

AMERICAN SOCIETY OF THERMAL AND FLUIDS ENGINEERS NEWSLETTER

2020 FALL ISSUE

WHO WE ARE

The Society was founded in 2014 to bring together researchers and engineers in the areas of thermal sciences and fluid mechanics and to encourage international and industrial collaboration.

We are an agile organization focusing on emerging research applications aligned with global challenges such as global climate change and renewable energy, as well as traditional topics of research.

SPECIAL INTEREST ARTICLES:

TECHNICAL GROUPS

YOUNG RESEARCHERS

CENTER OF LEADERSHIP
DEVELOPMENT IN BUILT
ENVIRONMENT SUSTAINABILITY
(CLDBES) PROGRAM

IN ADDITION TO THE ABOVE, THIS ISSUE CONTAINS:

– ASTFE STRUCTURE

– HOW TO GET INVOLVED

– LETTER FROM THE
PRESIDENT

– RESEARCH HIGHLIGHTS

– HONORS AND AWARDS
COUNCIL

– INDUSTRIAL RELATIONS

– CONFERENCES AND EVENTS

– FUNDRAISING INFORMATION



FOREWORD BY THE EDITOR



I hope you enjoy reading the newsletter. This is my second time editing the ASTFE newsletter and I have thoroughly enjoyed the experience; learning about the positive and proactive contributions that the society is making through its work.

Two things stand out for me in this edition, firstly, how the society is responding to the COVID-19 pandemic social restrictions through virtual workshops, making conference papers available online for free, and preparing for innovative ways of communicating with its members.

Secondly, the achievements of some of the society's young researchers and members are celebrated in this newsletter. I can say from personal experience that the society is extremely welcoming and eager for young members, both students and professionals, to be an integral part of the society.

If you have any ideas for the newsletter and want to get involved, please get in touch.

Kasturi Sukhapure, Editor

CONTACT US

ADDRESS:

**AMERICAN SOCIETY OF
THERMAL AND FLUIDS
ENGINEERS**

**50 NORTH STREET,
DANBURY, CT 06810, USA**

EMAIL ADDRESS:

INFO@ASTFE.ORG

PHONE: +1 212 288 9200

FAX: +1 212 427 0300

VISIT US AT:

WWW.ASTFE.ORG



ASTFE STRUCTURE

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HOW TO GET INVOLVED

BECOME A MEMBER

- Reduced registration fees to attend ASTFE sponsored conferences with deep discounts for students
- A direct path to submit technical papers to Begell House journals
- Advanced membership grades including senior member and Fellow grade
- Leadership roles on technical committees
- Honors and awards

[CLICK HERE FOR MORE INFORMATION ON MEMBERSHIP](#)

The introductory annual membership fee is \$25 for students and \$50 for professionals.

WANT TO LEAD A UNIVERSITY CHAPTER?

We are looking for volunteers. There is NO job descriptions so be as creative and imaginative as you like!

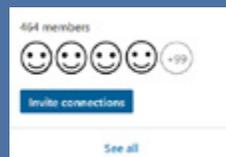
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Click on the bell icon to turn on notifications from the group and invite connections



Invite connections to the group

LETTER FROM THE PRESIDENT



I would like to thank Professor Yogesh Jaluria for his leadership as the first ASTFE president. During his tenure, ASTFE has grown to become an established society with more than 400 attendees to our annual TFEF conferences and 410 active members in 2019.

In 2019, working with academic institutions, we secured a grant from National Science Foundation to provide international experience to US graduate students through the leadership and professional development program in sustainable built environment research. Our aim is for this project is to be scaled up for broader adoption in the future for professional societies and academic institutions.

As we enter 2020, the entire world is facing new challenges associated with COVID-19. Normal life has been affected profoundly, and so have the Society's events. The 2020 Thermal and Fluids Engineering Conference has been postponed to 2021 and we have worked diligently to minimize the impacts of this on conference attendees, including publishing a special collection of the accepted papers and extended abstracts online.

The Society is working to develop flexible approaches to research dissemination and we welcome ideas from our members in this regard. Examples could include virtual forums, Technology Entrepreneurship Communication (TEC) talks, workshops and mini conferences. At previous conferences TEC talks were given by engineers working in applied areas in industry, business, national labs or academia. These are great opportunities to

promote our work and develop our networks.

We continue to contribute to the Begell House digital library which hosts papers presented at our conferences, special publications for virtual conferences and special issues of archival journals. Several Begell House journals are affiliated with the Society and authors are encouraged to submit their papers to these journals.

To honor members with impressive achievements and contributions, the Society has introduced the level of Fellow in our membership grades. Twelve distinguished scholars have now been elected as Fellows. In addition, two outstanding researchers have been awarded the Thermal and Fluids Engineering awards. Our Honors and Awards Council continues to accept new nominations.

Early in 2020 we started raising funds for developing virtual conferences, specifically to support diverse early/mid-career researchers to develop their leadership skills and underrepresented research students to present their work in a creative way. We continue to welcome corporate sponsorship and individual donations to benefit our members.

We encourage interested students, educators, engineers and researchers to become members of our Society. As we enter the third decade of the twenty first century the Society is striving to serve our members and thermal and fluids communities at large. We thank you for being part of this journey.

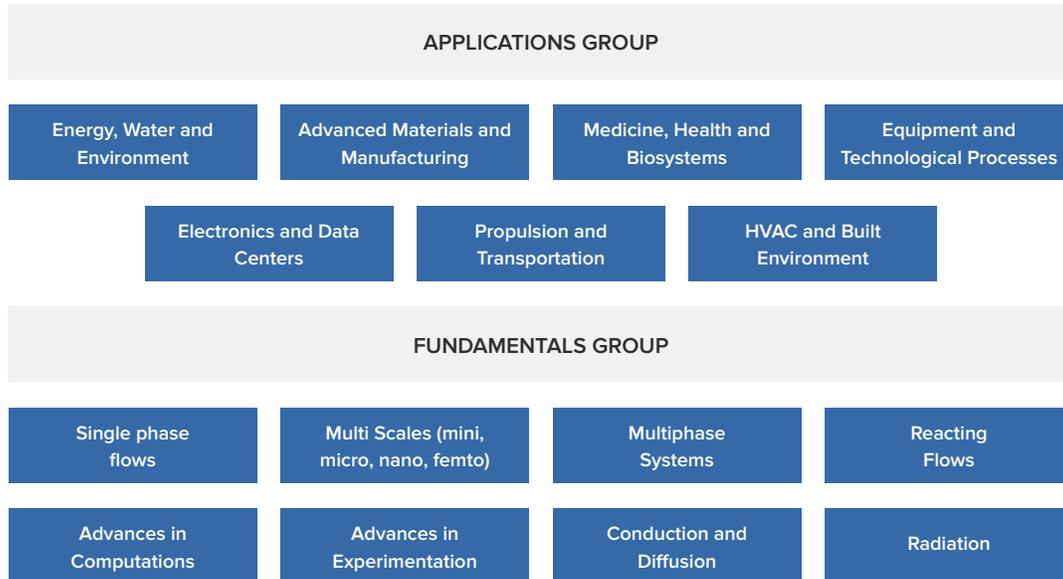
**Yong Tao,
Ph.D., P.E. (President)**

TECHNICAL GROUPS SPOTLIGHT

These days the Thermal and Fluids Research and Engineering Community has been facing the great challenges caused by pandemic limitations and restrictions, economic and political uncertainty as well as associated re-organization and multi-disciplinary re-integration. ASTFE responds to these

challenges by reforming the societal infrastructure and emerging topics to better serve the professional community and move forward into new reality.

The ASTFE technical committees are divided into two major groups:



BECOME A MEMBER

By participating in technical committees, you as an ASTFE member will contribute to the worldwide research and engineering community as well as benefit by being on the edge of the new fundamental research and advanced emerging technologies in the field of thermal and fluids engineering.

By getting involved and working in technical groups, you will develop a wide professional network via programming and attending the ASTFE in-person and virtual events, meeting with the colleagues and partners from industry, academia and government entities.

BECOME A LEADER

ASTFE is always looking for research and engineering professionals with a strategic vision who are willing to take a leadership role in these technical groups. They would be responsible for the development of these areas, including attracting members from industry, academia and national laboratories to the committee, spearheading special-

ized conferences and workshops, organizing sessions, inviting speakers and generating additional activities such as webinars, videocasts and online trainings. Each technical committee has flexibility and independence to pursue various ideas for the development of the society for the benefits of the community worldwide.

SELECTED REPORTS FROM TECHNICAL GROUPS

ENERGY AND SUSTAINABILITY TECHNICAL GROUP

The Energy and Sustainability Technical Group encourages the development of new knowledge and the dissemination and application of existing knowledge in the areas of energy conversion, storage and sustainability. This technical group's efforts are focused on some of the most interesting and promising areas of research and technology development including heat and mass transfer in renewable and clean energy systems, energy and sustainability, advanced energy devices and systems, techno-economic and ecological analysis of energy systems, and the energy-water-food nexus. The Energy and Sustainability Technical Group consists of about 30 members from Universities, industry, and research labs. The members assist with the planning and organization of the conferences and meet regularly during the annual Thermal and Fluids Engineering Conferences.

During the 4th Thermal and Fluids Engineering Conference held at the Westin Las Vegas Hotel

& Spa on April 14-17, 2019, our technical group organized 12 technical sessions that consisted of 54 contributed presentations. The technical sessions focused on CO₂ heat transfer in energy systems and applications, electrochemical energy, the energy-water-food nexus, solar energy, thermal energy storage, and other advanced energy systems. Prof. Christian Sattler gave the plenary lecture on “Concentrated Solar Radiation – An Option for Large Scale Renewable Fuel Production”. Prof. Srinivas Garmella gave a keynote presentation on “Waste Heat Recovery and Upgrade: Potential, Limits, and Practical Implementation”. Prof. Robert Boehm gave a keynote presentation on solar energy. Congratulations to Energy and Sustainability technical group member Prof. Jon Jongtin, who was recognized as an ASTFE Fellow at this meeting.

Wilson K. S. Chiu (Chair of technical group)

Lorenzo Cremaschi (Co-Chair of technical group)

HVAC AND BUILT ENVIRONMENT TECHNICAL GROUP

The mission of the HVAC and Buildings Technical Group is to advance the fundamental and applied research in thermal fluid engineering for the technological development in heating, ventilating, and air-conditioning and built environments. The

committee will disseminate the related knowledge primarily through organizing technical sections, workshops, panel discussions through ASTFE conferences.

Dr. Cheng-Xiang Lin (Chair of technical group)



THE CLDBES PROGRAM

ASTFE is a proud co-sponsor of an NSF-funded grant in support of the **Center of Leadership Development in Built Environment Sustainability (CLDBES)**. Awarded to Louisiana State University (LSU), the program is co-sponsored by ASTFE, Cleveland State University, Hong Kong Polytechnic University, and The University of Macau. CLDBES has developed a program designed to provide students an opportunity to conduct research in the field of built environment sustainability, develop leadership skills, and experience first-hand the progressive built environment sustainability efforts in Hong Kong/Macau.

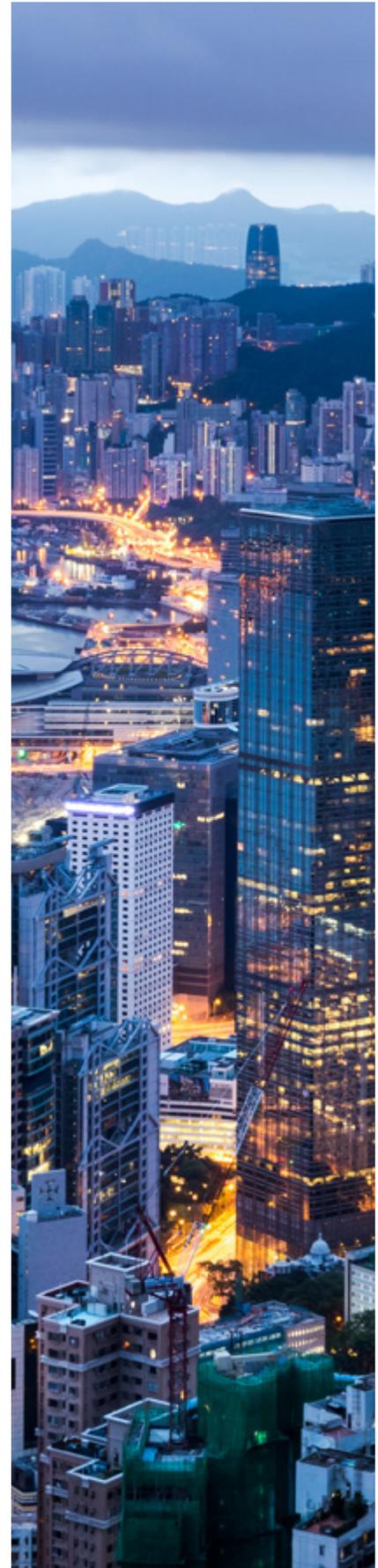
As a co-sponsor of **CLDBES**, ASTFE provides administrative support to the **CLDBES** Project Team. In addition, ASTFE is helping to organize student presentations at the first Sustainability Summit scheduled to take place in Cleveland, OH, in August 2020. ASTFE is also looking forward to the students sharing their experiences and research at the TFEC-2021 conference.

CLDBES welcomed its first cohort of students in April of 2020 including students from Cleveland State University, Louisiana State University, North-eastern University, and the University of North Carolina at Charlotte. Five U.S. students along with five students from Hong Kong Polytechnic University and the University of Macau are participating in the program which takes students through an 8-week virtual leadership training. They are introduced to a variety of professional leadership skills including problem solving, interpersonal communication, decision making, managing conflict, stress management, managing culture and diversity, and time management.

The **CLDBES** program is designed to include travel by U.S. students to Hong Kong/Macau to experience the region's progressive built environment sustainability efforts. Students will have the opportunity to learn and study in this field under the direction of the Hong Kong and Macau mentors and students while learning about the culture of the region. Travel this year has been severely limited because of the COVID-19 pandemic; however, the project team is focused on providing additional experiences to enhance the students' cultural experience while waiting for travel restrictions to relax.

The **Center for Leadership Development in Built Environment Sustainability (CLDBES)** will begin recruiting its second cohort of students beginning September 14, 2020. Information about the program, including the application process, can be found at WWW.CLDGES.ORG. U.S. students (including those of diverse backgrounds) are encouraged to apply. Please share this information with your colleagues and help us to recruit the next round of students for this extraordinary program.

Yong X. Tao (President)



RESEARCH HIGHLIGHTS

THE FLUID MECHANICS OF COUGHS AND SNEEZES

D. W. Pepper

**Department of Mechanical Engineering
University of Nevada Las Vegas**

It is well known that coughs and sneezes produce vapor clouds that allow infectious droplets to stay suspended over larger distances than first imagined. This is a common occurrence as these droplets develop near someone who is coughing or sneezing who does not prevent the spread of the droplet cloud. Since many of the droplets are small, or essentially invisible, it is not surprising that the range of travel of these droplets can extend over considerable distances. This can be seen in Fig. 1 of a person sneezing. The smallest of these droplets can travel up to 200X further than droplets normally grouped as unconnected droplets. Scharfman et al [1] found that these droplets can stay airborne, and become resuspended within the gas cloud, as a result of ventilation patterns common to HVAC systems. This ventilation contamination hazard is common in workplaces, hospitals, airplanes, auditoriums, and places where masses of people and/or confinement in tight places occur.

Scharfman et al [1], using high-speed imaging of coughs and sneezes, showed that the interactions of droplets with the overall gas cloud significantly affects the trajectories of the droplets. The previous belief that large droplets travel farther than smaller droplets was shown to be in error, where a

circulation pattern occurs within the cloud, allowing the smaller droplets to stay suspended longer within the eddies, as seen in Fig. 2. The larger droplets settle out more quickly due to gravitational settling and less suspension. They found that droplets of 100 nm diameter can travel about 5X farther than previously estimated, with droplets around 10 nm traveling up to 200X farther. Of importance was the fact that droplets < 50 nm in diameter can remain airborne longer and reach ceiling ventilation portals.

A cough or sneeze acts as a multiphase turbulent buoyant cloud. This cloud then mixes, or entrains, surrounding air, enabling the cloud to diffuse, or expand. As the expansion occurs, the diffusion rate slows down, and the cloud begins to lose (or deposit) the droplets. This type of behavior cannot be modeled using simple particle motion to represent an isolated droplet. A rethinking of airborne respiratory aerosol dispersion, and the influence of ambient air conditions on the spread of the droplets, needs to be undertaken to more accurately represent the distribution patterns and regions of potential infection. The fragmentation associated with this fluid breakup, or eddy cascade, dictates the formation of the pathogen-bearing droplets attributed to the indoor transmission of these respiratory viruses [2]. Droplet size distribution develops as the fluid breaks up in the respiratory tract and exits the mouth.



Figure 1. Dispersion of droplets during sneeze



Figure 2. Schlieren photo of air pattern during sneeze

[1] Scharfman, B. E., A. H. Techet, J. W. M. Bush, and L. Bourouiba, "Visualization of sneeze ejecta: steps of fluid fragmentation leading to respiratory droplets," *Ex. Fluids*, 57:24, 2016.

[2] Pepper, D. W. and D. B. Carrington, *Modelling Indoor Air Pollution*, Imperial College Press, London, UK, 2009.



ASTFE YOUNG RESEARCHERS

ASTFE is pleased to introduce four of our premier young researchers in this fall issue of the ASTFE newsletter. Below you will find a brief bio and summary of on-going research and papers for each of our featured young researcher. Each had a paper accepted for TFEC-2020.

Please access the Special Collection of Selected Papers, Extended Abstracts, and Presentations from TFEC-2020 to review the paper in its entirety for free. **Website:** [HTTP://DL.ASTFE.ORG/](http://DL.ASTFE.ORG/)



DR TING LIU

Graduate student from the School of Engineering, University of California, Merced

Research topic: A many-body dissipative particle dynamics study of coalescence induced jumping.

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My research mainly focuses on mesoscale liquid-solid interaction such as electrowetting induced jumping, coalescence induced jumping, water collection on fibers and cone surface, etc. This work, A Many-Body Dissipative Particle Dynamics Study of Coalescence Induced Jumping, aims to develop a fundamental understanding of the coalescence-induced jumping. First, Many-body Dissipative Particle Dynamics (MDPD) simulations are performed to capture the dynamics of droplet behavior during the coalescence process. Here, the threshold of contact angle of the flat substrate and maximum volume ratio for jumping of two dissimilar droplets are obtained. Especially, we successfully captured the dynamic internal velocity field of the merged droplet during the coalescence process. Based on these results, an analytical model can be developed to predict coalescence-induced jumping velocity using the energy balance analysis.



JIANJIAN WANG

Research & Development Engineer II,
Advanced Cooling Technologies

Research topic: Thermally driven ejector for vacuum freezing desalination at the triple point.

[ACCESS MY PAPER HERE.](#)

I graduated from MIT with a major in mechanical engineering and a minor in applied physics. My research interests center on energy conversion phenomena, radiative/optical properties of selective surfaces, thermal management systems, heat conduction mechanisms of composite materials, and desalination. My current research activities include vacuum freezing desalination at the triple point, volumetric solar absorption for desalination applications, and “dark” photovoltaic technology (aka. thermo-radiative cells) for space power generation. I have over 15 publications and 4 patents in application or granted.



CATLIN ETHRIDGE

Senior mechanical engineering major
at Bradley University

Research topic: Growth Control of SnO₂ Nanoparticles Using a Low-Temperature Solution Process.

[ACCESS MY PAPER HERE.](#)

Perovskite solar cells, specifically using SnO₂ nanoparticles, have been extensively researched and are proving to be extremely promising in the field of renewable energy by increasing a solar cell’s overall efficiency and lowering the cost of production. Me and my collaborators investigated how to synthesize semiconductor SnO₂ nanoparticles and enhance the quality of nanoscale semiconductor nanoparticles. In this study, an experiment was performed to synthesize SnO₂ nanoparticles over 8 days. Day 1 was the synthesis which included the mixing of water, tin (II) chloride, methanol, sodium carbonate and dimethylformamide and then heated in a water bath at 28°C. Sampling of this solution started on day 4 of the experiment when sufficient particle growth was observed and stopped at day 8. Centrifuging, freezing, and freeze-drying were used for each sample to isolate the solid product. Transmission electron microscopy and X-ray powder diffraction was used to characterize the isolated nanoparticle. The results from the X-ray powder diffraction showed that each sample consisted of SnO₂ nanoparticles of different sizes. From the transmission electron microscopy on the samples showed that the overall size of the nanoparticles gradually increased during each additional synthesis day. My research will lay the foundation for a low cost and environmentally friendly production of highly efficient perovskite solar cells.



JASON LOPRETE

Graduate student in the mechanical engineering department at Stony Brook University

Research topic: Convectors for low-temperature thermal distribution.

[ACCESS MY PAPER HERE.](#)

My research work as a graduate student has focused on computational modeling and experimental analysis of thermo-fluid systems. In particular, I have worked to improve the rate of heat transfer from hydronic heating systems. Next-generation heating technologies, such as condensing boilers and solar thermal systems, are highly efficient at supply temperatures far below that which traditional heat distribution systems are designed for. However, they lose their benefits as the temperature increases. The benefits are therefore unable to be realized without replacing the entirety of the heat distribution system, preventing many homeowners from experiencing the reduced costs and greenhouse gas emissions associated with such technologies. To investigate ways the supply temperature can be lowered and allow for the implementation of said devices, I have worked on computational models for fluid mechanics and heat transfer. Using information from numerical simulations, different components of the studied device were selected or redesigned to enhance the total mass flow rate of the air into the heating element and improve the overall performance at lower temperatures. Once his was completed, an experimental apparatus was designed and tested according to our new specifications. Thus far, our work has shown that the incorporation of forced-air assist devices can readily increase heat ratings and allow for the lowering of supply temperatures.

HONORS AND AWARDS

The Honors and Awards Council (HAC) of the ASTFE has evolved from the earlier “Fellows Review Council,” and is tasked to solicit nominations and, after deliberations, to recommend to the Executive Council outstanding individuals who will receive the societal awards and will be elevated to the rank Fellow of the ASTFE. In 2020, the Council was chaired by Professor Frank Kulacki and its membership comprised Professors S.A. Sherif, Vish Prasad, Wayne Strasser, Yongxin Tao and Efstathios E. (Stathis) Michaelides.

The HAC received several nominations of outstanding individuals, both from the U.S. and abroad. After the long process of evaluation and deliberations the Council recommended to the Executive Council of the ASTFE the following:

2020 Thermal Fluids Engineering Award: Professor Yogesh Jaluria, Rutgers University

For elevation to the grade of ASTFE Fellow:

- Professor Pradip Dutta, Indian Institute of Science
- Professor John K. Eaton, Stanford University
- Professor Afshin J. Ghajar, Oklahoma State University
- Professor Joseph Katz, The Johns Hopkins University
- Professor Masoud Kaviany, University of Michigan
- Professor Michael W. Plesniak, The George Washington University

The recommendations were approved by the Executive Council and I am in the pleasant position to congratulate the new Fellows and the 2020 Thermal Fluids Engineering Award recipient for these distinctions as well as their achievements in the thermal and fluids engineering field.

For the coming year, the HAC will collaborate with the Executive Council to finalize the requirements and the procedures for the societal honors; seek nominations for the 2021 honors and awards; and recommend, again, a slate of outstanding individuals for the 2021 awards. We all hope that the worldwide disruption by COVID-19, will be minimized and will not affect our work.

2021 NOMINATIONS NOW OPEN

The annual deadline for the receipt of all the documents for the nominations of all the awards of the Society is 15 September 2020. The annual deadline for the receipt of all the documents for the nominations of the Fellows grade is 30 September 2020. All nominations must be sent electronically to: FELLOW@ASTFE.ORG.

Finally, as the incoming Chair of this Council, I wish to express my profound thanks to Professor Frank Kulacki of the University of Minnesota for his tireless work and his immense contributions that established the Honors and Awards Council of ASTFE and paved the way for the future of the Society.

Efstathios E. (Stathis) Michaelides, Ph.D., P.E.



INDUSTRIAL RELATIONS

VISION

We aim to be an agile platform where thermal and fluids researchers and engineers from industry and academia come together to rapidly develop, transition and implement impactful new technologies at an industrial scale by exchanging needs, approaches, and solutions. Our focus is to facilitate strong industry-academia collaboration across the continents and generate an inclusive atmosphere for idea exchange. These factors will help determine how frequently you publish the newsletter and its length.

WHAT WE HAVE ACHIEVED

We have organized international conferences annually since Society formation in 2014, as well as collaborated with other societies worldwide by co-sponsoring conferences around the world. Our digital library has been expanded to include the papers presented at these conferences and have published special issues of archival journals. We have sponsored special courses and workshops and have typically attracted about 400-500 participants in each conference from many industries, national laboratories, and academia.

GROWTH EXPECTATIONS

We expect to expand our reach with greater interaction with industry, enhanced international collaborations, focused conferences, additional workshops and special courses, including training. We wish to provide a valuable forum for industry to seek appropriate talent and resources.

Networking opportunities abound through attending conferences, presenting lectures and panels, participating in special courses, and using our [LINKEDIN ASTFE GROUP](#) to reach out to the community. There are five more focused and strategic partnering methods:

- 1. Exclusive exhibition space:** The cost for a standard booth with a table and a banner is only \$1,200. This includes one full-access registration pass for the conference and food.
- 2. Company-named ‘Award Lecture’:** You would designate the title, topic, amount (\$2K minimum per lecture), and annually recurring nature. A representative from your company would be invited to present the award at our awards banquet and hold a special symposium or panel discussion on the topic of your interest.
- 3. Thermal and Fluids Engineering Award Lectures:** Your company name would be listed among the sponsors (\$2K minimum per sponsorship) for these annual awards designated by the society and presented at our awards banquet.
- 4. Start a conversation in our LinkedIn ASTFE Group about your research, products, or services.**
- 5. Advertising in our Newsletter:** You can post an open position or other company announcement in our annual Newsletter for \$2K (full-page) or \$1K (half-page).
- 6. Advertising on our Website:** You can post an open position or other company announcement on our Website for \$4K.
- 7. Support Portal:** Recent global challenges have ushered in a “new reality” where virtual participation and online training, consulting, etc. are essential. Our proposed model for meeting virtual needs for our community is shown in figure below, and we are looking for interested parties to help us develop this.

Wayne Strasser and Yaroslav Chudnovsky

CONFERENCES AND EVENTS

The 5th Thermal Fluids Engineering Conference (TFEC 2020) was scheduled to take place on April 5-8, 2020 in New Orleans, Louisiana.

New Orleans is world renowned for its vibrant live music, unique culture, distinct cuisines, and year-round festive atmosphere. A total of 561 submissions have been received. Among them, 385 full-length papers, extended abstracts, and presentation-only abstracts had been reviewed and accepted. Four plenary speeches and nine keynote presentations were scheduled. In addition, a special Technology, Entrepreneurship, and Communication (TEC)Talk session was to take place. Unfortunately, the outbreak of COVID-19 pandemic prompted the ASTFE Board and TFEC Organizing Committee to postpone the 5th TFEC until next year and combine it with the 6th TFEC in May 23-26, 2021 in the same venue in New Orleans. The authors had a choice of two options: (a) publish the papers and extended abstracts with recorded presentations in a special online session in 2020 or (b) transfer the papers to 2021.

There are 78 entries compiled in the Special Collection of Selected Papers, Extended Abstracts, and Presentations from the TFEC2020 conference. It has been published and is now available online in the [ASTFE DIGITAL LIBRARY](#). All papers are

open for download to everyone and some papers have PowerPoint presentations and/or audio/video recordings – those files are at the supplementary content link under the “Download article” option on the right-hand side.

On behalf of the Organizing Committee, we want to express our appreciation to all involved for making the 5th TFEC ready to be held, including the authors, plenary and keynote speakers, conference staff, and the reviewers and session organizers.

Thank you! We’re looking forward to seeing y’all in New Orleans in 2021.

CONFERENCE CHAIRS



Ting Wang



Michael W. Plesniak



[CLICK ON IMAGE FOR MORE INFORMATION. OR ACCESS THE WEBPAGE HERE.](#)

WE'RE RAISING FUNDS TO SUPPORT OUR YOUNG RESEARCH AND ENGINEERING LEADERS

YOUR SUPPORT MATTERS, MORE THAN EVER.

As a young, agile, volunteer-rooted, professional society, ASTFE provides a great opportunity for a diverse group of young, mid-career and established engineers and researchers to practice their leadership in scientific and technical, cutting-edge information dissemination and networking. Particularly, in areas such as global climate change, renewable energy, global challenges, sustainability and environment impacts. Your support is crucial now during this global pandemic health crisis, to enable our leaders to provide reliable information of scientific research related to fighting COVID-19 because it impacts everyone's life. This fundraising drive will enable more students, early and mid-career engineers, scientists and researchers to organize or participate in a themed virtual research workshop. It will have both short-term and long-lasting impacts on innovative, creative and effective solutions to problems facing the world.

The first workshop focuses on:

- Formation, spread and behavior of droplets in various airflow conditions
- Ventilation equipment designs and advanced manufacturing
- Reliability of PPE and diagnostic testing
- Other pertinent subjects related to COVID-19 thermal and fluids programs
- Evaluation of remote delivery of engineering courses

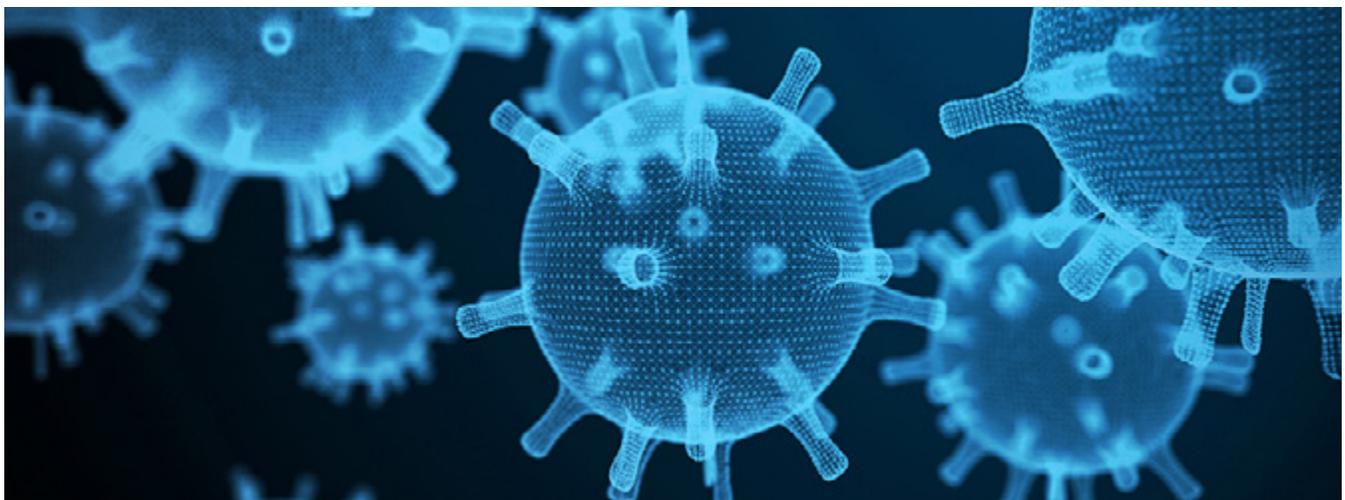
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Questions about giving?

Contact us at INFO@ASTFE.ORG.

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ASTFE

AMERICAN SOCIETY OF THERMAL AND FLUIDS ENGINEERS

50 NORTH STREET, DANBURY, CT 06810, USA

PHONE: +1 212 288 9200 | FAX: +1 212 427 0300

INFO@ASTFE.ORG | WWW.ASTFE.ORG