Graduate Colloquium, Aerospace Engineering

WPI

Airborne Particle Deposition in Jet Engine Hot Sections

Should I Board a Flight during a Sandstorm

Prof. Jeffrey Bons

Department of Mechanical and Aerospace Engineering, The Ohio State University, Columbus, Ohio

April 18 at 2 pm EST (AK 233) Zoom link: https://wpi.zoom.us/j/93296556476 Passcode: 892647

Abstract

The subject of deposition in gas turbine hot sections has seen an explosion of interest in the last thirty years. Growth markets for commercial aviation (Asia, Africa, and the Middle East) are known to be regions with elevated micron-sized particulate, both naturally occurring and man-made. This increased traffic in regions of heightened airborne particulate levels has resulted in loss of engine performance, increased maintenance intervals, and accelerated deterioration of engine components. At the same time, two key technological advances have combined to render modern gas turbines more susceptible to this increased particulate load. First, the pursuit of higher performance and efficiency has led to hot gas temperatures in modern engines that exceed melting temperatures of nearly all ingested particulate. Second, higher fidelity computational tools have significantly shortened the design cycle of modern engines while at the same time allowing for more complex designs that are operating closer to their peak efficiency. In some cases, this has resulted in products that have a reduced ability to compensate for erosion, deposition, and wear. Meanwhile, researchers have struggled to understand and model the complex physics of deposition at relevant engine operating conditions (high pressure and temperature). Full engine tests are prohibitively expensive and provide limited detailed data for CFD modeling and validation. To close this gap, Dr. Bons' lab has spent over two decades researching gas turbine deposition and providing key data, insights, and models to the engine community. In this presentation, he will share some of these insights as a pattern for tackling other multi-disciplinary challenges as tomorrow's engineers.

Dr. Bons received his PhD in Aeronautical and Astronautical Engineering from MIT in 1997. Prior to this, he worked for 4 years at the Air Force Research Laboratory in Dayton Ohio. From 1997-2002 he was an assistant professor at the Air Force Institute of Technology (AFIT) in Dayton, Ohio and from 2002-2007 he was an associate professor in the Department of Mechanical Engineering at Brigham Young University (BYU) in Provo, Utah. He has been part of the Aerospace Engineering faculty at OSU since 2007 and is the director of the Turbine Aerothermodynamics Laboratory at the Aerospace Research Center (https://mae.osu.edu/tal). His research interests include gas turbine hot section performance, turbine cooling, and deposition as well as active flow control for wings, propellors, and turbines. He and his wife Becky have 6 children and 12 grandchildren and live in Dublin, OH. He is a fellow of ASME and an associate fellow of AIAA. He is also associate editor for the AIAA Journal of Propulsion and Power.

Graduate Colloquium, Aerospace Engineering

3D Printed Cellular Solids for Energy Absorption – Testing, Modeling and Design

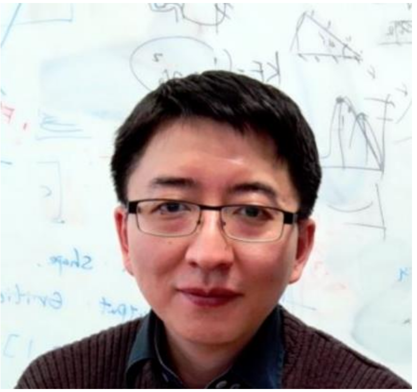
Prof. Feng Zhu

Associate Research Professor, Johns Hopkins University

March 21 at 2 pm EST (In-Person in AK 233) Zoom link: https://wpi.zoom.us/j/97588340864, Passcode: 674526

Cellular solids, with their diverse microstructures, play a crucial role as energy absorbers in aerospace, aeronautical, shipbuilding, automotive, and defense applications. These materials deform significantly under sustained stress during crushing, effectively absorbing kinetic energy before stabilizing or fracturing into a more secure state. Advances in additive manufacturing, particularly 3D printing, now enable the fabrication of intricate cellular structures with precise control over their geometry. Their mechanical properties are typically evaluated through a combination of mechanical testing and numerical simulations. However, the complex relationship between design parameters (e.g., geometric variations) and overall structural performance remains implicit in experimental and simulation data, posing challenges for conventional computer-aided engineering (CAE) tools. Traditional optimization methods often struggle to generate designs that meet desired performance metrics due to limitations in extracting insights from large datasets.

This study addresses these challenges by developing a systematic, data-driven design methodology leveraging machine learning. By correlating structural responses with design variables across extensive simulation datasets, this approach uncovers complex interactions and establishes decision-making rules to guide optimal design choices. The methodology is demonstrated through two case studies: (1) at the component level, illustrating its effectiveness in optimizing individual structures, and (2) at the system level, showcasing its application in designing complex mechanical systems. This innovative approach has the potential to transform the design and optimization of cellular solid materials, paving the way for more efficient and high-performance energy-absorbing structures in diverse industries.



Feng Zhu is an Associate Research Professor at the Hopkins Extreme Materials Institute (HEMI) at Johns Hopkins University, where he also holds adjunct appointments in the Department of Mechanical Engineering and the Ralph S. O'Connor Sustainable Energy Institute. Before joining JHU, he was an Assistant Professor at Embry-Riddle Aeronautical University. Professor Zhu has an interdisciplinary background, with research interests spanning material and structural behavior under extreme loading conditions (such as crash, high-speed impact, ballistic penetration, and blast), human body injury prevention, energy storage and transportation safety, and the application of AI in CAD/CAM/CAE. He has authored one book and over 130 technical papers and serves as an editorial board member and guest editor for multiple international journals. His research has been supported by government agencies and industry partners in the defense and automotive sectors. In 2025, he was elected a Fellow of the Society of Automotive Engineers (SAE). Dr. Zhu earned his BEng from Central South University (China), an MPhil (i.e. Master of Philosophy) from the University of Hong Kong, and a PhD from Swinburne University of Technology (Australia).

Series Algebra Methods for Aerospace

Dr. Nathan Strange

Founder & CEO, Vis Viva Space

February 28th at 2 pm EST (Streamed in HL 218)

Zoom link: https://wpi.zoom.us/j/96490320584, Passcode: 116183

Abstract

This talk will review mathematical methods for manipulating Taylor Series expansions of candidate solutions to differential equations and how this can be used to find recurrence relations for a solution's derivatives. These relations can be used to augment results from numerical integration or as a replacement for numerical integration. Example applications of these methods to the restricted three-body problem and the n-body problem will be used to illustrate how to apply these methods and to illustrate limitations requiring future research. Although the examples presented are in astrodynamics, the methods are also applicable to fluid dynamics, heat transfer, and other aerospace domains.

Dr. Nathan Strange is a former technical fellow at Blue Origin and a principal engineer at NASA's Jet Propulsion Laboratory. He has worked on robotic and human space missions in multiple roles including trajectory design, operations, systems engineering, and concept development. He received his Ph.D. at Purdue University with Prof. Jim Longuski.

Dr. Strange is currently building a new company Vis Viva Space in developing software for Mission Planning and Mission Design that will enable better communication and faster design iteration.

Graduate Colloquium, Aerospace Engineering

Ready to Launch? Pathways to Space Exploration

Prof. Kerri Cahoy

Sheila Evans Widnall (1960) Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology

January 17th at 2 pm EST (Streamed in HL 218)

Zoom link: https://wpi.zoom.us/j/95827904157, Passcode: 291863

Abstract

In order to even get to orbit, a “village” of different skills are needed: aerospace, electrical, mechanical, software, and systems engineers, as well as program managers, financial officers, and communications specialists. I will talk about why space exploration is important, my background, and how I developed several of these skills along my career path through academia, industry, government research, and back to academia. I will also talk about how spacecraft and rockets are developed, and some of the exciting new directions in Earth observation and communications as well as planetary exploration and astrophysics.

Prof. Kerri Cahoy received her bachelor’s degree in Electrical Engineering from Cornell University in 2000, and M.S. and Ph.D. degrees in Electrical Engineering from Stanford University in 2002 and 2008, respectively. Cahoy's work focuses on space systems engineering and nanosatellite technology demonstrations. Her research specializations include atmospheric sensing, exoplanet detection and characterization, laser communications, adaptive optics, and autonomy. Some recent flight projects include the Deformable Mirror Demonstration Mission (DeMi) for DARPA, the CubeSat Lasercom Infrared CrosslinK (CLICK) mission for NASA, and the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission for NASA.

Graduate Colloquium, Aerospace Engineering

Advancing Computational Methods: Physics-Informed Neural Networks and Neural Operator Networks

Dr. Ameya Jagtap

Assistant Professor, Aerospace Engineering

Worcester Polytechnic Institute

August 23rd at 2pm EST at WB 229 (zoom link: https://wpi.zoom.us/j/98326578074)

Classical methods in scientific computation have achieved significant advancements, yet they face substantial challenges, including the need for precise knowledge of underlying physical laws, an accurate understanding of boundary and initial conditions, and the involvement of time-consuming processes such as mesh generation and extensive simulations. Furthermore, these approaches are often inadequate for addressing high-dimensional problems governed by parameterized partial differential equations (PDEs), rendering them impractical in many applications. Physics-informed machine learning (PIML) presents a promising alternative to these traditional methods. This presentation focuses on a specific PIML approach known as physics-informed neural networks (PINNs). We provide a comprehensive overview of the current capabilities and limitations of PINNs, illustrating their effectiveness across diverse applications when compared to traditional computational methods. Additionally, we examine extensions of the standard PINN methodology, such as conservative PINNs and extended PINNs, which are tailored to handle big data and large-scale models. Our discussion also includes the role of various adaptive activation functions designed to expedite the convergence of deep, physics-informed neural networks. Furthermore, we explore recent advancements in deep operator networks, a novel class of neural operators that learn mappings between infinite-dimensional function spaces. Traditional PDE solvers are often both time-consuming and computationally intensive, especially when applied to complex systems. In contrast, neural operators have demonstrated superior performance in solving PDEs, achieving this while significantly reducing computational time compared to conventional numerical solvers. To this end, we investigate the application of deep operator networks in addressing stiff chemical kinetics problems and the use of innovative architectures for learning data-driven basis functions to map between discontinuous solutions.

Ameya D. Japtap is an Assistant Professor in the Aerospace Engineering Department at WPI. Before joining WPI, he was an Assistant Professor of Applied Mathematics (Research) at Brown University. He earned his PhD and Master’s degrees in Aerospace Engineering from the Indian Institute of Science, India. Following his doctoral studies, he served as a postdoctoral research fellow at the Tata Institute of Fundamental Research - Centre for Applicable Mathematics before undertaking postdoctoral research in applied mathematics at Brown University. His research focuses on the development of data- and physics-driven scientific machine-learning algorithms for a broad spectrum of problems in computational physics. His expertise includes Scientific Machine Learning, Deep Learning, Data/Physics-driven Deep Learning Techniques, Multi-scale/Multi-Physics Simulations, Spectral/Finite Element Methods, and WENO/DG Schemes. He is serving on the editorial board of several journals, including *Neurocomputing* and *Neural Networks*, both published by Elsevier.

Graduate Colloquium, Aerospace Engineering

Addressing Challenges in Flammability and Explosion Risk for Novel Fuels/Working Fluids

Joel Mathew
Ph.D. candidate, Aerospace Engineering
Worcester Polytechnic Institute

September 20rd at 2pm EST at WB 229 (zoom link: https://wpi.zoom.us/j/96718862516)

Have you ever wondered what it takes to study flames that move so slowly you can almost see them dance? As environmental concerns push us to explore cleaner energy and refrigerants, new challenges arise when working with fuels like ammonia (NH_3) and refrigerants such as R-32 and R-1234yf. When mixed with air, these compounds can sustain flames with very low laminar flame speeds—less than 10 cm/s. But studying these slowly propagating flames isn't as simple as with typical hydrocarbon-fueled flames. Due to their sluggish nature, they're heavily influenced by gravity, buoyancy, and radiation heat loss.

In this talk, I'll share my innovative approach to studying slowly propagating flames by developing a general methodology that is applied to NH_3/air flames, using a clever twist—dropping them! A low-cost, lab-scale drop tower was built to minimize the effects of buoyant convection, allowing for the study of these delicate, slow flames in free fall. Additionally, a computational model (SRADIF) was developed to account for the radiation heat loss. By combining this methodology with experiments over a range of fuel-air ratios, we discovered just how crucial it is to study these flames in free fall. Using static setups or failing to account for radiation leads to significant errors in flame speed measurements. I'll also show how comparing experimental data with simulations is essential for understanding these fascinating flames. So, if you're ready to see combustion from a new perspective, this talk is for you!

Joel Mathew is a Ph.D. candidate in the Aerospace Engineering Department at Worcester Polytechnic Institute. He completed his undergraduate degree in Engineering Physics from the University of Tulsa, where he is from. He is currently focused on developing novel experimental methodologies to probe hitherto unseen/unquantified areas of combustion.

Graduate Colloquium, Aerospace Engineering

WPI

Commercial Aviation Environmental Impacts Research

Dr. Rick C. Miake-Lye

Aerodyne Research, Inc.

45 Manning Road, Billerica, MA 01821 USA

November 15th at 2pm EST at SL 402 (IN-PERSON, and through zoom : https://wpi.zoom.us/j/98063725865)

Commercial aviation emits its exhaust and associated pollutants at an altitude where no other anthropogenic emissions occur other than space craft. Thus, they have a unique potential to influence the atmosphere and affect climate in ways that are different from most other human activities. With increasing awareness of the changing climate, there is a major focus on CO2 emissions which are very long lived and thus not sensitive to where they are emitted. But non-CO2 emissions from airplanes are predicted to have influence as great or greater than CO2, especially through the contrails that form behind some airplane flights. These trails of condensing water vapor are highly localized and short-lived and are connected to particulate matter (PM) emissions from airplane engines in important ways. Issues related to contrail impacts are being studied intensively and their mitigation is being discussed actively. But non-CO2 emissions are also very important for pollution in and around airports, so NOx and PM emissions continue to be studied for both climate and local air quality impacts.

Dr. Richard C. Miake-Lye is a Vice President, Principal Scientist and Director at Aerodyne Research, Inc. He leads both theoretical numerical modeling and experimental measurement projects to understand the environmental impact of airplanes. He was recognized for contributions to IPCC's 2007 Nobel Peace Prize and to the USEPA 2007 Climate Protection Award. He has been Chair of SAE's E-31 committee on aviation emissions and has served in many roles in support of ICAO CAEP and continues to serve with both groups.

Graduate Colloquium, Aerospace Engineering

Multi-Scale Simulations of Charging, Discharge, and Dielectric Breakdown of Dusty Spacesuit: Implications for Astronaut Safety at the Lunar Terminator

Dr. Joseph Wang

Professor, Department of Astronautical Engineering. University of Southern California, Los Angeles

December 6th at 2pm EST (zoom link: https://wpi.zoom.us/j/98080908785 , streamed in SL 402)

Lacking a global magnetic field and an atmosphere, the lunar surface is electrically charged due to direct exposure to space plasma and solar radiation. Charging was not a serious concern during the Apollo mission because astronauts always stayed under sunlit where the surface charging potential is typically slightly positive due to photoelectron emission. However, future lunar missions will explore the lunar terminator, and involve operations in the permanently shadowed regions, where the surface can be hundreds to thousands of volts negative due to the collection of hot ambient electrons. Moreover, the adhesion of lunar regolith on the extravehicular (EVA) spacesuit makes the suit surface a complex mixture of different dielectric and conducting materials, rendering the typical charging mitigation approach developed for spacecraft on orbit not applicable. Thus, charging induced risks will need to be re-evaluated for astronauts on the lunar surface.

This talk presents a multi-scale numerical simulation study applying particle-in-cell (PIC), direct simulation Montel Carlo (DSMC), and molecular dynamics (MD) simulation to investigate plasma charging of dusty EVA spacesuit at the lunar terminator and its potential consequences. This simulation study covers over 10 orders of magnitude of length scales (from nanometer to tens of meter). The results show that charging at dusty spacesuit surface can generate a microscale electric field reaching107V/m even under moderate global charging conditions. This strong electric field can trigger surface discharge, if spacesuit outgassing or leak provides a sufficient neutral environment around astronaut, and dielectric breakdown of spacesuit material. Moreover, comparing to deep dielectric charging caused by radiation, plasma charging may induce the dielectric breakdown of EVA suit more frequently and under much more moderate space weather conditions. Thus, the combination of plasma charging and dust adhesion on spacesuit surface may pose a significant safety risk for astronauts on EVA at the lunar terminator.

Joseph Wang is a professor of astronautics and aerospace & mechanical engineering at University of Southern California. Prof. Wang received his Ph.D from MIT Department of Aeronautics and Astronautics. Prior to joining the astronautical engineering faculty at USC, Prof. Wang had been a principal member of engineering staff at NASA Jet Propulsion Laboratory and on the aerospace engineering faculty at Virginia Tech. Prof. Wang's group at USC currently conducts numerical and laboratory studies in several areas of space technology and spacecraft environmental interactions as well as in space and planetary science.

Graduate Colloquium, Aerospace Engineering

Spin is all you need for versatile mobility

Dr. Phanindra Tallapragada,

Professor, Department of Mechanical Engineering, Clemson University

October 3rd at 2pm EST (zoom link: https://wpi.zoom.us/webinar/register/WN_lBa5XYAHTp2_QTEUMGPgrg , streamed in WB 229)

Mobility in robots is usually achieved by a few common means; with a few exceptions these are wheels or legs in ground robots, propellers in flying robots, articulated tails or fins and propellers in swimming robots or flapping flagella in micro swimmers. Nonlinear dynamics can provide insights into alternative means of generating efficient mobility. The talk will present several examples of locomotion produced by the interplay of variations in the inertia tensor, constraints (holonomic and nonholonomic) and periodic actuation. The actuation of such robots is achieved by means of internal actuators that do not directly interact with the environment. Periodic motion or spin of an internal body such as a rotor can transfer high frequency reaction forces and moments that in turn can produce oscillations of flexible structures like tails in a fish-like robot and in legs or cilia in a soft robot. Further these spin-generated forces modulate the forces at surfaces producing discontinuous phenomenon like slipping and jumping. In the low Reynolds number regime, spin actuation can produce propulsion of microswimmers and spinning swimmers can manipulate small particles in a contactless manner. The talk will demonstrate this framework with a spin driven swimming robot which has a locomotion efficiency approaching that of several species of fish, a spin driven pipe crawling robot, a spin driven jumping robot and a spin driven microswimmer and particle manipulator. Spin is all one needs.

Phanindra Tallapragada is a professor of mechanical engineering at Clemson University. He obtained his Ph.D in Engineering Mechanics from Virginia Tech in 2010 and did post doctoral research at the University of North Carolina Charlotte. Earlier he obtained his B.Tech and M.Tech in Civil Engineering from the Indian Institute of Technology, Kharagpur. He joined Clemson University as an assistant professor in 2013. His research interests are in dynamical systems and bioinspired locomotion related to terrestrial motion, fish-like swimming, low Reynolds number swimming and operator methods for transport and manipulation in dynamical systems

Graduate Colloquium, Aerospace Engineering

Navigation of Drones in Unknown Indoor Environments – Challenges and Opportunities

Manish Kumar, Professor, Graduate Program Director
Department of Mechanical and Materials, University of Cincinnati

October 10th at 2pm EST (zoom link: https://wpi.zoom.us/webinar/register/WN_IBa5XYAHTp2_QTEUMGPgrg , streamed in WB 229)

Safe and reliable use of drones in indoor environments poses several challenges from technological perspectives when it comes to their beyond visual line of sight (BVLOS) operation. While autonomous navigation capabilities in drones in outdoor environment have been achieved (and available in commercially available drones), doing the same for indoor environment has been extremely elusive. The most fundamental challenge that has been preventing us from achieving this capability is carrying out localization, i.e., determining drone's 3D location. In absence of GPS, that is widely used for outdoor environment, indoor drones need to rely on, often noisy, onboard sensors (such as vision, laser, ultrasound) to carry out localization. Additionally, drone's operation in a complex indoor environment in proximity with humans and other obstacles leaves very little room for errors. Attempting to solve these problems using complementary and redundant sensors would result in higher payload, an unaffordable luxury for indoor drones, where payload constraints need to be tightly enforced to keep the drone size within limits. In this talk, I will present our work aimed at solving the above problems.

Our overall approach combines multi-sensor fusion method for localization with navigation, path planning, and obstacle avoidance in a human-centered fashion to achieve a safe and reliable flight in indoor environments. Results from adaptive Kalman Filtering that combines data from LiDAR based 3D SLAM with IMU and another 1D LiDAR will be presented. By combining the Dynamic Window Approach with an Artificial Potential Field method, we achieve robust, collision-free navigation that supports fully autonomous operation while allowing human supervision when needed. We will share insights from two use-cases of indoor drones: telehealth applications and warehouse inventory management.

Brief Bio: Manish Kumar received his Bachelor of Technology degree in Mechanical Engineering from Indian Institute of Technology, Kharagpur, India in 1998, and his M.S. and Ph.D. degrees in Mechanical Engineering from Duke University, NC, USA in 2002 and 2004 respectively. After finishing his Ph.D., he served as a postdoctoral researcher in the Department of Mechanical Engineering and Materials Science at Duke University, the US Army Research Office, and General Robotics, Automation, Sensing, and Perception (GRASP) laboratory at the University of Pennsylvania, PA, USA. He started his career as a faculty member at University of Cincinnati (UC) in 2007 in the Department of Mechanical and Materials Engineering where he currently serves as a Professor and the Graduate Program Director. He established Industry 4.0/5.0 Institute which is consortium of industry members engaged in researching and developing advanced technologies for solving key challenges facing the industry. He currently directs Cooperative Distributed Systems (CDS) Laboratory, co-directs Industry 4.0/5.0 Institute, and co-directs UAV MASTER Lab. His research interests include Unmanned Aerial Vehicles, robotics, decision-making and control in complex systems, AI, multi-sensor data fusion, swarm systems, and multiple robot coordination and control. His research has been supported by funding obtained from National Science Foundation, Department of Defense, Ohio Department of Transportation, Ohio Department of Higher Education, and several industrial partners. He is a member of the American Society of Mechanical Engineers (ASME). He has served as the Chair of the Robotics Technical Committee of the ASME's Dynamic Systems and Control Division, and as Associate Editor for the ASME Journal of Dynamic Systems, Measurements and Control and ASME Journal of Autonomous Vehicles and Systems.

Graduate Colloquium, Aerospace Engineering

Power of Accurate Differentiation through Integration: Peridynamic differential Operator

Erdogan Madenci

Professor, Department of Aerospace Engineering, University of Arizona, Tucson Arizona, USA

February, 20th at 2pm EST (zoom link: https://wpi.zoom.us/j/94881763611?from=addon streamed in HL 218)

Peridynamic (PD) differential operator (PDDO) converts the existing governing field equations from their local to nonlocal form while introducing an internal length parameter. The PDDO enables differentiation through integration. As a result, the equations become valid everywhere regardless of discontinuities. The lack of an internal length parameter in the classical form of the governing equations is the source of problem when addressing discontinuities. Although the PD theory is extremely suitable to model the response of structures involving crack initiation and propagation at multiple sites, with arbitrary paths, it is also applicable to other field equations involving phase change arising from corrosion and electrodeposition. Furthermore, it is applicable to hyperbolic equations for which the solution does not smooth out with time and discontinuities persist such as a shock wave. Lastly, the PDDO enables the evaluation of derivatives of any order in a multi-dimensional space and provides a unified approach to transfer information within a set of discrete data, and among data sets. This presentation provides an overview of the PD concept, the derivation of the PDDO, and applications concerning data reduction and recovery, solutions to complex partial differential equations, failure prediction in structural materials under complex loading conditions.

Brief Bio: Erdogan Madenci has been a professor in the Department of Aerospace and Mechanical Engineering at the University of Arizona since 1989. Prior to joining the University of Arizona, he worked at Northrop Corporation, Aerospace Corporation, and the Fraunhofer Institute. Also, he worked at the KTH Royal Institute of Technology, NASA Langley Research Center, Sandia National Labs, MIT and the University of Oxford as part of his sabbatical leaves. He is the lead author of six books on Peridynamics (available in Chinese and Persian) and Finite Element analysis. He serves as the Editor-in-Chief of the Journal of Peridynamics and Nonlocal Modeling and an Associate Editor of ASME Open Journal of Engineering. He is a Fellow of ASME and an Associate Fellow of AIAA.

Graduate Colloquium, Aerospace Engineering

Hypersonic Flow Control: Generalized Deep Reinforcement Learning for Hypersonic Intake Unstart Control under Uncertainty

Trishit Mondal
Aerospace Engineering Department, Worcester Polytechnic Institute

February, 27th at 2pm EST (zoom link: https://wpi.zoom.us/j/94938169797?from=addon streamed in HL 218)

Abstract: The hypersonic unstart phenomenon poses a major challenge to reliable air-breathing propulsion at Mach 5 and above, where strong shock–boundary-layer interactions and rapid pressure fluctuations can destabilize inlet operation. Here, we demonstrate a deep reinforcement learning (DRL)- based active flow control strategy to control unstart in a canonical two-dimensional hypersonic inlet at Mach 5 and Reynolds number 5 × 106. The in-house CFD solver enables high-fidelity simulations with adaptive mesh refinement, resolving key flow features, including shock motion, boundary-layer dynamics, and flow separation, that are essential for learning physically consistent control policies suitable for real-time deployment. The DRL controller robustly stabilizes the inlet over a wide range of back pressures representative of varying combustion chamber conditions. It further generalizes to previously unseen scenarios, including different back-pressure levels, Reynolds numbers, and sensor configurations, while operating with noisy measurements, thereby demonstrating strong zero-shot generalization. Control remains robust in the presence of noisy sensor measurements, and a minimal, optimally selected sensor set achieves comparable performance, enabling practical implementation. These results establish a data-driven approach for real-time hypersonic flow control under realistic operational uncertainties.

Brief Bio: Mr. Trishit Mondal is a Ph.D. student in the Aerospace Engineering Department at WPI, joined in August 2025.

Graduate Colloquium, Aerospace Engineering

Safe LIDAR Navigation for Self-Driving Cars

Dr. Jason Rife
Professor and Chair of Mechanical Engineering, Tufts University

March 27th, 2026 2pm EST | Location: AK 233

Abstract: This talk discusses current research on assuring safety for LIDAR measurements used in urban driving applications. New methods will be discussed to ensure that sensor performance is sufficient to support safe automated lane-keeping. In particular, we consider the properties of lidar measurement-errors and how to characterize those properties in real time for changing roadway environments. These results have applications for sensor fusion and safety certification for highly automated road vehicles.

Brief Bio: Jason Rife is Professor and Chair of Mechanical Engineering at Tufts University. He directs the Automation Safety and Robotics Laboratory (ASAR), which applies theory and experiment to characterize robots and autonomous vehicle systems for safety-of-life applications. He is a Fellow of the Institute of Navigation (ION) and serves on the ION Executive Council.