PHIL LIGRANI

Professor of Mechanical and Aerospace Engineering, Eminent Scholar in Propulsion, Department of Mechanical and Aerospace Engineering, Propulsion Research Center, 5000 Technology Drive, University of Alabama in Huntsville, Huntsville, AL 35899 USA. MOBILE PHONE NUMBER 615-621-8252. E-MAIL ADDRESS p_ligrani@msn.com.

SECURITY CLEARANCE STATUS. Secret.

PROFESSIONAL PREPARATION

University of Texas at Austin	Mechanical Engineering	Bachelor of Science
Stanford University	Mechanical Engineering	Master of Science
Stanford University	Mechanical Engineering	Doctor of Philosophy

APPOINTMENTS

2014 – Present. Professor of Mechanical and Aerospace Engineering. 2014-2025. Eminent Scholar in Propulsion. Department of Mechanical and Aerospace Engineering, University of Alabama in Huntsville

2010 – 2014 Oliver L. Parks Endowed Chair, Professor of Aerospace and Mechanical Engineering, Parks College, Saint Louis University

2010 – 2013 Director of Graduate Programs, Parks College, Saint Louis University

2006 – 2009 Statutory Professor, Department of Engineering Science, University of Oxford, Donald Schultz Professor of Turbomachinery

2006 – 2009 Director, Rolls-Royce UTC (University Technology Centre) in Heat Transfer and Aerodynamics, University of Oxford

ACADEMIC APPOINTMENT DISTINCTIONS.

● 2006-2009. Donald Schultz Professor of Turbomachinery, Statutory - Chair Professorship. Department of Engineering Science, University of Oxford, Oxford, England, United Kingdom.

● 2010-2014. Oliver L. Parks Endowed Chair. Parks College of Engineering, Aviation and Technology, Saint Louis University, St. Louis, Missouri, USA.

● 2015-2019. Eminent Scholar in Propulsion. Endowed Professorship. Department of Mechanical and Aerospace Engineering, Propulsion Research Center, University of Alabama in Huntsville, Huntsville, Alabama, USA.

● 2020-2024. Eminent Scholar in Propulsion. Endowed Professorship. Department of Mechanical and Aerospace Engineering, Propulsion Research Center, University of Alabama in Huntsville, Huntsville, Alabama, USA.

● 1999. AGTSR Faculty Fellowship at General Electric Corp.-Corporate Research and Development Center. Funded by the SCERDC, South Carolina Energy Research and Development Center. Schenectady, New York, USA.

● 2000. Guest Professor. Institut fuer Thermische Stroemungs-maschinen, Universitaet Karlsruhe, Kaiserstrasse 12, 76128 Karlsruhe, Germany.

● 2001, 2002, 2004. Invited Visiting Scholar. National Academy of Sciences of Ukraine, Institute of Engineering Thermophysics, Kiev-57, 252057, Ukraine.

● 2015. Distinguished Visiting Scholar. School of Energy and Power, Dalian University of Technology, Dalian, P. R. China.

● 2010-2012, 2012-2014, 2014-2016, 2016-2018, 2018-2020, 2020-2022. Distinguished Advisory Professor. Department of Mechanical Engineering, Inje University, Gimhae, South Korea.

● 2019-2022. Guest Professor. School of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, P. R. China.

ARCHIVAL JOURNAL PUBLICATIONS AND RELATED ITEMS.

As of November 2025, Dr. Ligrani is author or co-author of more than 237 publications in archival journals, including the International Journal of Heat and Mass Transfer, the ASME Transactions-Journal of Turbomachinery, the ASME Transactions-Journal of Engineering for Gas Turbines and Power, the ASME Transactions-Journal of Heat Transfer, the ASME Transactions-Journal of Fluids Engineering, the International Journal of Thermal Sciences, Nature - Scientific Reports, the Journal of Fluid Mechanics, the AIAA Journal, Experiments in Fluids, Physics of Fluids, the AIAA Journal of Heat Transfer and Thermophysics, the International Journal of Rotating Machinery, Separation Science and Technology, Sensors and Actuators A: Physical, Measurement Science and Technology, Applied Thermal Engineering, Shock Waves, Microfluidics and Nanofluidics, and the Journal of Microcolumn Separations. He is also author of 11 book chapters, and about 177 conference presentations and publications. A number of these are invited conference presentations at international meetings, at locations which include Korea, France, the Ukraine, Croatia, Germany, England-United Kingdom, and Belgium. From 1994 to 2025, he has also presented approximately 208 lectures at different institutions and establishments, including many invited lectures. From 2006 to 2025, he presented or is scheduled to present 11 Invited Keynote Papers, 18 Invited Papers, and 12 Invited Plenary Papers at different international conferences.

● Current SCOPUS Reference Citation H-INDEX is 53.

● Current GOOGLE SCHOLAR Reference Citation H-INDEX is 59.

● GPS Scholar ranking in the top 22/100ths of one percent internationally in mechanical engineering and the top 8/100ths of one percent internationally in heat transfer.
● From evaluation of over 30 million ScholarGPS profiles, 19 ranking in Turbine Blade, 46 ranking in Turbomachinery, 137 ranking in Heat Transfer, and 384 ranking in Turbine.
● AD Scientific Index ranking of number 1 out of 9 scientists in mechanical engineering at the University of Alabama in Huntsville, and number 1 out of 59 scientists in engineering and technology at the University of Alabama in Huntsville.

RESEARCH FUNDING AWARDS

Dr. Ligrani has a strong past and present record of performing sponsored, fundamental and applied research for a variety of funding agencies, including ones in the USA and Europe. As such, he has successfully managed a wide variety of research programs, for different industrial, foundation, and government sponsors. The quality and importance of the associated reearch activities are illustrated by a **total career-to-date funding acquisition level in excess of 26 million U.S. Dollars**. **As of November 2025, research funding awards have been received from the following organizations**: NASA – MSFC (Marshall Space Flight Center), U.S. Air Force Research Laboratory - Aerospace Systems Directorate, CFDRC – Computational Fluid Dynamics Research Corporation, Alabama State Innovation Program Fund, University of Alabama in Huntsville Endowment for Eminent Scholar in Propulsion, University of Alabama in Huntsville Start-Up Funds, AEDC – Arnold Engineering Development Center of Arnold Air Force Base, National Science Foundation, Honeywell Aerospace Corp., The Boeing Company, IHI Corporation, the Henry Luce Foundation, South Carolina Institute for Energy Studies (SCIES-AGTSR) of the Department of Energy, U. S. Army Aviation Research and Technology Activity-AVSCOM, NASA-Ames Research Center, NASA-Lewis Research Center, Hispanic Research Center-Arizona State University, Turbo and Power Machinery Research Center-Seoul National University, Solar Turbines Incorporated, UCON U.S.-Japan Center-Weber State University, General Electric Corporate Research and Development Center, Pratt & Whitney Corporation-Florida, the North Atlantic Treaty Organization (NATO), Pratt & Whitney Corporation-Canada Corp., the Gas Technology Institute, Intel Corporation, HEET-High Efficiency Engines and Turbines Program - South Carolina Energy Research and Development Center, Invesys Corp. - Foxboro Company, Ceramatec Advanced Materials and Electrochemical Technologies Corp., CISCO Systems Inc., SEEDA-South East England Development Agency, EPSRC – Engineering and Physical Sciences Research Council of Great Britain, ISIS Innovation, John Fell Fund, European Community Sixth Framework Programme, Korea Institute of Geoscience and Mineral Resources - KIGAM, Lockheed Martin UK, The Royal Academy of Engineering, Rolls Royce PLC, Science and Engineering Research Council (SERC) Engineering Board of Great Britain, Office of Naval Research, Naval Postgraduate School Research Foundation, Aero-Propulsion Laboratory-Wright-Patterson Air Force Base, and Naval Postgraduate School Direct Funding.

UNIVERSITY OF ALABAMA IN HUNTSVILLE - CURRENT AND RECENT RESEARCH FUNDING AWARDS

As of November 2025, current and recent research sponsors at the University of Alabama in Huntsville include: (1) Solar Turbines, Inc. of San Diego, California, USA (multiple research contracts), (2) IHI Corp. (Ishikawajma Harima Heavy Industries), of Tokyo, Japan (multiple research contracts), (3) National Science Foundation, CBET Thermal Transport Processes, Division of Chemical, Bioengineering, Environmental, and Transport (CBET) Systems, Arlington, Virginia, USA (multiple funding awards). (4) Alabama Innovation Fund, Research Program, Montgomery, Alabama, USA. (5) Office of the Vice President for Research and Economic Development, University of Alabama in Huntsville, Huntsville, Alabama, USA. (6) AEDC – Arnold Engineering Development Center, Arnold Air Force Base, Tullahoma, Tennessee, USA. (7) State Administration of Foreign Expert Affairs, Federal Government of the P. R. China, Beijing, P. R. China (through the School of Aerospace Engineering, Beihang University, BUAA – Beijing University of Aeronautics and Astronautics, Beijing, P. R. China). *NOTE THAT COLLABORATIVE RESEARCH EFFORTS ASSOCIATED WITH THE P.R. CHINA WERE ENDED IN 2021 DUE TO CONCERNS REGARDING INTERACTIONS WITH INDIVIDUALS FROM THIS COUNTRY.* (8) U.S. Air Force Research Laboratory, SBIR/STTR Program, Aerospace Systems Directorate, Wright-Patterson Air Force Base, Ohio, USA. (9) NASA – Marshall Space Flight Center (MSFC), Huntsville, Alabama, USA (multiple funding awards).

GRADUATE STUDENT SUPERVISION

As of September 2025, successfully supervised a total of 113 graduate student theses and dissertations associated with Ph.D., M.S., M.E., and Diploma degrees. Of these, successfully supervised a total of 11 theses and dissertations of women graduate students..

SELECTED RECENT HONORS, AWARDS, ACADEMIC RECOGNITIONS

● 2024 ASME Henry R. Worthington Medal. Award bestowed by the American Society of Mechanical Engineers (ASME) for "the development of innovative and unique pumping concepts and devices with micro-, millimeter-, and macro-scale flow passage arrangements in consideration of the displacement of fluids subject to diverse physical phenomena." ● July 2024. Employee Service Award, Ten Years of Service. University of Alabama in Huntsville, Huntsville, Alabama, USA. ● 2020 College of Engineering Outstanding Faculty Member Award. University Award, University of Alabama in Huntsville, Huntsville, Alabama, USA. ● 2020 Undergraduate Research and Creative Activity Mentor Award. University of Alabama in Huntsville, Huntsville, Alabama, USA. ● May 2020. Hermann Oberth Award in recognition of outstanding individual scientific achievement in the field of astronautics and advancement of the aeronautical sciences. AIAA – American Institute of Aeronautics and Astronautics, Reston, Virginia, USA. ● March 2020. Employee Service Award, Five Years of Service. University of Alabama in Huntsville, Huntsville,

Alabama, USA. ● ASME IGTI Outstanding Service Award 2019. ● 2019 University Distinguished Research Award for Excellence. University of Alabama in Huntsville, Huntsville, Alabama, USA. ● Outstanding Senior Faculty Member Award for 2019. College of Engineering, University of Alabama in Huntsville, Huntsville, Alabama, USA. ● Member. European Union Academy of Sciences (EUAS). 2019 to present. ● Guest Professor. School of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, P. R. China. 2019 to 2022. ● Outstanding Mechanical Engineer of the Year Award 2016, ASME – American Society of Mechanical Engineers, NAS - North Alabama Section, USA. ● Marquis Lifetime Achievement Award, Marquis Who's Who, New Providence, New Jersey, USA, 2016. ● Associate Fellow, AIAA - American Institute of Aeronautics and Astronautics, 2016. ● Distinguished Advisory Professor, Inje University, South Korea, 2010 to 2022. ● Distinguished Lecture Award, 2011, CEAS Distinguished Lecture Series, College of Engineering, University of Wisconsin, Milwaukee, Wisconsin, USA. ● Fellow, ASME – American Society of Mechanical Engineers, 2000. ● Distinguished Editorial Review Board membership for Springer Publishing Corporation. ● Carl E. and Jessie W. Menneken Faculty Award for Excellence in Scientific Research. ● NASA Space Act Tech Brief Award for "Development of Subminiature Multi-Sensor Hot-Wire Probes." ● Silver Winner for the Annual 26th Educational Advertising Awards for the Higher Education Marketing Report.

RESEARCH AREAS AND EXPERTISE.

Dr. Ligrani has a strong past and present record of working with many different collaborators and co-workers, from many locations throughout the world. Additional information on selected, currently active research projects is provided within sections which follow.

(i) Traditional Heat Transfer and Fluid Mechanics Investigations involving electronics cooling, heat transfer augmentation, drag reduction, turbulent boundary layers, flows in channels with dimpled surfaces, flows in curved channels, elastic turbulence, slot impingement cooling, and macro-scale pumps and pump flows. Also included are **aerodynamics investigations with *high-speed, compressible flows at transonic, supersonic, and hypersonic Mach numbers***, including SWBLI – Shock Wave Boundary Layer Interactions. Related projects involve **transonic, supersonic, and hypersonic experimental testing**. Research interests also include experimental diagnostics in high speed flows, and air breathing propulsion.

(ii) Air Breathing Engines - Gas Turbine Heat Transfer, Cooling, and Aerodynamics Losses, including internal cooling, film cooling, impingement cooling, cooling of extremities, aerodynamic performance including aerodynamic losses, and transonic turbine flows and heat transfer. This subject area includes the effects of uses of bio-fuels, synthetic fuels, and renewable energy sources in relation to gas turbines and gas turbine heat transfer and cooling technologies. Note that an important area of turbomachinery research interest involves heat transfer and aerodynamics investigations with *high-speed, compressible flows at transonic and supersonic Mach numbers*, including linear cascade studies.

(iii) Micro-Fluidics and Millimeter-Scale-Fluidics, including micro-pump flows, and the effects of slip phenomena on gas and liquid flows in micro-scale passage flows with and without surface roughness, including the effects of hydrophobic surfaces and elastic turbulence.

(iv) Experimental Techniques, including development of millimeter-scale multiple-hole pressure probes, subminiature hot-wire anemometry, infrared thermography, liquid crystal thermography, and Particle Image Velocimetry (PIV)..

EDITORSHIPS

1. Guest Editor, Special Topical Issue on "Measuring Techniques for Turbomachinery," Measurement Science and Technology, 1998-2000.
2. Associate Technical Editor, ASME Transactions-Journal of Heat Transfer, July 1, 2003 – June 30, 2007.
3. "Special Issues on Gas Turbine Heat Transfer: Parts 1 and 2," ASME Transactions-Journal of Heat Transfer, Co-Editor with S. Acharya, Part 1 - April 2005, Part 2 – May 2005.
4. Associate Technical Editor, ASME Transactions-Journal of Fluids Engineering, July 1, 2005 – December 31, 2008.
5. Member, Distinguished Editorial Review Board, Advances in Transport Phenomena, Book Series, Springer Publishing Corporation, 2006 – Present.
6. Associate Technical Editor, ASME Transactions-Journal of Heat Transfer, July 1, 2010 – June 30, 2014.
7. Editorial Board Member, International Journal of Innovative Works in Engineering and Technology (IJIWET). ISSN: 2455-5797, Published by NAANJIL, India. October 2015 – Present.
8. Associate Editor, ASME Transactions-Journal of Journal of Engineering for Gas Turbines and Power, July 1, 2018 - June 30, 2021.
9. Associate Editor, ASME Transactions-Journal of Journal of Engineering for Gas Turbines and Power, July 1, 2021 - June 30, 2024.
10. Academic Editor, International Journal of Rotating Machinery, Hindawi Publishing Co., London, England, United Kingdom, April 2022 – Present.
11. Editorial Board Member, International Journal of Aeronautical Science and Aerospace Research (IJASAR), SciDoc Publishing Co., Lewes, Delaware, USA, January 2023 – Present.
12. Associate Editor, AIAA Journal of Thermophysics and Heat Transfer, September 1, 2025 – December 31, 2028.

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS AND ACTIVITIES

ASME, Member, American Society of Mechanical Engineering, July 1985-Present.

ASME, Fellow, American Society of Mechanical Engineering, December 2000-Present.

ASME, American Society of Mechanical Engineering, K-14 Gas Turbine Heat Transfer Committee. December 1986-Present. Executive Committee and Membership Committee, July 2018-June 2020. Chairman (Entire Committee), July 2016-June 2018. Vice Chairman (Entire Committee), July 2014-June 2016. Chairman, Honors and Awards Sub-Committee, July 2012-June 2014.

IGTI, International Gas Turbine Institute Heat Transfer Committee. December 1986-Present

AIAA, Member, American Institute of Aeronautics and Astronautics, January 2013 – Present.

AIAA, Associate Fellow, American Institute of Aeronautics and Astronautics, January 2016 – Present.

AIAA, American Institute of Aeronautics and Astronautics, Member, High Speed Air Breathing Propulsion (HSABP) Technical Committee, September 2022 – Present. Member, Gas Turbine Engine (GTE) Technical Committee, February 2023 – Present.

ICHMT, International Center for Heat and Mass Transfer. Member of the Scientific Council, January 2014 – Present.

EUAS, European Union Academy of Sciences, January 2019 – Present.

INTERNATIONAL SCIENTIFIC COMMITTEE MEMBERSHIPS.

1. Scientific Committee Member. VORTEX2025 International Conference – Toward World Consensus on Vortex Definition and Prediction, National Science Foundation and the University of Texas at Arlington, Arlington, Texas, USA. December 11-15, 2025.
2. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, October 29-30, 2024.
3. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 7-8, 2023.
4. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.
5. Conference Organizing Committee, 2021 3rd International Conference on Mechanical, Aerospace and Automotive Engineering (CMAAE 2021), Sponsored by the Hong Kong Society of Robotics and Automation and the Central South University (P. R. China), Changsha, P. R. China, December 3-5, 2021.
6. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence- SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, November 2-3, 2021.
7. Conference Co-Chairman, 4th International Conference and Expo on Aerospace and Aeronautical Engineering (ICEAAE-2021, Aerospace-2021), Valencia, Spain, Virtual Event, October 25-27, 2021.
8. Member of the Scientific Committee, HMTHSF-2019, Seventh International Conference "Heat and Mass Transfer and Hydrodynamics in Swirling Flows," National Committee on Heat and Mass Transfer of the Russian Academy of Sciences, Rybinsk, Russian Federation, October 16-18, 2019.
9. Invited Member. European Union Academy of Sciences (EUAS). An international scientific organization and among the most prestigious in Europe. The academy is composed of distinguished members worldwide, including the world's leading scientists, scholars and business people, aiming to promote excellence in science and technology. Membership was the result of an election done through President's Council consisting of the distinguished members of the Board of Governors. January 2019 to Present.
10. Invited Expert of the Aerospace Center of Multiscale Mechanics and Thermodynamics (The Overseas Expertise Introduction Center for Discipline Innovation), School of Aeronautic Science and Engineering (ASE), Beihang University, Beijing, P. R. China. A 111 Project, which is sponsored by the State Administration of Foreign Experts Affairs, Beijing, P. R. China. September 2018 to September 2022.
11. Academic Committee Member, 2018 ICAYS Organizing Committee, ICAYS – 2018 International Conference in Aerospace for Young Scientists, September 15-16, 2018. School of Aeronautic Science and Engineering (ASE), Beihang University, Beijing, P. R. China. July to October 2018.
12. Member of the Scientific Committee, ICHHFF6, Sixth International Conference "Heat and Mass Transfer and Hydrodynamics in Swirled Flows," Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russian Federation, November 21-23, 2017.
13. Member of the Scientific Committee, ICHHFF5, Fifth International Conference "Heat and Mass Transfer and Hydrodynamics in Swirled Flows," National Committee of the Russian Academy of Sciences, Kazan, Russian Federation, October 19-21, 2015.
14. Vice-Chairman and Member, Academic Committee, Institute of Gas Turbines, Beijing Tsinghua University, Beijing, P. R. China. February 2014-February 2017.
15. ICHMT, Scientific Council Member, International Center for Heat and Mass Transfer. Nominated for membership by Professor Richard Goldstein of the University of Minnesota. January 2014 to Present.
16. Member, Distinguished Technical Committee, Advising on Gas Turbine Development for Utility Power Generation, Department of Thermal Engineering, Tsinghua University, Beijing, P. R. China. September 2012 - February 2017.
17. International Scientific Committee, International Symposium on "Heat Transfer in Gas Turbine Systems," Antalya, Turkey, August 9-14, 2009.
18. International Conference on Mechanical Engineering-Algeria, Ministere de l'Enseignement Superieur et de la Recherche Scientifique, Oran, Algeria, April 28-29, 2002.

RESEARCH COLLABORATIONS AND PARTNERSHIPS (CURRENTLY ACTIVE AND RECENTLY ACTIVE).

University of Stuttgart. This research activity is a collaborative effort between Dr. Ligrani and Professor Bernhard Weigand, and associated graduate students, of the Institute of Aerospace Thermodynamics, of the University of Stuttgart in Germany. Of interest are several research topic areas, including: (a) heat transfer and fluid flows within swirl chambers, (b) determination of entropy production from the flow field around a turbine guide vane, (c) flow structure and surface heat transfer from a turbine component endwall contoured using the ice-formation method, (d) investigations of rarefaction slip phenomena within a Viscous Disk Pump, (e) investigations of shock wave unsteadiness and interactions with nearby flow phenomena, and (f) particulate deposition effects within gas turbine hot-section components. For topic (b), considered is the determination of entropy production from the flow field around a turbine guide vane, and the numerical simulation of this flow field by means of Computational Fluid Dynamics (CFD). These CFD simulations are based upon RANS, the Reynolds Averaged Navier-Stokes equations, and are carried out using ANSYS CFX-14.0 and the Shear Stress Transport (SST) turbulence model. The flows around the vane from experimental investigation are simulated for three vane Mach number distributions, each of which is characterized by a different vane trailing edge Mach number. To obtain entropy production from the numerical flow field, two approaches based on second law analysis are utilized: a conventional and a differential one. The conventional approach describes global entropy production between two thermodynamic states by calculating it from the total pressure loss inherent to irreversible processes. The differential approach makes use of the entropy transport equation and yields local entropy production rates along pathlines directly from local flow field variables predicted by the CFD. Global entropy production is then determined by integrating local exergy destruction rates along pathlines, with respect to time. More recent efforts, using similar investigative approaches, consider the flow field around a turbine guide vane with film cooling produced by one or two rows of different shaped holes. Other recent investigations address flow structure and surface heat transfer from a turbine component endwall contoured using the ice-formation method, heat transfer and fluid flows within swirl chambers, rarefaction slip phenomena, shock wave unsteadiness and interactions with nearby flow phenomena, and particulate deposition effects within gas turbine hot-section components.

Changwon National University. This research activity, involving Dr. Ligrani, is in collaboration with Professor Heesung Park and Dr. Hwabhin Kwon, and associated graduate students, of Changwon National University in South Korea. Of interest are several research topics, including: (a) compound angle film cooling thermal and flow characteristics, (b) double wall effusion plate thermal management using impingement jet array cooling, (c) combustor liner thermal management with compound angle and simple angle effusion holes, and (d) investigations of interrelationships of entropy production and turbulence kinetic energy. Within the first part of the collaboration, considered are numerically predicted distributions of film cooling effectiveness for single cylinder film holes and for single 15° forward diffused film cooling holes, with compound angles ranging from 0° to 180°. Hole inclination angle, with respect to the test surface, is 35° for all arrangements considered, and blowing ratios of 0.60 and 1.25 are used. Thermal performance is characterized using spatially-resolved distributions of surface adiabatic film cooling effectiveness. Also considered are local flow secondary flow vector distributions, local flow streamwise vorticity distributions, and local variations of film cooling effectiveness within the flow field. In the second part of the collaboration, full coverage effusion arrangements are considered, as employed within double wall arrangements. Within the flow field, predicted are spatially-resolved distributions of local secondary flow vectors, local streamwise vorticity, local stagnation pressure, local streamwise velocity, and local film cooling effectiveness. Thermal protection is further characterized using surface distributions of heat transfer coefficient and adiabatic film cooling effectiveness. Also of interest are comparisons of cooling performance and flow characteristics of a combustor liner plate with compound angle and simple angle effusion holes, and interrelationships of entropy production and turbulence kinetic energy associated with simple angle and compound angle full coverage film cooling.

Inje University. This research activity, involving Dr. Ligrani, is in collaboration with Professor Dae Hee Lee, and associated graduate students, of the Department of Mechanical and Automotive Engineering of Inje University, located in South Korea. Of interest is jet impingement cooling of electronic chips, which are equipped with different cylindrical pedestal fin arrangements. More recently, confined, milliscale unsteady laminar impinging slot jets are investigated as they influence surface Nusselt numbers with constant surface heat flux and constant surface temperature thermal boundary conditions. Also considered are effects of confined impinging slot jets on heat transfer to concave and convex surfaces. The structure of the associated vortices, which form within the shear layers, which are adjacent to the slot jets, are investigated using flow visualizations. From these data, flow characteristics of confined, laminar milliscale slot jets are revealed, as the jets impinge upon a flat target plate, with a fully-developed velocity profile at the nozzle exit. The effects of Reynolds number and normalized nozzle-to-plate distance are considered for specific values of nozzle width. Transition from a stable symmetric jet to an unsteady oscillating jet is observed as the Reynolds number increases (with normalized nozzle-to-plate distance constant), where the Reynolds number associated with this transition decreases as the normalized nozzle-to-plate distance increases. Instantaneous visualizations also show unsteady lateral distortions of jet columns at experimental conditions corresponding to the presence of continuous sinusoidal oscillations, intermittent oscillating motion of the jet column, and jet flow fluctuation/flapping motion. Associated jet and vortex structural changes are determined for different modes of unsteadiness, including characterization of jet column unsteadiness using jet column oscillation frequency, and lateral and streamwise extents of jet distortion. More recent research considers cross-flow effects on impingement array heat transfer, impingement arrays with large hole spacing, and surface roughness effects on impingement array cooling using different impingement hole shapes.

City University of London. This research activity, involving Dr. Ligrani, is in collaboration with Dr. Qiang Zhang, and associated graduate students, of the City University of London. Previous experiments recognize that substantial heat transfer augmentation is achieved by adding ribbed turbulators after jet impingement with cross flow present. The present study investigates the fundamental working mechanism in a typical turbulent channel flow. Conjugate CFD simulations are employed for ribs, jet impingement, and their combinations. Flow characteristics and drawbacks for the individual and combined enhancement techniques are highlighted. New analysis on the coupled design arrangement reveals that the counter-rotating vortices generated by the jet flow can energize inter-rib recirculating vortices and promote spanwise convection. With an optimal design combination arrangement, extra heat transfer benefit is achieved beyond that associated with simple superposition of rib and jet impingement techniques. As such, the resulting thermal design approach is confirmed using published experimental data, and thus, is useful for surface heat transfer augmentation optimization in practice. Also of interest are the effects of coolant and wall temperature variations on impingement jet array thermal performance.

University of Cincinnati. This research activity, involving Dr. Ligrani, is in collaboration with Professor Ian Papautsky, and associated graduate students, of the BioMicroSystems Laboratory of the University of Cincinnati. Of interest are spiral inertial microfluidic devices for continuous blood cell separations, as well as microfluidic inertial, continuous SPLITT, and field-flow fractionation technologies for separations of whole blood components. More recently, secondary Dean vortices in spiral microchannels are investigated, and used to advantage for cell separations. Recent attention is focused on curvilinear channel geometries because of the presence of secondary flows, which, with appropriate configurations and flow conditions, can be employed to promote cell separations. In general, such devices are designed with the assumption that there are two counter rotating Dean vortices, present in the curved rectangular channels, which exist in the state of steady rotation and amplitude. Within the collaborative effort, these secondary Dean flows are investigated in low aspect ratio spiral rectangular micro-channels, including their development with respect to the channel aspect ratio and Dean number. Dean vortex flows are shown to be present when Dean number exceeds a critical value. Multiple vortex vortices (>2) are also considered, including their effects on particle and cell focusing. Overall, results from these studies offer new insights into secondary flow instabilities for low-aspect ratio, spiral micro-channels, with improved flow models for design of more precise and efficient microfluidic devices for applications, which include cell sorting and micro-mixing.

Virginia Polytechnic Institute and State University. This research activity, involving Dr. Ligrani, and funded by the National Science Foundation, is in collaboration with Professor Danesh Tafti, and associated graduate students, of the Department of Mechanical Engineering of the Virginia Polytechnic Institute and State University. Underway are research activities, which address the ubiquitous presence of shock-turbulence interactions and their important role in the thermal management of engineering components associated with aerospace, aeronautical, rocket, scramjet, combustion, and turbomachinery technologies. The objective of this effort is enhancement of fundamental understanding of extreme thermal transport events associated with shock waves and high-speed turbulent flows by means of a careful coordination of numerical (VT) and experimental (UAH) approaches. High-speed flows can be classified as supersonic ($1 < M < 5$) or hypersonic ($M > 5$), both entailing intense aerodynamic heating and drag, and propulsion system complexity. For example, supersonic combustion and wave drag phenomena are present, which illustrate the need for sophisticated thermal protection systems (TPS) because of high oxidizing air temperatures, which can be in excess of 2000 C. The overall technical goal is to gain an unprecedented look at thermal processes, such as turbulent/convective and shock-wave-induced turbulent transport, within the boundary layer and flow separation regions.

George Mason University. This research activity, involving Dr. Ligrani, is in collaboration with Professor Robert Handler, and associated graduate students, of George Mason University. Professor Handler recently undertook research as the Co-Principal Investigator (with Dr. Ligrani) on a Collaborative Research effort funded by the National Science Foundation in the area of thermal transport from elastic turbulence. Collaborative efforts involve investigations of physical phenomena, which are unique to elastic turbulence, using numerical predictions combined with experimental measurements. Current research efforts consider thermal transport and transition to elastic turbulence in rotating Couette flow, and numerical predictions of the conversion of polymer elastic energy into kinetic energy and vorticity.

University of Kentucky. This research activity involves collaborative efforts between Dr. Ligrani and Professor Savio Poovanthingal, and a Post-Doctoral Research Fellow, of the University of Kentucky. The focus is on numerical predictions of non-continuum behavior with rarefaction slip effects when the Knudsen number is greater than 0.01. The environment, which is the subject of the predictions, is contained within a Viscous Disk Pump with substantial overall passage flow rates. Associated fluid flow characteristics are simulated using Direct Simulation Monte Carlo (DSMC) numerical prediction tools.

Beijing Tsinghua University. This research activity involves collaborative efforts between Dr. Ligrani and Professor Jing Ren and Professor Xueying Li, and associated graduate students, of the Institute for Gas Turbines of Beijing Tsinghua University of the P. R. China. Of interest are several topics, including experimental and numerical investigation of unsteady impingement cooling within a blade leading edge passage, as well as unsteady structure and development of both laminar and turbulent impingement jets, including Kelvin-Helmholtz vortex development. Different turbulence models are also assessed in regard to predictions of

narrow passage flows with impingement jets, and with pin fin arrays. Other recent efforts address effects of Reynolds number, hole spacing, jet-to-target distance, and hole inclination angle on the convective heat transfer performance of an impinging jet array over Reynolds numbers from 5,000 to 25,000. Streamwise and spanwise jet-to-jet spacing 4D-8D and jet-to-target plate distance of 0.75D to 3D are employed, where D is impingement hole diameter. Also investigated is the effect on the heat transfer coefficient of hole inclination angle θ, which ranges from 0° to 40°. More recent research efforts address the influences of arrays of surface micro pin-fins on jet array impingement heat transfer. In this investigation, considered are the effects of jet to target plate distance, micro pin-fin shape, micro pin-fin height, and Reynolds number. Other recent research efforts consider heat transfer characteristics in a pre-swirl rotor-stator cavity. ***NOTE THAT COLLABORATIVE RESEARCH EFFORTS ASSOCIATED WITH THE P.R. CHINA WERE ENDED IN 2021 DUE TO CONCERNS REGARDING INTERACTIONS WITH INDIVIDUALS FROM THIS COUNTRY.***

Shanghai Jiao Tong University. This research activity, involving Dr. Ligrani, is in collaboration with Professor Yu Rao and associated graduate students from the Institute of Turbomachinery, School of Mechanical Engineering of Shanghai Jiao Tong University, which is located within the P. R. China. Of interest are turbulent flow heat transfer and pressure loss over surfaces with dense micro-depth dimples as these are present beneath the viscous sublayer of a turbulent boundary layer. ***NOTE THAT COLLABORATIVE RESEARCH EFFORTS ASSOCIATED WITH THE P.R. CHINA WERE ENDED IN 2021 DUE TO CONCERNS REGARDING INTERACTIONS WITH INDIVIDUALS FROM THIS COUNTRY.***

RECENT U.S. NATIONAL SERVICE ACTIVITIES

1. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, October 29-30, 2024.
2. Panel Member, Division of Engineering Education and Centers, Directorate for Engineering, National Science Foundation, Arlington, Virginia, USA, 2024.
3. Panel Member, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2024.
4. Conference Moderator, Third International Forum on Aerospace and Aeronautics (AEROFORUM 2023), San Diego, California, USA, December 11-13, 2023.
5. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 7-8, 2023.
6. Panel Moderator for Panel Session, "Next Hypersonic Testing and Research Required," Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 7-8, 2023.
7. Panel Moderator for Panel Session, "Testing and Simulation Developments for Hypersonics," Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.
8. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.
9. Panel Member for Panel Session, "Applied Radiation Tracking for Defensive Hypersonic Weapons," 2022 Hypersonic Weapons Summit, 4th Annual Hypersonic Weapons Summit, Institute for Defense and Government Advancement (IDGA) of the International Quality and Productivity Center (IQPC) (London, England, United Kingdom), Arlington, Virginia, USA, September 28-29, 2022.
10. Panel Member, Thermal Transport Processes (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2022.
11. Panel Member, Reviewer, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2022.
12. Report Reviewer, Consultant, "Complex Air Defense – Countering the Hypersonic Missile Threat," CSIS Missile Defense Project, Center for Strategic and International Studies (CSIS), Washington, D.C., USA, December 2021.
13. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence- SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, November 2-3, 2021.
14. Panel Member, Thermal Transport Processes (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2021.
15. Hypersonic Aerodynamics. Online On-Demand Course. Taught by Professor Jason Cassibry, with topics of skin friction, heat transfer, and turbulence presented by Special Guest Lecturer Phil Ligrani. Spring, Summer, Fall Semesters of 2021, 2022, 2023, 2024, 2025.
16. Participation as Panelist, "Gas Turbine Cooling and Aerodynamics" Panel, American Society of Thermal and Fluids Engineers (ASTFE) Conference, Fort Lauderdale, Florida, USA, March 4-7, 2018.

17. Panel Member, Thermal Transport Processes (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2017.
18. Panel Member, Thermal Transport Processes (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2016.
19. Sponsored Representative, CVD – Congressional Visits Day, U. S. Senate and House of Representatives, Washington, D. C. Sponsored by Greater Huntsville Section of the AIAA – American Institute of Aeronautics and Astronautics, March 4, 2015.
20. Panel Member, Convection (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2014.
21. Participation as Panelist, "Educating Today's and Tomorrow's Propulsion Engineers" Panel, "Continuing Education and Professional Development" Program of the AIAA Science and Technology Forum and Exposition - SCITECH 2014, Washington, D.C., January, 13-17, 2014.
22. Participant, Second Graduate Deans Workshop on Institutionalizing Interdisciplinary Graduate Education, Virginia Tech, Virginia Polytechnic Institute and State University, and National Science Foundation, Arlington, Virginia, USA, November 1-2, 2012.
23. Participant, Graduate Deans Workshop on Institutionalizing Interdisciplinary Graduate Education, Virginia Tech, Virginia Polytechnic Institute and State University, and National Science Foundation, Arlington, Virginia, USA, April 2-3, 2012.
24. Panel Member, Convection (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2011.
25. Panel Member, Thermal Transport Processes Program (Unsolicited) Panel, Thermal Transport Processes Program, Chemical, Bioengineering, Environmental and Transport Systems (CBET) Division, National Science Foundation, Arlington, Virginia, USA, 2010.
26. Panel Member, Thermal Transport and Therma Processing (TTTP) Program, Chemical and Transport Systems (CTS) Division, National Science Foundation, Arlington, Virginia, USA, 2005.
27. Session Chair, External Turbine Cooling, Aero-Heat Transfer Workshop, SCIES-South Carolina Institute for Energy Studies, Baton Rouge, Louisiana, USA, November 11-13, 2002.

UNIVERSITY OF ALABAMA IN HUNTSVILLE – COLLEGE and UNIVERSITY SERVICE ACTIVITIES

1. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2025.
2. Member, Scholarship Oversight Committee, University of Alabama in Huntsville, May 2024 – May 2027.
3. Member and Chair, STEM Scholarship Committee, University of Alabama in Huntsville, August 2024 – August 2027.
4. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February – March 2024.
5. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2024.
6. Member and Chairman, Committee to consider Junior Faculty Member - Award of academic tenure and promotion to the rank of Associate Professor, College of Engineering, University of Alabama in Huntsville, October 2023.
7. Faculty Mentor to Junior Faculty Member, Assistant Professor, Department of Mechanical and Aerospace Engineering, College of Engineering, University of Alabama in Huntsville, July 2023 – Present.
8. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2023.
9. Member and Chairman, Committee to consider Senior Faculty Member – Promotion to the Rank of Full Professor, College of Engineering, University of Alabama in Huntsville, October 2022.
10. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2022.
11. Member, Committee to Evaluate College of Engineering 2021 Undergraduate Research Program Faculty Proposals, University of Alabama in Huntsville, October 2021.
12. Member, UAH COE Strategic Plan 2032: Goal 2. Leadership in Research, Scholarship, and Creative Achievement, Committee Member, College of Engineering, University of Alabama in Huntsville, September 2021-April 2022.
13. Member, Awards Judging Committee, Research Horizon Day Poster Presentations, University of Alabama in Huntsville, March 2021.
14. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2021.
15. Member, University Awards Committee for Undergraduate Research and Creative Activity Mentor Award, University of Alabama in Huntsville, January–February 2021.

16. Member, Search Committee, Associate Provost for Graduate Studies, International Services, and Academic Integrity, University of Alabama in Huntsville, November 2020 – September 2021.
17. Alternate Member, CoE PTAC, College of Engineering - Promotion and Tenure Advisory Committee, College of Engineering, University of Alabama in Huntsville, September 2020 – August 2021.
18. Member, University Awards for Excellence Committee, University of Alabama in Huntsville, September 2020 – August 2021.
19. Member, Committee to consider Senior Faculty Member – Promotion to the Rank of Full Professor, College of Engineering, University of Alabama in Huntsville, September 2020.
20. Member, Graduate Handbook Revision Committee, UAH Graduate Council, University of Alabama in Huntsville, April-May 2020.
21. Member, University Awards for Excellence Committee, University of Alabama in Huntsville, February – August 2020.
22. Member, Ad Hoc Committee for Leadership in Research, UAH Strategic Plan 2028, University of Alabama in Huntsville, January – April 2020.
23. Member, Graduate Mentor Award Committee, UAH Graduate Council, University of Alabama in Huntsville, February 2020.
24. Member, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, January 2020.
25. Member, Committee to consider Senior Faculty Member – Promotion to the Rank of Full Professor, College of Engineering, University of Alabama in Huntsville, January 2020.
26. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, January 2020.
27. CoE PTAC, College of Engineering - Promotion and Tenure Advisory Committee, College of Engineering, University of Alabama in Huntsville, September 2019 – August 2020.
28. Member, Committee to consider Junior Faculty Member – Tenure with Promotion to the Rank of Associate Professor, College of Engineering, University of Alabama in Huntsville, December 2019.
29. Member, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, April 2019.
30. Member, Graduate Mentor Award Committee, UAH Graduate Council, University of Alabama in Huntsville, February 2019.
31. Member, College of Engineering 2019 Research Horizons Poster Session Review Committee, College of Engineering, University of Alabama in Huntsville, February 2019.
32. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, January 2019.
33. Member, College of Engineering University Research Proposals Review Committee, College of Engineering, University of Alabama in Huntsville, December 2018.
34. Member, CoE PTAC, College of Engineering - Promotion and Tenure Advisory Committee, College of Engineering, University of Alabama in Huntsville, September 2017 – August 2018.
35. Member and Chairman, Committee to consider Senior Faculty Member Appointment with Tenure to the Rank of Full Professor, College of Engineering, University of Alabama in Huntsville, June 2018.
36. Member, College of Engineering Mid-Career Proposals Review Committee, College of Engineering, University of Alabama in Huntsville, April 2018.
37. Member, Graduate Advisor Award Committee, UAH Graduate Council, University of Alabama in Huntsville, February 2018.
38. Member, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, February 2018.
39. Member and Chairman, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, January 2018.
40. Member and Chairman, Committee to consider Senior Faculty Member – Promotion to the Rank of Full Professor, College of Engineering, University of Alabama in Huntsville, November 2017.
41. Faculty Mentor to Junior Faculty Member, Assistant Professor, Department of Mechanical and Aerospace Engineering, College of Engineering, University of Alabama in Huntsville, October 2017 – August 2024.
42. President's Council Member, University of Alabama in Huntsville, August 2017 – Present.
43. Member, College of Engineering Mid-Career Proposals Review Committee, College of Engineering, University of Alabama in Huntsville, April 2017.
44. Member, College of Engineering Best Teaching Award Review Committee, College of Engineering, University of Alabama in Huntsville, April 2017.
45. Member, Committee to consider Junior Faculty Member – Reappointment at the Rank of Assistant Professor, College of Engineering, University of Alabama in Huntsville, January 2017.
46. Member, Committee to consider Senior Faculty Member – Promotion to the Rank of Full Professor with Tenure, College of Engineering, University of Alabama in Huntsville, June – July 2016.

47. Member, College of Engineering Mid-Career Proposals Review Committee, College of Engineering, University of Alabama in Huntsville, March 2016.
48. COE (College of Engineering) Representative and Member, UAH Graduate Council, University of Alabama in Huntsville, August 2015 – September 2021.
49. Member, MAE Graduate Programs Committee, Department of Mechanical and Aerospace Engineering, College of Engineering, University of Alabama in Huntsville, August 2015 – December 2022.
50. Member, Task Force on Discussion of Immigration Matters Related to Hiring of Foreign Faculty, University of Alabama in Huntsville, July 2015 - Present.
51. Member, MAE PTAC, Mechanical and Aerospace Engineering Department - Promotion and Tenure Advisory Committee, Department of Mechanical and Aerospace Engineering, College of Engineering, University of Alabama in Huntsville, August 2014 – Present.
52. Member, Search Committee, Eminent Scholar in Systems Engineering, College of Engineering, University of Alabama in Huntsville, September 2014 – May 2015.

ARCHIVAL JOURNAL PUBLICATIONS – LAST 8 YEARS

2018

175. Heat Transfer Enhancements From Elastic Turbulence Using Sucrose-Based Polymer Solutions (P. M. Ligrani, D. Copeland, C. Ren, M. Su, and M. Suzuki), AIAA Journal of Thermophysics and Heat Transfer, Vol. 32, No. 1, pp. 51-60, January 2018.
176. Internal and External Cooling of a Full Coverage Effusion Cooling Plate: Effects of Double Wall Cooling Configuration and Conditions (Z. Ren, S. R. Vanga, N. Rogers, P. M. Ligrani, K. D. Hollingsworth, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), International Journal of Thermal Sciences, Vol. 124, pp. 36-49, February 2018.
177. Vortex Structure Effects on Impingement, Effusion, and Cross Flow Cooling of a Double Wall Configuration (P. M. Ligrani), Journal of Physics: Conference Series, IOP Science Publishing Corp., Vol. 980, pp. 012018-1 to 012018-15, March 2018
178. Flow Structure and Surface Heat Transfer From a Turbine Component Endwall Contoured Using the Ice-Formation Method (S. Winkler, B. Weigand, and P. M. Ligrani), International Journal of Heat and Mass Transfer, Vol. 120, pp. 895-908, May 2018.
179. Double Wall Cooling of a Full-Coverage Effusion Plate, Including Internal Impingement Array Cooling (P. M. Ligrani, Z. Ren, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), ASME Transactions-Journal of Engineering for Gas Turbines and Power, Vol. 140, No. 5, pp. 051901-1 to 051901-9, May 2018.
180. Effects of Hole Shape On Impingement Jet Array Heat Transfer With Small-Scale, Target Surface Triangle Roughness (P. McInturff, M. Suzuki, P. M. Ligrani, C. Nakamata, and D. H. Lee), International Journal of Heat and Mass Transfer, Vol. 127, Part A, pp. 585-597, December 2018.

2019

181. Winglet-Pair Target Surface Roughness Influences On Impingement Jet Array Heat Transfer (P. M. Ligrani, P. McInturff, M. Suzuki, and C. Nakamata), Journal of Enhanced Heat Transfer, Vol. 26, No. 1, pp. 15-35, January 2019.
182. Analysis of Shock Wave Unsteadiness Using Space and Time Correlations Applied to Shadowgraph Flow Visualization Data (S. R. Marko, and P. M. Ligrani), Advances in Aerodynamics, Vol. 1, No. 2, pp. 1-25, February 2019.
183. Double Wall Cooling of a Full Coverage Effusion Plate With Cross Flow Supply Cooling and Main Flow Pressure Gradient (P. M. Ligrani, Z. Ren, S. R. Vanga, C. Allgaier, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), ASME Transactions-Journal of Engineering for Gas Turbines and Power, Vol. 141, No. 3, pp. 031015-1 to 031015-11, March 2019.
184. Double Wall Cooling of a Full Coverage Effusion Plate With Main Flow Pressure Gradient, Including Internal Impingement Array Cooling (S. R. Vanga, D. Ritchie, A. J. Click, Z. Ren, P. M. Ligrani, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), ASME Transactions-Journal of Turbomachinery, Vol. 141, No. 4, pp. 041002-1 to 041002-11, April 2019.
185. Double Wall Cooling of an Effusion Plate With Simultaneous Cross Flow and Impingement Jet Array Internal Cooling (D. Ritchie, A. J. Click, P. M. Ligrani, F. Liberatore, R. Patel, and Y.-H. Ho), ASME Transactions-Journal of Engineering for Gas Turbines and Power, Vol. 141, No. 9, pp. 091008-1 to 091008-11, September 2019.
186. Flow and Heat Transfer Characteristics of Micro Pin-Fins Under Jet Impingement Arrays (X. Lu, W. Li, X. Li, J. Ren, H. Jiang, and P. M. Ligrani), International Journal of Heat and Mass Transfer, Volume 143, Paper No. 118416, pp. 1-14, November 2019.

2020

187. Parametric Study of Wind Tunnel Test Section Configurations For Stabilizing Normal Shock Wave Structure (P. M. Ligrani, and S. R. Marko), Shock Waves, Vol. 30, No. 1, pp. 77-90, January 2020.
188. Thermal Transport of Viscoelastic Fluids Within Rotating Couette Flows (P. M. Ligrani, M. Su, A. Pippert, and R. A. Handler), AIAA Journal of Thermophysics and Heat Transfer, Vol. 34, No. 1, pp. 121-133, January 2020.
189. Recent Investigations of Shock Wave Effects and Interactions (P. M. Ligrani, E. McNabb, H. Collopy, M. Anderson, S. R. Marko), Advances in Aerodynamics, Vol. 2, Article No. 4, pp. 1-23, February 2020.
190. Vortex Generation in a Finitely Extensible Nonlinear Elastic Peterlin Fluid Initially at Rest (R. A. Handler, E. Blaisten-Barojas, P. M. Ligrani, P. Dong, and M. Paige), Engineering Reports, Vol. 2, No. 3, pp. 1-17, March 2020.
191. Double Wall Cooling of An Effusion Plate With Cross Flow and Impingement Jet Combination Internal Cooling: Comparisons of Main Flow Contraction Ratio Effects (P. M. Ligrani, A. J. Click, D. Ritchie, F. Liberatore, R. Patel, and Y.-H. Ho), International Journal of Heat and Mass Transfer, Vol. 150, Article No. 119196, pp. 1-13, April 2020.
192. Effects of Coolant Supply Arrangement on Double Wall Cooling: Hot-Side Effusion Performance and Cold-Side Nusselt Numbers at Different Initial Blowing Ratios (A. J. Click, P. M. Ligrani, D. Ritchie, F. Liberatore, R. Patel, and Y.-H. Ho), International Journal of Heat and Mass Transfer, Vol. 156, Article No. 119808, pp. 1-15, August 2020.
193. Numerical Investigation of Adiabatic Film Cooling Effectiveness Through Compound Angle Variation (S. Tamang, H. Kwon, J. Choi, P. M. Ligrani, J.-H. Lee, Y.-G. Jung, and H. Park), Numerical Heat Transfer, Part A; Applications, Vol. 78, No. 10, pp. 595-618, October 2020.
194. Modeling the Socio-Economic Impacts of Covid-19 Using an Improved Traditional Travel Demand Model (M. Doustmohammadi, P. M. Ligrani, and M. Anderson), Current Urban Studies, Vol. 8, No. 4, pp. 2336-2350, December 2020.

2021

195. Effects of Coolant and Wall Temperature Variations on Impingement Jet Array Thermal Performance (S. Lu, Q. Deng, P. M. Ligrani, H. Jiang, Q. Zhang), Numerical Heat Transfer, Part A; Applications, Vol. 79, No. 1, pp. 68-82, January 2021.

196. Louver Slot Cooling and Full-Coverage Film Cooling With a Combination Internal Coolant Supply (P. M. Ligrani, A. J. Click, M. Hockensmith, J. Knox, C. Larson, A. Fairbanks, F. Liberatore, R. Patel, and Y.-H. Ho), ASME Transactions-Journal of Turbomachinery, Vol. 143, No. 3, Paper No. 031004, pp. 1- 10, March 2021.

197. Louver and Effusion Cooling Heat Transfer For a Double Wall Effusion Plate With Impingement Jet Array Coolant Supply (S. R. Vanga, P. M. Ligrani, J. Knox, F. Liberatore, R. Patel, and Y.-H. Ho), International Journal of Heat and Mass Transfer, Vol. 168, Paper No. 120861, pp. 1- 13, April 2021.

198. Spatial Coherence of Low-Frequency Unsteadiness Associated With a Normal Shock Wave (P. M. Ligrani, K. Goethals, and M. Cox), Aerospace Science and Technology, Vol. 112, Paper No. 106637, pp. 1- 14, May 2021.

199. Second Law Analysis of Aerodynamic Gains Associated With Simple Angle and Compound Angle Full Coverage Film Cooling (S. R. Vanga, and P. M. Ligrani), International Journal of Thermophysics, Vol. 42, Article No. 154, pp. 1- 27, August 2021.

200. EMS Response Time for Patients Critically-Injured From Automobile Accidents Using Regression Analysis (S. R. Vanga P. M. Ligrani, M. Doustmohammadi, and M. Anderson), Current Urban Studies, Vol. 9, No. 3, pp. 581-596, September 2021.

2022

201. EMS Response Time Analyses for a Rural County Using Geographically Weighted Regression with Different Kernel Weighting Functions (S. R. Vanga, P. M. Ligrani, M. Doustmohammadi, and M. Anderson), International Journal of Statistics and Applications, Vol. 12, No. 1, pp. 1-9 January 2022.

202. Characterization of Effective Diffusion Within Viscoelastic Fluids With Elastic Instabilities (V. Hietsch, P. M. Ligrani, and M. Su), Invited Journal Paper, Fluids, Special Issue: Transport in Viscoelastic Fluids (Editors: Robert Handler and Mahmoud Mamou), Vol. 7, No. 1, pp. 33-52, January 2022.

203. Flow Structure and Surface Heat Transfer From Numerical Predictions For a Double Wall Effusion Plate With Impingement Jet Array Cooling (H. Kwon, P. M. Ligrani, S. R. Vanga, and H. Park), International Journal of Heat and Mass Transfer, Vol. 183, Part A, Paper No. 122049, pp. 1- 18, February 2022.

204. Flow and Heat Transfer Characteristics in a Pre-Swirl Rotor-Stator Cavity (X. Yang, X. Li, Z. Ren, J. Ren, and P. M. Ligrani), International Journal of Thermal Sciences, Vol. 172, Part A, Paper No. 107271, pp. 1- 13, February 2022.

205. Measurement and Determination of Local Film Cooling Performance Along a Transonic Turbine Blade Tip With Viscous Dissipation (P. M. Ligrani, H. Collopy, and W. Manneschmidt), Measurement Science and Technology, Vol. 33, Paper No. 065302, pp. 1-28, March 2022.

206. Effects of Different Crash Data Variables on EMS Response Time for a Rural County in Alabama (S. R. Vanga, P. M. Ligrani, M. Doustmohammadi, and M. Anderson), Journal of Family Medicine and Primary Care, Vol. 11, No. 4, pp. 1462-1467, April 2022.

207. Flow and Heat Transfer in Swirl Tubes - A Review (F. Seibold, P. M. Ligrani, and B. Weigand), Invited Journal Paper, International Journal of Heat and Mass Transfer, Vol. 187, Paper No. 122455, pp. 1- 26, May 2022.

208. Effects of Tip Gap on Transonic Turbine Blade Heat Transfer Characteristics With Pressure Side Film Cooling (H. Collopy, P. M. Ligrani, H. Xu, and M. Fox), International Journal of Heat and Mass Transfer, Vol. 187, Paper No. 122513, pp. 1- 14, May 2022.

209. Celebration of Professor Bernhard Weigand On His 60th Birthday (X. Chu, G. Yang, A. Terzis, V. Vaikuntanathan, W. Wang, Z. Li, G. Lamanna, S. Fest-Santini, M. Santini, G. E. Cossali, P. M. Ligrani, B. A. Younis, M. Crawford, P. Ott, J. Kohler, C. Rohde, C.-D. Munz, R. Helmig, and T. Zhao), International Journal of Heat and Mass Transfer, Vol. 188, Paper No. 122626, pp. 1-2, June 2022.

210. Second Law Analysis of Aerodynamic Characteristics With Flow Temperature Variations of Simple Angle and Compound Angle Full Coverage Film Cooling (S. R. Vanga, and P. M. Ligrani), International Journal of Thermal Sciences, Vol. 176, Paper No. 107511, pp. 1-13, June 2022.

211. Experimental Study of Turbulent Flow Heat Transfer and Pressure Loss Over Surfaces With Dense Micro-Depth Dimples Under Viscous Sublayer (P. Zhang, Y. Rao, and P. M. Ligrani), International Journal of Thermal Sciences, Vol.177, Paper No. 107581, pp. 1-13, July 2022.

212. Transonic Turbine Blade Tip Heat Transfer With Pressure Side Film Cooling (H. Collopy, P. M. Ligrani, H. Xu, and M. Fox), AIAA Journal of Thermophysics and Heat Transfer, Vol. 36, No. 3, pp. 720–733, July 2022.

213. Dusting Hole Film Cooling Heat Transfer on a Transonic Turbine Blade Tip (W. Manneschmidt, H. Collopy, P. M. Ligrani, K. Goethals, M. Cox, H. Xu, and M. Fox), International Journal of Rotating Machinery, Volume 2022, Article ID 2006572, pp. 1-15, October 2022.

214. Effects of Pressure Side Film Cooling Hole Placement and Condition on Adiabatic Film Cooling Effectiveness Characteristics of a Transonic Turbine Blade Tip (H. Collopy, P. M. Ligrani, H. Xu, and M. Fox), International Journal of Heat and Mass Transfer, Vol. 199, Paper No. 123462, pp. 1-12, December 2022.

2023

215. Surface Film Cooling Characteristics of Rectangular Holes Along the Trailing Edge of a Transonic Turbine Blade Tip (M. Cox, H. Collopy, P. M. Ligrani, H. Xu, and M. Fox), International Journal of Thermal Sciences, Vol. 184, Paper No. 107920, pp. 1-11, February 2023.

216. Comparisons of Cooling Performance and Flow Characteristics of a Combustor Liner Plate With Compound Angle and Simple Angle Effusion Holes (H. Kwon, P. M. Ligrani, S. R. Vanga, and H. Park), International Journal of Thermal Sciences, Vol. 185, Paper No. 107984, pp. 1-20, March 2023.

217. Particulate Deposition Effects on Internal Swirl Cooling of Turbine Blades (X. Yang, Z. Hao, F. Seibold, Z. Feng, P. M. Ligrani, and B. Weigand), ASME Transactions – Journal of Engineering for Gas Turbines and Power, Vol. 145, No. 5, Paper No. 051020, pp. 1-13, May 2023.

218. Heat Transfer in Convergent Swirl Chambers for Cyclone Cooling in Turbine Blades (F. Seibold, P. M. Ligrani, X. Yang, R. Poser, and B. Weigand), Applied Thermal Engineering, Volume 230, Part B, Paper No. 120744, pp. 1-18, July 2023.

219. Statistical Analysis of Unsteady, Spatially-Varying Shock Wave Characteristics within a Supersonic Flow Environment (W. Manneschmidt, and P. M. Ligrani), International Journal of Statistics and Applications, Vol. 13, No. 1, pp. 13-19, July 2023.

220. Effects of Dusting Film Cooling Placement and Configuration on Surface Heat Transfer Characteristics of a Transonic Turbine Squealer Blade Tip (H. Collopy, P. M. Ligrani, W. Manneschmidt, H. Xu, and M. Fox), International Journal of Heat and Mass Transfer, Volume 212, Paper No. 124307 pp. 1-14, September 2023.

221, Relative Influences of Inertia and Polymeric Viscoelastic Effects on Nusselt Numbers within Rotating Couette Flows (P. M. Ligrani, V. Hietsch, and M. Su), Invited Journal Paper, Fluids, Special Issue: Non-Newtonian Flow: Interfacial and Bulk Phenomena (Editors: D. Andrew S. Rees, Amir H. Hirsa, and P. T. Underhill), Vol. 8, No. 1, pp. 258-273, September 2023.

222. Effects of Pressure Side Film Cooling Hole Placement and Condition on Surface Heat Transfer Coefficients Along a Transonic Turbine Blade Tip (H. Collopy, P. M. Ligrani, H. Xu, M. Fox), International Journal of Thermal Sciences, Volume 192, Part A, Paper No. 108399, pp. 1-14, October 2023.

2024

223. Conjugate Heat Transfer Evaluation of Turbine Blade Leading-Edge Swirl and Jet Impingement Cooling with Particulate Deposition (X. Yang, Z. Hao, Z. Feng, P. M. Ligrani, and B. Weigand), ASME Transactions – Journal of Turbomachinery, Vol. 146, No. 1, Paper No. 011003, pp. 1-16, January 2024.

224. Interrelationships of Entropy Production and Turbulence Kinetic Energy Associated With Simple Angle and Compound Angle Full Coverage Film Cooling (P. M. Ligrani, H. Kwon, and H, Park), International Journal of Thermal Sciences, Volume 197, Paper No. 108824, pp. 1-19, March 2024.

225. Effects of Blowing Ratio on Surface Heat Transfer Characteristics of a Transonic Turbine Squealer Blade Tip with a Double Plenum Film Cooling Supply Arrangement (G. Fulmer, P. M. Ligrani, H. Collopy, H. Xu, and M. Fox), International Journal of Heat and Mass Transfer, Volume 221, Paper No. 125043 pp. 1-15, April 2024.

226. Experimental and Numerical Investigation of Jet Impingement Cooling onto a Rib Roughened Concave Internal Passage for Leading Edge Cooling of a Gas Turbine Blade (M. Forster, P. M. Ligrani, B. Weigand, and R. Poser), International Journal of Heat and Mass Transfer, Volume 227, Paper No. 125572, pp. 1-15, August 2024.

227. Tip Gap Effects on Film Cooling Performance of a Transonic Turbine Blade With a Distinctive Coolant Supply Arrangement (P. M. Ligrani, H. Collopy, G. Fulmer, H. Xu, and M. Fox), International Journal of Heat and Mass Transfer, Volume 228, Paper No. 125667, pp. 1-10, August 2024.

228. Structural Margin Statistical Analysis: Effects of Reduction Factors and Statistical Noise on Performance Parameters (P. M. Ligrani, D. McDowell, S. L. Raghu, and L. D. Thomas), International Journal of Statistics and Applications, Vol. 14, No. 3, pp. 41-46, September 2024.

229. Normal Shock Wave Coherence Relative to Other Flow Events With High and Low Levels of Inlet Mach Wave Unsteadiness (W. Manneschmidt, P. M. Ligrani, M. Sorrell, A. M. Ciccarelli, and B. Weigand), Shock Waves, Vol. 34, pages 497–513, November 2024.

2025

230. Unsteady Relationships Between Instantaneous Surface Heat Flux, Instantaneous Surface Temperature, and Tracked Shock Wave Phenomena (M. Sorrell, W. Manneschmidt, and P. M. Ligrani), International Journal of Thermal Sciences, Vol. 208, Paper No. 109397, pp. 1-13, February 2025.

231. Consequences of Film Coolant Film Arrangement on Adiabatic Effectiveness of a Transonic Turbine Airfoil With Three Different Coolant Source Configurations (P. M. Ligrani, G. Fulmer, H. Xu, and M. Fox),), Heat Transfer Research, accepted for publication, to appear, 2025.

232. Quantification of Cooled Film Thermal Protection Using Net Heat Flux Reduction Within Transonic Environments (P. M. Ligrani, and N. Knox), Thermal Engineering, accepted for publication, to appear, 2025.
233. Heat Transfer and Aerodynamic Losses of Additively Manufactured Turbine Alloy Blades With Different Surface Enhancement Post-Processing (P. M. Ligrani, C. Bueschges, M. Tatge, B. Weigand, C. S. Subramanian, H. L. Collopy, Z. Taylor, J. Sheth,, and P. Gradl), International Journal of Thermal Sciences, accepted for publication, to appear, 2025.
234. Rarefaction Slip Phenomena Within a Viscous Disk Pump With Molecular Mean Free Path Sized Surface Roughness Elements (P. M. Ligrani, A. Pippert, and B. Weigand), Microfluidics and Nanofluidics, accepted for publication, to appear, 2025.
235. Tip Gap and Coolant Mass Flux Ratio Effects on Film Cooling Effectiveness, Coefficients of Convection, and Net Heat Flux Reduction Along a Transonic Turbine Airfoil (P. M. Ligrani, H. L. Collopy, H. Xu,, and M. Fox), International Journal of Heat and Fluid Flow, accepted for publication, to appear, 2025.
236. Unsteady Separation Region Characteristics Within a Normal Shock Wave - Lambda Foot Structure (P. M. Ligrani, and W, Manneschmidt), Physics of Fluids, accepted for publication, to appear, 2025.
237. Aerodynamic Losses and Heat Transfer of As-Built, Machined, Electropolished, and Chemical Polished Turbine Alloy Blades (H. L. Collopy, P. M. Ligrani, C. Herrin, M. Hancock, P. McMahan, M. Tatge,, Z. Taylor, J. Sheth,, and P. Gradl), International Journal of Heat and Fluid Flow, accepted for publication, to appear, 2025.
238.-241. Additional archival journal papers are under review for publication consideration within the journals International Journal of Thermal Sciences, International Journal of Heat and Fluid Flow, the International Journal of Heat and Mass Transfer, and Physics of Fluids.

BOOK CHAPTERS

1. Structure of Turbulent Boundary Layers (P. M. Ligrani), Aerodynamics and Compressible Flows, Encyclopedia of Fluid Mechanics (Editor: N. Cheremisinoff), Vol. 8, pp. 111-189, Gulf Publishing, October 1988.
2. Development and Structure of a Film-Cooling Jet in a Turbulent Boundary Layer with Heat Transfer (C. S. Subramanian, P. M. Ligrani, J. G. Green, W. D. Doner and P. Kaisuwan), Rotating Machinery Transport Phenomena, Proceedings of the Third International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-3), (Editors: J. H. Kim and W.-J. Yang), Hemisphere Publishing Corporation, pp. 53-68, March 1992.
3. Transient, Oscillatory and Steady Characteristics of Dean Vortex Pairs in a Curved Rectangular Channel (P. M. Ligrani), Ordered and Turbulent Patterns in Taylor-Couette Flow (Editors: C. David Andereck and F. Hayot) , NATO Advanced Science Institutes Series Volume, Series B: Physics Vol. 297, Plenum Press Publishing Corporation, pp. 281-288, October 1992.
4. Interactions Between Different Strength Vortices and Injectant Downstream of Film-Cooling Holes in a Turbulent Boundary Layer (P. M. Ligrani), Rotating Machinery Transport Phenomena, Proceedings of the Fourth International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-4), (Editors: J. H. Kim and W.-J. Yang), Begell Publishing Corporation, Vol. 2, pp. 644-654, October 1993.
5. Effects of Curvature on Heat Transfer in Channels and Swirl Chambers (P. M. Ligrani), Recent Research Developments in Heat, Mass, & Momentum Transfer, Vol. 2-1999, (Editor: S. G. Pandalai), Research Signpost Publishers, Vol. 2, pp. 171-183, 1999.
6. Dimple Array Effects on Turbulent Heat Transfer and Flow Structure (P. M. Ligrani), Turbulence, Heat and Mass Transfer 5 (Editors: K. Hanjalic, Y. Nagano, S. Jakirlic), Begell House Inc., New York, Wallingford (UK), pp. 59-78, 2006.
7. Measurements of Surface Heat Transfer Characteristics Using Infrared Imaging (P. M. Ligrani), Springer Handbook of Experimental Fluid Mechanics (Editors: C. Tropea, A Yarin, J. Foss), Springer-Verlag Publishers, Part B, Chapter 7, Section 7.2, pp. 500-515, 2007.
8. Recent Developments in Impingement Array Cooling, Including Consideration of the Separate Effects of Mach Number, Reynolds Number, Temperature Ratio, Hole Spacing, and Jet-to-Target Plate Distance (P. M. Ligrani), Impingement Jet Cooling in Gas Turbines (Editors: R. S. Amano, B. Sunden), WIT Press, Southampton, United Kingdom, Chapter 3, pp. 63-102, 2014.
9. Full-Coverage Effusion Cooling in External Forced Convection: Sparse and Dense Hole Arrays (P. M. Ligrani), Handbook of Thermal Science and Engineering (Editor-in-Chief: Francis A. Kulacki), Springer International Publishing AG, Springer Publishing Corporation, New York, New York, USA. Chapter 10, pp. 425-446, 2018.
10. Recent Research Developments for Turbine Blade Tip Heat Transfer, Including Development and Effects of Tip Leakage Vortices (H. Collopy, M. Sampson, and P. M. Ligrani), AIP Conference Proceedings, HEAT AND MASS TRANSFER AND HYDRODYNAMICS IN SWIRLING FLOWS (HMTHSF-2019): Proceedings of the Seventh International Conference (Editors: Alexander I. Leontiev, Yuriy A. Kuzma-Kichta, Shota A. Piralishvili, Sergey V. Veretennikov and Oleg A. Evdokimov), Vol. 2211, Paper No. 020002, AIP Publishing, American Institute of Physics, Melville, New York, USA, March 2020.
11. Detection and Tracking of Hypersonic Vehicles (P. M. Ligrani, and R. McGinley), Hypersonic Flight – Past, Present, and Future (Author and Editor: Manfred Dutch von Ehrenfried), Kindle Direct Publishing, Amazon Publishing Company, Irvine, California, USA, August 2023.

CONFERENCE PUBLICATIONS AND PRESENTATIONS – LAST 8 YEARS

2018

133. Gas Turbine Component Heat Transfer and Cooling Research Directions (P. M. Ligrani), Panelist, "Gas Turbine Cooling and Aerodynamics" Panel, American Society of Thermal and Fluids Engineers (ASTFE) Conference, Fort Lauderdale, Florida, USA, March 4-7, 2018.

134. Double Wall Cooling of a Full Coverage Effusion Plate With Main Flow Pressure Gradient, Including Internal Impingement Array Cooling (S. R. Vanga, Z. Ren, A. J. Click, P. M. Ligrani, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), Paper Number GT2018-77036, ASME TURBO EXPO 2018: Turbomachinery Technical Conference and Exposition, Lillestrom, Oslo, Norway, June 11-15, 2018.

135. Double Wall Cooling of a Full Coverage Effusion Plate With Cross Flow Supply Cooling and Main Flow Pressure Gradient (C. Allgaier, Z. Ren, S. R. Vanga, P. M. Ligrani, F. Liberatore, R. Patel, R. Srinivasan, and Y.-H. Ho), Paper Number GT2018-77061, ASME TURBO EXPO 2018: Turbomachinery Technical Conference and Exposition, Lillestrom, Oslo, Norway, June 11-15, 2018.

136. Propulsion Research and Academic Programs at the University of Alabama in Huntsville – PRC Laboratory Capabilities - 2018 (R. Frederick, P. M. Ligrani, and L. D. Thomas), Paper Number AIAA 2018-4805, 2018 AIAA Propulsion and Energy Forum and Exposition, AIAA – American Institute of Aeronautics and Astronautics, Cincinnati, Ohio, USA, July 10-12, 2018.

137. Aerospace and Aeronautical Engineering at the University of Alabama in Huntsville (P. M. Ligrani), Plenary Lecture, 2018 ASE International Week, Forum of the Future of Aerospace Engineering, School of Aeronautic Science and Engineering (ASE), Beihang University, Beijing, P. R. China, September 12-14, 2018.

138. Heat Transfer Enhancements From Elastic Turbulence Within Rotating Couette Flow Using Sucrose-Based Polymer Solutions (P. M. Ligrani), Plenary Lecture, ICAYS – 2018 International Conference in Aerospace for Young Scientists, School of Aeronautic Science and Engineering (ASE), Beihang University, Beijing, P. R. China, September 15-16, 2018.

139. Investigations of Normal Shock Wave Unsteadiness (P. M. Ligrani), Invited Paper, First International Symposium on Advances in Aerodynamics, Chengdu, Sichuan Province, P. R. China, December 14-15, 2018.

2019

140. Linear Cascade and Wind Tunnel Development for Turbine Blade Tip Heat Transfer Investigations With and Without Film Cooling (M. Sampson, A. Fairbanks, J. Moseley, P. M. Ligrani, H. Xu, and M. Fox), Paper Number GT2019-91074, ASME TURBO EXPO 2019: Turbomachinery Technical Conference and Exposition, Phoenix, Arizona, USA, June 17-21, 2019.

141. Propulsion Research and Academic Programs at the University of Alabama in Huntsville – PRC Strategic Plan 2019 (L. D. Thomas, R. A. Frederick, and P. M. Ligrani), Paper Number AIAA 2019-3891, 2019 AIAA Propulsion and Energy Forum, AIAA – American Institute of Aeronautics and Astronautics, Indianapolis, Indiana, USA, August 19-22, 2019.

142. Double Wall Cooling of an Effusion Plate With Cross Flow and Impingement Jet Combination Internal Cooling: Comparisons of Main Flow Contraction Ratio Effects (D. Ritchie, A. J. Click, P. M. Ligrani, F. Liberatore, R. Patel, and Y.-H. Ho), Paper Number AIAA-2019-3967, 2019 AIAA Propulsion and Energy Forum, AIAA – American Institute of Aeronautics and Astronautics, Indianapolis, Indiana, USA, August 19-22, 2019.

143. Effects of Coolant Supply Arrangement on Double Wall Cooling: Hot-Side Effusion Performance and Cold-Side Nusselt Numbers at Different Initial Blowing Ratios (A. J. Click, D. Ritchie, P. M. Ligrani, F. Liberatore, R. Patel, and Y.-H. Ho), Paper Number AIAA 2019-3965, 2019 AIAA Propulsion and Energy Forum, AIAA – American Institute of Aeronautics and Astronautics, Indianapolis, Indiana, USA, August 19-22, 2019.

144. Recent Research Developments for Turbine Blade Tip Heat Transfer, Including Development and Effects of Tip Leakage Vortices (H. Collopy, M. Sampson, and P. M. Ligrani), Invited Plenary Keynote Paper, HMTHSF-2019, Seventh International Conference "Heat and Mass Transfer and Hydrodynamics in Swirling Flows," National Committee on Heat and Mass Transfer of the Russian Academy of Sciences, Rybinsk, Russian Federation, October 16-18, 2019.

145. Academic and University Roles and Partnerships in the Development of Hypersonic Weapons (P. M. Ligrani), Invited Keynote Paper, 1st Annual Hypersonic Weapons Summit, 2019 Hypersonic Weapons Conference, IDGA - Institute for Defense and Government Advancement, Washington, D.C., USA, October 28-30, 2019.

2020

146. Physical Phenomena Associated With Hypersonic Weapon Vehicles (P. M. Ligrani), Invited Briefing Paper, 2nd Annual Hypersonic Weapons Summit, Digital Summit, 2020 Hypersonic Weapons Conference, IDGA - Institute for Defense and Government Advancement, Washington, D.C., USA, March 31-April 2, 2020.

147. Physical Phenomena Associated With Hypersonic Weapon Vehicles (P. M. Ligrani), Invited Briefing Paper, Hypersonic Weapon Systems, Digital Summit, IQPC, Defense iQ, London, England, United Kingdom, June 30-July 1, 2020.

148. Hypersonic Weapon Vehicles: Physical Effects and Phenomena (P. M. Ligrani), Invited Briefing Paper, Countermeasures Hypersonic Weapons Summit, Digital Summit, 2020 Hypersonic Weapons Conference, IDGA - Institute for Defense and Government Advancement, Washington, D.C., USA, July 23-24, 2020.

149. Propulsion Research and Academic Programs at the University of Alabama in Huntsville – PRC Graduate Student Production History (R. A. Frederick, L. D. Thomas, and P. M. Ligrani), Paper Number AIAA 2020-3909, AIAA Propulsion and Energy 2020 Forum, AIAA – American Institute of Aeronautics and Astronautics, Virtual Event, USA, August 24-26, 2020.
150. Louver Slot Cooling and Full-Coverage Film Cooling With a Combination Internal Coolant Supply (A. J. Click, P. M. Ligrani, M. Hockensmith, J. Knox, C. Larson, A. Fairbanks, F. Liberatore, R. Patel, and Y.-H. Ho), Paper Number GT2020-14520, ASME TURBO EXPO 2020: Turbomachinery Technical Conference and Exposition, Virtual Event, Virtual Online Conference, September 21-25, 2020.
151. Fostering Hypersonic Innovation Through Decisive Academic Research and Collaboration (P. M. Ligrani), Invited Briefing Paper, Hypersonic Weapons Summit, Digital Summit, 2020 2nd Annual Hypersonic Weapons Conference, IDGA - Institute for Defense and Government Advancement, Washington, D.C., USA, October 28-30, 2020.
152. R&D in Experimental Heat Transfer Diagnostics for Supersonic and Hypersonic Flow Environments (P. M. Ligrani), Invited Briefing Paper, Autonomous and Hypersonic Weapons Systems Conference, Technology Training Corporation (TTC), Washington, D.C., USA, November 4-6, 2020.

2021
153. Propulsion Research and Academic Programs at the University of Alabama in Huntsville – 30th Anniversary Summary (R. A. Frederick, P. M. Ligrani, and L. D. Thomas), Paper Number AIAA 2021-3347, AIAA Propulsion and Energy 2021 Forum, AIAA – American Institute of Aeronautics and Astronautics, USA, Virtual Event, August 9-11, 2021.
154. Topic AF19B-T012, Tailored Supersonic Flow Fields: Flow Shaping Technology to Enhance Test Rigs for Supersonic Inlets (M. Ostrander, S. Roth, and P. M. Ligrani), Propulsion-Airframe Integration Technical Interchange Meeting (PAI–TIM), Air Force / NASA / Industry / University Participation, Virtual Meeting, June 15-17, 2021.
155. Recent Investigations of Transonic, Supersonic, and Hypersonic Flow Phenomena (P. M. Ligrani), Invited Keynote Paper, 4th International Conference and Expo on Aerospace and Aeronautical Engineering (ICEAAE-2021, Aerospace-2021), Valencia, Spain, Virtual Event, October 25-27, 2021.
156. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, November 2-3, 2021.
157. Surface Heat Transfer Characteristics of Transonic Turbine Blade Tip Configurations With and Without Film Cooling (P. M. Ligrani), Invited Keynote Paper, 2021 3rd International Conference on Mechanical, Aerospace and Automotive Engineering (CMAAE 2021), Sponsored by the Hong Kong Society of Robotics and Automation and the Central South University (P. R. China), Changsha, P. R. China, Online Event, December 3-5, 2021.

2022
158. Effects of Pressure Side Film Cooling Hole Placement and Condition on Surface Heat Transfer Characteristics of a Transonic Turbine Blade Tip (P. M. Ligrani), Invited Plenary Paper, Global Experts Conference on Applied Science, Engineering and Technology (GECAET-2022), Virtual Conference and Amsterdam, Netherlands, July 28-29, 2022.
159. Panel Member for Panel Session, "Applied Radiation Tracking for Defensive Hypersonic Weapons," 2022 Hypersonic Weapons Summit, 4th Annual Hypersonic Weapons Summit, Institute for Defense and Government Advancement (IDGA) of the International Quality and Productivity Center (IQPC) (London, England, United Kingdom), Arlington, Virginia, USA, September 28-29, 2022.
160. Radiation Tracking Literature Overview (P. M. Ligrani), Invited Esteemed Speaker, 2022 Hypersonic Weapons Summit, 4th Annual Hypersonic Weapons Summit, Institute for Defense and Government Advancement (IDGA) of the International Quality and Productivity Center (IQPC) (London, England, United Kingdom), Arlington, Virginia, USA, September 28-29, 2022.
161. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.
162. Panel Moderator for Panel Session, "Testing and Simulation Developments for Hypersonics," Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.
163. Utilization of Electromagnetic Radiation for Detection, Tracking, and Characterization of Hypersonic Vehicles (P. M. Ligrani), Invited Paper, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 8-9, 2022.

2023
164. Effects of Dusting Film Cooling Placement and Configuration on Surface Heat Transfer Characteristics of a Transonic Turbine Squealer Blade Tip (H. Collopy, P. M. Ligrani, H. Xu, and M. Fox), Paper Number AIAA-2023-0883, 2023 AIAA Science and Technology Forum and Exposition (AIAA SciTech Forum), American Institute of Aeronautics and Astronautics, Gaylord National Harbor Hotel, National Harbor, Maryland, USA, January 23-27, 2023.

165. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 7-8, 2023.
166. Panel Moderator for Panel Session, "Next Hypersonic Testing and Research Required," Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Huntsville, Alabama, USA, November 7-8, 2023.
167. Recent Investigations of Transonic, Supersonic, and Hypersonic Flow Phenomena (P. M. Ligrani), Invited Plenary Paper, Third International Forum on Aerospace and Aeronautics (AEROFORUM 2023), San Diego, California, USA, December 11-13, 2023.
168. Conference Moderator, Third International Forum on Aerospace and Aeronautics (AEROFORUM 2023), San Diego, California, USA, December 11-13, 2023.

2024
169. Development of Innovative and Unique Pumping Concepts and Devices with Micro-, Millimeter-, and Macro-Scale Flow Passage Arrangements (P. M. Ligrani). Invited Plenary Lecture. Fluids Engineering Division Summer Meeting (FEDSM 2024), American Society of Mechanical Engineers (ASME), Anaheim, California, USA. July 15-17, 2024.
170. Investigation of Slip Flow Effects in a Micro-Channel Viscous Disk Pump Using DSMC (A. Appar, P. M. Ligrani, S. J. Poovathingal), 33rd International Symposium on Rarefied Gas Dynamics (RGD33), German Aerospace Center (DLR), Institute of Aerodynamics and Flow Technology Spacecraft Department – Göttingen, Germany, July 15-19, 2024.
171. Conference Chairman, Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, October 29-30, 2024.
172. Control of Shock Waves and Associated Flow Structure in Supersonic and Hypersonic Flow Environments (P. M. Ligrani), Invited Lecture. Hypersonic Defense Conference and Exhibition, Intelligence-SEC (Buckinghamshire, England, United Kingdom), Arlington, Virginia, USA, October 29-30, 2024.

2025
173. Coherent Interactions Between Test Section Inlet Unsteadiness, Surface Temperature Fluctuations, and Shock Wave Phenomena with Different Levels of Inlet Turbulence Intensity (W, Manneschmidt, and P. M. Ligrani), Paper Number AIAA-2025, 2025 AIAA Science and Technology Forum and Exposition (AIAA SciTech Forum), American Institute of Aeronautics and Astronautics, Hyatt Regency Orlando, Orlando, FL, USA, January 6-10, 2025.
174. Tip Gap Effects on Film Cooling Heat Transfer Coefficients Along a Transonic Turbine Blade with a Distinctive Coolant Supply Arrangement (P. M. Ligrani, H. Collopy, G. Fulmer, H. Xu, and M. Fox), Paper Number AIAA-2025, 2025 AIAA Science and Technology Forum and Exposition (AIAA SciTech Forum), American Institute of Aeronautics and Astronautics, Hyatt Regency Orlando, Orlando, FL, USA, January 6-10, 2025.
175. Propulsion Research and Academic Programs at the University of Alabama in Huntsville – Research Review (R. A. Frederick, L. D. Thomas, and P. M. Ligrani), Paper Number AIAA-2025, 2025 AIAA Science and Technology Forum and Exposition (AIAA SciTech Forum), American Institute of Aeronautics and Astronautics, Hyatt Regency Orlando, Orlando, FL, USA, January 6-10, 2025.
176. Design, Development, and Performance of Innovative Micro-Scale, Millimeter-Scale, and Macro-Scale Pumping Devices (P. M. Ligrani). Invited Keynote Lecture. Fluid Applications and Systems Technical Committee (FASTC), Fluids Engineering Division Summer Meeting (FEDSM 2025), American Society of Mechanical Engineers (ASME), Philadelphia, Pennsylvania, USA. July 27-30, 2025.
177. Vortex Development and Quantification Within Complex Mechanical and Aerospace Engineering Flow Environments (P. M. Ligrani). Invited Lecture. VORTEX2025 International Conference – Toward World Consensus on Vortex Definition and Prediction, National Science Foundation and the University of Texas at Arlington, Arlington, Texas, USA. December 13-16, 2025.

UPDATED. 2025-11-30