a new aviation market. By enabling electric and hybrid-electric aircraft, particularly electric vertical takeoff and landing (eVTOL) systems, AAM promises faster and cleaner urban transport, improved regional connectivity, and new emergency response capabilities. Joby Aviation, Volocopter, Vertical Aerospace, Eve, and EHang are leading companies of this shift. AAM's success, however, will hinge on how technological innovation aligns with societal and environmental priorities. Beyond flight efficiency, integration depends on public confidence in new mobility systems, including perceptions of safety, privacy, and noise from AAM aircraft. Building this trust is as critical to reducing emissions, since social acceptance determines whether these technologies can be responsibly scaled in cities. Also, operating thousands of

small aircraft requires charging infrastructure, vertiports, and integration with air traffic systems investments that may strain municipalities already challenged by housing and transport costs. On the regulatory side, the technology has outpaced certification and safety frameworks. Governments are beginning to respond though; and Transport Canada has placed AAM on its policy agenda. It has published an Advanced Air Mobility Aircraft Type Certification Roadmap, jointly with other national aviation authorities, to harmonize how emerging aircraft types such as eVTOLs will be certified. In parallel, the Canadian Advanced Air Mobility Consortium (CAAMC) has assembled over 70 partners from aerospace, government, and academia to coordinate trials and push the adoption of AAM.

The future of air travel won't be defined by a single breakthrough but by several innovations working side by side. Sustainable aviation fuels give us a way to reduce emissions now. Hydrogen propulsion, though still developing, has the strong potential to reshape aviation in the long run, and advanced air mobility is opening up new options for moving people within cities and across regions. To judge real progress, we have to look at the entire lifecycle, i.e., how these technologies are produced, how they operate day to day, and what happens at the end of their use. They need to be safe, affordable, environmentally friendly, and something society is willing to accept. That kind of change doesn't happen on its own. Governments and certification agencies need to set clear rules, industry has to create solutions that can scale safely, and communities must be part of the conversation about trade-offs and implementations.

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SURFACE GUSTS SIMULATIONS FOR AERO-VEHICLES



HORIA HANGAN, PhD, P.Eng., FCSME

Dr. Hangan graduated from "Politehnica" University Bucharest in 1985 and served as Senior Research Scientist at the Romanian National Institute of Science. He began his PhD at École Polytechnique Fédérale de Lausanne, then moved to Canada in 1992 and obtained his PhD at Western University in 1996. After a postdoctoral fellowship at the Université de Poitiers, he started his academic career at Western where he served as Research Director of the Boundary Layer Wind Tunnel Laboratory from 2000 to 2011. In 2009, he pioneered the design of the Wind Engineering, Energy and Environment (WindEEE) Dome and served as the Founding Director of the WindEEE Research Institute until 2021 when he received a Canada Research Chair Tier 1 in Aerodynamic Adaptation at Ontario Tech University. He conducts research related to the action of weather stressors (e.g. wind, rain, snow, ice) on civil and structural engineering, wind energy, automotive and aerospace applications.



CLÉMENT ROUAIX, PhD

Dr. Rouaix is a postdoctoral fellow at Ontario Tech University. He holds an Engineering Diploma in Mechanical Engineering and Aerospace Sciences, and a master's degree in Fluid Dynamics and Heat Transfer, both from the University of Toulouse, France. In 2025, he completed a joint PhD under a dual degree agreement between the Institut National Polytechnique de Toulouse and Ontario Tech University, focusing on wing aerodynamics and novel bioinspired morphing concepts through High-Fidelity numerical simulation and towards reduction of aviation's environmental impact. His current research includes fluid-structure interaction and focuses on gust effects over wings and their mitigation through adaptive aerodynamics concepts.

THE EFFECTS OF GUST WINDS ON AERO VEHICLES, including airplanes, helicopters, unmanned flying vehicles (UFVs) and low altitude electric vertical take-off and landing (eVTOL) vehicles are notoriously dangerous, especially during take-off or landing procedures. Crashes and aircraft incidents caused by gusts, microbursts and downbursts triggered recent numerical and experimental research (e.g. [1]) on gusts action and preliminary control for airplanes. While most of this research concerns gusts impacting an airplane in the cruise segment of flight, the effects of gusts near the ground, such as the action of microbursts and downbursts during take-off and landing phases, has not yet been addressed. Moreover, smaller and lighter UFVs and eVTOL aero-vehicles are impacted by up-drafts and downdrafts when flying over urban environments.

Herein we aim to define a new methodology combining: (a) an extended analytical characterization of surface gust flows; (b) implementation in numerical simulations and (c) the adoption of new wing morphing technology to mitigate their impact.

GUSTS MODELLING

In aviation, gusts are defined as sudden increase in wind speed with durations of 20 seconds or less and are mostly modelled based on the '1-cos' equation (1):

$$w_g(x) = w_{g0} \left(1 - \cos\left(\frac{2\pi x}{L_g}\right) \right) \quad (1)$$

with x being the position of the aircraft, w_g the variation of the gust velocity, w_{g0} the maximum value of the gust velocity, L_g the gust length. These gust functions can be applied either in the vertical or horizontal directions and both their length and intensity can be varied.

While this deterministic description of gusts is useful, it is mostly used to simulate turbulent gusts of relative small scales and duration (less than 20 sec) and it does not take into consideration any ground effects. Close to surface gusts, mostly in larger forms such as of microbursts or downburst with durations between 2 minutes and half hour, have a more complex spatio-temporal characterization. This is due to the complex interaction between the toroidal vortices (generated by the shear layer of the vertical downdrafts) and the surface.

Downbursts and microbursts can be modelled and simulated as dynamic impinging jets. The sudden inflow produces intense shear which triggers the formation of toroidal vortices (TV) which, after impacting the surface, change direction and begin travelling radially. A dynamic separation-reattachment bubble (SRB) is formed near the surface and produces intense stretching at the interface with the main toroidal vortices. This results in a maximum velocity (V_{max}) very close to the surface with an important vertical component, see Figure 1.

A typical decomposition of the space and time variation for downbursts winds is given by:

$$\underline{V}(z, t) = \underline{V}(z) \cdot \underline{V}(t) \quad (2)$$



FIG. 1: FLOW VISUALISATION OF DOWNBURST VORTEX INTERACTION WITH THE SURFACE AT WINDEEE DOME. THE VISUALIZATION SHOWS THE RIGHT RADIAL SIDE OF THE DOWNBURST WITH TV THE TOROIDAL VORTEX, SRB THE SEPARATION-REATTACHMENT BUBBLE AND V_{max} THE MAXIMUM VELOCITY OCCURRENCE IN THE FLOW

FEATURE

The time varying component, $\underline{V}(t)$ can be approximated by a function similar to eq. (1) and with scale variations to include microbursts and downbursts.

The vertical profile, $\underline{V}(z)$, does not follow a typical boundary layer profile, instead having a “nose-like” shape with the maximum value close to the surface. Several models are available to reproduce this type of profiles.²

In addition, the effects of storm translation, accompanying boundary layer parent winds and surface roughness have been recently studied³ and can be incorporated in a generalized gust model for use in the context of low-altitude aero-vehicles flights.

GUST INTERACTION AND MORPHING

When an aero-vehicle in the take-off or landing phases encounters a downburst or microburst flow, it will be impacted downwards when crossing the centre region of the flow while being uplifted when crossing the updraft part of the flow. This double action can produce a control loss for the airplane.

Presently, numerical simulations are developed to simulate the European Union Safety Agency (EUSA) deterministic gust equation for the vertical velocity component described by equation (1) for several gust sizes. In order to further integrate the effect of the surface, various vertical profiles for the horizontal velocity $V(z)$ will be included such as linear shear, boundary layer, as well as typical downburst/microburst profile.

Further on, in order to control the impact of gusts on airplanes, a morphing strategy will be adopted. Morphing involves optimal dynamic wing shape deformation in real time and has been extensively studied during the last decade. Very recent numerical implementations of trailing edge morphing through the Navier Stokes Multi-Block (NSMB) implemented Spanwise Travelling Wave (STW) morphing involving both frequency and spanwise wavelength actuation over a certain trailing edge length.

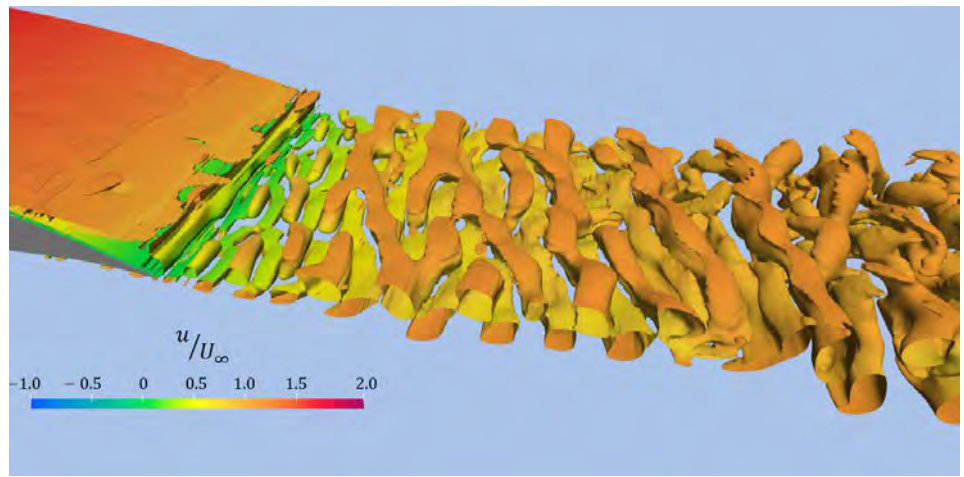


FIG. 2: Spanwise Travelling Wave (STW) Q-criterion isosurface ($Q = 1500s^{-2}$) coloured by the non-dimensional streamwise velocity u/U_∞ ; $f_a = 40 \text{ Hz}$; $\lambda_z/c = 0.21$ ($c = 70 \text{ cm}$, chord)

STW alters the near wake region producing spanwise dislocations of the upper and lower shear layer vorticity, as exemplified in Figure 2. As a result, mean performance increases, Figure 3a, and fluctuating forces decrease, Figure 3b, when actuating at relative low frequency and amplitude and at selected spanwise wavelengths.⁴

When passing through a microburst/downburst an airplane wing would be submitted to a downdraft (corresponding to the impinging part of the microburst) followed by an updraft corresponding to passage of the microburst toroidal vortices. In order to mitigate this impact, an extended trailing edge region of the wing will be actuated through STW morphing at relative low frequency but in antiphase with the microburst action.

CONCLUSIONS

The response to gusts acting on aero-vehicles is an important factor in assuring their flight safety. Recent studies address the action of gusts but only for cruise flight regime without the influence of the ground.

Surface gusts including downbursts and microbursts have a more complex spatio-temporal behaviour and produce incidents when occurring at the take-off or landing stages. A new modelling of gusts and microburst winds that includes the ground effect is introduced.

A new Spanwise Travelling Wave (STW) morphing has been developed and demonstrated performance improvement when the trailing edge is actuated at low frequencies and amplitudes and with spanwise modulation. This STW morphing will be used in an attempt to mitigate the alternative down lift and uplift acting on a wing passing through a vertical gust/microburst.

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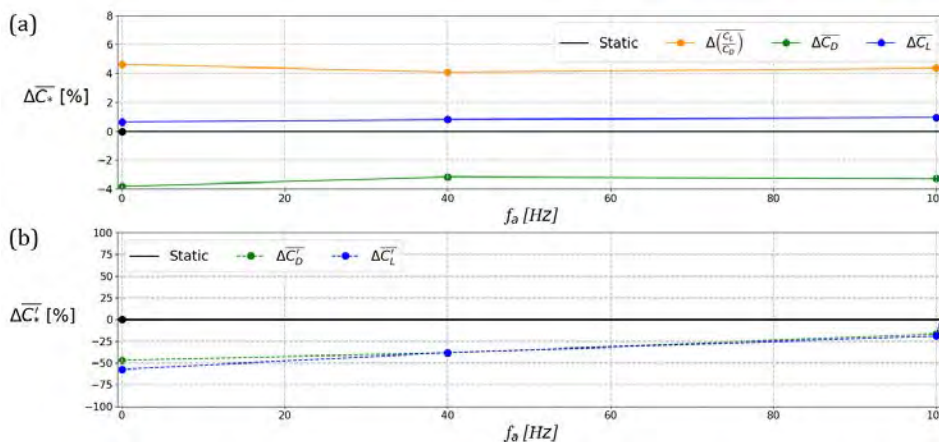


FIG. 3: MEAN PERFORMANCE COEFFICIENTS INCREASE (A) AND RMS DECREASE (B) AS FUNCTION OF THE ACTUATION FREQUENCY.

The Future of Advanced Air Mobility in Canada: A Practical and Safe Approach

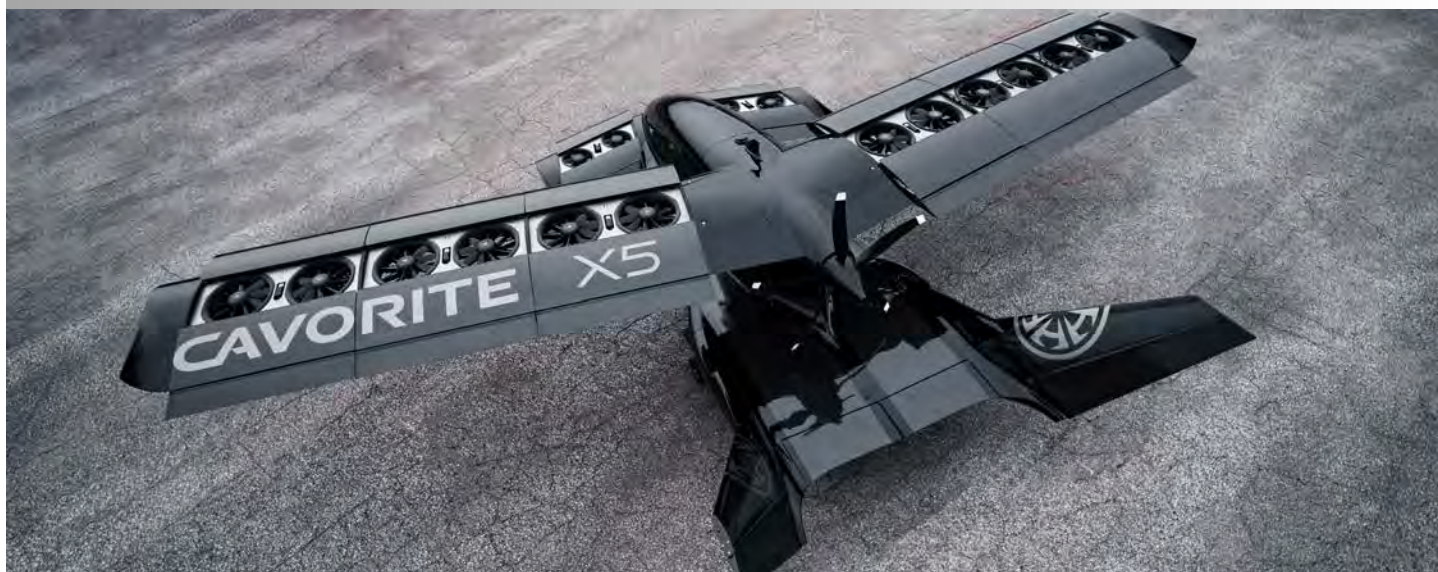


FIG. 1: LARGE-SCALE PROTOTYPE.



E. BRANDON ROBINSON BEng, MBA

Mr. Robinson is the Co-Founder and Chief Executive Officer of Horizon Aircraft Ltd., an advanced aerospace engineering company based in Lindsay, Ontario. For two decades Brandon served in the Royal Canadian Air Force as a CF-18 pilot after graduating Canada's Fighter Weapons Instructor Course. Brandon holds a Bachelor of Mechanical Engineering from Royal Military College, an MBA from Royal Roads University, an Airline Transport Pilot's License, and is the author of several aerospace patents. His military operational experience, engineering training, and MBA formed the ideal blend to co-found an aerospace company designing one of the world's first hybrid eVTOLs, leading a team of the world's most talented engineers right here in Canada.

ADVANCED AIR MOBILITY (AAM) REFERS

to integrated, novel modes of moving people, goods, and services by air using emerging aircraft and airspace services. Transport Canada defines AAM to encompass urban air mobility, short-range movements within and around cities, and regional air mobility that connects rural and remote communities, with potential benefits for economic growth, jobs, access, and sustainability.¹ Consistent with this scope, Canada has organized cross-departmental efforts, including an AAM integration team, and participates internationally through the International Civil Aviation Organization (ICAO) AAM Study Group, underscoring a pragmatic, safety-first policy environment. Achieving a rapid yet reliable path for novel AAM technologies requires a solid foundation with infrastructure and clearly defined regulations.²

NAV CANADA is focusing on providing safe and legal permissions to use drones. Its NAV Drone platform provides digital flight planning and authorizations in controlled airspace for Remotely Piloted Aircraft Systems (RPAS).³ In parallel, Transport Canada and industry partners continue RPAS Traffic Management (RTM) trials to demonstrate services such as automated approvals, real-time tracking, deconfliction, and airspace surveillance, essential precursors to scaled AAM operations. Recent Canadian trials have moved into interoperability testing, reflecting a stepwise progression from concept to operational data. In another infrastructure development, Québec-based VPorts plans for international electric AAM corridors, including Mirabel (QC) to Syracuse (NY), to explore vertiport operations, cross-border procedures, and charging readiness.⁴

Complementing these efforts, in April 2025 five national aviation authorities, including Transport Canada Civil Aviation (TCCA) and the Federal Aviation Administration (FAA), released the first joint "Roadmap for AAM Aircraft Type Certification," committing to performance-based requirements and multi-authority validation to streamline approval of new aircraft types. This is intended to maintain safety while reducing duplicative efforts as manufacturers pursue certification across jurisdictions.⁵ Although mentioned efforts are still progressing, the market already features a mix of cargo drones, piloted helicopters moving toward electrification, and early-stage electric Vertical Take-Off and Landing (eVTOL) and hybrid-eVTOL developers. Helijet, North America's longest-running helicopter airline, placed firm orders with BETA Technologies for its ALIA eVTOL and positioned itself to be Canada's first air carrier to offer passenger and cargo eVTOL services, an important demand signal for zero-emission short-haul operations on the West Coast.⁶

Extending this early market development, cargo-first use cases are maturing. Drone Delivery Canada's "Care by Air" program, run with partners including DSV, Air Canada Cargo, and McMaster University, established routes to move medical supplies and isotopes between logistics hubs and hospitals, advancing procedures, and safety cases. The company subsequently merged with Volatus Aerospace, consolidating capabilities and signaling a move toward scale.⁷

FEATURE

AAM in Canada

Canadian innovators are contributing beyond helicopters and small drones. British Columbia's Harbour Air, one of the world's largest all-seaplane airlines, is on a mission to be the world's first all-electric commercial airline. Testing of the retrofitted DHC-2 De Havilland Beaver all-electric seaplane is underway, and Harbour Air is currently undergoing the certification and approval process with the FAA and Transport Canada.⁸

Ontario's Horizon Aircraft (NASDAQ: HOVR) is developing one of the world's first hybrid eVTOLs. We are currently working on our full-scale prototype, the Cavorite X7, designing it for real-world emergency, military, and commercial operations. Carrying up to 6 passengers and one pilot, the aircraft will fly most of its mission like a conventional airplane using hybrid gas/electric power. It is projected to fly faster (450 km/h), farther (800 km), and carry more (1500 lbs) than other eVTOLs. It will be up to 75% cheaper per kilometer to operate and have reduced hydrocarbon emissions by more than 60% compared to conventional helicopters conducting similar operations. During flight, a thermal engine drives a pusher propulsor to recharge the battery system, giving the aircraft independence from ground charging infrastructure.

Our patented HOVR system embeds 14 electric lift fans within the wings and canards. During vertical flight, sliding panels open to expose the fans; once at a safe speed and altitude, the panels close and the aircraft reverts to a clean, fixed-wing configuration. In May 2025 we successfully performed a full-wing transition flight of our large-scale prototype, validating our "fan-in-wing" approach and placing Horizon Aircraft in a very small group of companies worldwide that have achieved this significant technical milestone.

While developing our unique aircraft, safety is paramount. In testing, our large-scale prototype has hovered with 30% of lift fans disabled, underscoring fault tolerance in the hover regime. The X7 will also have the capability to take off and land like a conventional airplane if needed. Once our full-scale prototype is completed, we plan to certify it to fly under Instrument Flight Rules (IFR) and for Flight Into Known Icing (FIKI), a rare certification across early concept eVTOLs and helicopters in the market.

CALL TO ACTION

Looking ahead, AAM's near-term Canadian trajectory is likely to emphasize practical, certified missions that complement existing aviation. On the West Coast, Helijet's planned adoption of eVTOLs signals how legacy operators can decarbonize established routes; in Ontario, medical logistics flights have shown how drones can move critical supplies predictably. In Québec, corridor initiatives are mapping how Vports and procedures could connect regions. Against this backdrop, a long-range hybrid-eVTOL such as



FIG. 2: PATENTED HOVR WING WITH ELECTRIC LIFT FANS.

the Cavorite X7 will offer dramatically improved operational flexibility, response times, efficiencies, and costs across a diverse range of flight missions.

In summary, Canada's AAM pathway is pragmatic: build enabling services and rules, validate aircraft with safety-critical testing and redundancy, and deploy where the technology can solve real problems. Stakeholders across government, airports, health systems, and events should continue partnering with experienced operators and manufacturers. By matching use cases with proven capabilities, measuring outcomes, and iterating, Canada's progress in advanced air mobility can continue. The time to plan safe, standards-based demonstrations that augment existing transport, without over-promising, has arrived.

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Planning and Control of UAV-Slung-Load Systems for Efficient and Smarter Aerial Transportation



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JUNJIE KANG, PhD
Dr. Kang received his PhD degree in space engineering from York University in 2020. He is currently a Postdoctoral Fellow with the Department of Earth and Space Science & Engineering, York University. His research interests include dynamics and control of space tethered system, UAVs and nonlinear underactuated system.

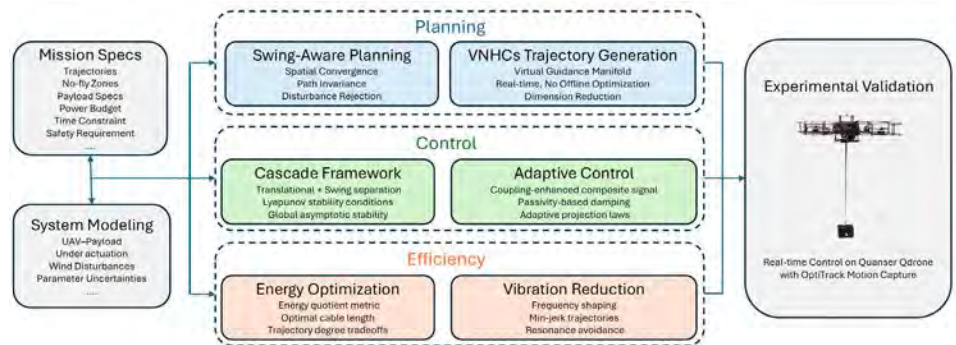


FIG. 1. ARCHITECTURE OF THE UAV-SLUNG-PAYLOAD FRAMEWORK WITH PLANNING, CONTROL, AND EFFICIENCY MODULES.

UNMANNED AERIAL VEHICLES (UAVS) HAVE seen substantial progress in the past few decades, making them capable of autonomous operation in environments that are uncertain or inaccessible, such as narrow industrial sites, forested or cluttered areas, post-disaster zones with blocked access, or hazardous facilities where human presence is restricted. Aerial transportation has emerged as an important application, with UAVs studied for their ability to deliver cargo safely and efficiently in real-world conditions.¹ Several transport methods are available for UAVs, including mounting systems together with passive and active manipulators, all of which provide the means to move supplies and equipment to places with restricted ground access or severe time constraints. Among various transport methods, cable-suspended or slung payload systems have attracted considerable research interest²⁻⁴, as they allow UAVs to transport loads without rigid mechanical connections or specialized grippers. This setup is simple and versatile for different payloads, while at the same time introducing strong dynamic effects that must be handled carefully in controller design.

Dynamics of the UAV-slung-load system introduces new challenges: the swing adds extra degrees of freedom, and the payload's motion couples with the airframe through the cable, resulting in an underactuated configuration.⁴ Aggressive maneuvers often excite payload oscillations, which reduce tracking accuracy and stability and add nonlinear effects, while factors such as wind, payload instabilities, and uncertain parameters further challenge control design. In addition, the onboard power capacity places limits on mission duration and allowable payload mass, and the suspended load alters the UAV's dynamic response. Therefore, ensuring safe and accurate operation requires more capable control and planning methods.

RESEARCH SCOPE: PLANNING, CONTROL, AND

EFFICIENCY

Our research contributes to three key areas, namely advancing both theoretical foundations and practical implementation through swing-aware planning and path invariance, improving robust and adaptive control, and enhancing energy efficiency and vibration reduction in aerial transportation using UAV-payload systems. Fig. 1 provides a detailed overview of the key contributions and their integration within the overall framework.

Swing-Aware Planning and Path Invariance
We introduced path-invariant controllers that ensure payload convergence to a desired spatial path and its maintenance during operation.² Unlike time-parametrized trajectories, the path is treated as an invariant set, allowing the system to move along it at its own rate even in the presence of disturbances.³ In addition, we developed a real-time trajectory generation method based on virtual nonholonomic constraints (VNHCs)^{5,6}, which act as guidance manifolds that reduce the high-dimensional dynamics to a lower-dimensional form while preserving the desired swing behavior. This approach produces smooth, swing-suppressing trajectories, guarantees asymptotic stability without relying on small-angle assumptions, and demonstrates robustness to variations in the initial conditions.

ROBUST AND ADAPTIVE CONTROL

A key challenge in UAV payload systems is ensuring stable performance for both the swinging payload and the UAV across the entire configuration space. To address this, we introduced a control framework that separates the overall system into translational and swing subsystems, using a cascade structure to design controllers for each.⁴ This framework enables the use of the full nonlinear dynamics without relying on small-angle approximations and provides a unified basis for a range of existing controllers. As shown in Fig. 2, the cascade design main-

FEATURE

tains accurate position tracking as it actively reduces payload swing. To further enhance robustness, we introduced a coupling-enhanced adaptive controller⁷ that incorporates swing states through a composite signal formed from position error and swing-angle information. This improves control over the coupled UAV–payload system, yielding stronger attenuation of oscillatory motion. The controller updates parameter estimates online when cable length or payload properties vary, keeping them bounded and the control inputs smooth. As a result, trajectory tracking remains reliable under uncertainties or external disturbances.

ENERGY EFFICIENCY AND VIBRATION REDUCTION

Onboard power is one of the main constraints in aerial transportation systems, making energy efficiency an important factor in controller and trajectory design. We analyzed system energy consumption using an energy quotient that enables trajectory comparison without detailed motor or propeller models.⁸ This analysis showed that higher-degree polynomial trajectories increase energy consumption, and that an optimal cable length exists that reduces swing-related losses and thrust demand. In addition to energy considerations, vibration behavior was analyzed by modeling the payload as a base-excited pendulum and shaping the trajectory to avoid resonance with its natural frequencies. To limit swing, minimum-jerk trajectories with lower peak acceleration were used⁹, resulting in smoother motion, reduced oscillations, and lower energy use.

EXPERIMENTAL VALIDATION

To validate the theoretical contributions presented in this work, experiments were carried out in the Spacecraft Dynamics Control and Navigation Laboratory (SDCNLab), which features the York Research Facility for Autonomous Unmanned Vehicles (YU-AUV). This environment offers integrated aerial and ground platforms together with a high-precision motion capture system, creating a versatile setting for autonomous systems research (Figure 3). For this study, a Quanser's QDrone quadrotor with a cable-suspended payload was employed. Real-time pose estimation of both the UAV and the payload was obtained using an OptiTrack motion capture system, while control commands were sent wirelessly. This setup made it possible to test the path-invariant controllers, swing-aware planning methods, and adaptive control strategies, showing that the proposed approaches work in practice. Additional demonstrations and video results are available on the Lab's YouTube channel:

www.youtube.com/@sdcnlaborku.

OUTLOOK AND FUTURE DIRECTIONS

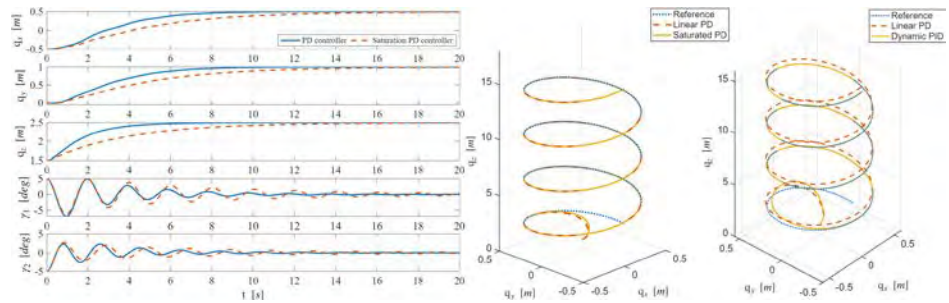


FIG. 2: CASCADE ROBUST CONTROL PERFORMANCE: POSITION TRACKING AND PAYLOAD SWING ATTENUATION ON STEP AND SPIRAL REFERENCES. ADAPTED FROM.⁴

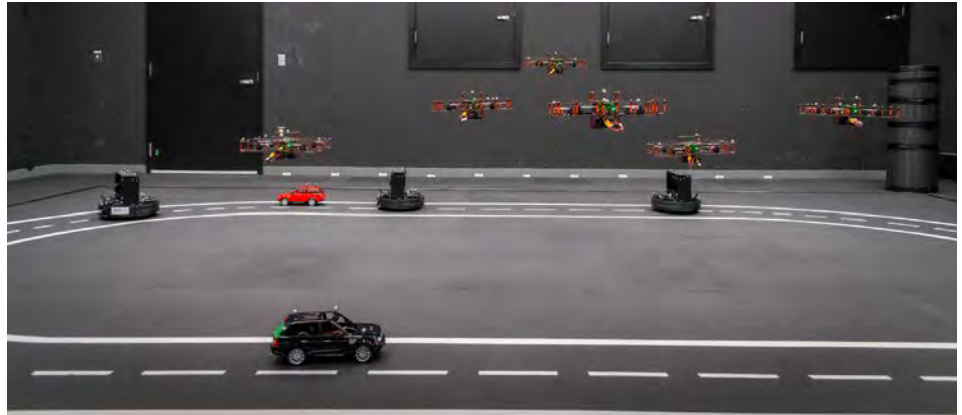


FIG. 3: SPACECRAFT DYNAMICS CONTROL AND NAVIGATION LABORATORY (SDCNLAB), THE HOST OF THE YORK RESEARCH FACILITY FOR AUTONOMOUS UNMANNED VEHICLES (YU-AUV).

A key priority of our work is a detailed safety analysis of payload transportation, as guaranteeing that both the UAV and the suspended payload remain within safe operating envelopes is essential for real-world deployment. Building on our stability and energy results, we aim to formally certify collision-free behavior. Future work will explore learning-based updates to the controller and the use of onboard perception for collision awareness. Equipped with such capabilities, the system can operate dependably in cluttered environments and adjust trajectories autonomously. Together these directions move toward a more autonomous, efficient, and safe transportation system.

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Building Canada's Aerospace Leadership through Training and Collaboration

CANADA'S AEROSPACE INDUSTRY STANDS

at a pivotal moment. Global aviation is undergoing one of the most profound transitions in its history, as the sector shifts toward carbon neutral solutions in response to climate imperatives, competitive pressures, and new international regulations. Canada has committed to achieving net zero by 2050^{1,2} mainly with the use of sustainable aviation fuels (see Figure 1), and aerospace will play a central role in meeting this target. Success will demand not only advances in sustainable propulsion systems and lightweight materials but also a steady supply of highly qualified personnel (HQP) trained to design, test, and implement these innovations.

Canada's aerospace sector has long been a source of national pride and economic strength. It contributes more than 30 billion dollars³ annually to the economy, supports over 200,000 jobs³ (see Figure 2), and ranks among the top five global aerospace nations.

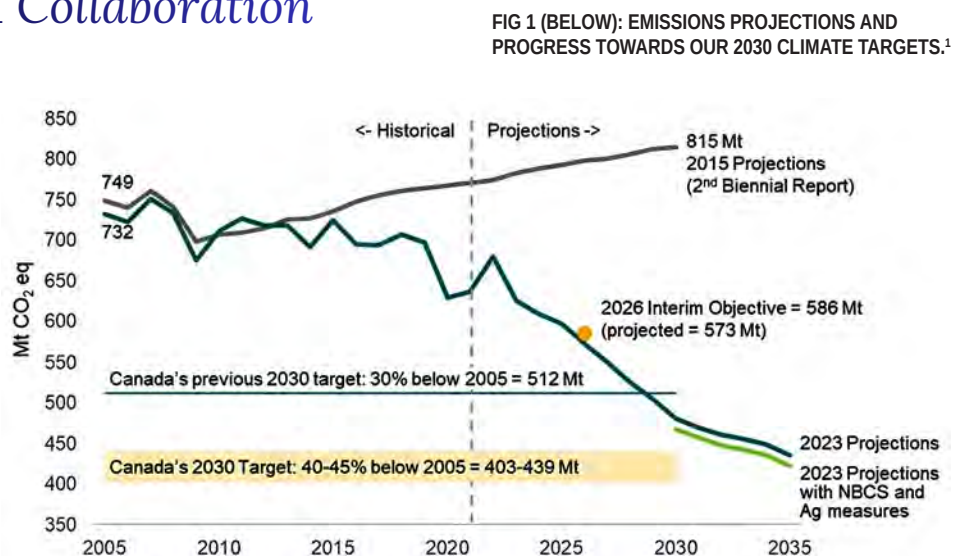
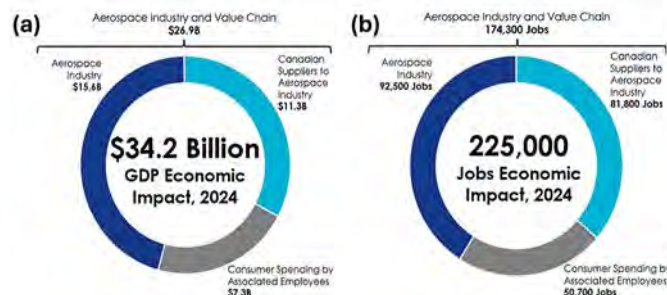


FIG. 2 (BELOW LEFT): (A) AEROSPACE INDUSTRY CONTRIBUTION TO GDP, 2024 AND (B) AEROSPACE INDUSTRY CONTRIBUTION TO JOBS, 2024. 3 PROJECTIONS AND PROGRESS TOWARDS OUR 2030 CLIMATE TARGETS.¹



Montreal has traditionally anchored this leadership, with Bombardier, Pratt & Whitney, Héroux Devtek, Air Canada, Polycontrols, and CMC Electronics driving industrial and technological development. Supported by world-class institutions such as Concordia University, Polytechnique Montréal, and McGill University, Montreal has built one of the few aerospace clusters worldwide that integrates design, testing, and manufacturing. A prime example, Concordia Institute for Aerospace Design and Innovation (CIADI), and the departments of Chemical and Materials Engineering (CME) and Mechanical Engineering demonstrate how universities can align innovative research and training with the needs of industry. By forming partnership, international collaboration, and student participation, these institutes propel both technological innovation and workforce development.



PHILIP EGBERTS, PhD, P. Eng.

Dr. Egberts obtained his PhD from the McGill University in 2011. Following his PhD studies, he studied at University of Pennsylvania where he held a Natural Sciences and Engineering Research Council Postdoctoral Fellowship. He joined the University of Calgary in 2013 and promoted to Professor in 2023. From 2019-2020 he was a visiting professor and Humboldt Fellow at the University of Hamburg. He was appointed Acting Head of the Department of Mechanical and Manufacturing Engineering in 2022/2023 and 2025/2026, as well as Associate Dean in 2024-2025. His current research interests focus on atomic and nanoscale investigation of adhesion, friction, and wear, as well as linking fundamental study of friction and lubrication with application.



PAYANK PATEL, PhD

Dr. Patel is a Postdoctoral Researcher in the Department of Mechanical, Industrial, and Aerospace Engineering at Concordia University, Canada. He completed his PhD through a collaborative program between Concordia University and McGill University, Canada, where his research focused on the development, characterization, and performance assessment of high entropy coatings for extreme environments. His work bridges materials science and tribology, emphasizing the design of advanced coatings and surface engineering for sustainable aerospace applications, such as next generation gas turbine engines. He also serves as a tribology subject matter expert, guiding HQPs to achieve their academic and scientific goals.



PANTCHO STOYANOV, PhD

Dr. Stoyanov is an Associate Professor in the Department of Chemical and Materials Engineering at Concordia University. He received his BSc in Materials Engineering from the University of California, Santa Barbara, and his PhD from McGill specializing in the micro- and in situ tribology of aerospace coatings. He has over 15 years of academic and industrial experience in aerospace coatings, tribology, surface characterization, and material solutions for sealing and bearing technologies in demanding environments. He was previously a Principal Engineer and Subject Matter Expert at Pratt & Whitney, leading tribology programs from discovery through development and commercialization. He has authored or co-authored over 85 publications and holds 58 patents with 86 applications.

On the other hand, Western Canada has traditionally lagged behind in aerospace engineering industry development (see Figure 3). However, Calgary has significant engineering expertise and is often referred to as the “Engineering Capital” of Canada and is now leveraging its engineering expertise to diversify into aerospace. Moreover, Calgary is located in close proximity to several testing facilities (e.g., Foremost UAS Test Range, CFB Cold Lake, and DRDC Suffield). Calgary is also the first major city in North America to allow mass testing of commercial drones. Several companies such as De Havilland, Lockheed Martin CDL, Raytheon Technologies, Canadian UAVS, and WestJet now have a strong presence, while the 2024 launch of the Aerospace Innovation Hub, a collaboration between the University of Calgary, Innovate Calgary, Prairies Economic Development Canada, and the City of Calgary, underscores the region’s growing role.

The University of Calgary, in collaboration with Concordia University, is working not only to connect these two regional strengths but also to build a Pan-Canadian aerospace network. Together, they are working on use of sustainable aerospace materials, training highly qualified personnel (HQP), and creating a trans-Canadian network that connects research excellence with industry needs. Through collaboration of Montreal’s well-established aerospace industrial strength with Calgary’s evolving industrial base, will position Canada as a global leader in decarbonizing the aerospace industry.

EVOLVING PRIORITIES IN CANADA’S AEROSPACE SECTOR

Canada’s aerospace sector, while a source of national pride and economic strength, faces increasing pressure to reduce greenhouse gas emissions, lower operating costs, and enhance safety. Meeting these demands requires advances in:

- The development of advanced materials and coatings to extend component life under extreme conditions.
- The introduction of eco-friendly sustainable lubricants to minimize energy losses and improve tribological performance of next generation gas turbine engines.
- Hydrogen-compatible systems designed to operate at elevated temperatures and pressures for propulsion and storage.⁴
- The use of additive manufacturing for lightweight, cost-effective components.
- The integration of predictive maintenance and digital tools to improve reliability and reduce downtime.

All these technological needs reflect global trends toward decarbonized aviation and strongly signal the need for a highly qualified workforce capable of bridging science and application.



FIG. 3: SHARE OF CANADIAN AEROSPACE INDUSTRY EMPLOYMENT BY REGION, 2024.³

WHY ACADEMIA MUST STEP IN

In addition to moving forward technical innovation, university-led programs and partnerships can also tackle systematic challenges that Canada is facing in STEM fields. The declining interest in STEM disciplines⁵, particularly among students in Alberta, could limit future economic growth. As a number of jobs in conventional energy sectors go down with the transition to low-carbon technologies, the aerospace field gives a good chance to retrain current engineers and encourage new HQP to enter into growing areas. Without a strong network of HQP trained in these areas, Canada risks losing its competitive edge. Industry and academia both drive aerospace innovation forward in Canada, each contributing in their own way. Companies focus on meeting production goals, following regulations, and launching new technologies. At the same time, universities support foundational research, come up with innovative solutions, and train future engineers that drive long-term progress. Collaborative initiatives such as undergraduate and graduate internships, co-supervised research projects, and industrial fellowships foster two-way knowledge exchange, ensuring that research remains relevant and that students gain hands-on experience with real-world challenges. Equally important, professional development and communication training prepare engineers not only to design and implement technical solutions but also to engage effectively with industry leaders, policymakers, and the public. Such collaborations between academia and industry create a workforce that is not only technically skilled but also adaptable and prepared to tackle new challenges in developing sustainable and carbon-neutral aerospace technologies.

LOOKING FORWARD

Several emerging technologies demonstrate how collaboration between universities and industry can advance Canada’s aerospace sector. For instance:

Electrification and hybrid propulsion are being studied as intermediate steps toward hy-

drogen. Training engineers to investigate these systems helps Canada remain competitive in as the global shift to cleaner propulsion continues.

Artificial intelligence in maintenance allows engineers to identify issues more quickly and maintain safer and more efficient operations. When academic programs incorporate AI into engineering curricula, they prepare HQP to effectively use these tools in their careers.

Lightweight structures using advanced composites and additive manufacturing can reduce emissions by cutting aircraft weight. Academic research is driving improvements in materials processing, testing, and certification.

These examples show that recent technological advances are closely tied to the skillsets of HQP. Without academic programs to train specialists in these fields, Canada might have to depend on imported expertise rather than growing its own leaders.

KEY TAKEAWAYS

To make aviation carbon-neutral by 2050, we need new technologies, advanced manufacturing techniques, and a new generation of engineers who are ready to take these challenges. The aerospace sector has both prospects and risks: without addressing technological gaps and workforce shortages, Canada could lose competitive edge; however, by investing in research and training, it could become a world leader in sustainable aviation.

The partnership between Montreal’s well-recognized aerospace leadership and Calgary’s rising ecosystem develops HQP, advances cutting-edge technologies, and supports industry transformation.

By means of training, research, and academia-industry collaboration, Canada is not simply preparing to participate in the future aerospace economy but is also laying the pathway for leadership.

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HIGHLIGHTS

Bio-inspired insights from extension-flexion coupled wing deformation in gliding birds



FIG. 1: PIGEON WING POSITIONED IN AN EXTENDED (UPPER) OR FOLDED (LOWER) POSITION WITH AND WITHOUT NEIGHBOURING FEATHERS. A DISTAL AND A PROXIMAL FEATHER (IN ORANGE) WERE TESTED.

THE EXTRAORDINARY FLIGHT PERFORMANCE

of birds continues to captivate researchers across disciplines, particularly in the context of energy-efficient gliding. Gliding birds such as albatrosses, hawks, and gulls can travel long distances with minimal energy expenditure, achieving sustained flight by exploiting environmental updrafts and dynamically adjusting their wing morphology. While traditional analyses of avian gliding have focused on static geometric features, such as wingspan, aspect ratio, and camber, emerging evidence suggests that birds actively engage more complex, time-varying structural adaptations during flight. Among these, the coupled motion of wing extension and flexion plays a pivotal role in modulating aerodynamic forces and enhancing flight efficiency. Unlike rigid wings in conventional aircraft, bird wings exhibit a high degree of structural flexibility and are capable of continuous shape adaptation through coordinated musculoskeletal actuation and passive aeroelastic response. This wing morphing behavior enables birds to optimize their aerodynamic profile in real-time, responding to changes in airflow, flight speed, and external disturbances. In particular, the coupled extension-flexion mechanism allows for nuanced control over spanwise and chordwise load distributions, which can delay flow separation, reduce drag, and improve lift-to-drag ratios. These benefits are especially pronounced in gliding, where maintaining stable, efficient flight with minimal muscular effort is crucial for both predator avoidance and energy conservation during migration. Despite its biological significance, the precise aeroelastic mechanisms underlying extension-flexion coupling remain

poorly understood. Previous studies often treat wing deformations as isolated modes, overlooking the dynamic interdependence between spanwise extension and chordwise flexion that naturally occurs in avian flight. Understanding this interplay not only advances our knowledge of avian biomechanics but also offers valuable design principles for bio-inspired morphing wing technologies in next-generation aircraft and unmanned aerial systems.

The Computational Multiphysics Lab at the University of British Columbia, led by Dr. **Rajeev Jaiman**, and the lab's collaborators have introduced an innovative approach using rock pigeon (*Columba livia*) to conduct detailed *in situ* mechanical testing of wing deformation. Details of the *in situ* mechanical testing have been published in the *Journal of the Royal Society Interface*. Their work integrated high-fidelity biomechanical modeling, experimental observations, and unsteady aerodynamic analysis, to uncover how these coupled deformations interact with airflow and structural dynamics to improve overall gliding performance. The anaesthetized pigeon was positioned ventral side up with its left wing secured for bending tests. Force data were recorded at 100 Hz as the feather resisted displacement. To assess the influence of wing morphing on out-of-plane bending stiffness, the wing was held in either an extended (elbow: 90°, wrist: 135°) or folded (elbow: 50°, wrist: 60°) configuration shown in Figure 1. The wing rotation was constrained using stoppers fixed to the rods. Bending stiffness was measured at two locations: distal and proximal. To isolate feather-feather interaction effects, tests were performed on both intact wings and those with

neighboring feathers clipped at the base (Figure 1). A simplified extended and folded wing was modelled and meshed for numerical solution using the delayed detached eddy simulation turbulence model.

Their results revealed that the flight feather support structures exhibit viscoelastic behavior with energy-dissipating hysteresis, characteristic of fibrous biomaterials. Under a 5 Hz dynamic load, the response was predominantly elastic, with minimal cycle-to-cycle variation but notable differences across individuals due to biological and experimental variability. Mechanical stiffness during loading and unloading varied locally with wing morphing, and was best explained by models incorporating feather location, wing position, and feather-feather interaction. Stiffness increased significantly in the proximal wing during folding but decreased slightly in the distal wing. When neighboring feathers were removed, the distal effect remained minimal, but the proximal stiffness increase was reversed, highlighting the role of feather interaction in modulating local wing stiffness.

Utilizing the fluid-structure interaction simulations, they evaluated combinations of wing shape and stiffness, including configurations not observed in nature. This approach not only aligned with *in vivo* experimental data but also extended the analysis beyond the natural parameter space. Across all cases, their computed lift and drag coefficients (CL and CD) fell within the expected range for pigeon flight, with the flexible wing model yielding mean aerodynamic values more consistent with those in literature than the rigid model. These findings highlight that, although prior studies have primarily focused on the role of flexibility during flapping flight, aeroelastic deformation also has a measurable impact in gliding. Notably, the aerodynamic influence of wing flexibility depends strongly on wing shape and, in some cases, can outweigh the effects of flight speed (shown in Figure 2, next page). Both flexible wing configurations, extended and folded, outperformed their rigid counterparts, with the extended flexible wing showing the greatest improvement. The most compliant wing model achieved the highest lift-to-drag ratio (CL/CD) due to increased lift and reduced drag. This performance gain was linked to enhanced suction peaks in the pressure distribution and more attached flow over the wing surface. While the rigid wing exhibited early flow separation and a large turbulent wake, the flexible wings interacted with the boundary layer to generate smaller vortices and maintain flow attachment. This shifted the aerodynamic force direction to favor lift. However, at high speeds, the extended wing experienced numerical convergence failure due to excessive deformation, which reflects similar structural issues observed in physical wind tunnel tests. The observed results provide evidence that mechanical changes coupled with flexural wing morphing can enhance flight performance.

— Technical Editor, **Baafour Nyantekyi-Kwakye**, MCSME

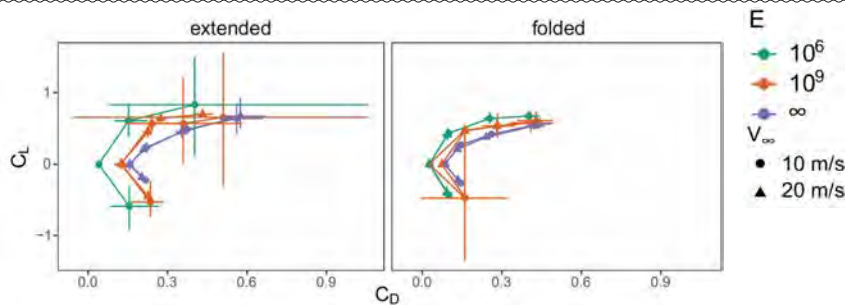


FIG. 2: C_L TO C_D FOR AN EXTENDED AND FOLDED WING MODEL. E REPRESENTS THE PRESCRIBED YOUNG'S MODULUS AND POINT SHAPE REPRESENTS THE INLET FLOW SPEED. RANGE BARS INDICATE THE MAXIMUM AND MINIMUM VALUES IN THE DATA IN THE STEADY-STATE RESULTS

Numerical Modeling of Multiphase Heat Transfer and Oil Dynamics in Aeroengine Components for Fire Safety and Design Optimization



FIG. 1: ISO-SURFACE OF OIL VOLUME FRACTION $\alpha_o = 0.3$ USING TWO SEPARATE COUPLING TECHNIQUES TO TRACK DROPLETS.

MODERN AEROENGINES OPERATE UNDER extreme thermal and mechanical loads, making effective fire safety and thermal management not only design priorities but also essential operational requirements. In practice, components such as bearing chambers and gearboxes are particularly vulnerable due to their exposure to high temperatures and the presence of lubricating oil-conditions that can lead to oil evaporation, pressure buildup, and eventual material degradation. These processes can result in oil ejection and internal fire propagation, potentially compromising engine integrity and flight safety. Ensuring that these components can withstand and contain fire incidents is therefore vital for maintaining system reliability and certification compliance. Current fire safety assessments rely heavily on expensive and time-intensive physical testing. Developing accurate numerical tools capable of predicting boiling and multiphase flow phenomena within oil-lubricated components would provide a practical and cost-effective alternative. Such models can be directly applied during the design phase to identify thermally critical regions, optimize oil flow pathways, and select materials capable of maintaining mechanical and chemical stability under extreme conditions. Optimizing bearing chamber performance in gas turbine engines

also significantly reduce oil and secondary air consumption, directly improving efficiency, reliability, and maintenance costs. Oil removes frictional heat and lubricates rotating parts, while sealing air prevents leakage. Understanding and modeling complex two-phase interactions within these chambers enable engineers to minimize droplet residence time and wall dry-out, improving heat transfer, oil stability, and scavenge efficiency. Accurate numerical modeling provides a cost-effective tool for evaluating lubrication and cooling before prototype manufacturing. However, simulating oil-air dynamics remains challenging. Eulerian models are computationally expensive for thin films, while Lagrangian models require precise droplet-wall treatment. Coupled modeling approaches, supported by experimental validation, offer a practical solution for improving design optimization, fire safety assessment, and overall engine performance in modern aerospace propulsion systems.

Collaborative research at the Laboratory of Applied Multiphase Thermal Engineering and Pratt & Whitney, led by Dr. Dominic Groulx, and supported by Dr. Mohammad Saeedi, Dr. Baafour Nyantekyi-Kwakyie, and graduate students Mr. Dylan Logan and Mr. Eric Boudreau, addresses the need for a validated, multiphase numerical framework that can accurately predict

boiling heat transfer and oil dynamics in aero-engine environments. By combining advanced wall boiling models and Lagrangian-Eulerian coupling techniques within commercial computational fluid dynamics platforms, the work aims to bridge the gap between physical testing and predictive simulation, enabling more efficient and safer aeroengine designs. Current boiling models use one of two approaches: general empirical correlations relating wall heat flux to wall superheat or mechanistic partitioning of the total wall heat flux into a single-phase convective heat flux and a nucleate boiling heat flux. The semi-mechanistic wall boiling model developed by Das and Puneekar (2013) within the mixture multiphase framework partitions the total wall heat flux but enhances the heat transfer in the nucleate boiling regime using Chen's one-dimensional empirical correlations modified for three-dimensional code. Recent strategies involve coupling models to account for the distinct flow regimes as indicated in Figure 1. The present collaborative research aims to generate a cost-effective technique for simulating an aero-engine bearing chamber using computational fluid dynamics. The focus is on identifying a comprehensive multiphase approach capable of resolving both the fine oil droplets and variable film thickness. A new Lagrangian-Eulerian approach has been developed in ANSYS Fluent and compared with existing strategies. The technique was then validated against experimental film thickness and scavenge efficiency data from the Karlsruhe Institute of Technology bearing chamber test rig, and a lower numerical error was observed.

This research holds significant implications for improving the safety, efficiency, and reliability of modern aeroengines. By developing accurate numerical models to predict boiling and multiphase interactions within oil-lubricated components, such as bearing chambers and gearboxes, the aerospace industry can move toward predictive fire safety and optimized thermal management without excessive reliance on costly full-scale testing. These simulations can inform the design of components that better withstand extreme fire and heat loads, reducing the risk of catastrophic engine failure. Furthermore, improved modeling of oil and air flow enables the optimization of lubrication and cooling strategies, minimizing oil consumption, reducing secondary air demand, and enhancing scavenge efficiency. This directly supports the development of lighter, more fuel-efficient engines with longer service life and lower maintenance costs. The insights gained from conjugate heat transfer and two-phase flow modeling can also guide the design of next-generation propulsion systems, including those used in hybrid-electric and sustainable aviation platforms, where thermal management and fire resilience are critical to safe and efficient operation. – *Technical Editor, Dr. Baafour Nyantekyi-Kwakyie, MCSME*

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University of Calgary

Dr. Vaishnavi Kale

Topology Optimization for Coupled Multi-Physics Problems in Aerospace

Aerospace systems operate under extreme conditions including high temperatures, dynamic loads, and vibration-sensitive environments. Designing lightweight and efficient components that can withstand these conditions requires advanced engineering approaches. Topology optimization (TO), a simulation-driven design method, offers a powerful solution by determining optimal material layouts within a design space¹. It enables engineers to explore unconventional geometries to achieve performance gains that are difficult to achieve through shape or size optimization or material selection alone.

Initial aerospace applications of TO mainly focused on lightweight structural parts like fuselage frames, wing spars, and trusses². These TO-generated designs are not easily manufacturable, motivating the use of advanced additive manufacturing (AM). Beyond large-scale structural parts, TO is increasingly being applied to components that must handle multiple physical effects simultaneously, where geometry, material distribution, and thermal or fluid transport must be co-designed³. For example, jet engine parts must withstand high temperatures and centrifugal forces while minimizing vibration. Similarly, thermal protection tiles and acoustic liners must manage heat flux or dissipate sound while carrying structural loads. These multifunctional demands require design methods that simultaneously control stiffness, damping, thermal conductivity, and flow transport properties.

Dr. Kale's lab, in collaboration with researchers at the University of Calgary, advances this research direction by developing fabrication-aware TO algorithms targeted at two fundamental archetypes: flow networks and microporous structures. These design classes



VAISHNAVI KALE, PhD

Dr. Kale is an Assistant Professor in the department of Mechanical and Manufacturing Engineering at the University of Calgary since April 2025. She earned her doctoral degree from the University of Alberta, where she developed topology optimization methods for designing flywheel energy storage. Thereafter, she was a postdoctoral fellow at the University of Alberta, where she developed models to simulate and design catalytic methane decomposition reactors for hydrogen production. Prior to academia, she developed automotive control systems at Sedemac Mechatronics and Mercedes Benz. Her current research integrates topology optimization with multi-physics modeling to design devices requiring tailored flow networks and porous structures, with applications extending to energy, biomedical and aerospace systems.

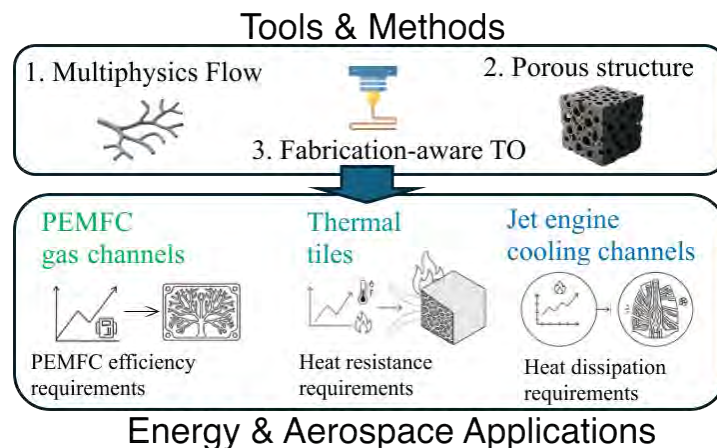


FIG. 1: TO-BASED DESIGN APPROACHES DEVELOPED IN DR. KALE'S GROUP AND APPLICATIONS ACROSS ENERGY AND AEROSPACE SECTORS.

capture recurring challenges across domains, and the lab's capabilities and future research directions, as illustrated in Figure 1, are rooted in a body of work spanning structural mechanics and multiphysics transport. Early work on stress-constrained TO, infill design, and robust TO formulations incorporated local stress constraints for improved load management, eroded / dilated designs to handle manufacturing tolerances, and local volume-fraction constraints for graded porosity⁴. Originally applied to energy storage rotors, these methods are also applicable to aerospace thermal tiles and vibration-damping trusses.

High-fidelity multiphysics finite-element based models, developed jointly with the University of Alberta and Innova Cleantech, simulate reacting, non-isothermal flows with catalyst deactivation in methane thermal decomposition reactors and for porous-media transport in polymer electrolyte membrane fuel cells (PEMFCs).⁵ These modeling and solver advances now serve as validated physics backends that enable current topology optimization efforts, where the integrated framework is applied to design PEMFC gas-channel networks that improve reactant distribution, reduce pressure drop, and enhance water management — capabilities directly relevant to aerospace thermal management systems and fuel-cell powered aircraft. In addition, the group contributes to open-source scientific software development (OpenFCST: Open-Source Fuel Cell Simulation Toolbox) and high-performance computing workflows, enabling scalable simulations for complex geometries.

Looking forward, techniques developed for electrochemical transport through gas channel and porous architecture design of energy devices will inspire future aerospace designs, from porous thermal tiles for reusable launch vehicles to optimized fuel cell components for all-electric aircraft. By unifying fabrication-aware TO with experimental validation and industry collaboration, the lab aims to deliver scalable, high-performance solutions that advance both sustainable energy technologies and next-generation aerospace systems.

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Standing waves in aircraft tires are a dangerous vibration phenomenon that occurs at high speeds, typically during takeoff or landing, when the tire deforms into a wave-like pattern instead of rolling smoothly. This behavior occurs at the tire's critical speed, and regulatory agencies such as the Federal Aviation Administration mandate that tires operate well below this threshold. Standing waves and critical

Ontario Tech University

Dr. Zeinab El-Sayegh

Finite Element Modeling of Standing Wave Formation in Aircraft Tires

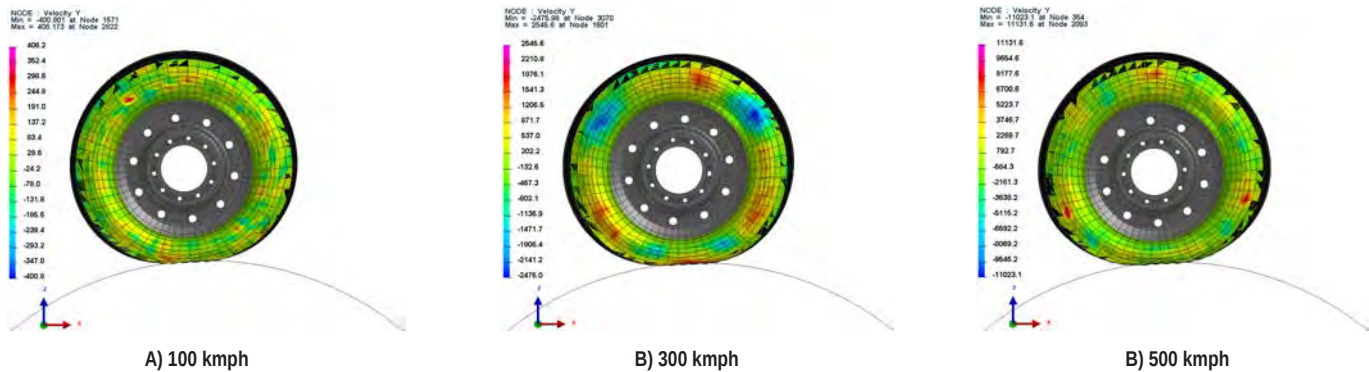


FIG. 1: SIDEWALL DISPLACEMENT OF AN AIRCRAFT TIRE OPERATING AT 220 PSI INFLATION PRESSURE, 270 KN VERTICAL LOAD AND SEVERAL SPEEDS

speed are determined using an expensive drum test machine, however Finite Element Methods (FEM) can provide a cost-effective alternative.

Dr. El-Sayegh and her team at the Tire-Terrain Interaction Simulation (TTIS) Laboratory are currently focusing on predicting aircraft tire-drum contact stresses during high-speed operations to better anticipate standing wave formation. This work involves precise modeling of the tire's geometry and material behavior, followed by extensive validation under both static and dynamic conditions.^{1,2} A key method to determine the standing wave uses a drum test to visually identify the tire irreg-

ular deformation (wave shape) which happens when the tire reaches its critical speed and the fundamental standing wave is generated. Dr. El-Sayegh's team employs FEM to predict the onset of standing waves with high accuracy as seen in *Figure 1(c)*. The aim is to reduce reliance on expensive experimental testing while offering deeper insight into tire deformation mechanics.

Figure 1 illustrates the lateral velocity distribution of the tire sidewall when operating at different speeds. The contour map highlights alternating regions of positive and negative velocity, indicating out-of-plane sidewall motion associated with the formation of a standing wave. *Figure 1(a)* shows the tire rigid structure at 100 kmph, *Figure 1(b)* shows the tire operating at 300 kmph with a prompter deflection at the contact with the drum. The high-intensity zones while operating at 500 kmph seen in *Figure 1(c)* represent the most critical deformation areas, confirming the onset of the standing wave phenomenon.

In collaboration with Pennsylvania State University, the TTIS lab members investigated the use of thin-film deposition techniques to enhance the tire's performance. Their experimental work focused on applying Parylene-C coatings to a small section of the tire using a vapor deposition process, which created uniform films with tunable hydrophobic properties. The research demonstrated that the coating improved water-repellent behavior and influenced hysteresis by increasing residual strain.³ These findings provide innovative strategies for improving the tire material performance without modifying the base composition resulting in higher tire speed and delaying the onset of the standing wave.

Dr. El-Sayegh's broader research program extends well beyond aviation, including tire-terrain interaction characteristics, thermal and wear analysis for passenger, truck, and racing vehicles.^{4,5} Her research work addresses challenges in vehicle safety and performance through combining simulations modeling and experimental testing. By collaborating with industry partners and leading research institutions, she continues to advance knowledge in tire mechanics and vehicle dynamics. Through this integrated program, Dr. El-Sayegh is shaping safer, more efficient, and more sustainable transportation solutions.

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ZEINAB EL-SAYEGH, PhD, P.Eng., MCSME

Dr. El-Sayegh is an Assistant Professor in the Department of Automotive and Mechatronics Engineering at Ontario Tech University, Canada. Her research focuses on tire modeling, vehicle dynamics, and automotive simulation, integrating computational methods with experimental validation to advance vehicle safety, handling, and efficiency. She co-directs the Tire-Terrain Interaction Simulation (TTIS) and Truck Driving & Vehicle Dynamics Simulation (TDVDS) Labs, leading studies that benefit both academia and industry. With over 90 publications, Dr. El-Sayegh has collaborated with global automotive manufacturers and institutions, significantly influencing vehicle system modeling. She also serves as Assistant Editor of the *International Journal of Heavy Vehicle Systems* and as a committee member with ASME. As a mentor, she has supervised numerous graduate students, fostering future innovators.

Toronto Metropolitan University

Dr. Reza Faieghi

Pushing the Boundaries of Aerial Autonomy

Dr. Reza Faieghi is the founder and director of the Autonomous Vehicles Laboratory (AVL) in the Department of Aerospace Engineering at Toronto Metropolitan University (TMU). The AVL's mission is *to advance aerial autonomy so uncrewed aerial vehicles (UAVs) become safer, smarter, and more capable in real-world conditions*. His research spans four pillars:

1) **Flight Control.** Small quadrotors have limited control authority in wind and exhibit underactuated, nonlinear dynamics, thus requiring advanced nonlinear control for robust flight. Using geometric-control methods, Faieghi's group has designed a new controller that delivers a level of robustness and agility rarely achieved by classical nonlinear controllers while remaining efficient for onboard implementation. Published in *IEEE Transactions on Robotics*¹, the controller responds in real time to varying disturbances and tracking errors, enabling the vehicle to withstand strong winds, perform flip maneuvers, and sustain high-acceleration trajectories. The flight controller code along with a link to flight experiments is available at: github.com/AVL-TMU/CrazyAQSMC

2) **Collision Avoidance.** As UAV applications in dynamic environments expand, the need for safe collision avoidance grows yet remains challenging due to uncertainty in predicting moving obstacles' future trajectories, and the limited onboard computing budget. Faieghi's group designs computationally efficient, certifiable collision-avoidance algorithms to address these challenges. They couple control barrier functions, which provide provable safety guarantees, with model predictive control, to predict the future motion of dynamic obstacles and compute optimized detours while accounting for prediction uncertainties, entirely onboard the UAV.²



REZA FAIEGHI, PhD

Dr. Faieghi received his PhD degree in biomedical engineering from the University of Western Ontario in 2018. From 2019 to 2020, he was a postdoctoral fellow with the University of Toronto. In 2020, he joined the Department of Aerospace Engineering, Toronto Metropolitan University, where he founded and currently directs the Autonomous Vehicles Laboratory (AVL). His research interests include a broad range of topics in motion planning and control for robotic systems.

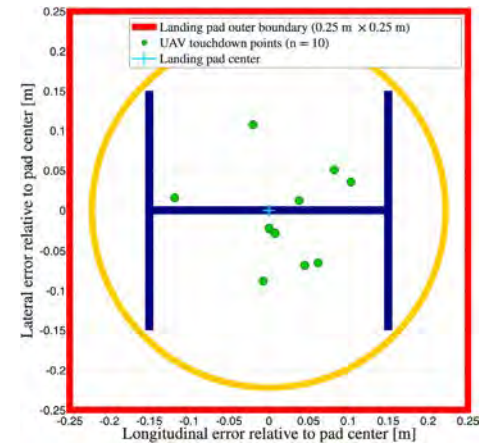
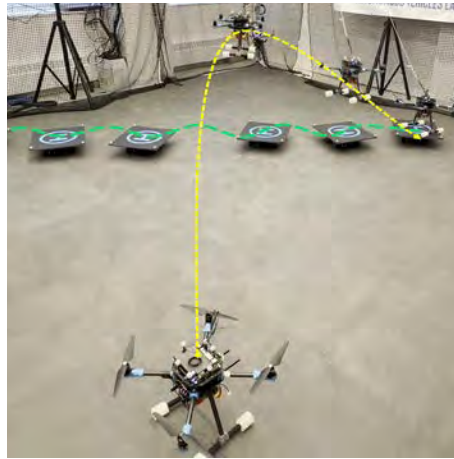


FIG. 1: DYNAMIC LANDING ON A MOVING PLATFORM. A MINIMUM-JERK LANDING TRAJECTORY PLANNER TIGHTLY COUPLED WITH NONLINEAR MODEL-PREDICTIVE FLIGHT CONTROLLER, WITH AN ADAPTIVE UNSCENTED KALMAN FILTER FOR PREDICTION OF THE LANDING PAD MOTION, ALL RUNNING ONBOARD A CUSTOM-BUILT UAV. LEFT: SUCCESSIVE POSITIONS OF THE SAME LANDING PLATFORM AND THE UAV OVERLAID; GREEN DOTTED LINE SHOWS THE PLATFORM PATH AND YELLOW DOTTED LINE THE UAV TRAJECTORY. RIGHT: TOUCHDOWN LOCATIONS OF THE UAV BODY-CENTER OVER 10 TRIALS RELATIVE TO THE PAD CENTER. A 100% SUCCESS RATE, WITH MAXIMUM RADIAL ERROR < 12 CM.

3) **Air-to-Air Object Detection.** Air-to-air object detection is essential for real-world autonomous flight; however, vision-based approaches are hampered by a scarcity of suitable datasets. Unlike autonomous driving, where large-scale, street-level data can be collected with relative ease, air-to-air data acquisition faces stringent regulatory, logistical, and safety constraints. To address this gap, Faieghi's group has developed a photorealistic simulator and generated a large synthetic dataset. The dataset is available at www.kaggle.com/datasets/avldevelopment/air-to-air-object-detection-dataset and related results are published in reference 3, "Synthetic dataset for vision-based air-to-air object detection." Deep neural networks trained on this dataset outperformed state-of-the-art vision-based methods trained on real data, particularly in challenging scenarios.

4) **Hardware Design.** Conventional quadrotors generate thrust only along the body-z (vertical) axis, requiring the vehicle to tilt for lateral motion. This leads to under actuation, and limits the maneuverability of quadrotors. Faieghi's group designed a gimballed-rotor mechanism⁴ that enables thrust vectoring on quadrotors, thereby decoupling thrust direction from the body. This increases maneuverability, enabling lateral translation without body tilt and stable hover in an inclined orientation.

While each pillar advances UAV technology on its own, together they enable interesting autonomous capabilities. For instance, by fusing robust, agile flight control with prediction and

planning, Faieghi's group developed a new algorithm for autonomous landing on moving platforms. Unlike prior work, it produces provably fixed-time feasible trajectories, yielding precise touchdown timing with higher success rates. Experimental results are shown in Fig. 1. This work has been submitted to The International Conference on Robotics and Automation 2026.

Faieghi's group excels at developing UAVs from the ground up and building onboard, real-time flight-control and planning software that delivers state-of-the-art robustness and agility. His team both uses and contributes to industry-standard open-source platforms, including *PX4 Autopilot and the Robot Operating System (ROS)*, and also emphasize rapid prototyping and deployment on real hardware, with results validated in motion-capture-arena experiments and field tests. These strengths have led to knowledge mobilizations through open-source code and datasets, and sustained collaborations with industry, translating academic advances into practical solutions.

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The Canadian Society for Mechanical Engineering
A constituent society of the Engineering Institute of Canada

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Une société constituante de l'Institut canadien des ingénieurs

NEWS COMMUNIQUÉ

November 2025

The Canadian Society for Mechanical Engineering (CSME), founded in 1970, is pleased to announce the winning recipients of its 2026 Technical Awards. These awards may be bestowed biannually to members of the society for their outstanding contributions to specific areas of mechanical engineering in Canada.

The following exceptional professionals will be presented with their medals on 26 May at the 2026 CSME International Congress to be hosted on 24-27 May by UBC in Vancouver.

Please consider attending the 2026 CSME International Congress to congratulate these exceptional winners and attend keynote lectures: www.csmecongress.org.

CSME Fluid Mechanics Medal

For “exceptional research and innovation contributions to the field of fluid mechanics in Canada”

Jerzy Maciej Floryan, PhD, FCSME
Western University, London, ON

CSME Manufacturing Medal

For “exceptional research and innovation contributions to the field of manufacturing in Canada”

Patrick C. Lee, PhD, FCSME
University of Toronto, Toronto, ON

CSME Solid Mechanics Medal

For For “exceptional research and innovation contributions to the field of solid mechanics in Canada”

Zengtao Chen, PhD, FCSME
University of Alberta, Edmonton, AB

Call for Nominations – 2026 CSME Annual Awards

Nominations of CSME peers are currently solicited for three of the society’s Annual Awards, including society fellowships. Note that members cannot nominate themselves – worthy candidates from the diverse CSME community must be nominated by CSME Fellows.

Deadline for 2026 Annual Awards: 31 January 2026

For Procedures, Terms/Criteria and the Nomination Form, visit: csme-scgm.ca/awards

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CSME Fluid Mechanics Medal

Dr. Jerzy Maciej Floryan

Dr. Jerzy M. Floryan is a Professor in the Department of Mechanical and Materials Engineering at the University of Western Ontario and a globally recognized leader in fluid mechanic research. With nearly 200 peer-reviewed journal publications and 277 conference papers, his groundbreaking contributions span boundary layer theory, laminar-turbulent transition, convection, droplet dynamics, flow control, drag reduction, and pattern interaction effects.

Currently Chair of the Canadian National Mechanics Committee, Professor Floryan is a Fellow of eight major professional societies including the Canadian Academy of Engineering, American Physical Society, and American Society of Mechanical Engineers. His distinguished career includes prestigious awards such as the C.N. Downing Award (CSME's highest honor, 2025), John B. Stirling Medal (2023), Stachiewicz/Heat Transfer Medal (2023), Robert W. Angus Medal (2011), and McCurdy Award (2015). His international recognition includes service on the 2020 Nobel Prize in Physics Nominating Committee and over 238 invited lectures worldwide, establishing him as a foremost authority in computational and applied fluid mechanics.



CSME Manufacturing Medal

Dr. Patrick C. Lee

Dr. Patrick C. Lee is an Associate Professor and founding director of the Multifunctional Composites Manufacturing Laboratory at the University of Toronto. Internationally recognized for pioneering manufacturing innovations in polymer processing, Dr. Lee has advanced hybrid composite technologies, micro-/nanolayer extrusion, and bio-inspired structuring for lightweight, multifunctional materials. His work has led to transformative applications in transportation, energy, and sustainability, supported by over \$10 million in research funding and protected by multiple international patents.

With 117 peer-reviewed journal publications and extensive industry partnerships, he has translated advanced materials research into scalable, commercially relevant processes. Dr. Lee's integration of process-structure-property relationships with manufacturing science has yielded composites with enhanced mechanical, thermal, and functional performance. He has trained over 100 highly qualified personnel who now lead in academia and industry. His contributions have significantly strengthened Canada's manufacturing sector, advancing both technological capability and global competitiveness.



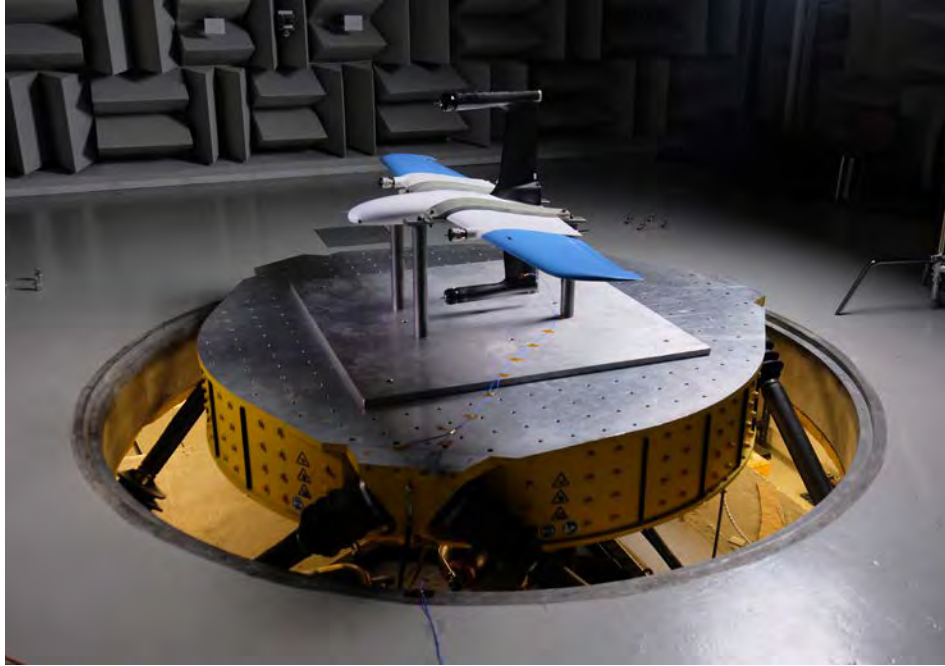
CSME Solid Mechanics Medal

Dr. Zengtao Chen

Dr. Chen is a Full Professor of Mechanical Engineering at the University of Alberta. He is internationally recognized for his significant contributions to solid mechanics, with a focus on the mechanical behavior of lightweight metals, thermal stress analysis, and the multi-physics analysis of advanced functional materials. Dr. Chen has authored over 300 peer-reviewed journal articles, three books, and numerous conference papers.

He has delivered over 120 invited and keynote lectures. Over the past decade, he has successfully supervised 6 postdoctoral fellows, 32 visiting scholars, 37 PhD students and 21 MSc students. Dr. Chen has served as editor or guest editor for nine international journals and has taken on leadership roles as a chair or scientific committee member at more than 30 international conferences.

He is an elected Fellow of the Canadian Academy of Engineering (CAE), the American Society of Mechanical Engineers (ASME), and the Canadian Society for Mechanical Engineering (CSME).



Fueling Aerospace Innovation and Engineering Talent at Ontario Tech's ACE

THE ACE RESEARCH & TESTING FACILITY AT Ontario Tech University continues to establish itself as a testing hub for the Canadian aerospace industry. As aerospace systems evolve, becoming more autonomous and environmentally sensitive, Canada's aerospace sector requires secure and reliable testing facilities to remain globally competitive. ACE is designed to recreate precise climatic and aerodynamic test conditions for rigorous validation. ACE's advanced testing infrastructure bridges across academic research and industry collaboration, with the unique ability to accelerate industrial innovation while cultivating the next generation of engineering talent necessary for the aerospace workforce.

Since opening in 2011, ACE has provided testing facilities for numerous leaders in the Canadian aerospace industry to conduct testing during the development of their products, including cutting-edge aircraft such as eVTOL aircraft and UAVs. The facility includes a Climatic and Aerodynamic Wind Tunnel (CAWT), two climatic chambers, a four-post suspension system located in a climatic chamber and a multi-axis shaker table located within a hemi-anechoic chamber. There is a constantly expanding list of advanced capabilities within the ACE Core Research Facility that includes icing testing, GPS simulation, subsonic aerodynamic testing, sensor calibration, noise vibration and harness (NVH) analysis.

What sets ACE apart from other wind tunnel testing facilities is the precise, repeatable, and complex environmental conditions available. All climatic chambers are able to simulate temperatures from -40 °C to +60 °C with control of relative humidity (5% and 95%), solar radiation,

rain, snow and icing conditions. These extreme capabilities allow for reliable evaluation of systems in environmental conditions encountered by aircraft in all climates across Canada and the globe. All of which is housed in one facility supported by an experienced and technically robust staff.

As a hub for academic, industry and government, ACE is uniquely positioned to support emerging technologies and security sensitive test material. As a Controlled Goods certified facility and NATO DIANA test site, ACE is a secure and trusted facility for all aerospace and defense testing needs.

ACE is proud to be a part of Ontario Tech University and works closely with academic researchers and students in all fields. Through capstone projects, graduate student research, co-ops, and R&D collaborations, students gain hands-on experience in real-world innovation. With special discounted rates for researchers, ACE welcomes all opportunities to collaborate on research and product development.

— *Technical Editor, Hassan Alkomy, MCSME*

Dr. Egberts et al., Building Canada's Aerospace Leadership through Training and Collaboration (p. 22)

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SPOTLIGHT *continued . . .*

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The CSME would like to acknowledge the support from the following ME Departments

La SCGM tient à remercier les départements de génie mécanique suivants pour leur aide



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