ASME INTERNATIONAL GAS TURBINE INSTITUTE

ASME 2020 TURBO EXPO

ASME SETTING THE STANDARD

Advance Program

JUNE 22 - 26, 2020 / LONDON, UNITED KINGDOM

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS® (ASME®)

ANSYS

We help you push the limits.

With every generation, you push your products to new limits. This puts pressure on your tools, your methods and even yourself. We get it, and we're working hard to deliver the next generation of tools, training and technology to help you stay ahead. Whether you are maximizing performance, reducing development time, adopting new manufacturing techniques, building smarter products or keeping our planet cleaner, ANSYS is there for you.

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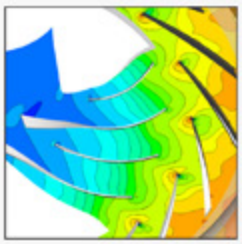

Turbomachine Design and Optimization

NEW! Multi-Frequency Harmonic Analysis

Additive Manufacturing & Materials Information

Digital Twins

Clean Power and Propulsion Systems

» *Visit us at Booth #306*

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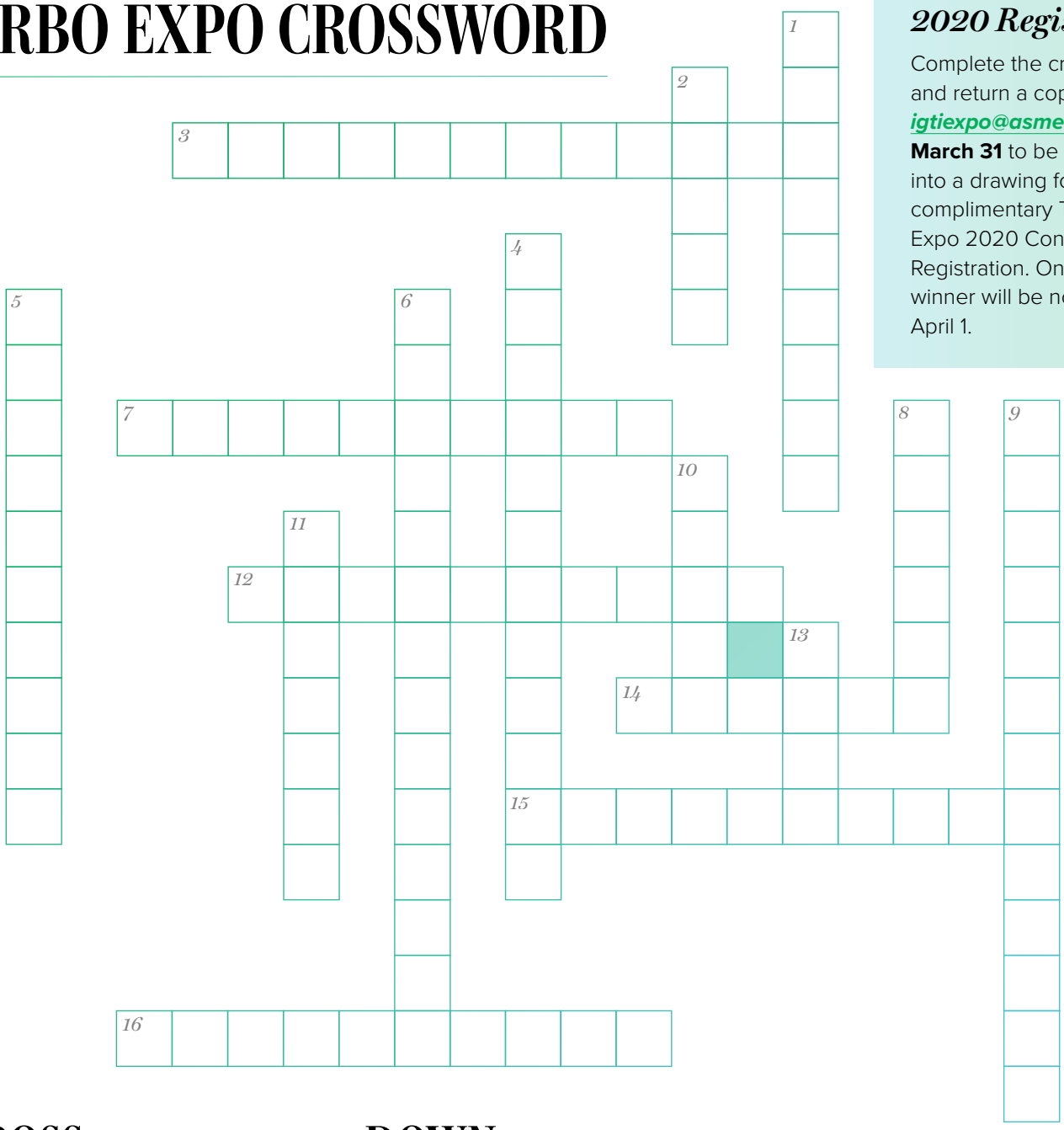
TURBO EXPO CROSSWORD



Win a Turbo Expo 2020 Registration

Complete the crossword and return a copy to ***igtiexpo@asme.org*** by **March 31** to be entered into a drawing for a complimentary Turbo Expo 2020 Conference Registration. One lucky winner will be notified by April 1.

ACROSS

3. First city where Turbo Expo was held.

7. IGTI Executive Committee Chair.

12. 2020 Platinum Sponsor.

14. What country hosted the 60th ASME Turbo Expo?

15. Award was established in 1972 to honor R. Tom Sawyer.

16. Turbo Expo Organizing Committee Chair.

DOWN

1. Gas Turbine Segment Leader.

2. 2020 Platinum Sponsor.

4. Award established in 1989 and awarded every other year.

5. City hosting ASME Turbo Expo in 2021.

6. What is the name of the first female Turbo Expo keynote speaker?

8. Bronze sponsor in booth space 404.

9. Attendee Bag Sponsor

10. What award provides up to $2,000 toward travel expenses for students to attend Turbo Expo?

11. What city has hosted Turbo Expo 9 times?

13. Bronze Sponsor.

LONDON, UNITED KINGDOM

About London

London is the capital and largest city of England and the United Kingdom. It is a 21st-century city with history stretching back to Roman times. London is filled with diversity and excitement with some of the world's best sights, attractions, and activities. It is also the largest metropolitan economy in the United Kingdom by GDP.

Getting Around in London

London is a city with a great public transportation network. Underground or "The Tube" is one of the most common ways to travel to and from central London and is an essential part of many people's stay in the capital. Using an ***Oyster travel smartcard*** is the easiest and cheapest way to travel around the city's public transport network. Double-decker buses are another fast, easy, and convenient option to travel across the city with sightseeing opportunities along route.

London Top Attractions

- Big Ben
- Coca-Cola London Eye
- Tower of London
- The View from The Shard
- Sea LIFE London
- Buckingham Palace
- Hyde Park
- Old Spitalfields Market
- Hampton Court Palace
- House of Parliament

Upper-right: Tower of London. **Middle-left:** Coca-Cola London Eye. **Middle-right:** Big Ben. **Lower-left:** Buckingham Palace.

ESSENTIAL INFORMATION

Currency

The currency in the United Kingdom is the pound sterling, known as the pound (£, GBP). There are 100 pence (p) to the pound (£). Notes come in denominations of £5, £10, £20 and £50. Coins come in 1p, 2p, 5p, 10p, 20p, 50p, £1 and £2.

Visa Requirements

Some people may require a visa to visit the United Kingdom. To find out whether you need a visa to visit London and how to apply, see the ***UK Visas and Immigration website***, or check with your local British Embassy or other diplomatic representative before you travel.

Tipping

It is common to leave 10-15% of the bill at restaurants, however some restaurants add on a service charge instead. It is courteous to top 10-15% of the taxi fare to black cans and licensed mini cabs. People normally, do not tip at bars and pubs.

Electricity

It is easy to stay connected in London. UK appliances are fitted with a three-pin plug. Power sockets deliver an average of 230v.

Local Liaison Committee

Dr. Luca di Mare, *University of Oxford*

Dr. Andrea Giusti, *Imperial College London*

Frédéric Goenaga, *Rolls-Royce Plc.*

Dr. Olaf Marxen, *University of Surrey*

Professor David Nowell, *Imperial College London*

Dr. Christoph Schwingshackl, Chair, *Imperial College London*

Dr. Sina Stapelfeldt, *Imperial College London*

Roger Wells, *Siemens Lincoln Wells*

Upper-right: The Shard.
Left: House of Parliament.

GRAND OPENING & AWARDS INFORMATION

The 2020 Keynote Theme is Responding to Market Transformation — Let's Learn from Others!

Conference Theme

RESPONDING TO MARKET TRANSFORMATION — LET'S LEARN FROM OTHERS!

Today's power and propulsion industry is undergoing a transformational change with an even higher demand to address environmental issues and sustainability challenges. To respond to this change there is a need to develop and introduce new technology more quickly, at lower cost and with a focus on 'net zero carbon'. The winners in this new world will be companies who can adapt to technology change in an agile way.

Existing technologies such as artificial intelligence, data analytics, virtual reality, rapid machining, rapid testing and additive manufacturing promise significant cost and time reduction in the design, manufacturing and testing processes while offering higher flexibility and better product insight throughout the lifecycle. To better exploit new technologies and improve agility, companies have started to explore new ways of working.

We believe that it is important to learn from others. With invited speakers from a variety of different industrial areas, the ASME Turbo Expo 2020 conference will offer a unique platform for the power and propulsion community to listen, discuss and learn from industrial leaders how new technologies and ways of working can help with agility and pace with the aim of meeting future challenges.

Keynote & Awards Program

The Keynote is held in conjunction with the annual ASME IGTI Honors & Awards program honoring individuals who have made significant contributions to the advancement of the turbomachinery technology.

AWARDS

Young Engineer Turbo Expo Participation Award

Nomination Deadline for the London ASME Turbo Expo was February 1.

The ASME Gas Turbine Segment **Young Engineer Turbo Expo Participation Award (YETEP)** is intended for young engineers at companies, in government service, or engineering undergraduate or graduate students in the gas turbine or related fields to obtain travel funding to attend ASME Turbo Expo to present a paper which they have authored or co-authored. The purpose is to provide a way for more to participate in the annual Turbo Expo.

The nominee must have obtained an academic degree (Bachelor, Master, PhD, or equivalent degrees) in an engineering discipline related to turbomachinery within five years from the year of the Turbo Expo that the applicant wishes to attend. The research results the applicant wishes to present at the conference can have been obtained either while pursuing an academic degree, or afterwards (students, professionals or young academics are eligible).

For 2020, ASME IGTI will provide YETEP Award winners with:

- **One Complimentary ASME Turbo Expo Technical Conference Registration**
- **Complimentary hotel accommodations (Sunday to Friday)**
- **Up to $1,000 toward approved travel expenses**

Congratulations to the 2019 Award Winners:

Parash Agarwal, *Cranfield University*

Nathan Balke, *Formosa Plastics Corp USA*

Nikhil Baraiya, *Indian Institute of Technology Madras*

Tania Sofia Cacao Ferreira, *Von Karman Insitute/Universite catholique de Louvain*

Cis Guy M De Maesschalck, *Rolls-Royce plc*

Xin Deng, *University of Virginia*

Antoine Durocher, *McGill University*

Theofilos Efstathiadis, *University of Thessaloniki*

Chiara Gastaldi, *Politecnico Di Torino*

Shuai Guo, *Technical University of Munich, Thermo-Fluid Dynamics Group*

Jee Hee, *University of Nottingham*

Yousef Kanani, *Illinois Institute of Technology*

Bonjin Koo, *Daikin Applied*

Eric Kurstak, *Ohio State University*

Madasseri Payyappalli Manas, *Indian Institute of Technology Bombay (IITB)*

Pedro Milani, *Stanford University*

Avinash Renuke, *University of Genoa, Italy*

Jon Runyon, *Cardiff University*

Jacob Snyder, *Penn State University*

Tingcheng Wu, *Texas A&M University*

Jing Yang, *Texas A&M University*

Wenqiang Zhang, *Imperial College London*

For more information, visit:

event.asme.org/Turbo-Expo/Students/Student-Travel-Awards

& SCHOLARSHIPS

AWARDS

ASME IGTI Student Scholarship Program

MARCH 1, 2020

Student application deadline for the 2020-2021 Academic School Year.

Scholarship winners will be notified between June 15 and July 15, 2020.

ASME IGTI has a long and proud history of providing scholarships to students who show promise for their future profession in the turbomachinery field. The aim is to attract young talent to the profession and reward their commitment, favoring their upcoming enrollment and active participation. The scholarship is to be used for tuition, books and other University expenses. The check will be made out to the University on the student's behalf.

Eligibility of the Applicants

ASME Scholarships are awarded annually to eligible ASME Student Members. You must be a current ASME student member in good standing (for login to the ASME online scholarship application). ***Click here*** to Join ASME or to Renew your dues.

To be eligible, you must be a community college, college, or university student who is enrolled full-time in Mechanical Engineering (ME), Mechanical Engineering Technology (MET), or closely related engineering studies.

For your major to be considered closely related to a Mechanical Engineering major, you must be taking at least 25% of your credits each semester in courses from the Mechanical Engineering Department.

Congratulations to the 2019 Award Winners:

Jerom Ashford, *Brigham Young University-Idaho*

Alene Basmadjian, *University of Oklahoma Norman Campus*

Andrew Blunt, *Northeastern University*

Sofia Gomez, *The University of Texas at El Paso*

Brandon Gurrell, *Kettering University*

Hunter Hodges, *Colorado School of Mines*

Jake Johnson, *Boise State University*

Taylor Kenda, *Texas Christian University*

Nicolas Kuperus, *Dordt College*

Jordan Miller, *Indiana Institute of Technology*

Jayden Parris, *Bryan College*

Jithu Paulose, *Indiana Institute of Technology*

Elyssa Penson, *Bucknell University*

Micaela Robinson, *Washington State University*

Katherine Schneider, *Colorado School of Mines*

Michael Ustes, *University of Michigan-Dearborn*

Jarred Vasinko, *Pennsylvania State University-Main Campus*

Luke Vilagi, *The University of Alabama*

William Welch, *University of California-Berkeley*

Mengyue Yang, *University of Tulsa*

For more information, visit:

asme.org/career-education/scholarships-and-grants/scholarship/asme-scholarships-how-to-apply

NEW

When you complete the online application, you will be considered for all ASME scholarships for which you qualify, not just the ASME IGTI scholarship.

& SCHOLARSHIPS

AWARDS

Student Advisory Committee Travel Award

The SACTA deadline for nomination was February 1, 2020.

The SAC is pleased to announce that 20 **Student Advisory Committee Travel Awards (SACTA)**, worth up to $2,000 each, have been made available to cover or partially cover student travel expenses to Turbo Expo 2020, with priority given to students who both participate in the conference and actively contribute to the growth of the SAC. Applicants for these awards must be seeking a degree and must be or plan to be members of the SAC. The applicant must agree to participate in the SAC Annual Meeting at Turbo Expo 2020 and willing to help SAC leadership team to review and set-up student posters. Communication with the SAC leadership team may be requested prior to, during, and following Turbo Expo 2020. All applicants will be notified of the decision on their application by March 15th, 2020.

Information can be found at: ***event.asme.org/Turbo-Expo/Students/Student-Travel-Awards***

The ASME R. Tom Sawyer Award

AUGUST 15, 2020

Your nomination package should be received at the ASME Office no later than the above date to be considered.

The **R. Tom Sawyer Award** is bestowed on an individual who has made important contributions to advance the purpose of the Gas Turbine Industry and to the International Gas Turbine Institute over a substantial period of time. The contribution may be in any area of institute activity but must be marked by sustained forthright efforts. The award was established in 1972 to honor R. Tom Sawyer who, for over four decades, toiled zealously to advance gas turbine technology in all of its aspects and includes a US $1,000 honorarium and a plaque presented during ASME Turbo Expo.

The nomination must be complete and accompanied by three to five Letters of Recommendation from individuals who are well acquainted with the nominees' qualifications. Candidate nominations remain in effect for three years and are automatically carried over. The completed reference form from a minimum of 3 people will need to be sent in with the nomination package. It is up to the "Nominator" to submit all required information.

Email completed nomination package to:

igtiawards@asme.org

Congratulations to the 2019 ASME R. Tom Sawyer Award winner Dr. Om Sharma, UTRC

& SCHOLARSHIPS

AWARDS

The ASME Gas Turbine Award

CLICK HERE FOR MORE INFORMATION

The **Gas Turbine Award** is given in recognition of an outstanding individual—or multiple—author contribution to the literature of combustion gas turbines or gas turbines thermally combined with nuclear or steam power plants. The paper may be devoted to design aspects or overall gas turbines or individual components and/or systems such as compressors, combustion systems, turbines, controls and accessories, bearings, regenerators, inlet air filters, silencers, etc. It may cover topics specifically related to gas turbines such as high temperature materials or fuel considerations, including erosion and corrosion complications. It can also be devoted to application or operational aspects of gas turbines for aircraft propulsion and ground power units, or automotive, electric utility, gas pipeline pumping, locomotive, marine, oil field pumping, petrochemical, space power, steel, and similar uses. This award was established in 1963 and includes a US $1000 honorarium and a plaque presented during ASME Turbo Expo.

Congratulations to the 2017 ASME Gas Turbine Award winners
Dr. — Ing Christoph Brandstetter, Maximilian Jüngst, and Heinz-Peter Schiffer.

The ASME IGTI Aircraft Engine Technology Award

OCTOBER 15, 2020

Nominating and supporting letters for the Aircraft Engine Technology Award should be sent by the above date to:

igtiawards@asme.org

The **Aircraft Engine Award** recognizes sustained personal creative contributions to aircraft gas turbine engine technology. Eligible areas of accomplishment are aircraft engine design, and/or research and development performed in an industrial, academic or research laboratory environment in one or more of the following fields:

- Aircraft Engine Propulsion
- Airframe-Propulsion Integration
- Combustion & Fuels
- Controls
- Diagnostics
- Heat Transfer
- Manufacturing Materials & Metallurgy
- Operability
- Structures & Dynamics
- Turbomachinery

The Aircraft Engine Technology Award will include an optional opportunity to deliver a lecture or present an invited technical paper on the work for which the award is being bestowed, at ASME Turbo Expo. The recipient of the award will very desirably, but not necessarily, be a member of The American Society of Mechanical Engineers. The award will be made to a single individual.

Nominating letters should contain all information on the nominee's relevant qualifications. The Award Committee will not solicit or consider materials other than those described below. The selection committee will hold nominations active for a period of three years.

A minimum of two supporting letters from individuals, other than the nominator, must accompany the nominating letter. Supporting letters should reflect peer recognition of the nominee's breadth of experience with various aspects of industrial gas turbine technology.

Congratulations to the 2019 Aircraft Engine Technology Award winner
Dr. Thomas Prete, Pratt & Whitney Military Engines.

& SCHOLARSHIPS

AWARDS

John P. Davis Award

Awarded to a paper that focuses on new or continuing gas turbine applications, identifies planning, installation, operating and/or maintenance problems and their solutions, and exemplifies candid exposure of real-world problems and solutions.

Congratulations to the 2016 ASME Gas Turbine Award winners Dr. Parthiv N. Shah, ATA Engineering Inc., Gordon Pfeiffer, ATA Engineering Inc, Dr. Rory R. Davis, ATA Engineering Inc., Thomas Hartley, Williams International, and Dr. Zoltan Spakovszky, Massachusetts Institute of Technology.

The ASME IGTI Industrial Gas Turbine Technology Award

OCTOBER 15, 2020

Nominating and supporting letters for the Industrial Gas Turbine Technology Award should be sent by the above date to:

igtiawards@asme.org

The **Industrial Gas Turbine Award** recognizes sustained personal creative scientific or technological contributions unique to electric power or mechanical drive industrial gas turbine technology. Eligible areas of accomplishment are gas turbine design, application, operations/maintenance, and research/development/deployment, performed in an industrial, academic or research laboratory environment in one or more of the following fields:

- Combustion, Fuels, & Emissions Abatement
- Controls
- Diagnostics
- Electric Power Plant Integration
- Fluid Dynamics & Thermal Sciences
- Operation, Maintenance, & Life Cycle Cost
- Manufacturing, Materials, & Metallurgy
- Structures & Dynamics
- Thermodynamic Cycles
- Turbomachinery

The Industrial Gas Turbine Technology Award will include an optional opportunity to deliver a lecture or present an invited technical paper on the work for which the award is being bestowed, at ASME Turbo Expo. The recipient of the award will very desirably, but not necessarily, be a member of The American Society of Mechanical Engineers. The award will be made to a single individual.

Nominating letters should contain all information on the nominee's relevant qualifications. The Award Committee will not solicit or consider materials other than those described below. The selection committee will hold nominations active for a period of three years.

A minimum of two supporting letters from individuals, other than the nominator, must accompany the nominating letter. Supporting letters should reflect peer recognition of the nominee's breadth of experience with various aspects of industrial gas turbine technology.

Congratulations to the 2019 Industrial Gas Turbine Technology Award winner Ron Natole, Retired.

& SCHOLARSHIPS

AWARDS

ASME IGTI Dilip R. Ballal Early Career Award

AUGUST 1, 2020

Nomination packets are due to ASME on or before the above date. Send complete nomination to:

igtiawards@asme.org

Early Career Awards are intended to honor individuals who have outstanding accomplishments during the beginning of their careers. Historically, there has been no such award to recognize early career engineers working in the area of turbomachinery.

An early career award is intended for those starting a professional career, which is typically after a relevant terminal degree: BS, MS, or PhD. A criterion of seven-years-from-degree will be used to define the nominee's eligibility. The nominee must receive the award prior to the completion of the seventh year beyond the terminal degree.

The recipient of the Dilip Ballal Early Career Award will be presented with the award at Turbo Expo. The award consists of a plaque, funds to support the travel and registration costs to Turbo Expo, free ASME membership registration for five years, and a US $2000 honorarium.

Nomination Requirements

a. A paragraph (less than 50 words) from the nominator highlighting nominee's contributions
b. Nomination letter
c. Two supporting letters
d. Current resume of the nominee

Congratulations to the 2019 Dilip R. Ballal Early Career Award winner Dr. Lisa Branchini, University of Bologna.

ASME Dedicated Service Award

The **ASME Dedicated Service Award** honors unusual dedicated voluntary service to the Society marked by outstanding performance, demonstrated effective leadership, prolonged and committed service, devotion, enthusiasm and faithfulness.

Congratulations to the 2018 award winner Dr. Sy A. Ali, Clean Energy Consulting and the 2019 award winner Patricia Cargill, GE Aviation.

2020

For details on the 2020 award winners, please refer to the 2020 Awards Program. Programs will be available during the Turbo Expo Grand Opening: Keynote and Awards Program on Monday, June 22nd in London.

& SCHOLARSHIPS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www.rolls-royce.com/poweroftrent

TECHNICAL SESSIONS

The Technical Conference has a well-earned reputation as the premier forum on all aspects of gas turbine and related turbine technology. The 2020 Program features technical sessions, panel discussions, tutorials, user-focused sessions and more.

TECHNICAL SESSIONS

Aircraft Engine

Sessions within this track address issues of interest across a broad spectrum of aircraft engine technology subjects.

Presenters will cover a range of topics including:

- Operability
- Modeling, Simulation and Validation
- Inlets, Nacelles, Nozzles and Mixers
- Thermal Management Systems and Aero-Engine Oil Systems
- Whole Engine Performance and Novel Concepts
- Propellers and Open Rotors

Additionally, the following tutorial and panel sessions will be presented:

- Basics of Turboshaft Engine Cycle Design and Optimization
- Contemporary Approach to Modeling Existing Gas Turbine Engines
- Overview of Fatigue Life Modeling
- Machine Learning for Aerothermal Systems
- Ice Crystal Icing Tool Development
- Propulsion Systems

Ceramics

Ceramics are important materials for consideration in the extreme environments found in the gas turbine engine hot sections due to their higher temperature mechanical as well as lower density than metals. The advantages of utilizing ceramic hot section components include weight reduction, improved thermal efficiency as well as enhanced power output and lower emissions. In order to realize the potential of rotating and static ceramic components, some unique technical challenges are being overcome by the engineering community. Specific areas of research and development include:

- CMC Components & Design Considerations
- CMC Material Behavior and Durability: Fast Fracture, Fatigue, FOD, Erosion and CMAS
- High Temp. Coatings for CMCs
- CMC and EBC Tutorials

Coal, Biomass & Alternative Fuels

Sessions focus on high-interest topics in the area of alternative fuel systems for gas turbines, including Hydrogen fuel systems, steam turbines, and other turbomachinery technologies. Alternative and renewable fuels including gaseous and liquid hydrocarbon fuels, alcohols, and ethers; as well as pure hydrogen, or high hydrogen content fuels. Alternative liquid hydrocarbon fuels derived from coal or biomass feedstocks or other technologies. Technical, tutorial, and panel sessions will cover the fundamental physical and chemical properties of alternate and renewable fuels, important to their use in gas-turbine engines and other power systems, as well as their application in different power systems. Sessions will be of interest to researchers, technologists, computational methods involved in the generation and utilization of non-conventional fuels in gas-turbine-based energy systems, and for those wishing to start a new activity in this field.

- Hydrogen Fuel Delivery Systems
- Hydrogen and Hydrogen Content Fuels for Gas Turbine Applications
- Alternative Fuel Chemistry and Fundamentals
- Alternative Fuel Use in Gas-Turbine Engines
- Basics of Hydrogen and Alternative Fuels
- Liquid Fuel Atomization and Combustion
- Computational Methods for Hydrogen and other Alternate Fuels
- Basics of Combustion Computational Fluid Dynamics

TECHNICAL SESSIONS

Combustion, Fuels & Emissions

Aero and Industrial Gas Turbines with low specific fuel consumption and reduced CO2 emissions require high combustor outlet temperatures with a continued emphasis on reducing emissions, without sacrificing operability or durability. In addition, combustion systems are increasingly expected to operate with synthetic gaseous fuels or alternative liquid fuels.

The Combustion, Fuels & Emissions sessions will highlight new technology and design approaches, using both experimental and computational techniques, employed to achieve improved combustor performance including ultra-low pollutant emissions and enhanced operability such as turndown and transient response.

Broad trends for the 2020 conference include a continued focus on combustion dynamics for lean, staged combustion systems, significant innovation in the development of combustion system such as dry low NOx or novel rotary detonation, maturation of large eddy simulation analyses, as well as continued research of fundamental and applied topics in atomization, mixing, ignition, auto ignition, blowout and chemical kinetics.

Technical sessions include:

- Ignition & Auto Ignition
- Atomization & Sprays
- Fundamental Combustion
- Novel Combustion Concepts
- Flashback & Blowout
- Pollutant Emissions Formation & Control: Combustor Performance
- Combustor Design & Development
- Chemical Kinetics
- Combustion Noise
- Pollutant Emissions: Modeling, Soot and Particulates
- Combustion Dynamics: Basic Mechanisms, Flame Response to Perturbations, Instability Analysis, Model Development, Nonlinearities and Damping & Control
- Combustion Modeling: Combustor Simulations and Large Eddy Simulations
- High Hydrogen Combustion
- Dry Low-NOx Combustor Development
- Micro Devices
- Combustor Flows
- Combustor Diagnostics
- Rotating Detonations

Controls, Diagnostics & Instrumentation

The Controls, Diagnostics & Instrumentation (CDI) Committee will host technical, panel, and tutorial sessions that will closely examine, discuss and report on the global challenges and state of the art technologies in the associated technical areas for gas turbine engines and power systems. These will include the latest developments in gas turbine instrumentation and control, diagnostics, prognostics and health management, applications of machine learning and artificial intelligence, data analytics, and the impact these technologies have in improving efficiency and reliability, lowering emissions, and reducing operating costs. More precisely, the exchange of information between experts from Government, Academia and Industry is promoted on the following topics:

- Control System Technology
- Optimal and Intelligent Controls
- Active Component Control
- Distributed Engine Control
- Engine Health Management
- Gas Path Performance Diagnostics
- Structural and Mechanical Component Health Management
- On-Board Engine Monitoring and Diagnostics
- Big Data Analytics for Engine Health Management
- Prognostics for Gas Turbine Engines
- Advanced Data Reduction Methods
- Integrated Controls and Diagnostics
- Modeling for Controls and Diagnostic Applications
- Life Usage Monitoring and Life Extending Control Algorithms and Sensors
- Novel Sensors and Sensor Technologies
- Development of Standard and High Temperature Test Rigs and Probes
- Optical and Non-intrusive Measurement Techniques
- Flow, Temperature, Pressure and Acoustic Instrumentation
- Applications of Machine Learning and Artificial Intelligence in CDI
- CDI Technologies for Hybrid Electric Propulsion Systems

TECHNICAL SESSIONS

Cycle Innovations

The Cycle Innovations Committee is dedicated to the advancement of technology and innovation, with a particular focus on the thermodynamic cycles of gas turbine–based plants for power generation and propulsion. Special attention is also devoted to energy storage technology and management aspects. The Committee traditionally attracts paper submissions from a wide range of disciplines and scientific areas. Some of the thematic areas the Committee currently encompasses are listed below:

- Low or no emissions thermal cycles and advanced CO_2 handling
- Supercritical CO_2 cycles
- H2 production and utilization
- Polygeneration cycles and process integration (power, heat, cooling, fuels, chemicals)
- Advanced steam and humid air cycles
- Steam and water injection gas turbine cycles
- Closed cycle gas turbine technology
- Novel aero propulsion systems for aircraft and rotorcraft
- Novel marine propulsion systems
- Innovative heat recovery steam generators & once through steam generators
- Renewable and bio-energy concepts and innovative cycles
- Concentrated Solar Power systems incorporating gas turbine technology
- Fuel cell driven cycles and hybrid systems
- Externally fired gas turbines and high temperature heat exchangers
- New cycles for distributed power generation
- Thermo-economic and environmental impact analysis
- Cycle simulation and analysis for performance and health assessment
- Low temperature heat recovery cycles
- Geothermal cycles
- Innovative control systems for power plants
- Optimization of traditional and innovative energy and propulsion systems
- Electrical energy storage
- Thermal energy storage (hot water, phase changing materials, nanomaterials, thermochemical devices, etc.)
- Storage solutions for hydrogen or complex chemicals
- Compressed air energy storage

Authors and presenters are invited to participate in this event to expand international cooperation, understanding and promotion of efforts and disciplines in the area of Cycle Innovations. Dissemination of knowledge by presenting research results, new developments, and novel concepts in Cycle Innovations will serve as the foundation upon which the conference program of this area will be developed.

A variety of sessions are available for presentations as it allows flexibility to the authors. All sessions are quality driven.

Education

Sessions encompass gas turbine/turbomachinery education both in the university and in the industry. Specific teaching tools and techniques will be discussed, including web-based and large-scale remote education, along with industry opportunities for gas turbine engineers. Anyone interested in gas turbine/ turbomachinery engineering education is welcome, from students to academics and professionals. Academics will be exposed to ideas and best practices used at other institutions as well as innovative approaches for gas turbine/ turbomachinery education. Industry will have an opportunity to interact with educators to discuss relevant topic areas and to express their expectations with regard to changing needs. Discussions here have the potential to influence engineering education for a positive impact on future engineers. The sessions provide an active and constructive dialogue about gas turbine/turbomachinery education among practitioners from the industry, students, educators and researchers.

- Education Issues
- Professional Development Workshop for Mid and Late Career Engineers on Transition Coaching

TECHNICAL SESSIONS

Electric Power

The Electric Power Committee (EPC) promotes the exchange of significant technical information on the application and operation of gas turbine power plant systems. The committee organizes technical and tutorial sessions that deal with the current topics in the electric power industry related to the turbine technology, power plant, digital solutions that prevent/reduce forced outages and improve operation efficiency, flexible operations, decarbonization and hybrid solutions etc. Presenters include owner/operators, original equipment manufacturers, industry independent service providers and other research institutions. The EPC also coordinates popular panel discussion sessions such as OEM technology updates, voice of the owners and operators, industry updates with respect to the economic and regulatory boundary conditions and other contemporary topics in electric power generation industry.

Fans & Blowers

Improvements in fans and blowers are means to address the global energy challenge, with manufacturers increasingly focusing on improvement in fan efficiency and the reduction of noise emissions under legislative pressure, as a part of their response to global climate change. The academia industry collaboration and the up-front use of Computational Fluid Dynamics (CFD) and Experimental Fluid Dynamics (EFD) are the key ingredients to facilitate the advancement from traditional empirical design methodologies. In response to these challenges, the ASMEIGTI Fans and Blowers Technical Committee consider all technical aspects associated with fans and blowers, with a special emphasis on:

- Fans and Blowers: Computational Fluid Dynamics
- Fans and Blowers: Experimental Methods
- Fans and Blowers: Basic Design and Industrial Application
- Fans and Blowers: Optimization
- Fans and Blowers: Machine Learning

Heat Transfer

Heat transfer is a pacing technology in the development of advanced high-performance gas turbines for aircraft propulsion and power generation in both simple and combined cycle operations. The heat transfer sessions offered at Turbo Expo 2020 relate to every aspect of the state-of-the-art heat transfer, internal air system, and seals design and will include presentations of over 200 technical papers and tutorials of basics in more than 40 sessions.

Heat transfer topics are subdivided into 5 tracks, which represent the major sub-disciplines within gas turbine heat transfer: Film Cooling, Internal Cooling, Internal Air Systems and Seals (organized jointly with the Turbomachinery Committee), Combustion (organized jointly second with the Combustion, Fuels & Emissions Committee), and General Interest. In addition, a Tutorials track presents background on turbine cooling fundaments for the benefit of all interested conference attendees

The Film Cooling track with almost 20 sessions offers a wide range of information related to the development and recent research activities on film cooling that contribute significantly to heat transfer advancements in cooled turbomachinery components. Sessions cover novel film cooling-hole geometries, film cooling optimization, multi-row effects, manufacturing impacts, scale-resolved turbulence modeling, and recent advances in computational methods suitable for advanced film cooling design.

The Internal Cooling track with 10 session covers experimental and numerical studies of all aspects of internal cooling technology for the design of turbine blades and vanes and adjacent hot components. Special emphasis will be put on rotational effects, impacts of additively manufactured cooling channels, various methods of enhancing heat transfer, and advanced cooling analysis techniques.

The Combustors track (3 sessions) is held jointly with the Combustion, Fuels and Emissions Committee. This track presents numerical and experimental studies on optimal cooling of combustor liners and all other heat transfer aspects in combustion systems.

Heat Transfer continued on following page...

TECHNICAL SESSIONS

The General Interest track with 7 sessions covers experimental and numerical investigations of diverse heat transfer problems ranging from external flow and heat transfer of non-film cooled structures to aircraft engine system heat exchange. Conjugate heat transfer and novel experimental techniques will also be presented in these sessions.

The Tutorials track (2 sessions) presents fundamental lectures on thermo fluid concepts associated with vorticity and vortex as well as conjugate heat transfer methodologies for combustor applications.

Following is a detailed listing of session content across all tracks.

Film Cooling

- Experimental Film Cooling
- Experimental Film Cooling – Airfoil
- Experimental Film Cooling – Endwall (multiple sessions)
- Experimental Film Cooling – Tip and Trailing Edge
- Experimental Film Cooling – Hole Shape Studies (multiple sessions)
- Experimental Film Cooling – Manufacturing Effects
- Film Cooling Optimization and Machine Learning
- Film Cooling with Conjugate Heat Transfer
- Numerical Film Cooling (multiple sessions)
- Numerical Film Cooling Methods
- Numerical Film Cooling and Manufacturing
- Scale-Resolved Turbulence Modeling of Film (multiple sessions)

Internal Cooling

- Internal Cooling with Rotation
- Additively Manufactured Cooling Channels
- Lattice Networks
- Pin Fins
- Jet Impingement (multiple sessions)
- Turbulators – Experimental
- Turbulators – Numerical
- Advanced Techniques in Cooling Analysis

Internal Air Systems & Seals (with Turbomachinery)

- Air System and Seal Design
- Air System Modelling & Validation
- Labyrinth and Finger Seals
- Brush Seals
- Rim Seals (multiple sessions)
- Rotating Cavities (multiple sessions)

Combustors (with Combustion, Fuels & Emissions)

- Combustor Cooling
- Interactions in Combustion Systems
- Liner Heat Transfer in Combustion Systems
- General Interest
- Internal Heat Transfer / Additive Manufacturing Considerations
- External Flow and Heat Transfer (multiple sessions)
- Conjugate Heat Transfer
- Special Topics In Heat Transfer
- Novel Experimental Methods
- Aircraft engine system heat exchange

Tutorials

- Basic Tutorial I: Counter Intuitive Concepts of Thermo Fluids: Vorticity and Vortex
- Basic Tutorial II: Conjugate Heat Transfer Methodologies for Gas Turbine Combustor Aerothermal Investigations

TECHNICAL SESSIONS

Industrial Cogeneration

Representing gas turbine applications within the cogeneration and process industries, technical sessions in this track cover a wide range of topics on cogeneration/CHP (Combined Heat & power) systems, including but not limited to the following: thermoeconomic analysis, optimization and simulation methods, design, operation & maintenance aspect of Heat Recovery Steam Generators, operation & maintenance issues of cogeneration plants, gas turbine power augmentation technologies (inlet chilling, high pressure fogging, and wet compression or overspray, dry/humid air inject, steam injection, etc.), compressor fouling, inlet air filtration systems, compressor washing, gas turbine upgrades and modifications, environmental and regulatory issues, and lessons learned from field experiences.

Other applications such as non-gas turbine based cogeneration/ CHP systems (steam turbine and reciprocating engine based systems, solar energy based systems, etc.), cogeneration and cold energy recovery in LNG plants, hybrid cogeneration systems (combined with fuel cells), integration between gas turbines and renewable generators (including storage technologies) and organic Rankine cycle based systems are also included.

Panel/Tutorial sessions cover topics on cogeneration technologies, compressor washing technologies, inlet air filtration systems, gas turbine power augmentation technologies, dynamic modeling of cogeneration/CHP systems, gas turbine combustion processes and emissions issues, fuel related issues, and impact of Shale energy market.

- Design and Evaluation Considerations of Waste Heat Recovery TechnologiesThermo-Economic Analysis of CHP/Cogeneration Systems
- Techno-Economic Analysis of CHP Systems
- Operational & Maintenance Aspects
- Gas Turbine Power Augmentation Technologies
- HRSG's Design & Operational Issues
- Inlet Air Filtration for Gas Turbines
- Combustion & Emissions
- Gas Turbine Applications Involving Heavy Fuel Oils and Crude Oils
- Dynamic Modeling of CHP Systems
- Condition monitoring and Diagnostics for CHP Systems
- Gas turbine Integration with Renewable Generators and Storage Technologies
- Renewable Energy
- Hydrogen, Synthetic Methane
- Energy storage
- LCA emissions
- Risk assessment

Manufacturing Materials & Metallurgy

The field of materials and metallurgy associated with gas turbine manufacturing has traditionally been the source of numerous disruptive technologies such as the development of superalloys, precision single-crystal investment casting and ceramic coatings. These in turn have allowed an incredibly accelerated pace of innovation. Next generation materials and processes will allow even higher efficiency and reliability as well as greater flexibility operational mode. A major goal is to balance these with lower emissions and lower life-cycle cost of turbomachinery. Materials with higher strength, lighter weight and improved durability are required for these applications. The continuing development in metallurgy and materials science has resulted in newer materials, better surface protecting methods, and more reliable component life. Development in manufacturing technologies, including better process planning/ optimization, advanced machining operations, additive manufacturing, newer coating and repair methods, helps to reduce the manufacturing cost and decrease overall operating cost of gas turbines. Condition assessment of parts after service and advanced repairs are required to further reduce life cycle cost and impact to the environment. Failure analysis is a key metallurgical tool to investigate shortcomings and identify opportunities to make gas turbine systems more robust.

The MMM committee is organized to disseminate the latest developments and research results in the areas of manufacturing, materials and metallurgy to gas and steam turbine designers, manufacturers, users, repair and service vendors, researchers and consultants. In addition to technical paper sessions, tutorial, lecture and panel sessions are planned where highly experienced panel members will discuss their latest experiences and knowledge in manufacturing methods, repair/coating processes and component inspections.

TECHNICAL SESSIONS

Marine

Gas turbines are increasingly being used in both naval and commercial marine applications. Marine sessions showcase the latest developments and best practices for gas turbines and associated equipment in marine electrical power and propulsion systems. Paper subjects cover a variety of gas turbine related topics ranging among hot corrosion of advanced material, prototype composite module enclosures, development and testing of hybrid electric propulsion, United States Navy gas turbine engine related upgrades and engineering program reviews, different innovative marine propulsion systems, and clutch designs and comparisons for these marine propulsion systems.

Technical Paper Session Topics include:

- Design and Development
- Applications
- Numerical Analysis and Performance Simulation

Microturbines, Turbochargers & Small Turbomachines

- Introduction to Gas Bearings for Oil-Free Turbomachinery (Tutorials of Basics)
- Microturbines: Component Design and Performance Analysis
- Microturbines: Compressors
- Micro Gas Turbine: Combustion and Fuels
- Microturbines for Distributed Power Generation and Hybrid Energy Grids
- Microturbines and Turbochargers: Emerging System and Application
- Microturbines and Turbochargers: Turbines
- Turbochargers: Performance Evaluation and Prediction
- Turbochargers: Bearing Systems
- Turbochargers: Compressors

Oil & Gas Applications

The Oil & Gas industry is a large user of turbomachinery. The demand for oil and gas is consistently growing, and changing market conditions require innovative solutions. Operation and optimization of turbomachinery in a variety of Oil & Gas applications is therefore of great interest. Moreover, potentially extreme operation environments require the consideration of innovative design and operational attributes.

Sessions in the Oil & Gas Applications Track address both theoretical and practical Oil & Gas industry perspectives. The technical sessions provide the latest information on gas turbines and compressors in pipeline and compression stations. Particular emphasis is given to design, operation and maintenance, management, dynamic behavior, diagnostics and vibration and noise, as well as to all engineering issues in Oil & Gas applications. Wet gas compression and multi-phase pumping are also addressed, due to the increasing interest in many installations.

The Oil & Gas Applications Committee brings industry experts together in panel and tutorial sessions jointly held by both academic educators and industry professionals. Both basics of Oil & Gas installations and off-design operation issues will be covered, aimed to ensure improved efficiency and safe and reliable operation. The latest information about environmental impact, product upgrade, risk assessment, standards and legislation of gas turbines and compressors in Oil & Gas applications is also provided.

- LNG Applications
- Wet Gas Compression and Multiphase Flow
- Surge, Stall and Critical Conditions
- Systems, Components and Auxiliary Devices Analysis: I
- Systems, Components and Auxiliary Devices Analysis: II
- Performance Degradation
- Diagnostics, Maintenance, Operation
- Performance Analysis
- Power Cycles and Thermodynamics

Organic Rankine Cycle Power Systems

The use of an organic fluid in place of water (steam) in Rankine cycles is in general advantageous if the thermal energy source is at low/medium temperature, and/or the thermal power availability is small (few kW to few MW). In these cases the proper selection of the working fluid allows to obtain comparatively higher cycle efficiency, to solve several technological problems, to obtain a more compact design of the expander and to limit the air leakage in the condenser. In the rather new framework of decentralized conversion of low temperature heat into electricity, the Organic Rankine Cycle (ORC) technology offers an interesting alternative, which is partly explained by its modular feature: a similar ORC system can be used, with little modifications, in conjunction with various heat sources such as waste heat, geothermal, biomass combustion or solar power. The technical sessions cover the latest research and operational experience in this field, with a special focus on working fluid, expansion machines design, modeling and optimization issues.

- Organic Rankine Cycle Design and Exploitation

Steam Turbines

Turbo Expo 2020 includes a track dedicated to Steam Turbines. While many of the analyses, computational methods, and experimental techniques are common for steam turbines and gas turbines, there are some unique features on steam turbines that warrant special consideration. Separate, co-located, steam turbine sessions at Turbo Expo provide a natural way of sharing many of the cutting edge technologies while giving the steam turbine community a dedicated forum for the unique technical challenges associated with wet steam, long last stage blades, industrial and co-generation steam turbines, erosion, stress corrosion-cracking (SCC) and more.

The following topics will be addressed:

- Steam Turbines Panel
- Steam Turbines Tutorial
- Last Stage Blades and Exhausts
- Wet Steam
- Valves & Seals
- Operational Aspects of Steam Turbines
- Mechanical Aspects of Steam Turbine
- HP/IP Aerodynamics
- General Design Aspects of Steam Turbines
- High Temperature Research in Mechanical Integrity

Structures and Dynamics

The expanded use of gas turbines in extreme environments introduces new demands on the structural integrity of aero and industrial gas turbine development and operation.

The program of seven Structures & Dynamics tracks, including (1) Emerging Methods in Design & Engineering, (2) Fatigue, Fracture & Life Prediction, (3) Probabilistic Methods, (4) Rotordynamics, (5) Bearing & Seal Dynamics, (6) Structural Mechanics, Vibration & Damping and (7) Aerodynamic Excitation & Damping, covers highly relevant issues concerning the mechanical integrity of gas turbine engines, compressors, steam and wind turbines as well as turbochargers.

Papers in the Structures and Dynamics Committee deal with best-in-class structural mechanics solutions by contributing fluid, acoustic, thermodynamic, and cooling interactions, which have an impact on the reliability and lifetime prediction or failure-free operation of mechanical components. Modeling and design methodologies based on analytical, numerical, probabilistic and experimental approaches are presented in more than 40 technical sessions organized by internationally recognized industry leaders and academic researchers.

International networking is arranged among all attended engineers, designers and researchers representing industry, academia and government from different countries. All participants benefit from scientific discussions and identification of cutting-edge technological news and trends in mechanical integrity for meeting today's and tomorrow's challenges in gas, steam and wind turbine industry for the best cross-product methodology synergy.

The diversity of subjects covered will boost attendees' knowledge and contribute to their professional career development.

The S&D panel and tutorial sessions, organized in collaboration with other Congress Committees, leverage engineer's knowledge for topics of the highest interest to the international mechanical engineering society.

Structures and Dynamics continued on following page...

TECHNICAL SESSIONS

Emerging Methods in Design & Engineering

- Emerging Methods on Advanced Designs
- Emerging Methods on Structural Design System – Mechanical Analysis
- Emerging Methods on Structural Design System – Dynamics Analysis

Fatigue, Fracture & Life Prediction

- Materials Constitutive Modelling
- Integrity of Engine Components I
- Integrity of Engine Components II
- Fatigue Crack Initiation and Prediction
- Fatigue Crack Growth Modelling
- Data Based Life Prediction
- Damage Modelling and Life Analysis
- Creep Analysis and Modelling

Probabilistic Methods

- Probabilistic Methods 1
- Probabilistic Methods 2

Rotordynamics

- Analysis I
- Analysis II
- Modeling improvements I
- Modeling improvements II
- Experiments and special investigations I
- Experiments and special investigations II
- Applications I
- Applications II
- Bearings and Seals I
- Bearings and Seals II
- Gas Turbine Rotordynamics - Practical Aspects
- Introduction to Torsional Rotordynamics
- Rotordynamics - Theory, Vibration Monitoring, and Case Studies
- How to Apply API Standards to Turbomachinery Rotordynamics - An Introduction

Bearing & Seal Dynamics

- Gas Bearings 1
- Gas Bearings 2
- Gas Bearings 3
- Gas Bearings 4
- Gas Bearings 5
- Tilting Pad Bearings
- Fluid Film Bearings 1
- Fluid Film Bearings 2
- Magnetic Bearings
- Squeeze Film Dampers
- Seals 1
- Seals 2
- Seals 3
- Seals 4
- Seals 5
- Seals 6
- Seals 7

Structural Mechanics, Vibration & Damping

- Vibration Safety
- Modal Analysis
- Mistuning I
- Mistuning II
- Mistuning III
- Novel Damping Technology
- Friction Damping I
- Friction Damping II
- Nonlinear Phenomena
- Blade-Casing Interactions
- Computational Techniques for Nonlinear Vibrations
- Experimental Techniques I
- Experimental Techniques II

Aerodynamic Excitation & Damping

- Aerodynamic Forcing in Axial Fan and Compressors
- Aeroelastic Stability in Axial Fans and Compressors
- Non-synchronous Vibrations
- Non-Synchronous Vibrations in Fans
- Methods for Aerodynamic Forcing and Damping Prediction
- Aerodynamic Forcing and Damping in Radial Turbomachinery
- Turbine Aerodynamic Forcing and Damping
- Seal Aeroelastic Stability

Supercritical CO_2 Power Cycles

Supercritical CO_2 based power cycles provide significant efficiency and cost of electricity benefits to applications in waste heat, thermal solar, nuclear, and fossil fuel power generation. They also provide for separation, compression, transportation, and storage (geologic) of CO_2 from fossil fuel power plants. The approach to supercritical geologic storage of CO_2 benefits greatly from the existing technology and knowledge amassed around CO_2 utilization and management in the oil & gas industry. While the end goals of the CO_2 based power cycles and the CO_2 storage applications in the oil & gas industry are different, the properties of the working fluid, thermodynamics, technology and machinery used for these applications are very similar.

The confluence of interests related to the use and management of supercritical CO_2 has created an imperative to further the understanding of these applications. The Supercritical CO_2 Power Cycle committee organizes sessions that focus on the dissemination of machinery and cycle related technologies of sCO_2 power plant applications.

- Supercritical CO_2 Turbomachinery
- Supercritical CO_2 Compressors
- Supercritical CO_2 Heat Exchangers
- Supercritical CO_2 Testing
- Supercritical CO_2 Properties and Design Considerations
- Supercritical CO_2 Cycle Optimization
- Supercritical CO_2 Oxy-Combustion
- Supercritical CO_2 Cycle Concepts and Modeling

Turbomachinery

The Turbomachinery Committee of ASME IGTI at Turbo Expo is the premier forum for the world's experts from academia, industry, and government to share advances in the state of the art in turbomachinery aero/thermodynamics technology. Technical paper sessions address aerodynamics topics on fans, compressors, turbines, and ducts in axial, radial and mixed flow configurations. The technical content covers not just a wide range of gas turbine applications for air and marine propulsion and power generation, but also other important sectors such as oil and gas, industrial gas compression, and expanders for waste heat recovery. Design concepts and processes, experimental results, and analytical approaches for modeling with CFD and simpler models are addressed. Design topics include such areas as optimization strategies, endwall profiling, leakage effects, tip clearance effects, quality effects, flow control, casing treatments, unsteady flows, and stall inception and control. Modeling topics include turbulence and transition modeling, LES and DNS, accelerated steady and unsteady formulations, and multi-stage steady CFD, as well as lower-order (non-CFD) models. The increasing emphasis on interaction effects between adjacent components and between multiple disciplines is reflected in specific sessions on these subjects. In addition, several sessions sponsored jointly with other committees focus on important areas of crossdisciplinary interest: with Heat Transfer, sessions on turbine cooling and secondary flow circuits; with Structures, on aeromechanics; and with Aircraft, on noise and acoustics. A new track was added this year to address all facets of deposition, erosion, fouling, and icing; sessions in this track are jointly sponsored by several other committees.

Turbomachinery: Axial Flow Fan & Compressor Aerodynamics

- Water Ingestion, Fogging, Pre-Cooling
- Transition & Roughness Effects
- Compressor Experiments
- Manufacturing & Deterioration Effects
- Transonic Compressor Design
- Tandem Aerofoils
- Tip-Clearance Flows
- Design Concepts
- End-Wall Flows & Passage Contouring
- Seal & Leakage Flows
- Flow Control – 1
- Flow Control - 2
- Flow Control – 3
- Casing Treatment - 1
- Casing Treatment – 2
- Stall
- Fan Design - 1
- Fan Design - 2
- Test Rig & Facility Design
- Compressor Design – 1
- Compressor Design – 2

Turbomachinery continued on following page...

TECHNICAL SESSIONS

Turbomachinery: Axial Flow Turbine Aerodynamics

- Endwall Profiling
- Tip leakage flows I
- Low Pressure Turbine Aerodynamics I
- Low Pressure Turbine Aerodynamics II
- Low Pressure Turbine Aerodynamics III
- Unsteady flows and transition
- Aerodynamic Studies I
- Aerodynamic Performances and Design
- Aerodynamic Losses
- Aerodynamic Studies II
- Aerodynamic Studies III

Turbomachinery: Design Methods & CFD Modeling for Turbomachinery

- LES and DNS Methods and Applications (1)
- LES and DNS Methods and Applications (2)
- Compressor Design Methods and Applications (1)
- Compressor Design Methods and Applications (2)
- Turbine Design Methods and Applications (1)
- Turbine Design Methods and Applications (2)
- Optimization Methods and Applications (1)
- Optimization Methods and Applications (2)
- Preliminary Design Methods (1)
- Preliminary Design Methods (2)
- Preliminary Design Methods (3)
- Radial Turbomachinery Design Methods and Applications (1)
- Cavity, Bearings and Seal Design Methods and Applications (1)
- Fan Design Methods and Applications • Component Interaction and Multi-Physics Coupling (1)
- Novel Solver and Simulation Frameworks (1)
- LES and DNS Methods and Applications (3)
- Novel Solver and Simulation Frameworks (2)
- Cavity, Bearings and Seal Design Methods and Applications (2)
- Methods and Application for Hydrodynamics
- Application and Methods for Unsteady Flow (1)
- Component Interaction and Multi-Physics Coupling (2)
- Geometry Design and Meshing (1)
- Flow Separation, Loss and Boundary Layer Interaction Methods
- Novel Solver and Simulation Frameworks (3)
- Geometry Design and Meshing (2)
- Preliminary Design Methods (4)
- Radial Turbomachinery Design Methods and Applications (2)
- Novel Methods for CFD (1)
- Novel Methods for CFD (2)

Turbomachinery: Noise, Ducts and Interactions

- Compressor and Combustion Noise
- Fan and Engine Noise
- Gas Turbine Engine Intakes, Exhaust Diffusers, and Ejectors
- Gas Turbine Engine Transition Ducts and Flow Interactions

Turbomachinery: Radial Turbomachinery Aerodynamics

- Radial and Mixed Flow Turbines I
- Radial and Mixed Flow Turbines II
- Centrifugal Compressors 1
- Centrifugal Compressors 2
- Centrifugal Compressors 3
- Centrifugal Compressors 4
- Centrifugal Compressors 5
- Centrifugal Compressors 6

Turbomachinery: Unsteady Flows in Turbomachinery

- Unsteady Flows in Compressors I
- Unsteady Flows in Turbines I
- Unsteady Flows in Turbines II
- Unsteady Flows in Turbines III
- Unsteady Flows in Turbines IV
- Stall and Surge I
- Stall and Surge II
- Stall and Surge in Centrifugal Compressors
- Unsteady Flows in Centrifugal Compressors
- Analysis and Processing Techniques for Unsteady Flows
- Unsteady Flows in Compressors II

Turbomachinery: Multidisciplinary Design Approaches, Optimization & Uncertainty Quantification

- Parameterization Approaches

Turbomachinery continued on following page...

- Manufacturing Tolerances and Uncertainties
- Surrogate-Assisted Approaches, including Sampling and Data Mining
- Axial Compressors, Propellers and Fans
- Turbine Design and Cooling
- Preliminary Design Systems and Approaches
- Adjoint Methods
- Multidisciplinary Optimization and Sensitivity Analysis (fluid, structure)
- Sensitivity Analysis and Design for AM

Turbomachinery: Deposition, Erosion, Fouling, and Icing

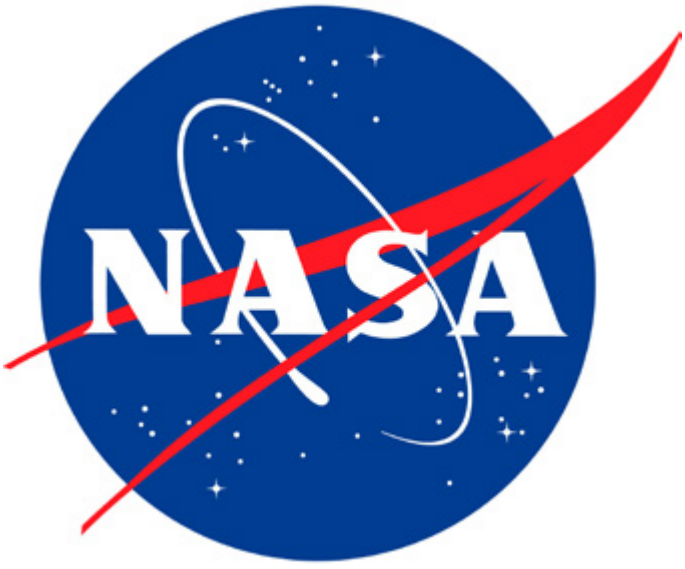
- Multi-phase (Water/Ice) Deposition in Gas Turbines
- Modeling Deposition in Turbine Cooling Passages
- Erosion in Turbines
- Deposition Modeling - I
- Deposition Modeling – II

Wind Energy

The rapid expansion of wind power and the steady decrease in the cost of wind-generated electricity has consolidated the position of wind power as an indispensable part of the global energy mix. The Technical Program of the Wind Energy Committee will focus on innovations that are driving technological advances in the wind industry. The technical presentations cover aerodynamics, aeroelasticity, structures and condition monitoring aspects of wind turbines, as well as the interaction of wind turbines with other energy systems. Based on the latest research tendencies, special focus is given this year to offshore wind turbines. These topics are addressed for small and large wind turbines, as well as vertical and horizontal axis wind turbines. For experts and beginners, tutorial sessions and workshops will be presented to detail developments and tools that are employed in the rapidly growing wind industry.

The main topics addressed during the Turbo Expo 2020 conference are:

- Introduction to Wind Energy
- Latest Developments on Wind Turbine Design
- Blade and Airfoil Aerodynamics: Experiments
- Blade and Airfoil Aerodynamics: Numerical Simulations
- Vertical Axis Wind Turbines
- Structural Loads, Aeroelasticity and Noise
- Condition Monitoring and Reliability
- Wind Turbine Simulation Methods and Applications
- Flow Control and Smart Wind Turbines
- Offshore bottom-fixed and floating wind turbines
- Wind farm design and production forecast



WORKSHOPS

Pre-Conference workshops will be held on Sunday, June 21 at the ExCeL Convention Center.* Consider attending one of the workshops and take advantage of the LOW registration fee. Registration is available online. Must register by March 23, 2020.

*Subject to cancellation if the minimum number of registrations is not achieved.

Workshop 1

PHYSICS-BASED MODELING OF GAS TURBINE SECONDARY AIR SYSTEMS

SUNDAY, JUNE 21, 2020 / 8:00 AM - 5:00 PM / GBP 500

In gas turbines used for power generation and aircraft propulsion, the main flow paths of compressors and turbines are responsible for the direct energy conversion. To ensure acceptable life (durability) under creep, LCF, and HCF from operational transients causing high temperatures and their gradients in critical engine components, around 20% of the compressor air flow is used for cooling and sealing. This is analogous to blood, water, and air flow within a human body for its proper functioning.

The main thrust of this workshop is to develop a clear understanding of the underlying flow and heat transfer physics and the mathematical modeling of various components of gas turbine secondary air systems (SAS). In addition to developing a clear understanding of the key concepts of thermofluids, the workshop will discuss vortex (free, forced, Rankine, and generalized), windage, and disk pumping in rotor/stator cavities, centrifugally-driven buoyant convection in compressor rotor cavities, pre-swirler systems, multiple reference frames, hot gas ingestion and rim sealing, and whole engine modeling (WEM) using nonlinear multisurface forced vortex convection links with windage in a layered approach.

Additionally, the workshop will provide a design-friendly overview of rotating compressible flow network methodology along with robust solution techniques, physics-based post-processing of 3-D CFD results, and the generation of entropy map for design optimization. The workshop will also present a number of design-relevant examples.

Learning Objectives

- Will develop a strong foundation in flow and heat transfer physics of various components of gas turbine secondary air systems.
- Will developed an intuitive understanding of 1-D compressible duct flows under the coupled effects of area change, friction, heat transfer, and rotation.
- Will be more knowledgeable in developing accurate physics-based and solution-robust secondary air flow network models
- Will be more knowledgeable in detecting input and modeling errors in SAS networks
- Will correctly interpret results from their models for design applications.
- Will develop skills to hand-calculate results to perform sanity-checks of predictions by design tools as well as to validate these tools during their development and continuous improvement.
- Will improve participant's engineering productivity with reduced design cycle time.

8:00 AM - 10:00 AM	Introduction: An Overview of Secondary Air Systems
10:00 AM - 10:15 AM	Break
10:15 AM - 12:00 PM	Part II: Special Concepts of Secondary Air Systems
12:00 PM - 1:00 PM	Group Lunch
1:00 PM - 2:00 PM	Part II: Special Concepts of Secondary Air Systems (Continued)
2:00 PM - 3:00 PM	Part III: Physics-Based Modeling of SAS Components
3:00 PM - 3:15 PM	Break
3:15 PM - 4:00 PM	Part IV: Hot Gas Ingestion and Rim Sealing
4:00 PM - 5:00 PM	Part V: Whole Engine Modeling (WEM)

10 complimentary, autographed copies of *Gas Turbines: Internal Flow Systems Modeling (Cambridge Aerospace Series)* will be distributed among workshop attendees using a random draw.

INSTRUCTORS (1 OF 3)

Bijay (BJ) K. Sultanian

Ph. D., PE, MBA, ASME Life Fellow

Dr. Bijay Sultanian is an international authority in gas turbine heat transfer, aerodynamics, secondary air systems, and Computational Fluid Dynamics (CFD).

Dr. Sultanian is Founder & Managing Member of Takaniki Communications, LLC, a provider of high-impact, web programs for corporate engineering teams. As an Adjunct Professor at the University of Central Florida, he has taught graduate-level courses in Turbomachinery and Fluid Mechanics for 10 years. He has instructed several workshops at ASME Turbo Expo since 2009. During his 30+ years in the gas turbine industry, Dr. Sultanian has worked in and led technical teams at a number of organizations, including Allison Gas Turbines (now Rolls-Royce), GE Aircraft Engines (now GE Aviation), GE Power Generation (now GE Power & Water), and Siemens Energy (now Siemens Gas and Power). He has developed several physics-based improvements to legacy heat transfer and fluid systems design methods, including new tools to analyze critical high-temperature components with and without rotation.

During 1971-81, Dr. Sultanian made landmark contributions toward the design and development of India's first liquid rocket engine for a surface-to-air missile (Prithvi) and the first numerical heat transfer model of steel ingots for optimal operations of soaking pits in India's steel plants.

Dr. Sultanian is a Life Fellow of the American Society of Mechanical Engineers; an Emeritus Member of Sigma Xi, The Scientific Research Society; a member of the American Society of Thermal and Fluids Engineers; and a registered Professional Engineer in the State of Ohio. He is the author of Fluid Mechanics: An Intermediate Approach, Gas Turbines: Internal Flow Systems Modeling (Cambridge Aerospace Series), and Logan's Turbomachinery: Flowpath Design and Performance Fundamentals, Third Edition.

Dr. Sultanian received his B.Tech. and MS in Mechanical Engineering from Indian Institute of Technology, Kanpur, and Indian Institute of Technology, Madras, respectively. He received his Ph.D. in Mechanical Engineering from Arizona State University, Tempe and MBA from the Lally School of Management and Technology at Rensselaer Polytechnic Institute.

Who should attend this workshop?

MS and PhD; Design and research engineers involved in secondary air systems design, whole engine modeling, and active and passive turbine tip clearance control of advanced gas turbines for aircraft propulsion and simple- and combined-cycle power generation, including Oil & Gas and Land & Marine applications; graduate students enrolled in related gas turbines/ turbomachinery courses; and faculty members teaching or desirous of introducing a graduate-level course on related topics.

Items to bring to this workshop:
A notebook and a pen or pencil to write.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

INSTRUCTORS (2 OF 3)

Riccardo Da Soghe

Ph. D.

After graduating in mechanical engineering, Dr. Da Soghe started his research activity, focusing on numerical analysis of gas turbine secondary air system, at the Department of Industrial Engineering (former Energy Engineering S. Stecco) of the University of Florence in 2006, achieving the title of PhD in 2010. Since then, and up to 2015, he worked as research fellow at the above-mentioned department, covering activities related to European research programs focused on aircraft engines. Dr. Da Soghe has been involved in many collaborations with European Universities for the numerical study of stator-rotor cavities. Since 2010, Dr. Da Soghe is a member of Ergon Research. The company, that is a University of Florence Spin-Off, supplies highly specialized services for the design the optimization and the development of innovative products, to turbines manufacturing industries and turbomachines users. Dr. Da Soghe role in Ergon Research consists in the supervision of the research branch acting as coordinator of the company CFD activities.

A selection of managed projects is listed below

- Design/characterization/optimization of compressors, combustors, oil systems and more in general turbine modules with special attention to components aero-thermal issues.
- Design and optimization of turbine intakes, diffusers, valves, focusing on aero-acoustic related phenomenon.
- Design and development of an aero-engine innovative stator-rotor cavities concept design.
- Design and optimization of pre-swirl systems and stator-rotor cavities cooling systems for large size heavy-duty gas turbines.
- Design and optimization of Active Clearance Control systems.
- Consultant for multinational power companies to maintain and upgrade power plant thermal systems.
- Definition of best practices for CFD analysis of turbine components, validating the numerical prediction against experimental data.
- Support to the design of test-rigs for research proposes.
- Development and testing of simplified approaches for gas turbine components thermal analysis.
- Development of empirical correlations for the heat load estimation in turbine components.
- Coordinator for Ergon Research numerical activities in the framework of the publicly funded research programs

Dr. Da Soghe is a passionate ASME member since 2009 making ASME his preferred institution to submit works. Dr. Da Soghe attended the Turbo Expo conferences since 2008 continuously and served as reviewer and session organizer also (Session Organizer in Internal Air Systems & Seals since 2014, Vanguard Chair since 2018). Dr. Da Soghe is an active member of the ASME K14 committee (Heat Transfer) and acts as reviewer of several international journals such as: International Journal of Heat and Mass Transfer, Journal of Mechanical Engineering Science, Journal of Power and Energy, Journal of Aerospace Engineering, Engineering Science and Technology, Archive of Mechanics, Thermal Science, Engineering Applications of Computational Fluid Mechanics.

Finally, Dr. Da Soghe is currently serving ASME as Associate Editor of the Journal of Engineering of Gas Turbines and Power.

INSTRUCTORS (3 OF 3)

Erinc Erdem

Ph. D.

After graduating from aerospace engineering in Middle East Technical University (METU) in 2002, Dr. Erdem started working for Roketsan Missile Industries, Inc. as a propulsion engineer, focusing on internal aerodynamics of internal solid rocket motors. In 2005, Dr. Erdem obtained his research M.Sc. from von Karman Institute for Fluid Dynamics (VKI) on numerical and experimental investigation of internal flows inside a simplified Ariane 5 rocket motor geometry with slag accumulation. In 2006, he obtained his M.Sc. from mechanical engineering in METU on a subject called numerical investigation of secondary gas injection systems for thrust vectoring. In 2011, he obtained a Ph.D. from the University of Manchester on active flow control studies at Mach 5 involving detailed wind tunnel measurements with various measurement techniques and complementary computational effort. Afterwards he carried on pursuing active research as a postdoctoral associate in the same university on low speed flow control using different actuation mechanisms. During his Ph.D. and postdoc studies, several projects on high/low speed wind tunnel testing were completed involving partners such as ESA, DSTL and EU FR7. Upon finishing the studies, Dr. Erdem started working for GE Aviation in Turkey in 2013 as thermal systems design lead engineer specializing on engine bay cooling and rotor-stator cooling in gas turbine engines. As of 2015, he is working for TUSAS Engine Industries (TEI) Inc., responsible for mainly thermal systems design comprised of secondary air systems, thermal analysis and component cooling. In addition, he works on radial compressor aerodynamics and rig testing. Dr. Erdem's role in Chief Engineers Office involves overseeing/reviewing technical activities for the indigenous Turboshaft Engine Development program related to his expertise.

A list of responsibilities is as follows

- Coordinator for compressor module/ whole engine testing, responsible for technical content, planning and budgeting
- Fluid Systems owner for the indigenous turboshaft engine. Aerothermals reviewer
- Owner of the core compartment cooling thermal model for LEAP-1A/B/C and GEnx-2B aero-engines
- Owner of the fan compartment cooling thermal model for GE9X aero-engine
- Owner of the design of pre-swirl systems for cooling circuitry for indigenous turboshaft engine.
- Research Associate "Manipulation of Reynolds Stress for Separation Control and Drag Reduction" (FP7) (€250k)
- Research Engineer "Laminar to Turbulent Transition in Hypersonic Flows" funded by ESA (€574k)
- Research Engineer "ExoMars Roughness Testing" funded by ESA (€450k)
- Research Engineer "Experimental Studies on Surface Roughness" funded by DSTL, UK (£87k)
- A member of 28th International Symposium on Shock Waves (ISSW28) local organising committee; was in charge of the external affairs, raised £11k from the exhibitors and managed the exhibition area in terms of logistics and organization
- Chief editor of the ISSW28 proceedings that included over 300 articles to be compiled in Latex by local organizing committee and uploaded to publisher website

Dr. Erdem was the editor of the special issue on Secondary Air Systems in Gas Turbine Engines in Aerospace Journal and acted as a reviewer of several international journals such as, Journal of Aerospace Engineering, Aerospace Journal, Journal of Aerospace Science and Technology, The Aeronautical Journal. Dr. Erdem is currently serving as an editor in Aerospace Journal and author/ co-author of 10 journal and 30 conference articles and a book chapter.

Workshop 2

ADVANCED DIAGNOSTICS: NEW SURFACE TEMPERATURE MAPPING TECHNIQUES FOR TURBO MACHINERY

SUNDAY, JUNE 21, 2020 / 1:00 PM - 5:00 PM / GBP 500

The drive to higher efficiencies in turbomachinery will require a new generation of materials capable of running at higher temperatures. Sophisticated designs and cooling systems are needed under these harsh operating conditions. Models are available and employed regularly in industry to simulate temperatures and therefore predict component life and emissions associated to novel designs. Computational fluid dynamics simulations, which are used for the generation of thermal models, will require appropriate temperature verification techniques as a validation check of new designs.

More advanced temperature monitoring for the next generation of materials and designs employed in turbomachinery is needed. As stated by the Propulsion and Instrumentation Working Group, temperature information over 80% of the blade aero foil surface is necessary for test monitoring of gas turbine durability in highly efficient engines. Therefore, surface temperature measurement techniques will prove key during material selection, thermal damage evaluation and reliability in-service behavior of components in combustion environments. Further, currently used post operation temperature measurement technologies, such as thermochromic paints, can be a bottleneck in the design process with long processing times hindering the full utilization of new additive manufacturing methods for rapid design validation.

A new measurement technique, called Thermal History Coating and Paint, has recently been developed and tested in gas turbines. The results have demonstrated the capability of the technique, which opens new measurement opportunities and considerations in the design and installation of the instrumentation. It is important that the instrumentation and design community are aware of the capability of this new technique and apply it in a way to extract the maximum benefit.

This course will review the fundamentals, development and current state-of-the art of novel thermal history coatings which promises rapid temperature mapping across complete areas and on complex components post operation. This technology is based on the use of thermographic phosphors, ceramic hosts doped with optically active dopants, which permanently change their structure with temperature. These changes can be interrogated with a suitable laser light, which is absorbed by the thermographic phosphor and then re-emitted and measured using a suitable detector.

The workshop will provide guidance on how to apply this technology to achieve the optimum results, for example preferred test operations, suitable materials and temperature ranges. Through a selection of case studies in industrial environments, the influence of different parameters will be addressed and the methods to overcome these in the calibration process.

Learning Objectives

- Review and comparison of common temperature measurement methods
- Physical fundamentals of thermographic phosphors for on-line and off-line (post operation) temperature measurements – hosts, dopants, emission processes, spectral responses, life-time decays
- Fundamentals of manufacturing processes for paints and coatings
- Review of instrumentation requirements for on-line and off-line measurements
- Automation requirements for off-line e.g. workflow, CAD drawings etc.
- The difference between coatings and paint applications and their application areas
- Understanding the uncertainty model for temperature detection
- The participants will practically learn how to generate a calibration curve and apply this to a component to generate a temperature map on their own
- Instrumentation and measurement samples will be provided by the instructors.

NOTE: This workshop will offer a practical application of the technology. During the workshop the participants will learn to use a customized detection system with a set of calibration samples to generate their own calibration data and apply this on a pre-heated component to detect the past temperature. This will illustrate the ease of the application and the main steps of generating a temperature profile.

Workshop 2 (Continued)

1:00 PM - 3:00 PM

Module 1: An Overview of temperature detection using thermographic phosphors

- Review of temperature measurement techniques
- Physical fundamentals of thermographic phosphors
- Thermographic phosphors for on-line detection including applications
- Thermographic phosphors for off-line detection (post operation) using memory materials
- Instrumentation requirements
- Material requirements

3:00 PM - 3:15 PM

Break

3:15 PM - 5:00 PM

Module 2: Application of temperature memory paints and coatings

- Materials aspects: applications of paints and coatings
- Calibration processes
- Processes for automated temperature mapping
- Uncertainty models and validation processes
- Industrial applications – short term, long term and cyclic operations
- Practical: generate your own calibration and apply this to a component.

WHO SHOULD ATTEND THIS WORKSHOP?

Engineers who are interested in the fundamentals and application areas of this new type of thermal diagnostic technique applicable in the hot section or secondary air systems of turbines. These are engineers working in heat transfer, instrumentation, diagnostic, lifing or materials evaluation. Participants should have a master's degree or higher in an engineering or natural science subject. Group leaders, managers, practitioners.

Items to bring to this workshop:
A notebook and a pen or pencil to write.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

INSTRUCTORS

The instructors are frequent participants at the ASME Turbo Expo and have contributed many papers in the past. The company, Sensor Coating Systems, will also support the exhibition in 2020 by having a booth again for the third year running.

Dr. Christopher Pilgrim — *Technical Director*

Christopher is responsible for the technical delivery of customer projects and the development of the technology at Sensor Coating Systems (SCS). He obtained an Engineering Doctorate degree from Imperial College London through the Research Centre for Non-Destructive Evaluation while working at SCS. During the degree he was awarded the Whittle Reactionaries Prize by the Institute of Mechanical Engineers. He completed a Master's degree in Materials and Mechanical Engineering at the University of Nottingham where he was given the Armourers and Braziers Award." Christopher has intimate knowledge about phosphor materials and coatings and their application in industrial environments.

Dr. Silvia Araguas Rodriguez — *Materials Engineer*

Silvia works as a Materials Engineer and focuses on the development of novel phosphorescent pigments and coatings for temperature sensing, as well as their application on industrial components. She has a Ph.D. in Material Science and Engineering from Imperial College London, carried out while working at SCS. Her Ph.D. project focused on the synthesis and development of Thermal History Paints and was co-sponsored by the Royal Commission for the Exhibition of 1851. She previously obtained an MSc in Nanotechnology from UCL in 2014, and BEng in Materials Science from Imperial College.

Dr. Jörg Feist — *Managing Director*

Jörg is responsible for general management at Sensor Coating Systems (SCS) and is a co-founder. Jörg was instrumental in raising finances for the development of the technology from private investors, industry and governmental organisations and led the company to profitability. Jörg has a PhD in Mechanical Engineering from Imperial College London and a Master's degree in Physics (German 'Diplom-Physiker'). He was responsible for delivering various programs to the Office of Naval Research, the Centre of Defence Enterprise, the EU Framework programs, several UK co-funded projects for Innovate UK and the Carbon Trust and multi-lateral industry projects most of them with international participation. On his initiative SCS started delivering projects to the German automotive industry. Some of the projects received prestigious awards such as the John P Davies Award of the ASME Turbo Expo, the Innovation Award of the Wall Street Journal Europe for new materials, the British Engineering Excellence Award and the Emerging Technologies Award from the Royal Society of Chemistry. Jörg published over 75 scientific articles, conference papers and patents mostly on luminescence sensing. Two of his papers received Best Paper awards at the ASME Turbo Expo in 2008 and 2012 respectively. More recently Jörg has received Recognized Teacher status from Cranfield University, UK, due to his work with students from BSc to PhD levels. He was voted Business Personality of the Year 2019 in the London Borough of Barking and Dagenham.

Jörg has worked in the area of phosphor thermometry for more than 20 years. He has set-up one of the first detection thermographic phosphor systems in the UK during his PhD at Imperial College and experimented with different material compositions and coating technologies before implementing those successfully on a Rolls-Royce jet engine for on-line measurements.

Workshop 3

GAS TURBINE ENGINE AEROTHERMODYNAMICS AND PERFORMANCE CALCULATIONS

SUNDAY, JUNE 21, 2020 / 8:00 AM - 6:30 PM / GBP 500

This interactive workshop introduces in 1 day carefully selected essential material on gas turbine aerothermodynamics and performance calculations. Performance of both industrial and aircraft gas turbines will be covered. The pedagogical treatment with illustrative examples, flavored with practical considerations, will make the workshop comprehensible, interesting, and useful to both early career and experienced engineers. After completing the course, the participants will have the knowledge to propel themselves in studying other gas turbine and turbomachinery topics.

Learning Objectives

- Introduce participants with major topics in gas turbine performance of both aircraft engine and industrial gas turbines including review of relevant aerothermodynamics and cycle analysis with illustrative examples
- Analyze turbomachinery velocity diagrams and relate those to thermodynamic parameters; appreciate the usefulness of the degree of reaction and the radial equilibrium equation. facilitated with illustrative examples
- Comprehend the discipline of operability and combustor characteristics
- Analyze cycle analysis problems on integrating the component performances to get the overall engine performance including compressor/turbine matching, design point and off-design calculations, and multivariable solver with the capability to match model to test data. Understanding facilitated with illustrative examples
- Present methods of performance enhancement of subsonic turbofans including analysis to show improvements
- Hybrid gas turbine cycles used in power generation

Instructor

Syed Khalid received the MSME degree from Purdue University and the Master of Engineering (Aerospace) degree from North Carolina State University.

He has extensive experience in performance, controls, installation aerodynamics, and systems integration at Pratt & Whitney, GE Aviation, Lockheed Martin, and Rolls-Royce. He currently works at NASA, Kennedy Space Center.

He has 21 issued patents with the last 6 for inventions at Rolls-Royce with the most recent one issued in August 2019. He has authored 16 technical papers and made numerous oral presentations. He has received numerous industry and professional society awards. He is an elected member of Phi Kappa Phi.

Who should attend this workshop?

- Early career engineers
- Students
- Experienced engineers interested in a refresher course
- Engineers with different expertise interested in a basic course in gas turbine performance.

Items to bring to this workshop

Laptop to review course material in the provided flash drive and to exercise the illustrative problems in excel spreadsheets.

OUTLINE

Part 1.

Introduction

This interactive one-day workshop introduces carefully selected essential material on gas turbine aerothermodynamics and performance calculations. Performance of both industrial and aircraft gas turbines is covered. The pedagogical treatment with illustrative examples, flavored with practical considerations, will make the workshop comprehensible, interesting, and useful to both early career and experienced engineers. After completing the course, the participants will have the knowledge to propel themselves in studying other gas turbine and turbomachinery topics.

Part 2.

Principle of Thrust Generation and Key Efficiencies

Gross thrust, net thrust, and ram drag; propulsive, thermal, core, transmission, and overall efficiencies; SFC to overall efficiency relationship; calculated propulsive efficiencies of propeller, transport and military turbofans, and supersonic cruise vehicles. Practical considerations in selecting bypass ratio.

Part 3.

Essential Aerothermodynamics Applied to Gas Turbine Engines

Review of thermodynamic concepts including enthalpy, entropy, and variable specific heats toward understanding cycle analysis. Illustrative examples on cycle analyses of both aircraft and industrial engines. Use of thermodynamic tables and turbine cooling flow accounting. Compressible flow review including conservation equations, non-dimensional parameters including total to static relationships, mass flow function and impulse function. Concept of choking. Nozzle and diffuser analysis with illustrative examples in spreadsheet format including C/D nozzle.

Part 4.

Non-Dimensional Gas Turbine and Turbomachinery Parameters

Advantage of generalized presentations. Maps used in aircraft and industrial engine models.

Part 5.

Basics of Turbomachinery Aero Design

Energy transfer in a generalized turbomachine; Euler equation; illustrative example. Compressor stage velocity diagram showing the benefits from variable IGV and stators; conversion of velocity diagram parameters into thermodynamic parameters; radial equilibrium equation and its use in blading design; work coefficient, pressure coefficient, isentropic efficiency, polytropic efficiency, and degree of reaction; stage characteristics and development of overall map; illustrative examples of stage design; variable IGV/stators in constant speed industrial compressor; tip clearance effects; operability analysis; and stall margin audit. Turbine stage velocity diagram analysis; work coefficient, pressure coefficient, isentropic efficiency, polytropic efficiency, and degree of reaction; Smith's turbine efficiency correlation and its adjustments for tip clearances and cooling flows; chargeable and non-chargeable cooling flows; illustrative examples including one showing blade twist in a free vortex design; Overall turbine maps.

Part 6.

Overview of Combustor Characteristics

Multidisciplinary design requirements; flow path through aviation and industrial combustors; emission reduction with premixing; pressure loss; combustion efficiency; stability, and pattern factor.

Part 7.

Component Matching and Integrated System Performance

Requirement to satisfy conservation laws; Design point & off-design calculations; compressor/turbine matching; illustrative examples of turbojet and turbofan in a spreadsheet format showing key iterations.

Part 8.

Multivariable Solver

Newton's 1-D method; multidimensional Newton-Raphson iteration; application to a mixed flow turbofan; model/data matching.

Part 9.

Performance Enhancement of Subsonic Turbofans

Turbofan cycle analysis methodology; high bypass ratio benefits; separate exhaust and mixed flow turbofans; on-line control optimization; ejector/engine/nacelle integration for high installed thrust.

Part 10.

Hybrid Cycles Used for Power Generation

Flowpath schematics and cycle performance (SFC & Specific Power) of combined cycle, cycles with steam ingestion, aero-derivatives with regeneration and intercooling, cycles with reheat.

Workshop 4

PRIMER ON GAS TURBINE POWER AUGMENTATION TECHNOLOGIES

SUNDAY, JUNE 21, 2020 / 8:00 AM - 5:00 PM / GBP 500

A comprehensive overview covering analytical, experimental, and practical aspects of the available gas turbine power augmentation technologies including a systematic approach of selecting a suitable power augmentation technology for a given application is provided. Importance of CFD analysis in case of specific technology is included. Case studies of actual implementation of discussed power augmentation technologies and lessons learned from these applications are included in the course. A significance of techno-economic evaluation and weather data analysis while selecting a suitable augmentation technology is discussed using a practical case.

Learning Objectives

- A comprehensive overview of available power augmentation technologies
- Significance of techno-economic evaluation and systematic weather data analysis
- Practical considerations in implementing different technologies
- Operational and maintenance issues of discussed technologies

There are no required items to bring to this workshop.

Topics also include...

- Basics of available power augmentation technologies includes: wet-media evaporative cooling, high pressure fogging, overspray/wet compression, steam injection, refrigerated inlet cooling (vapor compression, absorption refrigeration, and thermal energy storage), dry air injection, humid air injection and hybrid power augmentation systems
- Importance of proper weather data collection and analysis and its impact on power augmentation technologies and power boost achievable
- Practical considerations in implementing discussed power augmentation technologies
- Advantages and limitations of discussed power augmentation technologies
- Operational and maintenance considerations Will develop skills to hand-calculate results to perform sanity-checks of predictions by design tools as well as to validate these tools during their development and continuous improvement.
- Will improve participant's engineering productivity with reduced design cycle time.

Outline

I. Introduction and basics of gas turbines and power augmentation technology
II. Psychrometrics of GT power augmentation technologies
III. Various power augmentation technologies
IV. Analytical, experimental and CFD analysis aspects
V. Systematic techno-economic approach for selecting suitable technology
VI. Operational and maintenance aspects and practical considerations

WHO SHOULD ATTEND THIS WORKSHOP?

Engineers with EPC (Engineering, Procurement & Constructions) companies involved in power generation projects, power generation project developers, combined heat & power project developers, gas turbine users, gas turbine operators, consultants involved in gas turbine-based power generation projects, and young engineers looking for careers in gas turbine-based power generation and related technologies.

INSTRUCTORS

Dr. Rakesh Bhargava

Dr. Bhargava is Founder & President of Innovative Turbomachinery Technologies Corp. His expertise includes applications of gas turbines and other rotating and reciprocating machines and packaged process equipment used in the off-shore, refinery, power generation, chemical, and pipeline industries.

His more than 35 years of experience encompasses inspection and design reviews of process machinery and packaged equipment, evaluation and analysis of gas turbine power augmentation technologies, field problems resolution, failure analysis, inspection of turbomachinery component repairs, technical expertise in commercial disputes involving rotating machines and the global energy market analysis.

He has given numerous invited lectures on gas turbine technologies and energy market around the world and provides customized training courses on rotating machinery and related topics.

He is an active member of API Committee on Standards on Mechanical Equipment and has participated in upgrades of number of API specifications. He is a Fellow and Associate Fellow of ASME and AIAA, respectively and is past Chair of the ASME/IGTI Industrial & Cogeneration Committee and Oil & Gas Applications Committee. He is Associate Editor of the ASME Journal of Engineering for Gas Turbines and Power.

Dr. Mustapha Chaker

Dr. Chaker is a leading authority in the area of gas turbine power augmentation having done pioneering work on the inlet fogging while being director of R&D at Mee Industries, one of the leading suppliers of power augmentation systems.

He has conducted extensive analytical and experimental studies utilizing a wind tunnel and state of the art laser measurement system to evaluate the behavior of cooling systems. He has been also working on the thermodynamic modeling of gas turbines and the use of CFD methods for fogging and wet compression system design and optimization.

In addition, he has over 25 years of experience in multidisciplinary skills including gas turbine power generation and mechanical drive, compression systems (centrifugal, axial, integrally geared, reciprocating, steam turbine...) and LNG application.

He is currently working as Principal Turbomachinery engineer at McDermott. He is past chair of the Industrial and Cogeneration Committee. Dr Chaker has a Ph.D. in Engineering Sciences from the University of Nice – Sophia Antipolis in France. He is a fellow of the American Society of Mechanical Engineering.

EARN 7 PROFESSIONAL DEVELOPMENT HOURS (PDH'S) AND RECEIVE A CERTIFICATE OF COMPLETION!

Workshop 5

ADDITIVE MANUFACTURING SIMULATION

SUNDAY, JUNE 21, 2020 / 8:00 AM - 12:00 PM / GBP 500

Learn how simulations can be used to guide the entire design for additive manufacturing process from lightweighting (topology optimization) to orientation and support generation, gaining valuable insight into the process itself. Predict and prevent distortion, residual stresses, and blade crashes. Determine optimal process parameters and go further by exploring materials and microstructure.

Outline

I. Introduction and promise of metal additive manufacturing
II. Design to print workflow. Details of each step in the workflow.
III. Lightweighting – topology optimization, design validation
IV. Print process set-up and simulation

Instructor

Jeff Bronson is lead additive manufacturing expert at ANSYS. He has worked at aircraft manufacturing OEMS before joining ANSYS where he supported various design and analysis aspects of modern and next generation jet engines. Jeff has extensive knowledge of metal additive manufacturing workflow from design to print to microstructure analysis and has been acting as advisor to jet engine, gas turbine OEMs and other organizations in the turbomachinery field.

Learning Objectives

- Opportunities and challenges metal additive manufacturing presents for turbomachinery
- How to design a component for additive manufacturing (including lightweighting)
- How to get the print for a component right the first time!

Who should attend this workshop?

Engineers, leaders, engineering students with fundamental knowledge of mechanical or aerospace engineering. Professionals interested in “LightWeighting” through techniques like topology optimization. Professionals interested in “Metal” additive manufacturing.

There are no required items to bring to this workshop.

EARN 4 PROFESSIONAL DEVELOPMENT HOURS (PDH’S) AND RECEIVE A CERTIFICATE OF COMPLETION!

Workshop 6

MATERIALS SELECTION AND SUSTAINABILITY FOR AEROSPACE: TURBOCHARGERS

SUNDAY, JUNE 21, 2020 / 8:00 AM - 12:00 PM / GBP 500

Operating in very hostile environments, turbochargers are subjected to corrosive, high-velocity exhaust gases exceeding 1000°C, as well as significant tensile, vibrational and bending loads. In this workshop, we will explore the basics of systematic materials selection methodology and how to apply those techniques to ensure the mechanical and sustainability of the turbine blades.

Attendees will...

- Get hands-on experience of software-assisted material selection relevant to turbocharger applications
- Discover how CES EduPack supports specific material selection needs, boosting power to weight ratios
- Learn the basics of systematic materials selection and assessment methodology
- Address issues like thermal shock, creep and fatigue
- See the breadth of case studies, exercises, lecture units, and other teaching resources available for educators in the field.

Who should attend this workshop?

- Aerospace engineers
- Mechanical engineers
- University professors
- PhD Students

Learning Objectives

- Gain practical knowledge and skills regarding systematic materials selection methodology
- Learn about the concept of “critical materials” and what challenges are faced in aerospace applications
- Discover how to consider environmental and sustainability performance of your options
- Get hands-on experience of software-assisted material selection relevant to turbocharger applications

Workshop Outline

- Introduction to ANSYS Granta and GRANTA EduPack software
- Database organization and visualization tools
- Advanced material selection
- Hands-on and interactive exercises
- Turbocharger Case Study
- Sustainability issues with superalloys

Bring a laptop to this workshop.

EARN 4 PROFESSIONAL DEVELOPMENT HOURS (PDH’S) AND RECEIVE A CERTIFICATE OF COMPLETION!

INSTRUCTORS

Claes Fredriksson

Claes Fredriksson has 20 years' experience teaching materials-related subjects to undergraduate and post graduate students in Sweden, Canada, Belgium, and the U.S.A, mainly in mechanical engineering. After gaining an M.Sc. in Engineering Physics and Ph.D. in Theoretical Physics, he worked in both theoretical and experimental research on polymers, metals, and biomaterials. He has a passion for teaching and won a grant as part of Sweden's Excellence in Teaching Programme to enable him to teach in the U.S.A. and facilitate the cross-pollination of pedagogical approaches. Claes is an Associate Professor of Materials Science and works with academics across the world, collaborating on producing teaching resources and running CES EduPack training.

Luca Masi

Luca Masi is a Principal Development Manager at ANSYS Granta, and Aerospace Engineer with R&D experience in multi-objective optimization and bio-inspired computational techniques for automatic design of interplanetary space trajectories (University of Strathclyde, software development for CNES and Thales Alenia Space), as well as spacecraft propulsion (Alta-Space, Universita' di Pisa). For the past five years, Luca has run several materials selection workshops and lectures at leading US universities (Georgia Tech, Arizona State, MIT, University of Michigan, Stanford) and has published technical papers and book chapters for AIAA, IEEE, Acta Astronautica, and others.

Tatiana V. Vakhitova

Tatiana V. Vakhitova holds a PhD Degree from University of Cambridge Engineering Department, Centre for Sustainable Development. At ANSYS Granta she leads development of teaching resources in an area of Sustainable Development and Materials, working closely with Prof. Mike Ashby. Tatiana is a principal development manager of the University Relations Team. She is also responsible for coordinating our activities in an EU project on Sustainable Critical Materials (SUSCRITMAT). Tatiana has several publications on topics ranging from social and environmental impact assessment, CSR, circular economy to sustainability teaching. She is an experienced educator and facilitator, has delivered various trainings, workshops and lectures at universities and international events around the world.

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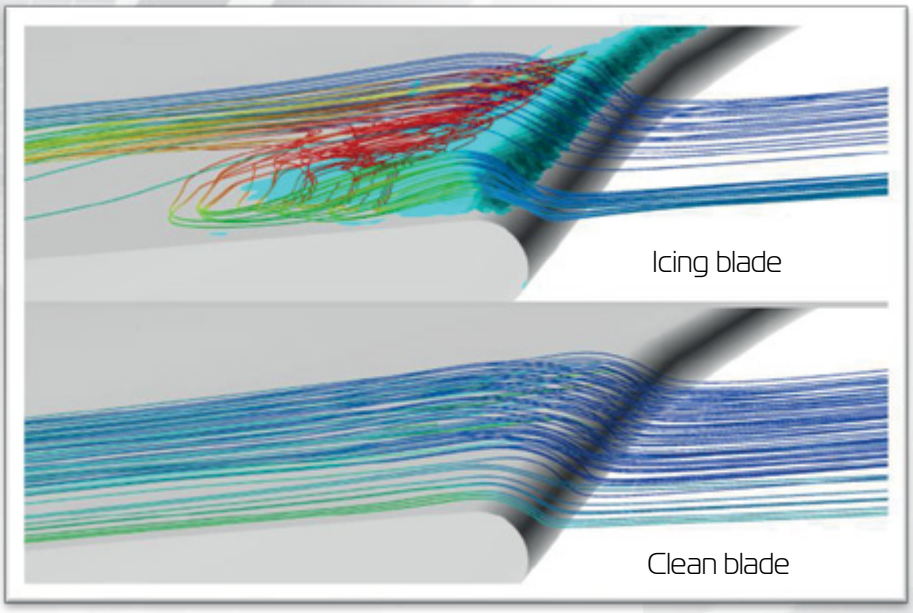
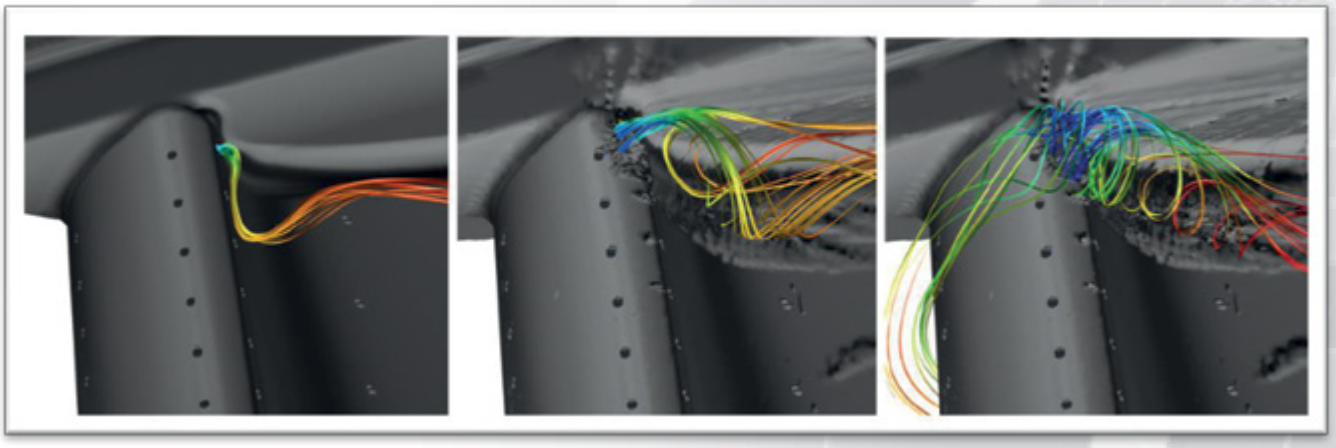


Compressor blade ice build up

- Deliver organic time and physics-dependent shape change directly to the simulation system
- Simulate in-service performance degradation
- Use scalar fields from your solver to drive erosion, ablation, accretion, fouling and any other mechanisms that change the shape of your components



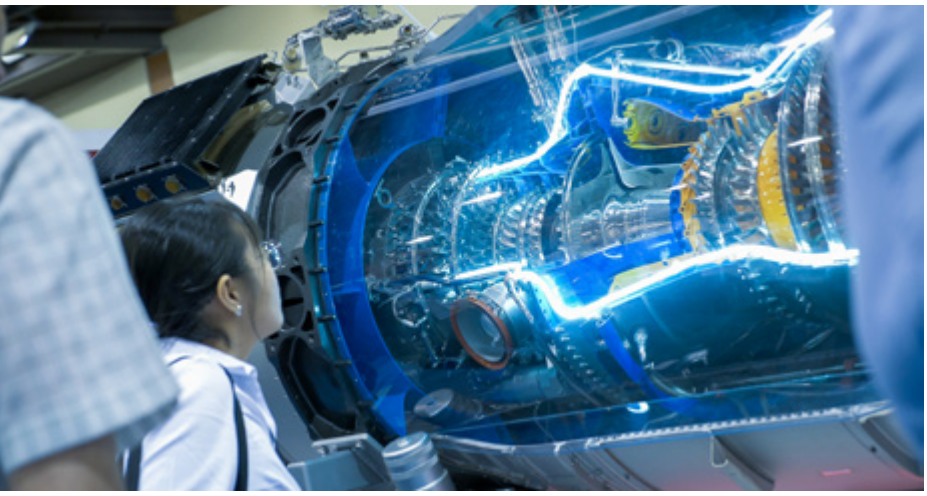
Turbine cooling hole thermal damage over time

BOXERgeom
Scalable Parallel Digital Geometry for Large Scale Simulation

BOXERmesh
Scalable Parallel Mesh Generation for Large Scale Simulation

EXHIBIT AT ASME TURBO EXPO 2020

WHY EXHIBIT?



To gain access to

professionals in the power generation and turbomachinery fields from industry, R&D, academia and government over three days while showcasing your products and services and building your customer base.

The 3-day exposition will be held June 23-25 in London, England, UK with some value-added activities to promote traffic! Daily lunches in the exhibit hall are included in the registration package for exhibit booth staff. There are daily afternoon coffee breaks and open bar receptions in the Hall.

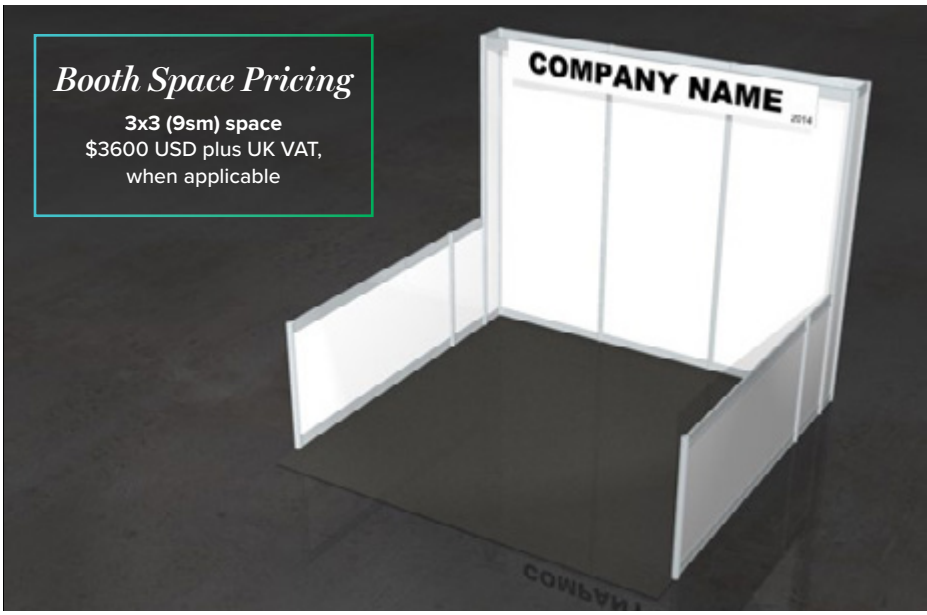
This is your chance to attract new clients, visit with current ones, learn more about the changing needs of the international turbomachinery industry—and ultimately, increase your sales.

ASME Turbo Expo brings together from around the world the top players in the turbomachinery industry and academia - attracting a key audience of over 2500 delegates from aerospace, power generation and other prime mover-related industries interested in sharing the latest in turbine technology, research, development, and application.

EXHIBITION INFORMATION

Secure your booth now for prime space availability and see how this event can generate bottom-line results for your marketing dollars. Visit the ***online floor plan*** and reserve your booth today. Click on the desired booth space and select RESERVE BOOTH. You will then be prompted to complete an application. Contact ***igtiexpo@asme.org*** if you have any questions or issues with space selection.

- Each exhibit space will be constructed from the **modular system**, using aluminum profiles with white infill panels to rear 2.5m walls and 1m high dividing walls, 300mm deep fascia to all open sides with a standard name board per side detailing company name and stand number.
- 1 **technical conference badge** per 9 square meters of exhibit space including access to the technical conference papers.
- 3 **booth personnel badges** per 9 square meters of exhibit space each including the Monday evening Welcome Reception, Monday morning Keynote and Opening Luncheon and lunch in the Hall on Tuesday, Wednesday and Thursday.
- Complimentary **exhibit hall passes** to share with customers and prospects to drive awareness of your company's booth.
- 1 complimentary **Lead Retrieval unit**.
- Significantly **discounted technical conference registration** for company employees.
- 15-word **company listing** in the printed Conference Program.
- **Discounted advertising options** to increase the effectiveness of this opportunity.
- Product category and company description in the **online exhibitor directory** with press releases, logo, brochure to promote your products.
- **Opportunity to present** on the exhibitor stage in the Hall and reach all of the attendees at once.



Sponsorship Information

Take control of your company's exposure before, during and after the event. Featuring a variety of sponsorship opportunities designed to maximize your company's visibility, the ASME Turbo Expo sponsorship program provides even more ways to stand out from the crowd and make the most of your budget. Additional opportunities and descriptions can be found at ***event.asme.org/Turbo-Expo/Sponsor-Exhibit***.

PLATINUM CLUB: $20,000

GOLD CLUB: $15,000

SILVER CLUB: $10,000

BRONZE CLUB: $5,000

STAY AHEAD OF THE COMPETITION AND MEET YOUR CUSTOMERS FACE TO FACE.

2020 EXHIBITORS

ADS CFD Inc.
Advanced Design Technology Ltd.
Aerodyn
Aeroprobe Corporation
Aikoku Alpha Corp.
Altair Engineering, Inc.
AneCom AeroTest GmbH
ANSYS
ASME Headshot Lounge
ASME Recharge and Relax Station
ASME Turbo Expo 2021
ASME Turbo Expo Sales
ATE Antriebstechnik und Entwicklungs GmbH & Co. KG
Calnetix Technologies
Calspan Systems Corporation
Cambridge Flow Solutions Ltd
CEROBEAR GmbH
CFturbo GmbH
Chell Instruments
Concepts NREC
Convergent Science GmbH
Cross Manufacturing
Dassault Systemes Simulia Corp.
datatel Telemetry
e+a
European Turbine Network
Flow Systems, Inc.
Flownex Simulation Environment
FOGALE nanotech
Forming Technologies
Franke Industrie AG
GadCap Technical Solutions Ltd.
Haynes International, Inc.
IfTA GmbH
IHI Bernex AG
Intelligent Light
JETSEAL, Inc.
Kistler Instruments Corp.
LG Tech-Link Global, LLC
Mineral Insulated Cable Company Ltd
MKS Instruments
MMP Technology
Modelon US
Modern Power Systems
MTU Aero Engines
National Aeronautics and Space Administration
National Research Council of Canada
Northwestern Polytechnical University
Notre Dame Turbomachinery Laboratory
NUMECA International
OROS
Parker Hannifin Corporation
PCA Engineers Limited
Photron Europe Ltd
Präwest Präzisionswerkstätten GmbH & Co. KG.
Prime Photonics, LC
RINA Consulting Ltd
Rodyn Vibration Analysis, Inc.
Scanivalve
Scitek Consultants Ltd
Sensor Coating Systems Limited
Sensorade
SoftInWay Inc.
TE Connectivity
TEES - Turbomachinery Laboratory
Torquemeters Ltd.
Turbocam International
Turbostream Ltd
Tutco SureHeat
University of Genoa
University of Stuttgart, ITSM
Vectoflow GmbH
Waukesha Bearings Corporation

Click here to view the current floor plan and exhibitor list.

NETWORKING EVENTS

Networking during the conference is an effective method of marketing that is used to build new business contacts through connecting with other like-minded individuals. Make sure you attend all of the networking opportunities during the event. Bring your business cards!

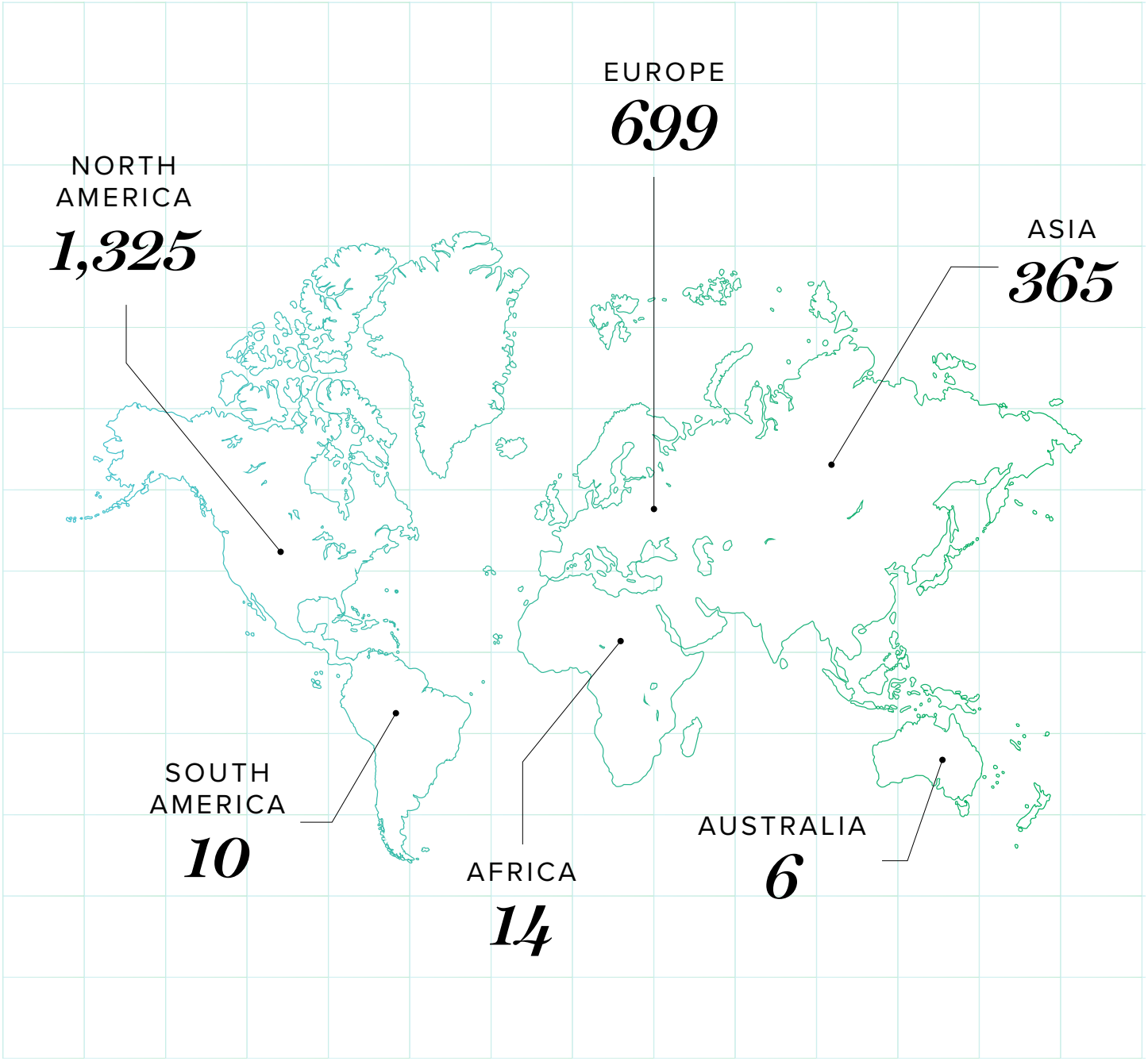
WOMEN WORKING IN TURBOMACHINERY NETWORKING EVENT

SPONSORED BY

SIEMENS
Ingenuity for life

TUESDAY, JUNE 23 / 7:45 PM - 9:30 PM

Female registrants are invited to join their colleagues for a networking event that will feature motivating talks by GE and Siemens representatives. Attendees will have the opportunity to network with women in the industry and learn about the career paths of some successful women in the industry. Dinner will follow the talks and is included with your registration.



INDUSTRY PARTICIPANTS

ASME Turbo Expo is proud to have over 2,419 Industry participants from all over the world. These individuals are active within the technical conference and participate as authors, panelists, reviewers, session organizers, session chairs, etc

REGISTRATION INFORMATION

Be sure to register for ASME Turbo Expo as soon as possible as rates will increase as the conference approaches. Continue reading to see the full details on rates and benefits.

REGISTRATION

TECHNICAL CONFERENCE

Please be aware of the spamming non-official vendors contacting you. ASME does **NOT** sell or share the conference attendee list with anyone.

All fees are in **British Pounds (GBP)**. **Photo identification** will be required for all badge pick-ups. All fees include **20%*** **United Kingdom Value-Added Tax** (VAT).

Please note that UK VAT may be refundable under certain conditions (not guaranteed). For more information, please refer to ***the FAQ*** on the UK VAT.

If you have any questions regarding VAT refunds you may contact ***n.petit@bc-a.com***.

*The standard rate of VAT in effect at the time of the event.

The invoice for your participation shall be issued by:

VMC
1 Rond-Point de l'Europe
92250 La Garenne Colombes (France)
French VAT Number: FR75523098614
UK VAT Number: GB975109011

Technical Conference Registration Includes...

- Access to every session in the Technical Conference
- Professional Development Hours (PDHs) Certificate
- Admission to the following networking events:
  - Opening Ceremony & Awards Program (June 22, 2020)
  - Keynote Session (June 22, 2020)
  - Welcome Reception (June 22, 2020)
  - Tuesday Plenary Panel (June 22, 2020)
  - Wednesday Plenary Panel (June 23, 2020)
- Daily Lunch (June 22-26, 2020)
- Daily Coffee Breaks (June 22-26, 2020)
- Exhibition (June 23-25, 2020)
- Exhibit Hall Reception (June 23-24, 2020)
- Opportunity to attend Facility Tours

The following may register at the discounted Member rate(s):

- ASME Members
- Point Contacts, Vanguard Chairs
- Session Chairs, Session Co-Chairs
- Authors, Presenters, Speakers
- ASME IGTI Committee Members
- Active Military
- Members of Reciprocating or Participating Organizations

Registration Type	REGISTER BY *April 17, 2020*	REGISTER AFTER *April 17, 2020*
ASME Member 5-Day	1,090	1,190
ASME Member 3-Day	895	990
ASME Life Member 5-Day	445	545
Platinum Sponsor Employee 5-Day	840	940
Exhibiting Company Employee 5-Day	890	990
Non-Member 5-Day	1,290	1,390
Non-Member 3-Day	1,090	1,190
Student Member 5-Day	445	545
Student Non-Member 5-Day	470	570

REGISTRATION

EXHIBITION PERSONNEL

Exhibition Personnel Registration Includes...

Admission to the following networking events:

- Opening Session: Turbo Expo Keynote & Awards Program (June 22, 2020)
- Welcome Reception (June 22, 2020)
- Daily Lunch (June 22-26, 2020)
- Exhibition (June 23-25. 2020)
- Exhibit Hall Reception (June 23-24, 2020)
- Opportunity to attend **Facility Tours**

Booth purchase includes one technical conference badge per 9sm of booth space.

Contact ***igtiexpo@asme.org*** for more information.

Registration Type	REGISTER BY *April 17, 2020*	REGISTER AFTER *April 17, 2020*
Booth Personnel *Three (3) free badges per 9sm of booth space.*	FREE	FREE
Additional Booth Personnel	200	200

PRE-CONFERENCE WORKSHOPS

All pre-conference workshops will take place at the ExCeL London Convention Center on Sunday, June 21, 2020.

Subject to cancellation if the minimum number of registrations is not reached by March 23, 2020.

Workshop #1 Physics-Based Modeling of Gas Turbine Secondary Air Systems	8:00 am - 5:00 pm	500
Workshop #2 Advanced Diagnostics: New Surface Temperature Mapping Techniques for Turbo Machinery	1:00 pm - 5:00 pm	500
Workshop #3 Gas Turbine Engine Aerothermodynamics and Performance Calculations	8:00 am - 6:30 pm	500
Workshop #4 Primer on Gas Turbine Power Augmentation Technologies	8:00 am - 5:00 pm	500
Workshop #5 Additive Manufacturing Simulation	8:00 am - 12:00 pm	500
Workshop #6 Materials Selection and Sustainability for Aerospace: Turbochargers	8:00 am - 12:00 pm	500

REGISTRATION

VISITOR / GUEST

Visitor / Guest Registration Includes...

Admission to the following networking events:

- Welcome Reception (June 22, 2020)
- Exhibition and Exhibition Receptions (June 23-24, 2020)

Registration Type	REGISTER BY *April 17, 2020*	REGISTER AFTER *April 17, 2020*
Visitor/Guest 3-Day	140	140

ADDITIONAL INFORMATION

Registration Deadlines

The registration fee category is determined by when the payment is received. Regular registration fees will be charged onsite for any unpaid pre-registrations. The deadline for pre-Conference registration is Monday, June 15, 2020. Registrations will also be accepted onsite. The registration deadlines are as follows:

Early Bird Registration Ends	April 17, 2020 (by 23:49 PST)
Regular Fee	As of April 18, 2020
Online Registration Closes	June 15, 2020
Onsite Registration Opens	June 21, 2020

Free ASME Membership

The following paid registrants will receive a free one-year ASME membership:

- Non-Member 5-Day/Non-Member 3-Day
- Student Non-Member 5-Day

ASME will contact eligible registrants and invite them to join within 90 days after the conference. For more information, visit ***ASME Membership website***.

Payment, Confirmation and Receipt

All payments are due in British Pounds (GBP). Registration fees are determined by when payment is received. Registrants who pay their registration fee after Friday, April 17, 2020 will be charged the regular registration fees.

A confirmation email will be sent shortly after you register. If you submitted payment by credit card, a receipt will be included. If you wish to pay by cheque or wire transfer, an invoice will be sent to you via email once you have completed your online registration.

THE OFFICIAL LANGUAGE OF THE ASME TURBO EXPO 2020 IS ENGLISH.

REGISTRATION

CONTINUED FROM PREVIOUS PAGE

Cancellation, Refund and Substitution Policy

Refunds for Turbo Expo 2020 are available until Thursday, May 14, 2020 and are subject to an administrative cancellation fee of 165 GBP per person.

As of Friday, May 15, 2020 no refunds will be provided. NO EXCEPTIONS. No-shows are not eligible for refunds. Substitutions may be made until Monday, June 15, 2020. Substitutions must be made at an equal or lesser registration category and no refunds will be issued for substitutions at a lesser registration category.

All changes, except full cancellations, that result in a refund will incur a GBP 50 administrative fee.

All cancellations or substitution requests must be received in writing by Sea to Sky Meeting Management at ***turbo@seatoskymeetings.com***.

Individuals take part in the ASME Turbo Expo 2020 at their own risk and are responsible for their own health and travel insurance arrangements

Letter of Invitation

To request a letter of invitation, complete the ***Letter of Invitation Request Form*** and send your request to Ashley Villa at ***VillaA@asme.org***. Please type your information into the form and do not handwrite. Once approved, an invitation letter will be sent to the email provided during registration. Please allow 3-5 business days for processing.

You may request and pay for a hard copy invitation letter during the registration process. Please make sure to note that you have purchased a hard copy invitation when emailing the Letter of Invitation Request Form.

Registration Inquiries

Contact us at ***turbo@seatoskymeetings.com***.

Carleigh Soo
ASME Turbo Expo 2020: Turbomachinery Technical Conference and Exposition
c/o Sea to Sky Meeting and Association Management Inc.
Suite 206, 201 Bewicke Avenue
North Vancouver, BC, Canada V7M 3M7
Phone: +1-778-338-4142
Email: ***turbo@seatoskymeetings.com***
Web: ***www.asme.org/events/turbo-expo***

KEEP UP WITH IGTI ON SOCIAL MEDIA

facebook.com/asmeigti

linkedin.com/company/asme-international-gas-turbine-institute

twitter.com/IGTI

linkedin.com/groups/4058160

REGISTRATION

FREQUENTLY ASKED QUESTIONS

GREAT BRITAIN VAT REFUND FOR ASME

Why am I paying a VAT on the Meeting Registration Fee?

You are paying a Value Added Tax (VAT) on the registration fee because it is required by the laws and regulations of the EU and its Member States. They establish that VAT must be paid on the fees in the country where the meeting is held; in this case, the United Kingdom.

Can the VAT be recovered?

Possibly. Only applicants registered for business purposes in an EU or non-EU country can use the scheme to reclaim VAT paid in the UK.

The applicant must not be VAT-registered in the UK and does not have to be, or can't be, VAT-registered in the UK and he does not have a place of business or other residence in the UK. Also, he must not make any taxable supplies in the UK for which he is responsible for paying the VAT.

To recover the VAT you must provide the details of your company – name, address, VAT number or Tax ID – for all expense invoices and submit all original documentation to your company for its processing.

Note that VAT can't be reclaimed on certain items, like the cost of buying a car, or for goods and services bought for resale, used for business entertainment or used for non-business activities.

What process should companies follow to recover the VAT?

EU COMPANIES

EU companies must contact the Tax Administration of their own country for instructions regarding the conditions and process to follow for reclaiming the UK VAT. You must claim no later than 9 months after the end of the calendar year the VAT was paid.

There are also minimum VAT amounts that must be met. If the application relates to a period of less than one calendar year, but not less than three months, the amount for which the claim is made may not be less than GBP 295; if the application relates to a period of a calendar year or the remainder of a calendar year if this is less than 3 months, the amount may not be less than GBP 35.

NON-EUROPEAN COMPANIES

The Non-European companies must send the VAT refund application directly to the UK Tax Administration (HMRC) at the address below:

HM Revenue and Customs Compliance Centres
VAT Overseas Repayment Unit
S1250 Benton Park View
Newcastle upon Tyne
NE98 1YX
UNITED KINGDOM

You must make the claim no later than six months after the end of the 'prescribed year' in which you incurred the VAT. The prescribed year is the twelve months from 1 July to 30 June of the following calendar year, so you must make your application no later than 31 December.

The Non-European companies must make their application on form ***VAT 65A***. Instructions on how the form must be filled in are available ***here***.

The application form must be supported by the original copy of all invoices included in the claim, as well as an original certificate from the official authority in your own country showing that you are registered for business purposes in that country (ex: for US company = IRS form 6166).

There are also minimum VAT amounts that must be met. If the application is for a period covering less than 12 months, the total amount of VAT claimed must not be less than GBP 130. However, when the application is for the full 12 months of the prescribed year, or the period remaining in the prescribed year, the amount of VAT claimed must not be less than GBP 16.

HOTEL INFORMATION

DoubleTree by Hilton London ExCel

2 Festoon Way, Royal Dock, E16 1RH London, United Kingdom

Tel: +442075404820
£200 Single / £210

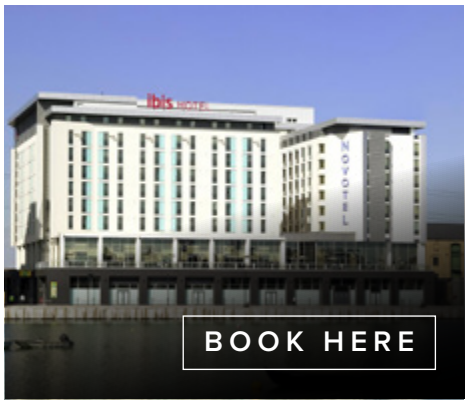
Distance to London ExCeL Convention Center: One kilometer

Conference Headquarters Hotel Novotel London Excel

7 Western Gateway, Royal Victoria Dock, E16 1AA London, United Kingdom

Tel: +442076600677
£170 Single / £180 Double

Distance to London ExCeL Convention Center: 500 meters

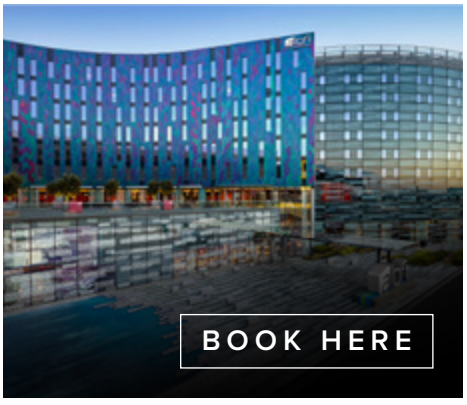


Ibis London Excel Docklands

9 Western Gateway, Royal Victoria Dock, E16 1AB London, United Kingdom

Tel: +442070552300
£145 Single / £155 Double

Distance to London ExCeL Convention Center: 550 meters

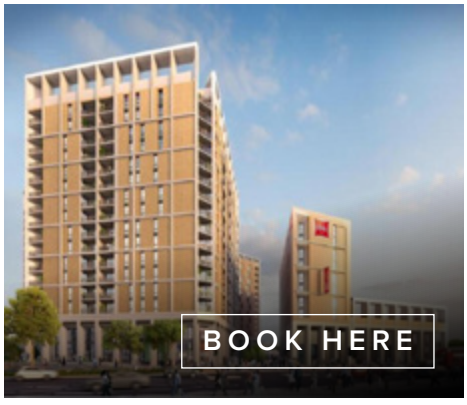


Aloft London Excel

One Eastern Gateway, Royal Victoria Dock, E16 1FR London, United Kingdom

Tel: +44 (0) 207 290 7132
£145

Distance to London ExCeL Convention Center: 160 meters



Ibis London Canning Town

8 Silvertown Way, E16 1ED London, United Kingdom

Tel: +442030021614
£140 Single / £150 Double

Distance to London ExCeL Convention Center: 2 kilometers

NOTE

ASME has not engaged any housing bureaus to represent or sell Turbo Expo hotel guest room blocks. Please make your hotel reservations directly through the Turbo Expo hotel links.

LEADERSHIP TEAM

ASME Gas Turbine Segment Leadership Team

Nicole Key
Leader
Purdue University

Mark Zelesky
Vice Leader, TEC Liaison
Pratt & Whitney

Paul Garbett
Member
Siemens

Daniela Gentile
Member
Ansaldo Energia

Eisaku Ito
Member
MHI

Zolti Spakovsky
Member
MIT

Tim Stone
Member
GE

Damian Vogt
Member, IGTI EC Chair
University of Stuttgart

Jaroslaw Szwedowicz
Member
Siemens

Ruben Del Rosario
Advisor
Crown Consulting, Inc.

Richard Dennis
Advisor
DOE, National Energy Technology Laboratory

Turbo Expo Organizing Committee

Conference Chair
Akin Keskin
Rolls-Royce

Executive Conference Chair
Rob Miller
University of Cambridge

Technical Program Chair
Natalie Smith
Southwest Research Institute

Review Chair
Wing Ng
Virginia Tech.

Vice Review Chair
Ardy Riahi
Honeywell

Vice Review Chair
Harald Schoenenborn
MTU Aero Engines AG

Vice Review Chair
Keun Ryu
Hanyan University

Tutorial Chair
Alberto Traverso
University of Genova

Review Process & Peer Review Paper Advisor
Patricia Cargill
GE Aviation

IGTI EC Representative
Atul Kohli
Pratt & Whitney

Local Liaison Chair
Dr. Christoph Schwingshackl
Imperial College

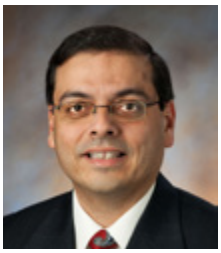
IGTI Executive Committee

Professor Damian Vogt, PhD MSc Director
Director
Institute of Thermal Turbomachinery and Machinery Laboratory
University of Stuttgart

Douglas Hofer, PhD
Senior Principal Engineer,
Aero Thermal Systems
GE Global Research

Kenneth L. Suder, PhD
Senior Technologist,
Airbreathing Propulsion
Propulsion Division, Research and Engineering Directorate, NASA Glenn Research Center

Professor Ricardo Martinez-Botas, FREng
Professor of Turbomachinery
Mechanical Engineering
Imperial College London



Atul Kohli, PhD
Senior Fellow, Heat Transfer – Analytical Methods
Aero Thermal Fluids
Pratt & Whitney

STUDENT NEWS

STUDENT NEWS

The Student Advisory Committee (SAC) is a group of students who work to foster student engagement in the IGTI community and improve the Turbo Expo conference every year. Towards this goal, the SAC organizes various sessions and events during the conference, provides opportunities for students to work behind the scenes with leaders in their technical area, and awards travel funds to eligible degree seeking individuals.

Poster Session

The Student Advisory Committee is once again sponsoring a student poster session at ASME Turbo Expo. Student posters will be on display on the main exposition floor on **Tuesday, June 23rd from 12:30 – 2:00 p.m.** Be sure to stop by the poster session to see the results of their work and encourage them to become active in the ASME IGTI community.

CASH PRIZES FOR POSTER SESSION WINNERS

1st Place	$500
2nd Place	$250
People's Choice	$100

Student/Early Career Mixer

WEDNESDAY, JUNE 24, 6:45 - 8:00 PM

The sessions organized by the SAC during the technical conference are focused on professional development and are open to all conference attendees. In previous years, the SAC has curated panel sessions led by community leaders on Turbomachinery Careers and Networking, as well as tutorial sessions titled "Effective Technical Presentations", and "The Art of the Peer Review Process".

SAC Committee Members

Chair

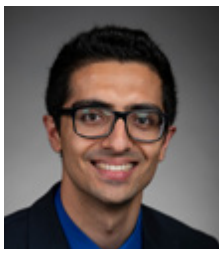
Shawn Siroka
Penn State University

Vice Chair

Deepanshu Singh
University of Oxford, UK

Secretary

Gen Fu
Virginia Tech



Past-Chair

Paudel Wisher
University of Virginia

SAC Sessions at Turbo Expo

The sessions organized by the SAC during the technical conference are focused on professional development and are open to all conference attendees. In previous years, the SAC has curated panel sessions led by community leaders on Turbomachinery Careers and Networking, as well as tutorial sessions titled "Effective Technical Presentations", and "The Art of the Peer Review Process".

Up to $400,000 in

ENGINEERING SCHOLARSHIPS

AT ASME

ASME wants to help you make a difference in mechanical engineering by providing up to $400,000 in Scholarships for ASME Student Members!

Apply Now

from a previous scholarship recipient...

"Thanks to ASME donors, I'll be able to graduate with a Mechanical Engineering degree in the summer... I am so grateful for the scholarship I received. Without it, I simply wouldn't have the funds to complete my degree. Thank you for helping me and other students facing financial hardships."

Delbert J. Stewart
California State University, Northridge

Questions

For questions regarding the scholarship program or applying ***click here***, call toll free (U.S. applicants only) ***(855) 276-3734***, or email us directly at ***ASME.University@applyISTS.com***. Our offices are open Monday through Friday from 8:00 AM to 5:00 PM Central.

Application submissions open December 3, 2019 to March 3, 2020

Is the financial burden of paying for education stressing you out? Are you working several jobs to pay for classes? Don't fret - ASME is here to help!

Over the past 29 years The ASME Foundation has awarded **$2 million** in scholarships to **853 individual mechanical students**—SO FAR! We're looking for outstanding engineering students, like you, to take advantage of this opportunity and contribute to the wellbeing of all humanity.

Here's what you need to know before applying:

- We have 80+ scholarships available—for both undergraduate, and graduate students.
- ***NEW*** 20 IGTI scholarships / $2K each (applicants have to take one course in gas turbomachinery to be eligible AND these can be added on to other scholarships by the Scholarship Committee)
- ***NEW*** $10K petroleum engineering scholarship + 10 brand new $5,000 scholarships, all in petroleum engineering (min 50% for female engineers!)
- Scholarship money is paid to the recipient's academic institution.
- By completing a single electronic application you will be applying for any ASME Scholarshipsfor which you may be eligible!
- For ME/MET students enrolled full-time in a college or university during the 2020-2021 academic year.
- Students who demonstrate a high level of financial need--we want to help you graduate!

GET AHEAD OF THE GAME! SUBMIT EARLY TO BE CONSIDERED FOR ALL ASME SCHOLARSHIPS THROUGH ONE ONLINE APPLICATION!

NUMECA INTERNATIONAL

Boost your performance in Design - Analysis - Optimization

OMNIS™ /Turbo - From design to analysis within one collaborative environment

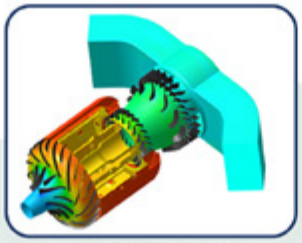
Turbo-machinery

Multiphysics & External Aero

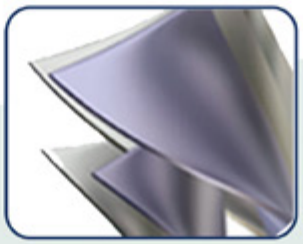
Meshing

Marine

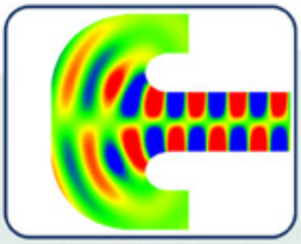
Preliminary and detailed 3D design



Full engine CFD simulation with NLH



Robust Design Optimization with UncertaintyQuantification



Fully coupled aero-vibro-acoustics suite with wizard-based automation

Visit us at **stand #404**

Join our **FREE Lunch & Learn session*** Tuesday June 23rd

*(*) Contact us at **info@numeca.com** to reserve your seat*

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