ATHENS INSTITUTE

Abstract Book

10th Annual International Conference on Electrical Engineering
20-24 July 2026, Athens, Greece

Edited by
Bala Maheswaran & Olga Gkounta

2026

Abstracts
10th Annual International Conference on Electrical Engineering

20-24 July 2026, Athens, Greece

Edited by
Bala Maheswaran & Olga Gkounta

First published in Athens, Greece by the Athens Institute.
ISBN: 978-960-598-792-3

9 Chalkokondili Street
10677 Athens, Greece
www.atiner.gr

TABLE OF CONTENTS

(In Alphabetical Order by Author's Family Name)

Preface		7
Editors' Note		9
Scientific & Organizing Committee		10
Conference Program		11
1.	**Comparative Data Science Analysis for Cybersecurity: From Statistical Analytics to Agentic AI** *Paolina Centonze*	15
2.	**Visual Dialogues in AI Ethics through Human and Generative Art Comparisons** *Anna Farzindar*	16
3.	**Building Scientific Capacity for the 21st Century: A STEAM-Oriented Interdisciplinary Education Model at CNPEM** *Adalberto Fazzio*	18
4.	**Optical Band-Edge Properties of Multilayered MoTe2 and its Application in van der Waals-Stacked Heterojunction Devices** *Ching-Hwa Ho*	19
5.	**Beyond Memorization: Integrating the 3SAI Immersive Teaching Methodology and Human Rights Education into Historical Thinking Courses to Fulfil University Social Responsibility** *Su-Hua Ho*	20
6.	**Seeking, Exploring and Designing Shapes: Unpacking Synergies Between Mathematics and Visual Arts** *Mairead Hourigan & Anne Marie Morrin*	22
7.	**The Significance of Using Patent Information and Patent Protection in Research** *Snezana Ilic-Stojanovic, Suzana Cakić & Slobodan Petrović*	23
8.	**Future of STEAM: Z-STEAM Health Foresight through SMS (Stories based on Music about Science): Three Case Studies in Biophysical Learning** *Yelena Istileulova & Veronika Kralj-Iglič*	25
9.	**iMAKE Innovation Center: The Utilization of Experiential Learning to Drive STEM Interest in Diverse Populations** *Donnell Layne & Adrienne Coleman*	27
10.	**In Situ Atomic Force Microscopy for Real-Time Nanoscale Observation of Galvanic Corrosion in Liquid Environments** *Bernard Liu*	28
11.	**Optimizing Complex Non-Deterministic Business Processes Using AI-Assisted Deterministic Control Layers** *Mihail Mateev*	30
12.	**Comparative Analysis of Distance-Based Multivariate Outlier Detection Methods - An Application to Wine Data** *Nemanja Milenkovic, Aleksandar Dokovic, Dusan Mitrovic & Aleksandar Rakicevic*	31

13.	**Studio Classroom: Cultivating Creative Inquiry – An A/R/Tographic, Arts Based Model for Art & STEM in an Initial Teacher Education Program** *Anne Marie Morrin*	33
14.	**Effect of Deep Cryogenic Treatment on Hot Corrosion of Nimonic-90 Alloy** *Kailash Narayan Pandey*	35
15.	**Neuromorphic Gel-Like Architecture as a System for Encoding Photon Information** *Andrii Pantus & Nataliia Kovalchuk*	36
16.	**Finite Element and Experimental Investigation of Plate Vibrations Using Chladni Techniques** *Iole Pecora, Bilva Gummadi & Sakhin Anooj Selvamani*	38
17.	**Deep Learning Surrogate Models for Brain White Matter Mechanics** *Assimina Pelegri & Parameshwaran Pasupathy*	39
18.	**Effects of Thermal Preload Change and Preload Relaxation of Screw Joints as Base for Positive Long-Term Behavior** *Jens Peth, Christoph Friedrich & Tobias Held*	41
19.	**Cognitive Foundations of STEAM Education: Tables of Ordered Pairs** *Julia P. Shaw*	43
20.	**Patel Reduced Energy Consumption of Air Conditioning by incorporating a Desert Cooler** *Rakesh Singhai, Chandra Shekhar, Abhimanyu Singh Yadav, Piyush Singh & Shaury Kumar*	45
21.	**Blockchain-Based Trust Infrastructures for Sustainable Biomass Markets in Europe** *Volker Wannack*	47
22.	**Expanding Engineering Education through Outreach at the SEPT Learning Factory** *Tom Wanyama & Michele Vaz*	48
23.	**A Monte Carlo OPF and Deep Learning Surrogate Model Approach for Power System Resilience Assessment Under Typhoon Hazards** *Yu-Chi Wu*	50
24.	**Study on the Novel Inlet Bleed Heating Control Strategy for a Power Generation Gas Turbine Engine** *Huisheng Zhang, Xiao Cui & Jinwei Chen*	52
References		53

Preface

This book includes the abstracts of all the papers presented at the *10th Annual International Conference on Electrical Engineering* (20-24 July 2026), organized by the Athens Institute.

A full program can be found before the relevant abstracts. In accordance with Athens Institute's Publication Policy, the papers presented during this conference will be considered for inclusion in one of the Athens Institute's many publications only after a blind peer review process.

The purpose of this abstract book is to provide members of the Athens Institute and other academics around the world with a resource through which they can discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. Athens Institute was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world can meet to exchange ideas on their work and consider the future developments of their fields of study.

To facilitate the communication, a references section includes all the abstract books published as part of this conference (Table 1). I invite the readers to access these abstract books –these are available for free– and compare how the themes of the conference have evolved over the years. According to the Athens Institute's mission, the presenters in these conferences are coming from many different countries, presenting various topics.

Table 1. *Publication of Books of Abstracts of Proceedings, 2017-2026*

Year	Papers	Countries	References
2026	24	12	Maheswaran and Gkounta (2026)
2025	34	15	Maheswaran and Papanikou (2025)
2024	78	25	Maheswaran and Gkounta (2024)
2023	44	22	Maheswaran and Gkounta (2023)
2022	35	24	Maheswaran and Gkounta (2022)
2021	19	12	Papanikos (2021)
2020	31	10	Papanikos (2020)
2019	28	17	Papanikos (2019)
2018	26	12	Papanikos (2018)
2017	19	13	Papanikos (2017)

It is our hope that through Athens Institute's conferences and publications, Athens will become a place where academics and researchers from all over the world can regularly meet to discuss the developments of

their disciplines and present their work. Since 1995, Athens Institute has organized more than 400 international conferences and has published over 200 books. Academically, the institute is organized into 7 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of the Athens Institute for putting this conference and its subsequent publications together.

Gregory T. Papanikos
President

Editors' Note

These abstracts provide a vital means to the dissemination of scholarly inquiry in the field of Electrical Engineering. The breadth and depth of research approaches and topics represented in this book underscores the diversity of the conference.

Athens Institute's mission is to bring together academics from all corners of the world in order to engage with each other, brainstorm, exchange ideas, be inspired by one another, and once they are back in their institutions and countries to implement what they have acquired. The *10th Annual International Conference on Electrical Engineering*, accomplished this goal by bringing together academics and scholars from 12 different countries (Brazil, Bulgaria, Canada, China, Germany, India, Ireland, Serbia, Slovenia, Taiwan, Ukraine, USA), which brought in the symposium the perspectives of many different country approaches and realities in the field.

Publishing this book can help that spirit of engaged scholarship continue into the future. With our joint efforts, the next editions of this conference will be even better. We hope that this abstract book as a whole will be both of interest and of value to the reading audience.

Bala Maheswaran & Olga Gkounta
Editors

10th Annual International Conference on Electrical Engineering, 20-24 July 2026, Athens, Greece

Organizing & Scientific Committee

All Athens Institute's conferences are organized by the Academic Council. This conference has been organized with the assistance of the following academic members of Athens Institute.

Dr. Gregory T. Papanikos, President, Athens Institute & Professor (Adjunct), University of Tennessee, Knoxville, USA.

Dr. Bala Maheswaran, Director, Engineering Division, Athens Institute & Professor, Northeastern University, USA.

Dr. Nikos Mourtos, Head, Mechanical Engineering Unit, Athens Institute & Professor and Chair San Jose State University USA.

Dr. Assimina Pelegri, Deputy Head, Mechanical Engineering Unit, Athens Institute & Department Chair and Professor, Rutgers University, USA.

Dr. Theodore Trafalis Head, Industrial Engineering Unit, Athens Institute & Professor & Director, Optimization & Intelligent Systems Laboratory The University of Oklahoma USA.

FINAL CONFERENCE PROGRAM
10th Annual International Conference on Electrical Engineering, 20-24 July 2026, Athens, Greece

PROGRAM

Monday 20 July 2026

08:30-09:15
Registration
09:15-10:00 Opening Speech and Welcoming Remarks
Speakers: Gregory T. Papanikos, President, Athens Institute & Professor (Adjunct), University of Tennessee, Knoxville, USA.

10:00-11:30 Session 1
Moderator: Nikolaos Dimakis, Deputy Director, Sciences Division, Athens Institute & Professor and Chair, Department of Physics and Astronomy, University of Texas Rio Grande Valley, USA.

1. **Julia P. Shaw**, Professor, SUNY Empire State University, USA.
   ***Title**: Cognitive Foundations of STEAM Education: Tables of Ordered Pairs.*
2. **Donnell Layne**, Director, STEM Innovation, Career and Technical Education, Moreno Valley College, USA.
   Adrienne Coleman, Director of Diversity, Equity and Inclusion, Illinois Mathematics and Science Academy, USA.
   ***Title**: iMAKE Innovation Center: The Utilization of Experiential Learning to Drive STEM Interest in Diverse Populations.*
3. **Tom Wanyama**, Associate Professor, McMaster University, Canada.
   Michele Vaz, Business Manager, McMaster University, Canada.
   ***Title**: Expanding Engineering Education through Outreach at the SEPT Learning Factory.*
4. **Yelena Istileulova**, Researcher, University of Ljubljana and Head of STEAM Session of the Socratic Lectures Symposium, Slovenia.
   Veronika Kralj-Iglič, Professor, University of Ljubljana, Slovenia.
   ***Title**: Future of STEAM: Z-STEAM Health Foresight through SMS (Stories based on Music about Science): Three Case Studies in Biophysical Learning.*

11:30-13:00 Session 2
Moderator: Assimina Pelegri, Deputy Head, Mechanical Engineering Unit, Athens Institute & Department Chair and Professor, Rutgers University, USA.

1. **Yu-Chi Wu**, Professor, National United University, Taiwan.
   ***Title**: A Monte Carlo OPF and Deep Learning Surrogate Model Approach for Power System Resilience Assessment Under Typhoon Hazards.*
2. **Mihail Mateev**, Associate Professor, University of Architecture, Civil Engineering and Geodesy, Bulgaria.
   ***Title**: Optimizing Complex Non-Deterministic Business Processes Using AI-Assisted Deterministic Control Layers.*
3. **Volker Wannack**, Head of Blockchain and AI in the Energy Sector, Blockchain Competence Center Mittweida, University of Applied Sciences Mittweida, Germany.
   ***Title**: Blockchain-Based Trust Infrastructures for Sustainable Biomass Markets in Europe.*

13:00-14:00 Session 3 – Symposium on "Science and Technology in the Age of AI"
Moderator: Bala Maheswaran, Director, Engineering Division, Athens Institute & Professor, Northeastern University, USA.

Speakers:

1. **Nikos Mourtos**, Head, Mechanical Engineering Unit, Athens Institute & Professor, San Jose State University USA.
   Title: *AI in Science & Engineering Education: Navigating the Exciting and Dangerous Road Ahead.*
2. **Timothy M. Young**, Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.
   Title: *The Rapid Evolution of AI and Sustaining Human Intelligence.*
3. **Kailash Narayan Pandey**, Professor, Motilal Nehru National Institute of Technology Allahabad, India.
   Title*: Mechanical Engineering in the age of AI.*
4. **Yelena Istileulova**, Researcher, University of Ljubljana and Head of STEAM Session of the Socratic Lectures Symposium, Slovenia.
   Title: *Artificial Intelligence: from Historical Ideas to Modern Biophysics.*

Interventions:

1. **Tom Wanyama**, Associate Professor, McMaster University, Canada.
2. **Andres Tremante**, Deputy Director, Engineering Division, Athens Institute & Professor, Florida International University, USA.
3. **Julia P. Shaw**, Professor, SUNY Empire State University, USA.
4. **Costa Karavas**, Assistant Professor, University Canada West, Canada.

14:00-14:30 Lunch

14:30-16:30 Session 4
Moderator: Nikos Mourtos, Head, Mechanical Engineering Unit, Athens Institute & Professor, San Jose State University USA.

1. **Assimina Pelegri**, Professor and Chair, Department of Mechanical and Aerospace Engineering, Rutgers, The State University of New Jersey, USA.
   Parameshwaran Pasupathy, Graduate Student, Rutgers, The State University of New Jersey, USA.
   Title*: Deep Learning Surrogate Models for Brain White Matter Mechanics.*
2. **Ching-Hwa Ho**, Distinguished Professor & Dean, College of Applied Sciences, National Taiwan University of Science and Technology, Taiwan.
   Title*: Optical Band-Edge Properties of Multilayered MoTe2 and its Application in van der Waals-Stacked Heterojunction Devices.*
3. **Bernard Liu,** Professor, National Cheng Kung University, Taiwan.
   Title*: In Situ Atomic Force Microscopy for Real-Time Nanoscale Observation of Galvanic Corrosion in Liquid Environments.*
4. **Andrii Pantus**, Professor, Ivano-Frankivsk National Medical University, Ukraine.
   Nataliia Kovalchuk, Associate Professor, Ivano-Frankivsk National Medical University, Ukraine.
   Title*: Neuromorphic Gel-Like Architecture as a System for Encoding Photon Information.*
5. **Iole Pecora**, Assistant Professor, San Jose State University, USA.
   Bilva Gummadi, Student, San Jose State University, USA.
   Sakhin Anooj Selvamani, Student, San Jose State University, USA.
   Title*: Finite Element and Experimental Investigation of Plate Vibrations Using Chladni Techniques.*

18:00-20:00 Session 5 – Visit Aristotle's Lyceum

This is not a guided tour, and participation in this visit is **not included in any conference registration fee**. **It requires pre-booking.** It includes visits to Aristotle's Lyceum, the Panathenaic Stadium (Kallimarmaro), the National Garden, the statues of Sophocles, Aeschylus, and Euripides, and Syntagma Square, where the tour concludes in front of the Hellenic Parliament. Click here for more details.

20:30-22:30 Athenian Early Evening Symposium (Sequence of Events: Ongoing Academic Discussions, Dinner, Wine and Water, Music, Dance)

Tuesday 21 July 2026

09:00-10:30 Session 6
Moderator: Bala Maheswaran, Director, Engineering Division, Athens Institute & Professor, Northeastern University, USA.

1. **Adalberto Fazzio**, Professor, CNPEM – Brazilian Center for Research in Energy and Materials, Brazil.
   ***Title**: Building Scientific Capacity for the 21st Century: A STEAM-Oriented Interdisciplinary Education Model at CNPEM.*
2. **Mairead Hourigan**, Associate Professor, Mary Immaculate College, Ireland.
   Anne Marie Morrin, Assistant Professor, Mary Immaculate College, University of Limerick, Ireland.
   ***Title**: Seeking, Exploring and Designing Shapes: Unpacking Synergies Between Mathematics and Visual Arts.*
3. **Anne Marie Morrin**, Assistant Professor, Mary Immaculate College, University of Limerick, Ireland.
   ***Title**: Studio Classroom: Cultivating Creative Inquiry, An A/R/Tographic, Arts Based Model for Art & STEM in an Initial Teacher Education Program.*
4. **Su-Hua Ho**, Associate Professor, National United University, Taiwan.
   ***Title**: Beyond Memorization: Integrating the 3SAI Immersive Teaching Methodology and Human Rights Education into Historical Thinking Courses to Fulfil University Social Responsibility.*

10:30-12:00 Session 7
Moderator: Anna Farzindar, Professor, Loyola Marymount University, Los Angeles, USA.

1. **Rakesh Singhai**, Professor, IIT Gandhinagar, India.
   Chandra Shekhar, Student, IIT Gandhinagar, India.
   Abhimanyu Singh Yadav, Student, IIT Gandhinagar, India.
   Piyush Singh, Student, IIT Gandhinagar, India.
   Shaury Kumar Patel, Student, IIT Gandhinagar, India.
   ***Title**: Reduced Energy Consumption of Air Conditioning by incorporating a Desert Cooler.*
2. **Huisheng Zhang**, Professor, Shanghai Jiao Tong University, China.
   Xiao Cui, PhD Candidate, Shanghai Jiao Tong University, China.
   Jinwei Chen, Assistant Professor, Shanghai Jiao Tong University, China.
   ***Title**: Study on the Novel Inlet Bleed Heating Control Strategy for a Power Generation Gas Turbine Engine.*
3. **Kailash Narayan Pandey**, Professor, Motilal Nehru National Institute of Technology Allahabad, India.
   ***Title**: Effect of Deep Cryogenic Treatment on Hot Corrosion of Nimonic-90 Alloy.*
4. **Jens Peth**, Researcher, University of Siegen, Germany.
   Christoph Friedrich, Professor, University of Siegen, Germany.
   Tobias Held, PhD Student, University of Siegen, Germany.
   ***Title**: Effects of Thermal Preload Change and Preload Relaxation of Screw Joints as Base for Positive Long-Term Behavior.*

12:00-14:00 Session 8
Moderator: Kailash Narayan Pandey, Professor, Motilal Nehru National Institute of Technology Allahabad, India.

1. **Anna Farzindar**, Professor, Loyola Marymount University, Los Angeles, USA.
   ***Title**: Visual Dialogues in AI Ethics through Human and Generative Art Comparisons.*

2. **Paolina Centonze**, Associate Professor, Iona University, USA.
   ***Title**: Comparative Data Science Analysis for Cybersecurity: From Statistical Analytics to Agentic AI.*
3. **Snezana Ilic-Stojanovic**, Associate Professor and Head, Department of Organic-Technological Sciences, University of Niš, Serbia.
   Suzana Cakić, Professor, University of Niš, Serbia.
   Slobodan Petrović, Emeritus Professor, University of Belgrade, Serbia.
   ***Title**: The Significance of Using Patent Information and Patent Protection in Research.*
4. **Nemanja Milenkovic**, Assistant Professor, University of Belgrade, Serbia.
   Aleksandar Dokovic, Associate Professor, University of Belgrade, Serbia.
   Dusan Mitrovic, Teaching Assistant, University of Belgrade, Serbia.
   Aleksandar Rakicevic, Associate Professor, University of Belgrade, Serbia.
   ***Title**: Comparative Analysis of Distance-Based Multivariate Outlier Detection Methods – An Application to Wine Data.*

14:00-15:00 Lunch

16:45-20:30 Session 9
Old and New-An Educational Urban Walk

The urban walk ticket is not included as part of your registration fee. It includes transportation costs and the cost to enter the Parthenon and the other monuments on the Acropolis Hill. The urban walk tour includes the broader area of Athens. Among other sites, it includes: Zappion, Syntagma Square, Temple of Olympian Zeus, Ancient Roman Agora and on Acropolis Hill: the Propylaea, the Temple of Athena Nike, the Erechtheion, and the Parthenon. The program of the tour may be adjusted, if there is a need beyond our control. This is a private event organized by the Athens Institute exclusively for the conference participants.

21:00-23:00
Closing Remarks by Gregory T. Papanikos: "Wine, Words, and Wisdom: An Ancient Athenian Dinner Symposium" followed by an Ancient Athenian Dinner

Wednesday 22 July 2026
An Educational Visit to Selected Islands
or Nafplio & Mycenae Visit

Thursday 23 July 2026
Visiting the Oracle of Delphi

Friday 24 July 2026
Visiting the Ancient Corinth and Cape Sounion

Paolina Centonze
Associate Professor, Iona University, USA

Comparative Data Science Analysis for Cybersecurity: From Statistical Analytics to Agentic AI

To comprehend and analyze the true phenomena with data, many methodologies, such as artificial intelligent (AI), data analytics, machine learning, processes, and systems are used, which is known as data science. Before data science cybersecurity, traditional cybersecurity methodologies were static, and signature based. These traditional cybersecurity solutions if used with analytic models, machine learning and big data could be improved by automatically providing mitigation or relevant awareness to control or limit cyber security threats. This effective technique is hidden in the context of data science for cybersecurity. Data science provides an essential factor in cybersecurity by applying the power of data, high-performance computing, data mining and machine learning to protect users against cyber-attacks. This paper provides a comparative data science cybersecurity analysis of the latest advanced data science methodologies adopted in cybersecurity to detect, filter, and prevent security computing, software, networking vulnerabilities, and cybersecurity threats. With the rapid evolvement in data science, cybersecurity computing engineers and organizations are eager to invest and adopt even more data science cybersecurity to eliminate risks within their computing and software systems. This comparative data science cybersecurity analysis proposed in this paper is critical for security engineers and security scientists to have a clear vision of the most effective data science cyber security solutions for a specific cyber security thread. This paper also compares traditional cybersecurity approaches with data science cyber security methodologies to show statistical results, benefits, and advantages using data science cyber security techniques to decrease cybersecurity faults. For example, identify security risks, incidents patterns or valuable information from cybersecurity data and mapping the corresponding data driven model, is fundamental to make a security system automated and intelligent. The paper concludes with the current data science cybersecurity challenges and its future directions.

Anna Farzindar
Professor, Loyola Marymount University, Los Angeles, USA

Visual Dialogues in AI Ethics through Human and Generative Art Comparisons

As Generative AI (GenAI) continues to transform creative practices, a significant gap has emerged between rapid technological advancement and meaningful ethical understanding. This talk presents an innovative, interactive approach to AI ethics education grounded in the comparative analysis of human-created paintings and their AI-generated counterparts. Traditional methods often rely on abstract explanations or case studies that fail to fully convey the complexity of issues such as bias, authorship, hallucination, and cultural misrepresentation. In contrast, this approach uses art as a lens to make these ethical challenges visible, tangible, and experientially accessible.

At the core of the session is an interactive platform that places human and AI-generated artworks in direct visual dialogue. Participants are invited to explore the *interpretive gap,* the space where AI reinterprets human intent, revealing how generative models may distort meaning, amplify biases, or overlook cultural and contextual nuances. This side-by-side comparison transforms ethics from an abstract discussion into a perceptual and reflective experience, encouraging participants to actively question and analyze AI outputs.

What distinguishes this research is its art-driven, comparative methodology. By leveraging the emotional and interpretive power of visual art, it creates a visceral learning environment where ethical concerns become immediately perceptible. This approach engages both analytical and affective dimensions of cognition, fostering deeper critical thinking and enabling participants to connect technical AI behaviors with their broader societal implications. It offers a unique interdisciplinary pathway that bridges technology, ethics, and creative expression.

The impact of this session lies in its ability to equip participants with a more intuitive and nuanced understanding of responsible AI. Attendees will develop skills to critically evaluate generative outputs, identify bias and distortion, and reflect on questions of authorship, authenticity, and cultural representation. Furthermore, the session provides educators, students, and practitioners with a novel framework for integrating ethics into AI learning and practice. By transforming ethics education into an engaging, visual, and participatory experience,

this work contributes to fostering more informed, reflective, and responsible AI development and use.

Adalberto Fazzio
Professor, CNPEM - Brazilian Center for Research in Energy and Materials, Brazil

Building Scientific Capacity for the 21st Century: A STEAM-Oriented Interdisciplinary Education Model at CNPEM

Nations increasingly face complex challenges — including the energy transition, advanced materials, artificial intelligence, climate change, and technological sovereignty. Addressing these problems requires scientists capable of working across disciplinary boundaries and translating knowledge into innovation. In Brazil, as in many countries, the traditional pathway to becoming an independent researcher is long and highly specialized, often delaying exposure to frontier research environments and the development of scientific autonomy. To address this gap, the National Center for Research in Energy and Materials (CNPEM) launched in 2022 a three-year interdisciplinary Bachelor's program in Science aligned with the principles of STEAM education (Science, Technology, Engineering, Arts and Mathematics). The program integrates education with direct exposure to cutting-edge research.

Ilum – School of Science operates within the CNPEM national laboratory campus, which hosts large-scale facilities such as synchrotron light sources and advanced laboratories, allowing students to interact with researchers and experience state-of-the-art scientific exploration. The program is guided by three objectives: (i) accelerate scientific maturity through early engagement with research; (ii) integrate disciplines by combining Life Sciences, Materials Science, Mathematics, Data Science and Humanities; (iii) strengthen innovation ecosystems by preparing graduates for academia, national laboratories and technology-based industries.

The curriculum emphasizes interdisciplinary courses, project-based learning, computational and AI training, and laboratory immersion. Each year, 40 students are admitted through Brazil's national high school examination followed by a selective interview process. With approximately 50 applicants per seat, the program has rapidly become one of the most competitive science undergraduate programs in Brazil.

Ching-Hwa Ho
Distinguished Professor & Dean, College of Applied Sciences, National Taiwan University of Science and Technology, Taiwan

Optical Band-Edge Properties of Multilayered MoTe2 and its Application in van der Waals-Stacked Heterojunction Devices

$MoTe_2$ distinguishes as a promising two-dimensional (2D) material in solar energy and optoelectronics applications due to its suitable bandgap value and the specific excitonic behaviors. However, its band edge and excitonic transitions are not yet explored clearly to date. In this paper, micro-thermoreflectance (μTR) spectroscopic result showed that multilayered (ML) 2H-$MoTe_2$ exhibits multiple excitonic features including A_{1s}, B_{1s}, A′, C, D, E, F, and G excitons as well as one indirect-gap related feature of E_g^{ind}-related peak presented in a 500-nm nanoflake at 300 K. Thickness-dependent micro-photoluminescence (μPL) measurement revealed that the PL emission is undetectable at t~40 nm (28L), while it is initially detected at approximately 20 nm (14L) at 0.944 eV, and finally it shifts to 1.042 eV and presents the highest PL intensity when its thickness decreases to 5 nm (4L). Density-function-theory (DFT) band-structure calculations revealed that monolayer $MoTe_2$ is a direct semiconductor with the highest bandgap whereas it will become lowered and finally converted to indirect band with t > 20L, matching well with the thickness-dependent μPL result. According to the DFT calculations, the band-edge excitons of A_{1s}, B_{1s}, A′, C, D, E, F, and G of μTR features in the ML $MoTe_2$ are successfully verified and assigned. A porotype of p-SnS/n-$MoTe_2$ stacking heterojunction device is fabricated. The built-in potential (V_{bi}) of the heterojunction diode is approximately 0.62 V, matching well with the measured work function difference between the two materials of the p-SnS/n-$MoTe_2$ heterojunction device.

Su-Hua Ho
Associate Professor, National United University, Taiwan

Beyond Memorization: Integrating the 3SAI Immersive Teaching Methodology and Human Rights Education into Historical Thinking Courses to Fulfil University Social Responsibility

History education in Taiwan has been widely critiqued for reinforcing linear, single-dimensional thinking, wherein students acquire isolated historical terminology without developing the interpretive or analytical capacities essential to critical citizenship. This study responds to this pedagogical gap by designing, implementing, and evaluating the 3SAI Immersive Teaching Methodology within a university-level "Historical Thinking" general education course at National United University — an institution serving both senior high school and vocational school graduates, with approximately 400 students enrolled annually.

Pre-course diagnostic data revealed that 78% of students perceived history as primarily a memorization exercise, while only 12% demonstrated the capacity to analyze the power structures underlying historical events, indicating a significant gap between surface-level knowledge acquisition and deeper historical consciousness. To address this, the 3SAI framework operationalizes five interconnected pedagogical dimensions: Story (narrative-driven emotional engagement), Subject (structural and institutional contextualization), Source (primary document analysis via a four-stage decoding model), Action Plan Design (immersive civic simulation activities), and Issue Understanding (human rights value construction and contemporary application). The framework is further integrated with the ARCS motivational model (Attention, Relevance, Confidence, Satisfaction) to scaffold progressive learner engagement from initial curiosity through analytical competence to public knowledge production.

The 18-week curriculum incorporates thematically sequenced human rights case studies spanning transitional justice, refugee crises, racial discrimination, colonial history, and gender rights, drawn from Taiwanese, German, American, and global contexts. Instructional strategies include role-play simulations, mock tribunals, historical drama performance, primary source decoding exercises, and collaborative media production through a student-generated "Human Rights Weekly Report." Learning outcomes are assessed via a competency-based system comprising source analysis assignments (20%), historical drama and

textual analysis (25%), the Human Rights Weekly Report (30%), classroom participation (15%), and peer and self-evaluation (10%). Pre- and post-course questionnaires serve as the primary instruments for measuring shifts in students' historical awareness, human rights sensitivity, and civic engagement motivation.

This study contributes to the scholarship of teaching and learning by proposing a replicable, evidence-informed pedagogical model that bridges historical thinking, human rights education, and University Social Responsibility (USR). The findings are expected to demonstrate that immersive, issue-centered instructional design can effectively transform students from passive recipients of historical knowledge into active, reflective, and socially engaged citizens — capable of connecting historical experience to contemporary human rights challenges and fulfilling the university's broader mission of humanistic education and community responsibility.

Mairead Hourigan
Associate Professor, Mary Immaculate College, Ireland
&
Anne Marie Morrin
Assistant Professor, Mary Immaculate College, University of Limerick, Ireland

Seeking, Exploring and Designing Shapes: Unpacking Synergies Between Mathematics and Visual Arts

STEAM education is an evolving area that is being explored and unpacked in education systems internationally. This presentation reports on the STEAM education journey of a mathematics teacher educator and a visual arts teacher educator as they engage in a process of collaborative self study to explore the possibilities for authentic STEAM education. In particular, rather than merely using the arts to promote communication of STEM knowledge, the STEAM teacher educators sought to engage in authentic integration of mathematics and the arts, with a concomitant focus on developing knowledge and dispositions in both the arts and STEM disciplines.

This presentation focuses on a particular project, that uses the geometric shapes and patterns that are created within Pascal's triangles as an initial stimulus to design and craft an original piece of art, with meaningful and authentic learning outcomes for both visual arts and mathematics education. The designs are developed and constructed based on rules rooted in the mathematical shapes and calculations discovered within Pascal's triangle. Shapes and variations of shapes and patterns are identified, assigned a code, and used to form a uniquely designed tessellation. The overall design will emphasize the use of semi-regular and irregular shapes. Additionally, colour theory is applied to enhance the aesthetic quality of geometric shapes and further advance mathematical concepts.

This process of collaboration between the arts and STEM educator supports the promotion of a shared understanding of the possibilities for meaningful and authentic STEAM education within the Irish educational context as well as the design of high-quality STEAM education for initial teacher education and primary education that targets the development of sought after knowledge, skills, and dispositions.

Snezana Ilic-Stojanovic
Associate Professor and Head, Department of Organic-Technological Sciences, University of Niš, Serbia
Suzana Cakić
Professor, University of Niš, Serbia
&
Slobodan Petrović
Emeritus Professor, University of Belgrade, Serbia

The Significance of Using Patent Information and Patent Protection in Research

Innovations are important for the development of science and industry, and their patent protection is of particular significance. Innovative technologies are often kept secret as "know-how", although they are more often protected by patent rights, especially in industry. Numerous companies, universities and institutes have embraced these global trends in business and international cooperation. In addition to publications in scientific papers, patent documents are a source of data, especially important for making correct decisions about discovering new products or processes. This paper aims to present the latest achievements in this field, with the analysis of patent documents and published scientific papers in the field of biopolymers and their applications in biomedical engineering. A comparison of the complementarity of databases on bioactive compounds showed that the largest commercial database contains only about 6% of patent data. Data published in patents can often be found at least a year earlier than in scientific papers. However, searching patent databases is complex and requires special knowledge to understand the essence of patent protection. Worldwide databases are available, e.g. Patentscope, Espacenet, USPTO, Lens, Derwent, which allow advanced search options using, e.g. patent classifications and keywords. The International Patent Classification (IPC) allows for a quick search in different technical fields and classification codes. The search is complex because many inventions are classified in multiple classification codes and technical fields, and the problem is also the substantive analysis and interpretation of the scope of protection through patent claims. Knowledge of the state of the art, especially in patent documents, is very important in planning research and development of new products in science and industry for both large and small companies.

The project was financed by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Grant No. 451-03-137/2025-03/200133.

Yelena Istileulova
Researcher, University of Ljubljana and Head of STEAM Session of the Socratic Lectures Symposium, Slovenia
&
Veronika Kralj-Iglič
Professor, University of Ljubljana, Slovenia

Future of STEAM: Z-STEAM Health Foresight through SMS (Stories based on Music about Science): Three Case Studies in Biophysical Learning

This paper proposes the Z-STEAM (Z-Science, Technology, Engineering, Arts, Mathematics) approach as an interdisciplinary educational framework integrating Health Sciences, SMS (Stories based on Music about Science), biophysics, music composition, scientific storytelling, and foresight methodologies. The concept of "Z" derives from the Slovenian word *zdravje* (health), positioning health-oriented inquiry at the centre of the framework. The paper argues that the future of STEAM education will increasingly depend upon the integration of ancient systems of knowledge with emerging technologies, interdisciplinary artistic-scientific methodologies, and innovative approaches developed through the practices of the LKBF Z-STEAM Platform (lkbf.si/Z-STEAM).

Developed through artistic research and health-oriented educational practices, the paper investigates how future STEAM education may evolve through embodied, dialogical, and multisensory learning environments responsive to scientific, technological, and societal change. In this context, music operates not only as artistic expression, but also as a historical and cognitive medium reflecting memory, perception, social transformation, and anticipatory tendencies associated with SMS, biophysics, music composition, scientific storytelling, and foresight (Weak Signals and Wild Cards, Trends and Emerging Issues Analysis, Horizon Scanning Scenario) methodologies. The artistic research practices have been developed within the framework of the Socratic Lectures Symposium, through which Z-STEAM explores educational models connecting historical scientific thought with contemporary artistic and scientific practices.

The paper demonstrates the Z-STEAM framework through three interdisciplinary case studies developed by scientists and artists affiliated with the Z-STEAM Platform. The first case presents membrane-enclosed vesicles through a musical composition, with future possibilities for development toward choreographic interaction and

movement-based learning (immersive) practices. The second case examines the composition The First Open Reading Frame of SARS-CoV-2, performed by the Spectrum Quintet. The third case explores Lucretian atomism from De Rerum Natura

as an early philosophical model of scientific imagination whose understanding of matter continues to resonate within contemporary STEAM discourse and foresight-oriented educational thinking. This case further demonstrates how artistic-scientific methodologies may connect historical knowledge, Health Sciences, and future-oriented educational frameworks through embodied and interdisciplinary learning environments.

The project argues that the future of STEAM education depends not only on technological innovation, but also on historically informed, embodied, and foresight-responsive methodologies capable of integrating science, health, philosophy, music, and human experience into new interdisciplinary ecosystems of learning. In this sense, the future of STEAM is understood not as a departure from the past, but as a renewed integration of ancient knowledge, scientific imagination, artistic practice, and contemporary technologies within evolving educational environments.

Donnell Layne
Director, STEM Innovation, Career and Technical Education, Moreno Valley College, USA
&
Adrienne Coleman
Director of Diversity, Equity and Inclusion, Illinois Mathematics and Science Academy, USA

iMAKE Innovation Center: The Utilization of Experiential Learning to Drive STEM Interest in Diverse Populations

Persistent inequities continue to limit STEM participation and success for historically underrepresented and low-income learners. Moreno Valley College's HSI STEM & Articulation Project addresses this challenge through an experiential learning model anchored in the iMAKE Innovation Center—expanding makerspace-enabled applied learning, integrating VR/AR into historically challenging courses (including mathematics), strengthening data science/statistics/biology pathways with research and work-based learning connections, and using place-based/project-based learning to connect theory to real-world relevance.

This presentation shares findings from an external mixed-method evaluation conducted across Phase 1–2, including structured makerspace observations, stakeholder interviews (students, faculty, staff, and administrators), and an equity assessment to examine implementation quality, barriers, and early outcomes. Observations occurred near semester-end when typical iMAKE usage averages 287 unique users per month.

Evaluation results indicate strong progress toward project goals, including 72% achievement for iMAKE utilization/resources (13/18) and 90% for interview-based impact of experiential learning (54/60), with an overall STEM equity assessment average of 3.38/4 (85%) and an overall average score of 88% across measures. Reported course-level impacts included ~70% retention in courses with hands-on projects and 95% of surveyed students indicating they would have dropped without hands-on learning. A newly launched Data Science course (Fall 2024) enrolled 7 students and retained 6 (86%), attributed to iMAKE collaboration and applied research.

Participants will leave with an evaluation-informed, scalable framework and practical implementation guidance—including a roadmap for expanding makerspace-based AI desktop computing and machine learning instruction as the next phase of the model.

Bernard Liu
Professor, National Cheng Kung University, Taiwan

In Situ Atomic Force Microscopy for Real-Time Nanoscale Observation of Galvanic Corrosion in Liquid Environments

Understanding galvanic corrosion at the nanoscale is essential for predicting material degradation and improving corrosion-resistant design, yet direct observation of corrosion processes under realistic liquid-phase conditions remains technically challenging. Conventional approaches often rely on ex situ characterization after corrosion has occurred, which obscures early-stage dynamics and introduces artifacts associated with drying, surface alteration, or post-treatment. In this study, we present an in situ, real-time atomic force microscopy (AFM) methodology that enables continuous monitoring of metal surface morphological evolution during electrochemical corrosion reactions in a liquid environment.

The core innovation of this approach lies in maintaining probe–sample positional stability during the transition from ambient to liquid-phase measurement. Instead of removing or lifting the AFM probe—an action that frequently causes lateral drift and loss of the original imaging area—the corrosive liquid is introduced directly during scanning. Combined with optimized AFM stage and scanner configuration, this strategy minimizes mechanical disturbance and ensures that the same surface region can be observed continuously throughout the corrosion process. As a result, nanoscale surface changes associated with the onset and progression of galvanic corrosion can be captured with both high spatial and temporal resolution.

Using this technique, we successfully observed early-stage corrosion phenomena that are typically inaccessible with conventional post-mortem methods. AFM topography images obtained in air establish the initial surface morphology, while subsequent imaging under liquid-phase corrosive conditions reveals progressive nanoscale alterations over time. Representative results demonstrate clear morphological differences after 20 minutes of exposure, including localized surface roughening and feature evolution attributable to galvanic interactions. These observations directly visualize corrosion-induced changes as they occur, providing valuable insight into dynamic surface processes.

Beyond topographical imaging, nanomechanical AFM measurements were incorporated to enhance sensitivity to surface responses during corrosion. Changes in local mechanical properties can precede or accompany visible morphological transformation, offering an

additional dimension for probing corrosion mechanisms at the nanoscale. Such multimodal data significantly enrich the interpretation of corrosion behavior and may help distinguish between different degradation pathways.

Furthermore, we discuss the potential of integrating machine learning techniques with in situ AFM datasets. Automated feature extraction, pattern recognition, and data-driven modeling could enable more objective analysis of complex surface evolution and facilitate the identification of subtle, time-dependent trends. In the long term, this integration may support predictive frameworks for corrosion behavior based on nanoscale observations.

Overall, this work demonstrates that liquid-phase in situ AFM is an effective and robust platform for investigating galvanic corrosion mechanisms in real time. By enabling continuous observation without probe repositioning, combining morphological and nanomechanical measurements, and exploring data-driven analysis strategies, this approach advances nanoscale corrosion characterization and lays the groundwork for future predictive corrosion studies.

Mihail Mateev
Associate Professor, University of Architecture, Civil Engineering and Geodesy, Bulgaria

Optimizing Complex Non-Deterministic Business Processes Using AI-Assisted Deterministic Control Layers

Modern enterprise processes such as Request-for-Quotation (RFQ) handling, supplier negotiation, and multi-party communication are inherently non-deterministic, driven by unstructured human input, asynchronous interactions, and incomplete information. Traditional process optimization techniques assume deterministic workflows and therefore struggle to scale or adapt to such environments.

This paper presents a hybrid process optimization approach that combines AI-driven reasoning layers with deterministic control and persistence layers. The proposed architecture allows non-deterministic activities—such as free-text communication, requirement clarification, and iterative negotiation—to be analyzed and guided by AI agents, while ensuring that all critical business state transitions remain deterministic, auditable, and reproducible.

Using a real-world RFQ-to-quotation automation platform as a case study, the paper demonstrates how AI agents can optimize clarification cycles, reduce iteration counts, and improve completeness of outcomes without introducing uncontrolled behavior. The approach leverages modern software technologies including agent-based AI systems, vector-based knowledge retrieval, event-driven automation, and relational persistence to transform loosely structured processes into optimized, semi-deterministic workflows.

Experimental observations from production-like implementations indicate measurable reductions in process latency, communication overhead, and human intervention, while preserving governance and compliance. The paper argues that process optimization in complex environments is best achieved not by replacing deterministic models, but by augmenting them with controlled non-deterministic reasoning layers, offering a practical blueprint for next-generation enterprise software systems.

Nemanja Milenkovic
Assistant Professor, University of Belgrade, Serbia
Aleksandar Dokovic
Associate Professor, University of Belgrade, Serbia
Dusan Mitrovic
Teaching Assistant, University of Belgrade, Serbia
&
Aleksandar Rakicevic
Associate Professor, University of Belgrade, Serbia

Comparative Analysis of Distance-Based Multivariate Outlier Detection Methods - An Application to Wine Data

Outlier detection in multidimensional data spaces represents an important aspect of modern statistical analysis. A multivariate outlier is generally defined as an observation that differs substantially from the remaining observations within a dataset. The presence of such observations may significantly affect the estimation of sample characteristics and consequently lead to unreliable conclusions regarding population parameters. Although numerous definitions of outliers have been proposed in the literature, one of the most widely accepted describes an outlier as "an observation that deviates so much from other observations as to arouse suspicion that it was generated by a different mechanism."

Multivariate outliers are most commonly detected using the Mahalanobis distance, which measures the distance of each observation from the centroid of the distribution while incorporating the covariance structure of the variables. However, recent studies emphasize that the application of multiple detection techniques may improve the robustness and interpretability of outlier diagnostics. Within the regression framework, Cook's distance is widely utilized to evaluate the influence of individual observations on estimated regression coefficients and fitted values. Consequently, Cook's distance is frequently applied in combination with other multivariate outlier detection methods in order to ensure more reliable statistical inference.

The Ivanović distance represents a metric in an n-dimensional space that accounts for the discriminatory power of each observed variable. Numerous extensions and modifications of this method have contributed to its broader application in multivariate statistical analysis, including variable significance assessment and multivariate outlier detection.

This study investigates the presence of multivariate outliers in a dataset containing physicochemical characteristics of wine samples by applying three different multivariate statistical approaches: Mahalanobis distance, Cook's distance, and Ivanović distance. The analysis aims not only to identify atypical observations, but also to compare the sensitivity, robustness, and interpretability of these methods within a multivariate analytical framework.

Anne Marie Morrin
Assistant Professor, Mary Immaculate College, University of Limerick, Ireland

Studio Classroom: Cultivating Creative Inquiry – An A/R/Tographic, Arts Based Model for Art & STEM in an Initial Teacher Education Program

This paper reports on the development and ongoing piloting of Studio Classroom: Cultivating Creative Inquiry, a pedagogical model for initial teacher education (ITE) in Art & STEM that has evolved over twenty years of studio-based teaching, practitioner reflection, and iterative stakeholder review. The model positions the classroom as an adaptive studio ecology in which creative inquiry emerges through dialogic making, collaborative critique, and authentic problem framing. Within the initial teacher education context, learning begins in the art studio, where exploratory engagement with materials and artistic inquiry catalyse the development of STEM concepts, connections, and ways of thinking.

Methodologically, the study integrates arts-based research (ABR) with a/r/tography, an arts-based praxis that interweaves the identities of artist, teacher and researcher (A/R/T). Within this orientation, a/r/tography understands inquiry as a *living, relational and rhizomatic process*: the artist enacts curiosity, material engagement and imaginative risk; the teacher cultivates inclusive, dialogic and process rich conditions; and the researcher traces emergent disciplinary and conceptual connections. Rather than operating as a linear sequence, the model embodies a way of being in Art & STEM education, where the artist's dispositions coexist with the teacher's pedagogical commitments and the researcher's analytic sensibilities.

Design-based research (DBR) guides the iterative refinement of the learning environment and integrates multiple data sources: (i) longitudinal practitioner observations and reflective analyses; (ii) a voluntary alumni survey exploring the perceived personal and professional impact of the studio elective; and (iii) an expert survey and workshop series with STEAM educators focused on creative pedagogy and effective STEAM practice. The framework was further refined through an arts-based making-plus-dialogue focus group in which participants collaboratively interrogated developing principles.

Through this process, the model articulates a constellation of mutually reinforcing roles, routines and pedagogical commitments that support the cultivation of creative inquiry, including curiosity driven

exploration, collaborative critique, material thinking, reflective practice and assessment for/through/as learning. Early implementation with a visual art elective cohort suggests enhanced learner agency, increased tolerance for ambiguity and a growing capacity for both problem finding and problem solving, indicating the framework's potential to support creative and critical thinking across STEAM contexts.

Adopting a post-structural, Deleuzian lens, the framework reads identity as multiplicity and practice as rhizomatic becoming. The paper contributes a theorised, practitioner-generated model and a set of actionable design principles that offer new insights for creative Art & STEM teacher education, programme design and pedagogical research.

Kailash Narayan Pandey
Professor, Motilal Nehru National Institute of Technology Allahabad, India

Effect of Deep Cryogenic Treatment on Hot Corrosion of Nimonic-90 Alloy

Nimonic-90, a nickel-based super alloy, is widely used in various industries for various components, such as turbine blades, discs in jet engines, and boiler parts etc. It is used in high-temperature and corrosive environments where hot corrosion is a matter of concern. Deep cryogenic treatment (DCT) is a novel technique for improvement of properties of materials where retained austenite is either completely transformed or eliminated. In some cases, fine carbides are precipitated and redistributed along the matrix. The present study is focused on the effects of DCT on the rate of hot corrosion of Nimonic-90 alloy after establishing optimal cooling rate (ramp down), heating rate (ramp up), tempering temperature, and tempering time and number of tempering. The weight gain method was used to study the effect of DCT on the rate of hot corrosion. The fuels used in power generation devices such as gas turbines contain a mixture of molten sodium sulphate (Na2SO4) and Vanadium pentoxide (V2O5). The Na2SO4 may present in the intake air or form by reaction between NaCl present in the intake air and sulphur present in the fuel as an impurity, V2O5 is formed during the combustion process of the fuel where it is present in the form of vanadium porphyrin. V2O5 and Na2SO4 are mainly responsible for the corrosion of the components. In the Na2SO4-60%V2O5 molten salt environment, the rate of hot corrosion significantly decreased for the DCT sample. It has also been noticed that DCT variations in tempering temperature and time influence the alloy's resistance to environmental degradation under simulated high-temperature corrosive conditions using Na2SO4-60%V2O5. Through a series of controlled experiments, the research demonstrated that DCT, when optimized with lower tempering temperatures and shorter tempering durations, significantly enhances the hot corrosion resistance of Nimonic-90. The findings indicate that DCT can be a valuable treatment process for improving the lifespan and performance of Nimonic-90 in hot corrosion environments.

Andrii Pantus
Professor, Ivano-Frankivsk National Medical University, Ukraine
&
Nataliia Kovalchuk
Associate Professor, Ivano-Frankivsk National Medical University, Ukraine

Neuromorphic Gel-Like Architecture as a System for Encoding Photon Information

Next-generation photonics envisages electronics without microcircuits, capable of processing optical signals and reorganising at the molecular level, mimicking the work of the brain's neural network. However, progress has so far been limited by the need for reversibly responsive materials that can respond to light and reconfigure quickly.

That is why the goal of our work was to create such a neuromorphic material and study its properties for processing and encoding photon information.

The non-flowing gel-like material we developed changed the profile of the laser beam when activated by a 532 nm wavelength laser. This change in the laser beam profile changed dynamically over time and formed a pattern or optical code unique to each section of the material. After conducting a series of tests, we concluded that the nature and frequency of changes in such an optical code depended on the frequency and duration of photonic activation, as well as the number and duration of relaxation periods. Thus, with a photonic activation time of 2 seconds and a 5-second pause (relaxation), the laser beam profile changed 68 times within 2 seconds in the time interval from 0 to 28 seconds. From 28 seconds to 01:05 minutes, the frequency of optical code changes ranged from 56 to 44 changes per 2 seconds. Analysis of the last time interval from 01:10 to 02:00 minutes showed the lowest frequency of laser beam profile changes, which was only 33.82–50% of the initial frequency. When the time between periods of material activation was reduced to 3 and 1 second, the frequency of change in the laser beam profile was the highest (68 changes per 2 seconds) during the entire 2-minute testing period. It should be noted that reducing the time between periods of photonic stimulation affected not only the frequency but also the nature of the change in the laser beam profile. A detailed analysis of the laser beam profile at all test times (2 seconds of activation at 5, 3 and 1 second relaxation) revealed a non-chaotic but cyclical and logical type of optical code rearrangement, which changed significantly every 12–30 seconds. Thus, in a series of tests with 5-second relaxation in the middle of each

30-second time cycle, the same type of code usually prevailed, with minor changes, which changed significantly in the next time cycle. However, with 1 and 3-second relaxation within each 12 and 20-second time cycle (with an 8-second activation cycle), up to 20 previous and new combinations of 272 optical codes were observed, which changed significantly in each subsequent time cycle.

The dynamic change in the laser beam profile, which forms the specified combination of previous and new optical codes within each subsequent time cycle, in our opinion, may be a sign of molecular changes in the material and indicate the formation of associative connections also at the molecular level, similar to the connections in the brain's neural network.

Iole Pecora
Assistant Professor, San Jose State University, USA
Bilva Gummadi
Student, San Jose State University, USA
&
Sakhin Anooj Selvamani
Student, San Jose State University, USA

Finite Element and Experimental Investigation of Plate Vibrations Using Chladni Techniques

Introducing students to the fundamentals of vibration and modal behavior can be challenging without engaging and intuitive methods. This study presents an approach to initially engage students in vibration concepts through the use of Chladni plates, which visually demonstrate mode shapes and resonance patterns. By exciting a plate at various frequencies, students can directly observe nodal lines and the formation of distinct geometric patterns, fostering a deeper conceptual understanding of vibrational phenomena.

To complement this hands-on experience, modal analysis is introduced as a theoretical framework for understanding natural frequencies, mode shapes, and system response. Furthermore, numerical simulation using ANSYS is incorporated to provide students with initial exposure to computational tools widely used in engineering practice. By comparing experimental Chladni patterns with simulation results, students gain insight into the relationship between physical behavior and numerical models.

This combined approach—integrating experimental visualization, theoretical analysis, and computational simulation—enhances student engagement and promotes a deeper understanding of vibration behavior, while also familiarizing students with industry-standard simulation tools.

Assimina Pelegri
Professor and Chair, Department of Mechanical and Aerospace Engineering, Rutgers, The State University of New Jersey, USA
&
Parameshwaran Pasupathy
Graduate Student, Rutgers, The State University of New Jersey, USA

Deep Learning Surrogate Models for Brain White Matter Mechanics

Predicting the mechanical response of brain white matter (BWM), even in the limit of small strains is challenging owing to the inherent anisotropy of the three-dimensional microstructure and the various interactions between the heterogeneous structural components of brain tissue. Given the large number of simulations required to capture the wide variations in BWM geometry and microstructural properties—such as axon density, diameter, tortuosity, myelin content and its composition, the computational cost of traditional approaches for material characterization such as the finite element (FE) method can become prohibitive.

In this study, we aim to develop a surrogate deep learning neural network model for characterizing BWM mechanical response under specified quasi-static loading. The forward problem of predicting the evolution of stress for a given geometry—typically performed using FE modeling—is replaced by recurrent neural network (RNN) architectures that learn the structure–property relationship between BWM microstructure, material properties, and stress-strain behavior. Using a Sobol sequence for sampling the material-geometry feature hyperspace, we generate a diverse dataset of microstructure geometries comprising axon, myelin, and an extracellular matrix (ECM). We conduct a comparative evaluation of two prominent RNN architectures: (1) Long Short-Term Memory (LSTM) networks with separate input, output, and forget gates controlling an explicit memory cell, and (2) Gated Recurrent Unit (GRU) networks with a simplified gating mechanism that merges memory and hidden states. Both models are trained on identical datasets, with architecture-specific hyperparameter tuning. Comparative metrics include mean absolute percentage error (MAPE), computational cost per forward pass, and scalability to higher-resolution microstructures. Once trained, the optimal network significantly accelerates the prediction of stress-strain response. When integrated into an optimization workflow for estimating homogenized BWM properties, the selected RNN architecture permits rapid evaluation of forward predictions at a fraction

of the computational cost, enabling near-real-time estimation of BWM material properties.

Jens Peth
Researcher, University of Siegen, Germany
Christoph Friedrich
Professor, University of Siegen, Germany
&
Tobias Held
PhD Student, University of Siegen, Germany

Effects of Thermal Preload Change and Preload Relaxation of Screw Joints as Base for Positive Long-Term Behavior

Screw joints since years are the most used method of bringing components together. For technical use this means to transmit forces between fastened components. Besides others this is an important influence to achieve low cost of the entire product over time of operation. This aspect can determine the entire product success in markets - this makes it important in product engineering. Additionally, even more features in modern components and also smaller components make the use of light weight design necessary.

For screw joints this means to look to the preload behavior over time. This includes two effects: thermal preload shift when heating up to operating temperature (loading and stressing of components) and preload relaxation over time in operation (creeping of clamped materials or screw materials). Only stability guarantees sufficient service time, therefore it is necessary to design this behavior for future applications. Up to now mainly clamp force right after assembly is focused.

Based on this, the contribution shows measurements of preload change, dependent on the temperature influence and time influence. Because a reliable measurement of preload change needs a special setup, also this is explained and referenced as starting point. Obtained measurement results are compared with calculation results, e.g. from standard VDI 2230, which is used worldwide. For measurement well defined sample screw joints are used, which mainly have components made of aluminum and a screw made of steel as it is suitable (property class 10.9). The screw dimension is M10. The screw is mainly tightened to an initial preload of 30 kN.

A main finding is, that preload shift more or less is lower than expected with linear, handleable calculation from standard. For preload loss over time (preload relaxation) no prediction is standardized up to now – this is even more critical for future reliability.

The measurements show, for which design the behavior gets critical and how to manage these effects. Important influences are length of tread engagement (screwing depth) and support diameter of screw head; the paper shows examples for this. Also the preload level of screw joint shows different temperature- and time behavior – this points to a right design of assembly process, not only component itself. The results are supported by additional investigations from contacts and cross sections (microscopic deformations, determination of roughness change), so the reasons for behavior get clear. As a conclusion drawn from this, light weight design of screw joints has to be done differently from traditional steel components; such steel components are mainly focused in standards up to now. The paper will meet scientific needs like structure and references.

The authors think, this paper would enrich the topics of the conference, because the results are important in general. Therefore, we would appreciate your acceptance.

Julia P. Shaw
Professor, SUNY Empire State University, USA

Cognitive Foundations of STEAM Education: Tables of Ordered Pairs

One direction to explore in the future of Steam is the foundation of cognitive processes common to all modes of scientific thinking, with the assumption that students who succeed in one area of STEAM succeed in other areas. A premise here is that one common cognitive skill crossing all STEAM domains is the ability to organize relevant data into tables/matrices of ordered pairs.

1- **Level 1 Integration:** Students, in teams, first experience the value of tables of ordered pairs in exploration of each area of STEAM. **Age: Upper Elementary**

   a. **Science:** Replicate Galileo's Inclined Plane experiment creating a table recording time for four balls of different weights/sizes to traverse 1st and 2nd half of an inclined plane, concretely demonstrating concept of acceleration.
   b. **Technology**: Create process chart to plan a children's party, considering roles and activity sequences.
   c. **Engineering**: Relate gear ratios of interlocking input and output gears discovering relationships between speed and torque.
   d. **Arts**: Relate story plot sequence with key story characters to analyze characters' emotional shifts with plot progression.
   e. **Mathematics**: Determine probabilities for roles of 2 sided coins and 3 sided die, then chart results of actual roles.

2- **Level 2 Integration:** Students then view and analyze how organization into their five tables helped to solve a scientific problem. They see how organizing ordered pairs into tables facilitates solutions in each area. They then create a schedule of their school activities on a calendar.
   Age: Upper Elementary/Middle School

3- **Level 3 Integration:** Students now applies the concept of tables of ordered pairs to new problems, such as graphing the time for two runners to complete a race. This demonstrates the transition –

transformation, perhaps – from the concrete exploration of scientific phenomena to the organization of those experiences into patterns that can be described by mathematics.

Age: Middle School or Beyond

Piaget well-established that the capacities for categorization, ranking, and sequencing of data are foundational cognitive skills that develop across childhood into early adulthood. Students make use of these interdisciplinary cognitive skills in increasingly complex ways when they create tables of ordered pairs in pursuit of answers to scientific questions. Effective use of tables indicates that they recognize that data can be categorized, ranked, and sequenced to create dimensional patterns in time and space.

Photos of students engaging in these tasks will be presented, and the audience will be encouraged to consider other foundational skills that cross interdisciplinary boundaries.

Rakesh Singhai
Professor, IIT Gandhinagar, India
Chandra Shekhar
Student, IIT Gandhinagar, India
Abhimanyu Singh Yadav
Student, IIT Gandhinagar, India
Piyush Singh
Student, IIT Gandhinagar, India
&
Shaury Kumar Patel
Student, IIT Gandhinagar, India

Reduced Energy Consumption of Air Conditioning by incorporating a Desert Cooler

Desert coolers are very effective in temperature control when humidity is low. They are however ineffective when humidity is high. As households get prosperous, they switch to air conditioners and stop using desert coolers. This increases their electricity consumption very substantially. Typical room air conditioner consumes about 1800 watts against about 180 watts for a typical desert cooler.

This paper discusses the development of a room air conditioning system for a household, incorporating a room air conditioner, a desert cooler, an exhaust fan and a ceiling fan. All of these devices are controlled automatically to maintain desired temperature and humidity within a range.

All the four devices in the system which are fitted with IOT switches, communicate wirelessly with a smart controller unit which is equipped with temperature and heat sensors and a micro controller. The controller is placed near the user. The controller unit is programmed to compute heat index using the inputs from the sensors and the inbuilt algorithm controls the four units automatically, to ensure that room temperature and humidity are maintained within a band while minimizing the electricity consumption of the system. The controller is equipped with a rechargeable battery and a charging socket to make it truly wireless.

The energy simulation study suggests that this system reduces energy consumption during peak summer in northern India by nearly 50% without compromising on comfort levels and is expected to reduce electricity consumption by 20-25% during monsoon season when humidity levels are high.

Added benefit of such a system vis-à-vis just a room air conditioner is a superior healthy environment as very low humidity caused by air

conditioning alone, leads to dry skin and several other health problems related to low humidity levels.

Volker Wannack
Head of Blockchain and AI in the Energy Sector, Blockchain Competence Center Mittweida, University of Applied Sciences Mittweida, Germany

Blockchain-Based Trust Infrastructures for Sustainable Biomass Markets in Europe

Sustainable biomass markets in Europe depend on complex, multi-actor value chains that span production, certification, logistics, and regulatory oversight. Ensuring transparency, trust, and regulatory compliance across these distributed structures remains a persistent challenge. This paper explores blockchain-based trust infrastructures as an enabling foundation for reliable, auditable, and interoperable biomass markets. By combining distributed ledgers with smart contracts and continuously updatable metadata, critical sustainability and compliance information can be securely documented and exchanged across organizational and national boundaries. Such infrastructures support tamper-resistant traceability, automate verification processes, and reduce administrative overhead in certification and reporting workflows. Drawing on early experimental implementations and conceptual system designs, the paper discusses how blockchain-based approaches can enhance market integrity, improve cross-border interoperability, and support the scalable deployment of sustainable biomass systems in alignment with European policy and regulatory frameworks.

Tom Wanyama
Associate Professor, McMaster University, Canada
&
Michele Vaz
Business Manager, McMaster University, Canada

Expanding Engineering Education through Outreach at the SEPT Learning Factory

This paper presents a case study on the strategic deployment of the W. Booth School of Engineering Practice and Technology (SEPT) Learning Factory at McMaster University as a platform for community engagement, experiential learning, and the cultivation of socially conscious engineers. Traditionally, learning factories are designed as controlled environments where students simulate industrial practices, explore smart manufacturing, and apply Industry 4.0 principles. While these uses remain valuable, they often overlook the potential to connect technical education with pressing societal needs. The SEPT Learning Factory extends the conventional model by embedding outreach-driven product development into both curricular and co-curricular activities. In doing so, it demonstrates that technical training and community engagement can coexist as mutually reinforcing elements of engineering education.

Projects developed within the Learning Factory intentionally address authentic community challenges while building technical competencies. For example, students design and manufacture walking canes, which serve as exercises in user-centered design while also enhancing accessibility for underserved populations. Water filtration systems, created in collaboration with health initiatives in East Africa, provide practical experience in low-resource innovation and technology transfer. Similarly, the design of radio-controlled (RC) cars for high school STEM outreach allows students to apply mechatronics and systems integration while also practicing leadership, mentorship, and science communication. Collectively, these initiatives highlight the versatility of the Learning Factory as a site for both technical mastery and civic engagement.

The model is anchored in experiential, situated, and transformational learning theories. Students learn by doing, reflecting, and iterating; they gain knowledge in authentic contexts shaped by community needs; and they develop broader ethical and professional perspectives as their assumptions about engineering are challenged. The approach fosters social cohesion, motivation, persistence, and deeper

technical learning, while simultaneously strengthening teamwork, communication, problem solving, innovation, and professional identity. In this way, the Learning Factory helps students cultivate both technical expertise and civic responsibility.

This outreach-centered pedagogy also aligns with global imperatives such as the UN Sustainable Development Goals and the competencies demanded by Industry 4.0. Engineers today must design smart, interconnected systems that are not only efficient but also equitable and inclusive. The SEPT Learning Factory prepares students for this hybrid skill set by merging digital fluency with social awareness. Its role in international collaborations—such as the Learning Factories World-Wide (FWW) project under the International Association of Learning Factories—further demonstrates the scalability of this model across diverse contexts, including institutions in the Global South.

In conclusion, the SEPT Learning Factory illustrates how outreach-driven product development can serve as both a pedagogical innovation and a mechanism for social impact. By integrating technical excellence with empathy, ethical reasoning, and interdisciplinary collaboration, the model produces graduates who are not only technically proficient but also deeply aware of the societal contexts in which engineering solutions operate.

Yu-Chi Wu
Professor, National United University, Taiwan

A Monte Carlo OPF and Deep Learning Surrogate Model Approach for Power System Resilience Assessment Under Typhoon Hazards

As extreme weather events and anthropogenic threats grow more frequent, power system resilience has become a critical national infrastructure concern. Traditional Monte Carlo simulation combined with Optimal Power Flow (MC-OPF) analysis, though effective for reliability assessment, faces prohibitive computational costs due to its NP-hard complexity and limited capacity to handle dynamic network topology changes. This study proposes a two-stage data-driven framework to overcome these challenges, validated on the IEEE 14-bus benchmark system under real typhoon hazard conditions.

In the first stage, an AC OPF environment was built using Julia 1.10.9 with PowerModels.jl and the Ipopt solver. Forced outage rates (FOR) derived from four typhoon records — typhoon 1 (55%), typhoon 2 (70%), typhoon 3 (35%), and typhoon 4 (47.5%) — were incorporated to simulate realistic line and transformer failures, alongside localized generator cost curves in New Taiwan Dollars (NTD). A total of 33,214 converged OPF scenarios were generated from 200 Monte Carlo weekly samples, with 25% representing typhoon conditions. Results showed an overall Expected Energy Not Served (EENS) of 4,806.55 MWh/week, with typhoon scenarios yielding a 22.6% increase over baseline (5,578.65 vs. 4,549.18 MWh/week), confirming the hazard model's validity. Line 16 recorded the highest outage frequency (57.4%), while Line 4 proved most critical, contributing a marginal ΔENS of +18.99 MW.

In the second stage, a four-layer Fully Connected Neural Network (FCNN) — architecture 256→128→64→32 — was developed as a surrogate model in PyTorch. Taking 35 input features including per-bus power demand, binary line status, temporal indicators, and typhoon flags, the model was trained on just 30% of the dataset (9,964 samples). It achieved near-perfect accuracy on the independent test set of 21,590 scenarios, with $R^2 = 0.9989$, MAE = 0.65 MW, and RMSE = 0.98 MW. Statistical comparisons of mean, median, standard deviation, kurtosis, and skewness between OPF ground truth and FCNN predictions confirmed near-identical distributions. Survivability curves across all typhoon scenarios agreed within 0.1% at operational thresholds of 0.6–0.9 pu, demonstrating that the surrogate model reliably preserves system reliability characteristics.

The proposed framework compresses analysis time from hours to seconds, enabling real-time resilience screening for grid operators. Grounded in localized Taiwanese typhoon data and generation economics, it offers a replicable and scalable methodology for techno-economic resilience justification, critical infrastructure prioritization, and renewable-energy grid planning. Beyond technical contributions, the project cultivated interdisciplinary talent with integrated competencies in high-performance scientific computing (Julia), deep learning (PyTorch), and power engineering — equipping the next generation of researchers to address the intersection of climate resilience and intelligent energy systems.

Huisheng Zhang
Professor, Shanghai Jiao Tong University, China
Xiao Cui
PhD Candidate, Shanghai Jiao Tong University, China
&
Jinwei Chen
Assistant Professor, Shanghai Jiao Tong University, China

Study on the Novel Inlet Bleed Heating Control Strategy for a Power Generation Gas Turbine Engine

For a power generation gas turbine (GT) engine, the inlet bleed heating (IBH) technology can extend the lower load limit of engine operation and prevent safety risks such as inlet icing and compressor surge. However, it will reduce the system operation efficiency. The IBH control for the current GT engine is based on the fixed rule with the change of load while ignoring the ambient conditions and safety margin. In this paper, a novel IBH control strategy based on the multi-objective optimization of safety and efficiency will be proposed.

A GT system model incorporating IBH is established. The impact of the bleed-air flow rate on compressor inlet temperature (CIT), combustor exit temperature (CET), surge margin and GT efficiency under different ambient conditions and loads is analyzed. Considering the operating envelope and safety-related constraints, a Simulated Annealing–Particle Swarm Optimization (SA–PSO) algorithm is used to optimize the Inlet Guide Vanes (IGV) position and the IBH bleed-air ratio with a multi-objective optimization of system performance and safety margin. The new control strategy for IBH under different ambient conditions and loads was obtained.

Field test result proves that the proposed optimization-based control strategy improves system efficiency at part-load conditions with a higher safety margin for the gas turbine engine comparing to the fixed IBH control rule. This model based approach can be extended for the online optimum control for complex power generation system.

References

Maheswaran B, Gkounta O (2026) *Electrical Engineering. Abstract Proceedings of the 10th Annual International Conference.* Athens: Athens Institute.

Maheswaran B, Papanikou A (2025) *Electrical Engineering. Abstract Proceedings of the 9th Annual International Conference.* Athens: Athens Institute.

Maheswaran B, Gkounta O (2024) *Electrical Engineering. Abstract Proceedings of the 8th Annual International Conference.* Athens: Athens Institute.

Maheswaran B, Gkounta O (2023) *Electrical Engineering. Abstract Proceedings of the 7th Annual International Conference.* Athens: Athens Institute.

Maheswaran B, Gkounta O (2022) *Electrical Engineering. Abstract Proceedings of the 6th Annual International Conference.* Athens: Athens Institute.

Papanikos GT (2021) *Electrical Engineering. Abstract Proceedings of the 5th Annual International Conference.* Athens: Athens Institute.

Papanikos GT (2020) *Electrical Engineering. Abstract Proceedings of the 4th Annual International Conference.* Athens: Athens Institute.

Papanikos GT (2019) *Electrical Engineering. Abstract Proceedings of the 3rd Annual International Conference.* Athens: Athens Institute.

Papanikos GT (2018) *Electrical Engineering. Abstract Proceedings of the 2nd Annual International Conference.* Athens: Athens Institute.

Papanikos GT (2017) *Electrical Engineering. Abstract Proceedings of the 1st Annual International Conference.* Athens: Athens Institute.