



**FFHMT**  
2021

**PROCEEDINGS OF THE 8<sup>TH</sup>  
INTERNATIONAL CONFERENCE ON FLUID  
FLOW, HEAT AND MASS TRANSFER  
(FFHMT'21)**

May 21, 2021 - May 23, 2021 | ~~Niagara Falls, Canada~~ | Virtual Conference

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# WELCOME MESSAGE FROM THE CONFERENCE CHAIR

On behalf of the International Academy of Science, Engineering and Technology (International ASET Inc.), the organizing committee would like to welcome you to the 8<sup>th</sup> International Conference of Fluid Flow, Heat and Mass Transfer (FFHMT'21).

FFHMT'21 is aimed to become one of the leading international annual conferences in the fields of heat, momentum, and mass transfer. This conference will provide excellent opportunities to the scientists, researchers, industrial engineers, and university students to present their research achievements and to develop new collaborations and partnerships with experts in the field.

FFHMT is a series of international conferences held yearly. These conferences focus on all aspects of fluid flow, heat and mass transfer. Due to COVID-19, we have made the decision to hold the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21) virtually this year.

In the eight meeting of this conference, five keynote speakers will share their expertise with the aim of exposing participants to a wide spectrum of applications, and to foster crosspollination of ideas and develop new research interests. In addition, approximately 30 papers will be presented from professors, students, and researchers across the world.

We thank you for your participation and contribution to the 8<sup>th</sup> International Conference of Fluid Flow, Heat and Mass Transfer (FFHMT'21). We wish you a very successful and enjoyable experience.

**Dr. Boguslaw Kruczek**

*Conference Chair and Proceedings Editor  
FFHMT'21*

**Dr. Xianshe Feng**

*Conference Co-Chair and Proceedings Editor  
FFHMT'21*

**Dr. Wael H. Ahmed**

*Technical Program Chair  
FFHMT'21*

# ABOUT FFHMT'21

**The International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT) aims to become the leading annual conference in fields related to traditional and modern transport phenomena.** The goal of FFHMT'21 is to gather scholars from all over the world to present advances in the fields of transport phenomena and to foster an environment conducive to exchanging ideas and information. This conference will also provide an ideal environment to develop new collaborations and meet experts on the fundamentals, applications, and products of the mentioned fields.

FFHMT is a series of international conferences held yearly. These conferences focus on all aspects of fluid flow, heat and mass transfer. Due to COVID-19, we have made the decision to hold the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21) virtually this year.

**FFHMT** is an acronym for **F**luid, **F**low, **H**eat, and **M**ass Transfer.

All papers were peer-reviewed

The conference proceedings are published under an ISSN and ISBN number

Each paper is assigned a unique DOI number by [Crossref](#)

The conference proceedings are indexed by [Scopus](#) and [Google Scholar](#)

The proceedings are permanently archived in [Portico](#) (one of the largest community-supported digital archives in the world)

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# SCIENTIFIC COMMITTEE

We would like to thank the following for accepting to act as a member of the Scientific Committee for the FFHMT'21 Conference:

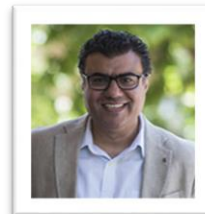
## Scientific Committee Chairs



**Dr. Boguslaw Kruczek**  
**University of Ottawa, Canada**  
Conference Chair



**Dr. Xianshe Feng**  
**University of Waterloo, Canada**  
Conference Co - Chair



**Dr. Wael H. Ahmed**  
**University of Guelph, Canada**  
Technical Program Chair

## Scientific Committee Members

**Dr. Jules Thibault**, University of Ottawa, Canada

**Dr. Sanjeev Chandra**, University of Toronto, Canada

**Dr. Lee Poh Seng**, National University of Singapore, Singapore

**Dr. Junfeng Zhang**, Laurentian University, USA

**Dr. Rayhaneh Akhavan**, University of Michigan-Ann Arbor, USA

**Dr. Lian Shen**, University of Minnesota, USA

**Dr. Yan Chen**, Purdue University, USA

**Dr. Yusuf Chisti**, Massey University, New Zealand

**Dr. Nikolai Kozlov**, Institute of Continuous Media Mechanics UrB RAS, Russia

**Dr. Kamiel Gabriel**, Ontario Tech University, Canada

# KEYNOTE SPEAKERS

The keynote information for the 8th International Conference of Fluid Flow, Heat and Mass Transfer (FFHMT'21) is as follows:

## Keynote Speaker



**Dr. Kamiel Gabriel**  
Ontario Tech University,  
Canada  
Keynote Speaker



**Dr. Andrei Fedorov**  
Georgia Institute of  
Technology, USA  
Keynote Speaker



**Dr. Aimy Bazylak**  
University of Toronto,  
Canada  
Keynote Speaker



**Dr. Poh Seng (PS) Lee**  
National University of  
Singapore (NUS), Singapore  
Keynote Speaker



**Dr. Junfeng Zhang**  
Laurentian University,  
Canada  
Keynote Speaker

# FFHMT'21 KEYNOTE SPEAKERS



**Titles:** Scalable Low-Carbon Hydrogen Production  
Technology Utilizing Waste/Process Heat

[Dr. Kamiel Gabriel, Ontario Tech University, Canada](#)

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Dr. Gabriel is an elected member of the Canadian Academy of Engineering and the former A/Deputy Minister at the Ontario Ministry of Research and Innovation. In 1990, Dr. Gabriel attended the prestigious, MIT-founded, International Space University and received a diploma in Space Sciences. For over 14 years, Dr. Gabriel led an international team in the research efforts spearheaded by NASA to design, test and operate a thermal management system for the International Space Station (ISS). In 2004, Dr. Gabriel was invited to lead the development of the research and innovation ecosystem in a newly announced university. He assumed the position of the founding AVP research and graduate programs at Ontario Tech University (formerly known as University of Ontario Institute of Technology) in Ontario, Canada. Under his leadership, Ontario Tech University was ranked as one of the top Canadian higher learning institutions in the categories of innovation and leaders of tomorrow.

# FFHMT'21 KEYNOTE SPEAKERS



**Titles:** Advanced Materials for High Performance Fuel Cells and Electrolyzers

Dr. Aimy Bazylak, University of Toronto, Canada

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Prof. Aimy Bazylak is the Canada Research Chair in Thermofluids for Clean Energy and Professor in the Department of Mechanical and Industrial Engineering at the U of T. Her research is focused on advancing fuel cells, electrolyzers and batteries for clean power and energy storage in the absence of greenhouse gas emissions. She uses modelling and real-time imaging to design new materials for high efficiency and high-performance electrochemical energy conversion, and she has published 117 journal papers in her field. In 2011, she was awarded the I.W. Smith Award from the Canadian Society for Mechanical Engineering, and she received the Ontario Early Researcher Award in 2012. From 2015-2018, she served as the Director of the U of T Institute for Sustainable Energy. In 2015 she was named an Alexander Von Humboldt Fellow (Germany), and in 2019 she was named a Fellow of the American Society of Mechanical Engineers. In 2020, she was named a Helmholtz International Fellow (Germany), was awarded the U of T McLean Award, and was elected to the Royal Society of Canada College of New Scholars, Artists and Scientists.



**Titles:** Cooling of High Power Generation Systems: Matching Demands with Supplies across the Length and Time Scales

Dr. Andrei Fedorov, Georgia Institute of Technology, USA

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Andrei G. Fedorov is the Rae S. & Frank H. Neely Chair Professor in the School of Mechanical Engineering at Georgia Tech. His current research focuses on thermal management of high performance electronics, and portable/distributed power generation with CO<sub>2</sub> capture, MEMS-enabled bioanalytical instrumentation, and electron-beam-mediated direct-write nanomanufacturing.

For more information please visit:

<https://ffhmt.com/keynote-speakers/>



# FFHMT'21 KEYNOTE SPEAKERS



**Titles:** The Temperature Decomposition Method for Simulating Periodic Thermal Flows

**Dr. Junfeng Zhang, Laurentian University, Canada**

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Dr. Junfeng Zhang obtained his Ph.D. degree in Mechanical Engineering from University of Alberta (Edmonton, Canada) in 2005. He then worked in the Department of Biomedical Engineering at Johns Hopkins School of Medicine (Baltimore, USA) for two years as a NSERC postdoctoral fellow. Dr. Zhang joined the Laurentian Engineering School in 2007 and was promoted to Full Professor in 2016. His research mainly focuses on computational modeling and numerical investigations of microscopic complex flows. Relevant research topics include heat and mass transfer, porous and particulate flows, the lattice Boltzmann method, microscopic blood flows, nanofluids and microfluidics. He is the author/co-author of more than 60 articles in peer-reviewed journals.



**Titles:** Single Phase Convective Heat Transfer Passive Enhancement: Techniques, Mechanisms, Performance Comparisons and Applications

**Dr. Poh Seng (PS) Lee, National University of Singapore (NUS), Singapore**

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Dr. Poh Seng (PS) Lee is an ASME Fellow and Associate Professor of Mechanical Engineering at the National University of Singapore (NUS). He currently serves as the Deputy Executive Director of Energy Studies Institute, Director of Singapore Energy Centre, Director of Centre for Energy Research & Technology (CERT) and Programme Director of Cooling Energy Science & Technology Singapore (CoolestSG) national consortium. Prof Lee's research interests include high performance cooling techniques (in particular single and two-phase microchannel cooling), energy efficient air conditioning and low-grade waste heat recovery. He is the recipient of numerous research and innovation awards including 2013 NUS Faculty of Engineering's Young Faculty Research Award, 2011 Institution of Engineers Singapore (IES) Prestigious Engineering Achievement Award, 2011 Asia Pacific Clean Energy Summit Top 10 Defense Energy Technology Solutions Award and 2009 Tan Kah Kee Young Inventors Award (TKKYIA) – Defense Science. Prof Lee is passionate about translating R&D outcomes into innovations & enterprises and have founded CoolestDC Pte Ltd to commercialise his group's liquid cooling solution for sustainable tropical data centres.

# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## CFD

**Titles:** Modelling of Supersonic and Subsonic Flows Using Hybrid Pressure-Based Solver in Openfoam

**Authors:** Janhavi Gharate, Rudra N. Roy

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**Titles:** An Innovational, Collision Model and Data Set Generation at Novel Test-Rig for Validation of Numerical Model in the Frame of Machine Learning

**Authors:** Agata Widuch, Marcin Nowak, Ziemowit Ostrowski, Adam Klimanek, Ryszard Biatecki, Kari Myöhänen, Alessandro Parente and Wojciech Adamczyk

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**Titles:** Modelling of Heat Exchangers with Computational Fluid Dynamics

**Authors:** Chamil Abeykoon

[View Paper](#)

**Titles:** Computational Study on Wingtip Vertical Fluid Injection for Induced Drag Reduction

**Authors:** Hariprasad Thimmegowda, Yadu Krishnan S, Gisa G S

[View Paper](#)

**Titles:** A CFD/DEM Approach to Determine the Flow Resistance of Randomly Packed Bed of Crushed Rock Particles

**Authors:** Jaap Hoffmann

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# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## CFD

**Titles:** Heat Transfer Augmentation Using Dissimilar Porous Baffles in a Backward-Facing Step Flow

**Authors:** James Arthur

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**Titles:** Simulation of Metal Additive Manufacturing

**Authors:** J. Angel Diosdado De la Pena, Kyosung Choo

[View Paper](#)

**Titles:** Efficient Heating Strategies Based On Variable Set-Point Temperature of a Bus Cabin with No Air Recirculation

**Authors:** Ehsan Afrasiabian, Roy Douglas, Gareth Cunningham , Marco Geron

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**Titles:** Numerical Study Of Three-Winged Passive Micromixer Based On Sar Principle

**Authors:** Monther Jomha, Sedat Yayla

[View Paper](#)

**Titles:** Thermal Analysis of a 3U-Cubesat, a Case Study of Pakal Satellite

**Authors:** Gabriel Salazar-Salinas, Estefanía Botello-Ramírez, Edgar Avalos-Gauna

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# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## Combustion

**Titles:** Explosion Characteristics of Syngas/air Premixed Flames

**Authors:** Manh-Vu Tran, Gianfranco Scribano

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**Titles:** Modeling Laser-Induced Incandescence of Soot Particles Produced In A Premixed Ch<sub>4</sub>/O<sub>2</sub>/N<sub>2</sub> Flat Flame

**Authors:** Sébastien Menanteau, Romain Lemaire

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## Laminar And Turbulent Flows

**Titles:** Bayesian Cluster Characterization and Classification for Direct Numerically Simulated Turbulence Features

**Authors:** Nicholas V. Scott, Jack McCarthy, Robert A. Handler

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**Titles:** Bayesian Structural Characterization and Classification for Direct Numerically Simulated Turbulence Features

**Authors:** Nicholas V. Scott, Jack McCarthy, Tian-Jian Hsu

[View Paper](#)

**Titles:** Bayesian Data Characterization and State Prediction for a Large Eddy Turbulent Flow Simulation: A Revisitation

**Authors:** Nicholas V. Scott, Jack McCarthy

[View Paper](#)

**Titles:** Turbulent Flow in an Annular Channel of Variable Cross-Section

**Authors:** Vladimir Trifonov, Alexander Reshmin, Sergei Teplovodskii

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# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## Experimental Fluid Flow

**Titles:** Investigation of Inverse Magnus Effect by Partial Circulation Control Elements: Experimental Design

**Authors:** Acar Celik, Sercan Acarer, Ian Jacobi, Beni Cukure

[View Paper](#)

**Titles:** Comparison of Experimental and Theoretical Characteristics of Linear Waves in the Submerged Air Jet

**Authors:** Linar Gareev, Anastasia Chicherina, Alexander Reshmin<sup>1</sup>, Vladimir Trifonov, Vasily Vedeneev, Julia Zayko

[View Paper](#)

**Titles:** High Subsonic Flow Field from the Serpentine Nozzle

**Authors:** A Nageswara Rao, Rajat Arora, Abhijit Kushari

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**Titles:** Thermal Analysis of Latent Heat Thermal Energy Storage Systems Enhanced with Annular and Radial Fins

**Authors:** Saeed Tiari, Addison Hockins, Samantha Moretti

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# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## Boiling and Condensation

**Titles:** On Jet Impinging Boiling Heat Transfer

**Authors:** Mahmoud A. Abdelfattah and Mohamed S. Hamed

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**Titles:** The Effect of Surface Vibration on Spray Evaporative Cooling

**Authors:** A. Sarmadian, J. F. Dunne<sup>1</sup>, C. A. Long, J-P Pirault, J. Thalackottore-Jose, Cedric Rouaud

[View Paper](#)

## Mass Transfer

**Titles:** Generalizability of the Time-Lag Method for Mixed-Matrix Membranes: Does One Method Fit It All?

**Authors:** Haoyu Wu, Zheng Cao, Boguslaw Kruczek, Jules Thibault

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**Titles:** Estimation of the effective permeability of mixed-matrix membranes via Monte Carlo simulations

**Authors:** Zheng Cao, Haoyu Wu, Boguslaw Kruczek and Jules Thibault

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# LIST OF PAPERS

The following papers were presented at the 8th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'21).

## Energy Conversion and Storage

**Titles:** Integration of Cement and Hydrogen Industries for Canada's Climate Plan: Case Study

**Authors:** Rami S. El-Emam, Neha Bagria, Kamiel S. Gabriel

[View Paper](#)

**Titles:** Modelling of the Effects of Renewable Energy Establishments towards the Economic Growth of a Nation

**Authors:** Chamila H. Dasanayaka, Chamil Abeykoon, Padmi Nagirikandalage

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# SPONSORS

International ASET Inc. would like to thank the following sponsors for their support of FFHMT'21:



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# JOURNAL PUBLICATION

**Selected articles from the conference will be published in the [Journal of Fluid Flow, Heat and Mass Transfer \(JFFHMT\)](#) after a secondary review process.**

**The publication fee will be waived for papers that win the best paper award. Other attendees will receive a 25% discount towards the publication fee of the journal.**

This journal has adopted to the open-access model, meaning all free access to the journal's articles and content with no need for subscription. This ensures larger audience and therefore higher citations.

Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles in this journal without asking prior permission from the publisher or the author. This is in accordance with the BOAI definition of open access.

All published papers of JFFHMT will be submitted to Google Scholar, Microsoft Academic Search, Open J-Gate, Mendeley, Index Copernicus International, Academic Index, Mendeley, Primo Central, and Genomics JournalSeek for possible indexing. Additionally, they will be permanently archived in Portico (one of the largest community-supported digital archives in the world) and will be assigned unique DOIs.

# FFHMT'22

The 9<sup>th</sup> International Conference of Fluid Flow, Heat and Mass Transfer (FFHMT'22) will be held on June 8, 2022 - June 10, 2022 in Niagara Falls, Canada.



For inquiries and to obtain further information on the congress,  
please visit the [website](#)

You can also email [info@ffhmt.com](mailto:info@ffhmt.com) or call us at: +1-613-834-9999

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# ETHICS & MALPRACTICE

## Publication Ethics and Publication Malpractice Statement

The following statement is mainly based on the [Code of Conduct and Best-Practice Guidelines for Journal Editors](#) (Committee on Publication Ethics, 2011).

### Scientific Committee

#### *Scientific Committee*

Scientific committees consisting of experts in the fields are established. The committees oversee the peer-review and publication process. To see the scientific committee members, please follow the link below.

#### [Scientific Committee](#)

#### *Equality and Decisions*

One or more reviewer, scientific committee member, or chair, (internal or external), are responsible for evaluating the relevance of the submitted manuscripts to the proceedings, technical and scientific merit, originally, and impact. These evaluations are to be carried out regardless of ethnicity, religion, gender, sexual orientation, political beliefs, and institutions. Successive to peer-review, the Chair has full authority and is solely responsible for the published content and the process thereof.

#### *Confidentiality*

Scientific committee member(s) and publishing staff may not disclose manuscripts or their content, directly or indirectly, to anyone other than individuals invited to review the manuscript (whether they accept or not), other reviewers of the same publications, and publishing staff.

#### *Conflicts of Interest*

Scientific committee member(s) and publishing staff may not utilize the contents of submitted manuscripts whether accepted or rejected, directly or indirectly for their own research purposes without prior written consent by the authors.

# ETHICS & MALPRACTICE

## Reviewers

### ***Contribution to Decisions***

In order for final decisions to be made regarding acceptance or rejection of papers, we rely on peer-review. Peer-review is the process of experts in the field reading, understanding, and objectively commenting on submitted papers. Through peer-review, scholars give back to the academic and scientific community by helping the chair(s) make decisions regarding manuscripts.

### ***Promptness***

Reviewers should promptly notify the chair(s) if they are unable or unqualified to carry out their reviewing duties. Reviewers should do their best to provide the reviews to the chair(s) as promptly as possible, and within the designated time-frame.

### ***Confidentiality***

Reviewers must not share the contents of the manuscripts they receive for review, regardless of their decision to review or contents of the review, directly or indirectly, with anyone other than the person who has assigned the review.

### ***Fairness***

Reviewers should review manuscripts fairly and objectively, with supporting evidence or arguments, regardless of personal feelings or biases.

### ***Thoroughness***

Reviewers should thoroughly read, understand, and provide constructive feedback with the aim of improving the manuscript. Reviewers should aim to identify and report technical issues, irregularities, mistakes, missing citations, and similarity to other published work.

### ***Conflicts of Interest***

Invited reviewers should immediately inform the chair(s) in case of a conflict of interest based on competitive, collaborative, personal, family, and other relationships with the authors or people involved in the work.

# ETHICS & MALPRACTICE

## Authors

### ***Authorship***

Only persons who have significantly contributed to the work and the manuscript can be named authors on a paper. These contributions include the idea/concept, design, experiments, evaluation, analysis, drafting or revision of the manuscript, and others. Authors must all have agreed to be named as such and for the manuscript to be submitted. Anyone who has contributed based on the above, but the level of contribution is not significant, may appear in the acknowledgement section of the manuscript.

### ***Accuracy, Originality, and Plagiarism***

Authors should describe their work and the results of their work accurately and in full. The level of provided accuracy and detail should be such that a reader can replicate the work independently. Inaccurate, incomplete, fraudulent, and misleading statements are considered unacceptable and unethical. Direct or indirect use of other people's work is not allowed, unless properly cited. Previous works that have influenced the current work should also be cited. Presenting someone else's work as one's own is strictly prohibited and is considered plagiarism.

### ***Data and Material***

Authors are encouraged to share their data, software, or other sharable material online, provided copyright and ownership laws surrounding that particular project permit. Authors may also be asked to share such material with the chair(s), and/or reviewers, and must be willing to do so if asked.

### ***Dual Submissions***

Submitting a manuscript to more than one venue (conference, journal, etc) simultaneously is not allowed. Presenting previously published work to be considered as a new submission, without a significant new interpretation or analysis, is prohibited.

# ETHICS & MALPRACTICE

## ***Conflicts of Interest***

Authors must notify the chair(s) at the time of submission, if any factor outside the scope of the research has influenced any step of the work and manuscript writing. Examples of such factors include but are not limited to funding, grants, advisory and consultancy, stock ownership, current or past employment, and memberships, among others. All funding sources should be disclosed in the manuscript.

## ***Animal and Human Subjects***

Works involving human and/or animal subjects must ensure that the work has abided by institutional guidelines, and pre-approved by required bodies. Moreover, consent must be acquired from participants, and privacy of subjects must be ensured. All of the above must be specified with clear statements in the manuscript.

## ***Hazardous Material***

It should clearly be identified in the manuscripts if the works have involved hazardous chemicals and material, or devices that can be harmful.

## ***Reporting of Mistakes, Errata, and Retractions***

If an author identifies a major error in a published paper, he/she must immediately identify the publisher. Regardless of whether a significant error is reported by the authors of the work or other readers, authors are obligated to take the necessary steps to correct the issue. It is decided on a case-by-case basis whether an erratum will be submitted to notify future readers of the error and correction, or whether the paper will be retracted.

Unethical/plagiarism issues mostly result in a retraction, while unintended mistakes will mostly result in the publication of an erratum.

# ETHICS & MALPRACTICE

## **Publisher**

### ***Errata and Retractions***

The publisher takes the necessary steps to prevent mistakes, academic and scientific misconduct, and unethical behavior, both intended and unintended. When mistakes are reported, the publisher works with chair(s) and authors to publish an erratum clarifying the issue. In cases where the mistakes are severe and significant, the paper might be retracted. If unethical behavior, plagiarism, academic and scientific misconduct, or other such activities are proven to have taken place by an author or authors, the publisher will retract the paper.

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### ***Ownership and Management***

This conference-proceedings is managed and operated by the International ASET (International Academy of Science, Engineering, and Technology) and Avestia Publishing (the publishing arm of ASET).

### ***Schedule***

This conference proceeding accompanies the conference, meaning a new proceedings will be published every year for the corresponding annual conference of this series.

# CONTACT US

For inquiries and to obtain further information on the conferences, please visit our [website](#)  
You can also email [info@ffhmt.com](mailto:info@ffhmt.com) or call us at: +1-613-834-9999

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