# ICRNE-2024 & ICMME-2024

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# Abstract Book

## 2ND INTERNATIONAL CONFERENCE ON RENEWABLE AND NON-RENEWABLE ENERGY

&

## INTERNATIONAL CONFERENCE ON MECHANICAL AND MECHATRONICS ENGINEERING

**April 22-23, 2024 | Munich, Germany**

# FOREWORD

**Dear Colleagues**,

It is our pleasure to extend a warm invitation to all scientists, academicians, young researchers, business delegates, and students from around the globe to participate in the 2nd International Conference on Renewable and Non-Renewable Energy (Renewable and Non-Renewable Energy -2024) and the International Conference on Mechanical and Mechatronics Engineering (ICMME-2024), scheduled to take place in Munich, Germany from April 22-23, 2024.

Renewable and Non-Renewable Energy -2024 & ICMME-2024 will provide a platform to explore recent research and cutting-edge technologies, attracting a diverse and enthusiastic audience of young and talented researchers, business delegates, and student communities.

The primary objective of Renewable and Non-Renewable Energy -2024 & ICMME-2024 is to bring together, a multidisciplinary gathering of scientists and engineers from across the globe to share and exchange groundbreaking ideas in the fields of Renewable and Non-Renewable Energy -2024, as well as Mechanical and Mechatronics Engineering. The summit aims to foster high-quality research and international collaboration, facilitating discussions and presentations that are globally competitive and highlighting recent notable achievements in these fields.

We're looking forward to an excellent meeting with scientists from different countries around the world and sharing new and exciting results in Renewable and Non-Renewable Energy & Mechanical and Mechatronics Engineering.

# COMMITTEE

## Organizing Committee Members

- **Uldis Zaimis** Liepaja University, Latvia

  **Amedeo Amoresano** University of Naples, Italy

- **Abdeltif Amrane** Director of Technological Institute of Rennes, France
- **Fong-Chin Su** National Cheng Kung University, Taiwan
- **Tin-Kan Hung** University of Pittsburgh, USA
- **Ma'Moun A. Abu--Ayyad** Pennsylvania State University, USA
- **Raul D S G Campilho** Instituto Superior de Engenharia do Porto, Portugal

# Direct Model Predictive Control of Impedance Source Inverters–Making Full Use of Power Electronics for Energy Conversion

**Ralph Kennel**
*Technical University of Munich, Germany*

## Abstract:

The aviation industry has dealt with many problems and COVID-19, which is one of them. It is addressed all the challenges faced and been successful remain in the leading example of engineering and safety in the global stage. This is the most more part to the role of systems and of course the organizations to oversee the whole process. We are now at the dawn of a new problem that is not artificial intelligence, but the implications of cyber psychology and how it may be used for both are good and nefarious actions.

This research paper to present the findings and challenges from several international research projects, looking at how to ensure the aviation sector remains secure and safe from accidental and deliberate problems to its systems and operations. Furthermore, it was addressed issues that I needed immediately, and the actions and suggestions for medium-term solutions.

## Biography:

Kennel's research interests also include the sensor and encoder-free control of electric drives, the predictive control of converters and power electronic "hardware in the loop" systems. Due to the wide spread of teaching and research areas, the Chair for Electrical Drive Systems and Power Electronics offers the best possible basis for future-oriented training in the field of system and drive technology. After studying at the University of Kaiserslautern, he received his doctorate there in 1984. Until 1999 he worked in various positions at Robert Bosch GmbH and from 1994 to 1999, he was also a "Visiting Professor" at the University of Newcastle-up-on-Tyne, Great Britain. He then headed the chair for electrical machines and drives at the Bergische University Wuppertal until he was appointed professor at TUM in 2008.

# Environmentally Friendly Aviation with Airships Using Solar and Wind Energy

**Christoph Pflaum**
*University of Erlangen-Nuremberg, Germany*

## Abstract:

Even after intensive research, it is still unknown how conventional aircraft could enableclimate-friendly aviation. For example, long-haul flights are not possible using climate-friendly technologies with hydrogen. Therefore, three companies currently develop largerigid airships worldwide. Using light weighted thin film solar cells on the surface of suchairships can provide energy for the thrust of the airship.In order to use the renewableenergies wind and solar for such airships efficiently, optimal travel routes have to calculated.This is analyzed for arigidairship ofthesizeof the historical airships LZ129,R101, USS Arkon.

The latter used helium as a buoyancy gas and transported 200 passengers on oneflight. For a mid-range and long-haul use case for passenger or freight transport, travel timeshave been calculated. Building on these results, analysis of CO2 emissions, land-use, andoperating costs are carried out to reveal that depending on the use case, CO2 emissions ofsolar-powered airships could be as low as 1% to 5% of the emissions of a conventional aircraft at an estimated energy consumption in USD per kmof0.5%to2.5%.

**Literature:**

Christoph Pflaum, Tim Riffelmacher& Agnes Jocher (2023) Design and route optimisation foran airship with onboard solar energy harvesting, International Journal of Sustainable Energy,42:1,289-303,DOI:10.1080/14786451.2023.2189488

## Biography:

Christoph Pflaum is Professor at the Department of Computer Science at FAU. His research topics are high performance computing and numerical simulation with respect to different engineering applications. In particular, he is interested in optical applications, simulation of solar cells, and simulation of airships. Christoph Pflaum studied mathematics at Technical University Munich. He worked at Technical University Munich, University Wurzburg, Germany, and at the Lawrence Livermore National Laboratory, USA, before he obtained a professor position at University Erlangen-Nürnberg, Germany. Additionally, Pflaum is cofounder and CEO of the company ASLD GmbH.

# A Step Towards Smart, Ergonomic and Sustainable Mining Machinery Workplaces

**Vesna Spasojevic Brkic**
*University of Belgrade, Serbia*

## Abstract:

Although the mining industry is the oldest one, it is still a major source of pollution with more people hurt or injured than in any other industry, while social conflicts around it are worldwide spread. Namely, mining projects still have direct and indirect environmental impacts and seriously affect land, water, air, biota, and people, while mining equipment focused in this paper has the highest footprint. The reason for the lack of progress in mining industry is the most likely the fact that in current research streams technology-centered design dominates. Our novel Smart Miner concept aims to create a step toward smart, ergonomic and sustainable mining machinery workplaces. It proposes a paradigm shift from pure technology to a Human and Data-Centric Engineering, which could be easily transferred to other industries, and develops solutions for raising the level of environmental quality in complex interactions between physical, behavioral and organizational processes field, by matching advanced operator I4.0&5.0 and society S5.0 standards.

An original idea approval route starts with mining machinery operator wellbeing in its microenvironment and its cyclical alignment with stakeholders in the value chain. After development of smart, ergonomic, non-invasive and reliable operator aid systems for regulation of physical environment job stressors - noise, human vibration, lighting, temperature, air quality, workplace layout issues etc., which solve environmental and human health issues and influence overall performance, research passes to operator macroenvironment determined by organizational contextual factors, which also impair sustainable development results. Micro and macro levels are planned to be connected and balanced by real time analytics to fit high sustainability performance indicators in novel, flexible and scalable system, aimed to increasing productivity and production together with reducing emissions and decrease of accidents rate.

**Keywords**: Ergonomics, Industry 4.0, Sustainability, Mining Machinery.

## Biography:

Vesna Spasojevic Brkic is a Full Professor in Industrial Engineering at the University of Belgrade-Faculty of Mechanical Engineering. She is Head of Industrial Engineering Department and of the Center for Teaching Quality and Accreditation. Also acts as certified professional in quality management, safety and health at work, business continuity and risk management, with 10 certificates. She graduated at the Faculty of Mechanical Engineering, University of Belgrade, Serbia in 1994, received her MSc degree in 1999 and PhD degree in 2008 at the same place. The teaching activity of Prof. Vesna Spasojevic Brkic includes lecturing for undergraduate, master and doctoral students in the following fields: Production Management, Risk Management, Quality and Maintenance Management, Ergonomics and Design of Organization.

**Acknowledgement/ Funding Support**

This research was supported by the Science Fund of the Republic of Serbia, hashtag#GRANT No. 5151, Support Systems for Smart, Ergonomic and Sustainable Mining Machinery Workplaces – SmartMiner and the Ministry of Science, Technological Development and Innovations contract no. 451-03-47/2023-01/200105 from 03/02/2023.

# Biodegradable Force Sensor: Research of Characteristics and Applications

**Uldis Zaimis**
*Institute of Science and Innovative technologies, Latvia*

## Abstract:

Robotics generate a rapid demand for different sensors to be used in manufacturing and robotics applications for quality control, process monitoring, and automation. They can detect defects, measure dimensions, and provide feed-back to adjust manufacturing processes in real-time. Applications in environmental monitoring and security systems are on the list, but not concluded either.

This work provides a comprehensive analysis of the mechanical behaviour of biopolymer sensors for compression and tension modes. New experimental data have been obtained on sensor material properties, such as hysteresis, initial plastic deformation of starting load cycles, and differences in tension or compression modes for such sensor materials.

An innovative numerical procedure has been proposed to derive mechanical and electric characteristics using accumulated test data (load-resistance relationships in steady and transient modes). A simple transformation formula has been proposed for tension and compression cases correspondingly.

The proposed numerical procedure has been applied to the test data to derive the force-resistivity relationships of the biopolymer sensors. The force-electrical resistance dependency was exposed because it follows an inverted square law and the signal drift is controllable in the defined regions.

It was concluded that biopolymer sensor operation in tension and com-pression modes provides reliable mechanical behaviour and corresponding electric signal properties. Obtained hysteresis and signal drift exist, but they are accountable and not prevent to use of this type of sensor for practical applications.

## Biography:

Uldis Zaimis's scientific interests are wide-ranging and include environmental processes and their modelling, robotics, artificial intelligence, and Internet of Things (IoT) applications: the creation and characteristics of surface nanostructures. His leadership positions and scholarly contributions include Lecturer at the LiepU Faculty of Science and Engineering since 2017, Director of the LiepU Institute of Science and Innovative Technologies since 2020, Director of the professional bachelor study program "Smart technologies" at the Liepaja University Faculty of Science and Engineering since 2022, and Chairman of the LiepU Senate since 2022. Dr.Zaimis's extensive expertise in these interdisciplinary fields significantly contributes to the academic and scientific community.

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# Necessary Contributions to Reach 100% Renewable Energy and Energy Justice

**Winfried Hoffmann**
*Applied Solar Expertise GmbH, Germany*

## Abstract:

This paper refers to my two presentations, given last year at the 1st ICRNRE in Valencia [1, 2] and describes the most important contributions necessary to reach the goals discussed:

- **Storage**

After a short overview on existing storage technologies emphasis is taken on further developments fort the different future applications with special emphasis on critical materials. An order of magnitude estimate is given for the future needed battery capacity.

- **Mobility without fossil fuel**

Reasoning why batteries for cars, most light- and some heavy-duty vehicles are superior to other technologies (hydrogen/fuel cell and green fuel)!
Electric motors without the need for rare-earth elements!
Adjusted liquid green fuel for ships and long range airplanes;
Is it possible to reach the necessary ramp-up for fossil fuel free mobility by 2050?

- **Industry**

The decarbonization of the global industry needs huge amounts of hydrogen, process heat and low cost electricity. A rough estimate is given for these needs.

- **Air conditioning of buildings**

Huge amounts of oil and gas are needed in the building sector – heating in northern and cooling in southern countries. Necessary developments are described.

As a conclusion it can be stated that we have the cost-effective technologies available to reach the goals – however, the reluctance from many old industries and political institutions are the biggest hurdle which has to be overcome!

## Biography:

Winfried Hoffmann is a renowned physicist and biophysicist with a distinguished career in the photovoltaic industry since 1979. He spearheaded the R&D group at NUKEM, focusing on thin-film solar cells, and later became CEO of ASE and RWE Solar GmbH, leading companies to global prominence. As managing director of Applied Materials GmbH and a board member of SMA Solar Technology AG, he contributed significantly to solar technology advancements. His publication in 2017 highlights his vision for photovoltaics in renewable energy. Dr. Hoffmann's work continues to influence the field of sustainable energy.

# Green Hydrogen Fuel Cells as Renewable Energy Sources for Circular Economy-Challenges and Perspectives

**Nevenka R. Elezovic**
*University of Belgrade, Serbia*

## Abstract:

**Objective:** Synthesis and characterization of the ceramic based supports, to replace state of the art carbon based; Synthesis of the Pt and Pd nanocatalyst for PEMFCs onto these supports; Characterization of the catalysts for green hydrogen PEM fuel cells reactions.

**Methods or procedures:**
BET technique – surface area determination, pore size distribution

X-ray diffraction, X-ray PhotoelectroinSectroscip (XPS);

High angle annular dark filed scanning transmission electron microscopy (HAADF, STEM) and electron energy loss spectroscopy (EELS);
Electrochemical characterization: RDE measurements, cyclic voltammetry and linear sweep voltammetry, US DOE stability tests.

**Outcome:**
The novel ceramic supports – tin oxide and titanium oxide doped by Nb were successfully synthesized and characterized. High surface area, one of the most important demands was achieved for tin oxide and titanium oxide based supports. Pt and Pd based catalysts exhibited higher activity and stability in comparison to carbon supported ones.

**Conclusion:**
High stability of these materials under US DOE standardized stability tests was achieved. The challenges and perspectives of green hydrogen fuel cells were discussed in line with circular economy and sustainable development, following the ongoing energy transition from fossil fuels to renewable sources. The future directions were discussed as well.

## Biography:

Nevenka R. Elezovic is a Research Professor at the University of Belgrade's Institute for Multidisciplinary Research. With a PhD from the University of Belgrade, her expertise lies in nanostructured materials for green energy production. A prominent figure in the European Academy of Surface Technology, she has contributed over 50 scholarly articles and served as a reviewer for top journals. Dr. Elezovic is a sought-after speaker at international energy conferences and is currently focused on developing materials for hydrogen fuel cells to reduce reliance on fossil fuels.

# Influence of Interactive Nanosized Metal-Oxides Supports on Catalyst Electroactivity and Stability for Ethanol Oxidation in Fuel Cell Applications

**Milica P. MarcetaKaninski**
*Institute of General and Physical Chemistry, Serbia*

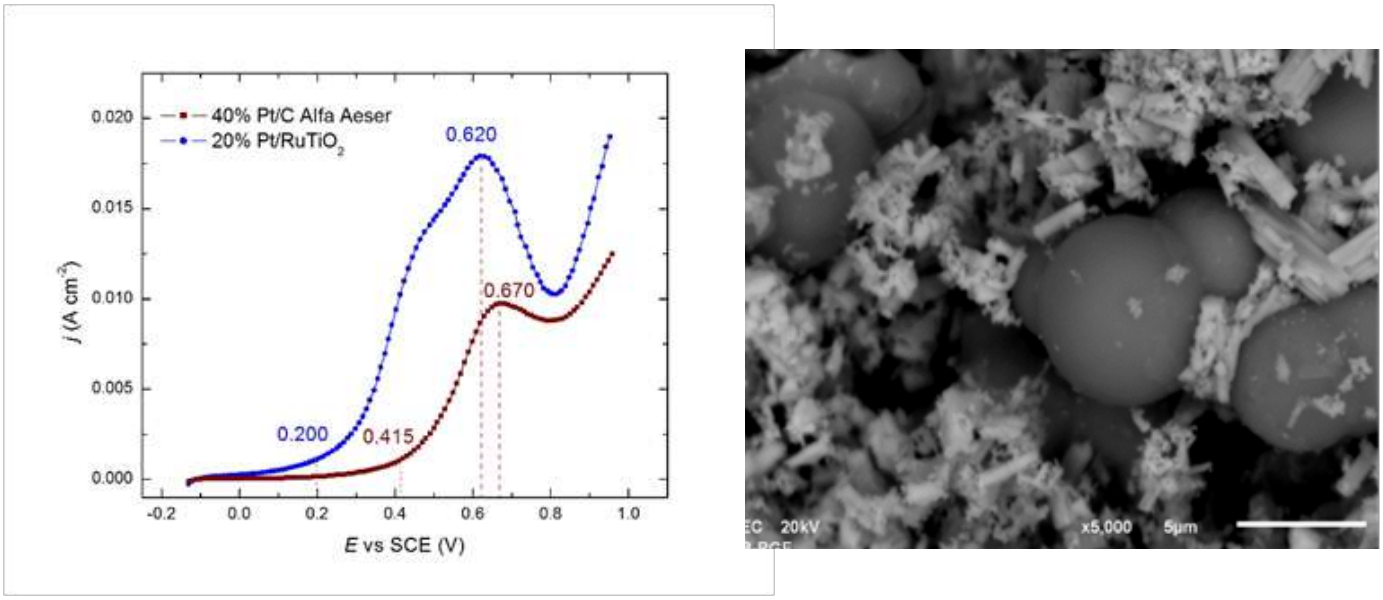
## Abstract:

Hydrogen research projects around the world try to develop low cost and durable fuel cells according to specific applications. One of the obstacles they try to overcome are durability of the catalyst support, which is commonly a carbon based, and exhibits severe corrosion that influence increased reparation cost and lowers the overall durability of the fuel cells. Direct alcohol fuel cells (DAFCs) today have limited application due to numerous challenges that need to be resolved for their wider use. The most important challenge is slow kinetics of alcohol oxidation reactions at catalyst layer and alcohol crossover, limiting long-term stability and durability in operation. Several important properties have to be achieved during the catalyst synthesis: 1) high specific surface area, to attain high catalyst dispersion, 2) suitable porosity, to boost gas flow, 3) high electrical conductivity at room temperature, 4) co-catalyst behaviour, for increased electrocatalytic activity.

This article presents designing of the interactive catalyst to be cost-effective, nano-sized, based on metal oxides support of various shapes, obtained via simple and inexpensive new synthetic route, and low amount of platinum. Investigations showed that it is possible to increase the catalytic activity of Pt nanoparticles when utilizing metal doped or non-stoichiometric TiO2 as supporting materials instead of carbon support. The enhanced activity could be explained through the mismatch in the lattice constant between Pt and support, that caused interactions between them changing the d-band properties of Pt nanoparticles. The results show synergy, beneficial for the oxidation of ethanol, which is favoring reaction mechanism pathway of complete alcohol oxidation, avoiding formation of intermediaries that poison the active sites of the catalyst layer. Presented results are beneficial for increased durability in operation of the DAFC application.

**Keywords:** catalyst, interactive catalyst support, direct alcohol fuel cell (DAFC), ethanol oxidation reaction (EOR)

## Graphical abstract:




## Biography:

Milica P. MarcetaKaninski is currently working as a Research Professor at Institute of General and Physical Chemistry, Serbia. She is an experienced Head of Hydrogen Energy Division with a demonstrated history of working in the research industry. Skilled in Nanomaterials, Environmental Protection and Chemical Engineering. Strong R&D, awarded with PhD at Faculty of Physical Chemistry of University of Belgrade and also a Member of the Scientific Committee for Materials and Chemical Technology at Ministry of Education.

# Enhanced Nanocatalysts for Improved Ethanol Oxidation in Fuel Cell Applications

**Vladimir Nikolic**
*Institute of General and Physical Chemistry, Serbia*

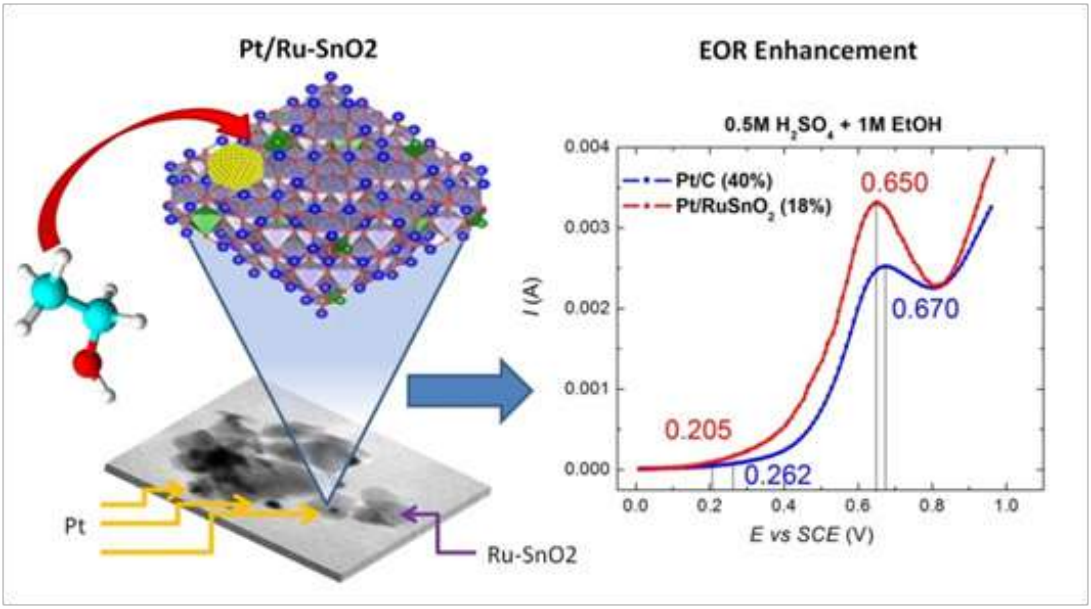
## Abstract:

The worlds energy demands are constantly increasing in all areas of life. By mitigating the climate changes and recent energy crisis, more developments are devoted to decentralized power production systems, primarily consisting of using hydrogen as the main environmentally friendly energy carrier. The use of hydrogen in PEM fuel cells is a very good solution for large stationary and transport applications, such as connections with renewable power sources (solar PV plants and wind turbines) for on-site hydrogen generation and electricity production when necessary, and hydrogen powered electric vehicles. On the other hand, PEM fuel cells are not a used for portable and mobile applications, such as laptop chargers, mobile-home chargers, etc, which is related to safety issues of using hydrogen. This is where direct alcohol fuel cells (DAFC) found its main applications, as they use alcohols (methanol and ethanol) as fuel, which are easy to store and transport. The main challenges of the DAFC are poor reaction efficiencies and durability, which implies more R&D work to be performed.

The article presents recent developments on promising electrocatalysts, applicable for DAFC, used for portable and mobile applications. The goal of this the work was development of low PGMnanocatalysts, deposited on interactive nanocrystalline metal-oxide supports, implying the improvements in their performances. New and simplified synthetic route applied for preparation of interactive catalyst support are presented with the aim to enable easy scale-up of the catalyst production process. Obtained results promise great potential in improving performance and durability of the investigated catalyst suitable for the use in DAFC.

**Keywords:** catalyst, interactive catalyst support, direct alcohol fuel cell (DAFC), ethanol oxidation reaction (EOR)

**Graphical abstract:**




## Biography:

Vladimir Nikolic is a distinguished research professor at the Institute of General and Physical Chemistry in Serbia. His leadership roles include serving as Deputy Director of the Department for Physical Chemistry at the Institute of Nuclear Sciences Vinca, overseeing a diverse team of 50 researchers from 2013 to 2017. He further extended his expertise as the Deputy Director of the Vinca Institute of Nuclear Sciences, managing a multidisciplinary team of approximately 500 researchers from 2017 to 2019. His tenure at these institutions highlights his significant contributions to the scientific community.

# Poseidon Hydroelectric System

**Rick Navarro**
*Renewable Ocean Energy, Inc, USA*

## Abstract:

**Statement of the Problem:** Climate change impacts everyone while the need for more electricity is expanding exponentially with electric vehicles, artificial intelligence, and cryptocurrency. Low-cost, reliable electricity without sun, wind, waves, tides, currents, or batteries is needed. This report describes how Poseidon Hydroelectric System produces electricity on any water source without a dam to reduce climate change by eliminating carbon emissions, reducing transmission line costs, and expand the opportunity to provide electricity to people of the world.

**Methodology & Theoretical Orientation:** Three proven technologies used for hundreds of years have been blended in a new way using a siphon to lift water from any source, a hydraulic ram pump to capture the kinetic energy of flowing water and deliver pressurized water to an electric generator for less than .002 of a penny/kWh. Controlled operation provides efficiencies for minimizing water waste, eliminating fish kill, noise control, and dam hazards while allowing controlled 24/7 electricity production.

**Conclusion & Significance:** Renewable Ocean Energy, Inc.'s working prototype will be described with an operational video of the generator Power may be generated on or offshore with an aesthetically pleasing modular generator without harm to fish, birds, marine life, or the environment. Vetted by the Texas Environmental Quality Board and the National Atmospheric Administration Agency.

## Biography:

I have 14 innovations total; I constructed my first one on my own at the age of 17, after building a radio at the age of ten. It was an unusual voyage to get here. This person's journey is characterized by tenacity and inventiveness—from making a radio at the age of ten to running two cutting-edge businesses. They overcame a profound hearing loss to achieve academic excellence, winning scholarships and awards, and finishing a B. Sci, M.A., and Ph.D. cum laude in just 6.5 years. They currently lead Creative Minds Solutions and Renewable Ocean Energy, advancing green technology and catastrophe mitigation with 140 published articles and 40 years of management experience. One of their 14 creations, the patented EZ-GO travel bag, demonstrates their unwavering dedication to innovation throughout a lifetime.

# Heat Pumps as Vital Elements of the Energy Transition

**Tobias Schrag**
*Ingolstadt Technical University, Germany*

## Abstract:

### 1. Introduction

Heat pumps are widely recognized as essential tools for harnessing renewable energy sources to supply heating energy. They operate by using electrical energy to draw heat from ambient, low-grade heat sources, which is then supplied as high-grade heat to the heating system. Thus, the system's efficiency relies heavily on optimized access to ambient heat sources, an effective heat delivery system, and a smart operation strategy to adapt to variable heat demands and environmental conditions in buildings. Essential prerequisites include enhancing cost-competitiveness, optimizing efficiency, and bolstering system integration. The Institute of New Energy Systems (InES) at the Technische Hochschule Ingolstadt is actively engaged in investigating an array of innovative methodologies to address these challenges.

### 2. Two exemplary projects

Although they occupy only a fringe part of the heat pump market, in research dual-source heat pumps (DSHPs) are gaining significant recognition. DSHPs are fundamentally distinctive from traditional heat pump systems as they do not rely on just one source of ambient heat but utilize two sources, typically air and ground. The rationale behind using two sources is to exploit the desired advantages of both, and to evade the respective disadvantages that could adversely affect the performance under certain conditions. This mechanism facilitates the heat pumps to function in an optimized way and significantly allows for better adaptation to the changing ambient and demand conditions, often resulting in greater energy savings and environmental benefits.

At the InES, a unique refrigerant cycle was conceived to efficiently exploit the capabilities of DSHPs and to additionally accommodate the need for minimizing the necessary geometrical considerations of the ground sources. This innovation includes the parallel operation of both heat sources to reduce energy and power loads. A dual-compressor system was designed and put through rigorous testing under lab conditions. Based on a further simulation study, the

intelligent utilization of this novel interconnection results in seasonal efficiencies on par with ground source heat pumps, whilst substantially diminishing the energy and power demanded by the heat source.

On the other hand optimization of the operational periods of air source heat pumps (ASHPs) is crucial, as it significantly affects the energy consumption and overall performance of the systems for a large part of the heat pump market. The ambient air temperature varies throughout the day, with certain periods having more optimal temperatures for the operation of ASHPs than others. It is during these periods of optimal temperature that ASHPs can operate with greater energy efficiency. To fully capitalize on these, the heat pumps should be set to function predominantly during these optimal periods using heat storages to efficiently manage the load. For instance, in cooler climates, operating the heat pump during the warmer daytime hours can be more beneficial and energy efficient.

Predictive control involves using a mathematical model to foresee the future behavior of certain variables of interest - in this case, the outside air temperature and internal heating demand. Based on this prediction, the operation of the ASHP can be adjusted to maximize efficiency and cost- effectiveness. Additionally, thermal storage in the building mass can also be exploited for operation optimization. Essentially, the building mass can be used as a thermal battery, storing excess heat during periods of abundant heat supply or low demand, and then releasing it when required. This can further

optimize the operation of the ASHP, smoothing the heating demand, increasing the opportunities for operating the ASHP at optimal conditions, and reducing the need for backup heating systems. The InES investigates such a predictive controller in conjunction with a thermal building activation in a real application.

## 3. Conclusion

In summary, optimizing heat pump constructions and operations, particularly dual-source and air source heat pumps, with efficient control strategies and thermal storage approaches, can substantially improve energy efficiency. The research at the InES is consistently innovating to tackle challenges of cost and efficiency. This ongoing research and future advancements would not only enhance the sustainable energy sector but also contribute to the global effort of reducing carbon emissions.

## Biography:

Tobias Schrag is currently working at Ingolstadt Technical University, Germany. The courses he teaches reach from thermodynamics over building physics to solar powered buildings. Due to his change from a facility management department to a renewable energy department my research area is shifting from life cycle costs more to small scale heating networks, passive houses and heat pumps. At the moment he is establishing a laboratory with a heat pump testing facility and a DEC-Air handling unit.

# Challenges of Renamable Energy Projects - Using Selected Projects in Africa as Examples

**Kay Pfaffenberger**
*Flensburg University of Applied Sciences, Germany*

## Abstract:

Africa is Europe's closest continent and, with its 54 countries, represents a great development opportunity not only for the European Union, especially for a diversified supply of green energy and green products ("green steel").

A secure and affordable energy supply is not only important for Africa and the African countries, but also for the European Union. Energy prices are also crucial for economic development in both the consumer goods and capital goods markets.

The development of renewable energies, especially with regard to solar energy generation and wind power, is also of particular importance. Available hydropower plays a subordinate role.

The fact that Africa accounts for over 40% of the world's cobalt, manganese and platinum reserves - important minerals for batteries and hydrogen technologies - plays a role here. The development of more financial resources also plays a decisive role as the key to Africa's energy future. Countries outside Europe, for example from the Gulf region, have also recognized this (it doesn't always have to be China).

In the context of due diligence or supply chain regulations and laws within the European Union, the answer to the question of whether people need to be at the center of Africa's new energy economy will be crucial.
Proximity allows for many different ways of transporting energy. Many scenarios are conceivable, from submarine power cables from central locations to pipelines (some of which already exist, e.g. Trieste-Ingolstadt) and the transportation of hydrogen derivatives by ship

Not only at the Compact with Africa (CwA) summit in Berlin in November 2023, where German Chancellor Olaf Scholz, among others, emphasized the need to expand the value chain in Africa and not just export energy.

Both the operation of the gigantic plants and the consequences for expanding the value chain are not covered by the current projects; they only assume inert profitability. Furthermore, many investors see this as a task for the state or as a task for society as a whole or a global task.

An investor model is used to illustrate why these considerations fall short and why a joint strategy by investors and policymakers from the countries involved is necessary.

**Keywords:** Renewable Energy, Africa, O&M (operations and maintenance), Value Chain, Vocational Training.

## Biography:

Kay Pfaffenberger is a prominent academic and consultant with a Master's in Economic Sciences and a PhD in Business Administration. He has a rich career in banking, company communication, and academia, notably founding the Institute for Communication, Finance and Good Governance. As a Professor at Flensburg University and managing director of CBTA, his work spans business administration, political economics, and renewable energy, with a special focus on Africa. His expertise has greatly influenced cooperative banks and renewable energy projects, particularly in West Africa, and he has played a pivotal role in discussions on Green Hydrogen cooperation between Africa and Europe.

# Research and Development of Key Technologies for High Strength Gears and Bearings of New Energy Vehicles

**Yong Chen**
*Guangxi University, China*

## Abstract:

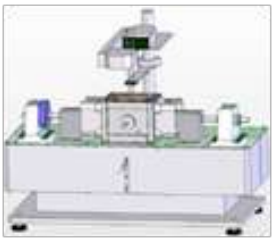
New energy vehicles have put forward higher requirements for the fatigue strength limit of transmission system components such as gears and bearings, while also increasing the incidence of key component gear and bearing failures. The key components of the transmission, such as gears and bearings, are prone to pitting, gluing, and wear under high speed and torque conditions, seriously affecting the performance and status of the vehicle's transmission system.

This paper proposes a material analysis and evaluation method for key components of gears and bearings based on material parameter data and nonlinear parameter models. Taking 20MnCrS5 gear low-carbon alloy steel and GCr15 bearing steel as research objects, this paper explores their heat treatment deformation process and optimal heat treatment methods, and develops high-strength gears and bearings for new energy vehicles. Provide theoretical guidance for the source of high hardness and high fatigue resistance characteristics, as well as the design of gears and bearings.

The gearbox gears that have undergone enhanced processing operate for more than twice the enterprise design specifications under high-speed conditions, and meet their requirements for high-speed transmission conditions. Compared to the enterprise design standard, the fatigue limit of the reducer gear coated with manganese phosphate has been increased by more than 20%. The fatigue limit of the reducer gear after composite small diameter shot peening+WST treatment has been increased by more than 30%. The design life of the strengthened gearbox gears and bearings far exceeds 350000 kilometers. Life tests were conducted on needle roller bearings and cylindrical bearings using carbon nitrogen co infiltration strengthening technology, and the results showed that the fatigue life of the bearings was significantly improved. Through the combination of life verification and finite element simulation data, the

fatigue limit of the strengthened bearing significantly increased under the same test conditions. Through various strengthening measures, the performance of the reducer gears, gearbox gears, and bearings of new energy vehicles has been significantly improved, greatly extending their reliable operating time and service life, and further meeting the requirements for high-speed transmission conditions.

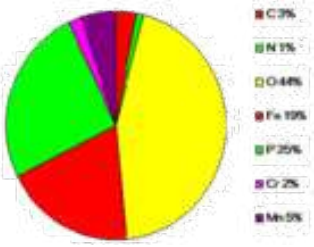
**Keywords:** Intelligent simulation of heat treatment, Manganese phosphate coating, Composite small diameter shot peening, Carbonitriding, Fatigue life



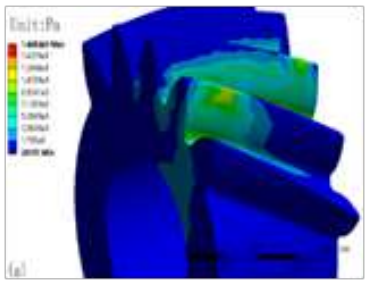
a) Thermal simulation experimental machine

(b) Disk sample before processing

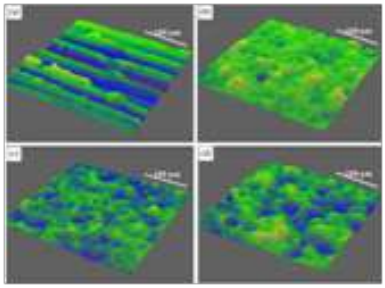
(c) Manganese phosphate coated disk specimen




(d) Distribution of wear surface elements

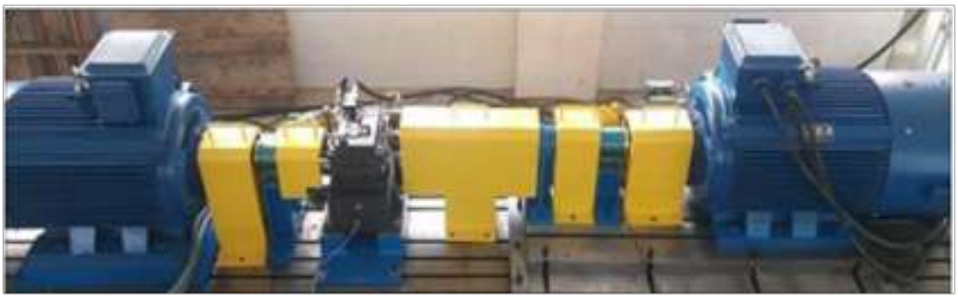


(e) Finite element contact model



(f) Surface morphology after shot peening

(g) High speed performance testing machine for bearings



(j) Gear fatigue durability test bench

## Biography:

Chen Yong is a renowned Professor of Automobile Engineering with a rich academic and professional background. A graduate of Saga University's Mechanical Engineering Department, he earned his Ph.D. there in 1995. Dr. Chen's career includes significant tenure at JATCO, where he held various management roles in Powertrain Development from 1990 to 2008. He further distinguished himself as Vice President and Chief Engineer at Zhejiang Geely Automobile Research Institute until 2015.In 2015, Dr. Chen was appointed as the leader of the New Energy Vehicle Research Center at Hebei University of Technology, reflecting his expertise in vehicle dynamics, powertrain systems, and automotive engineering. His scholarly contributions are extensive, with numerous publications and patents in the field.

# Development of an Intelligent Manufacturing System using Abductive Reasoning

**Anil Kumar Srivastava**
*University of Texas Rio Grande Valley, USA*

## Abstract:

God having omniscient, omnipotent, and omnipresent attributes has designed, automated and now controlling the whole universe in a perfect manner. However, humans have abductive reasoning that starts with an observation or set of observations.

Abductive reasoning is generated within an intelligent mind and provides a hypothesis, adds new knowledge through synthetic reasoning, may provide multiple possibilities in place of a single solution, and may result in hypothesis generation and evaluation. Thus, the 'intelligence' in human minds has a direct impact on design, automation, and control. Perhaps that is why the adoption of artificial intelligence (AI), machine learning (ML), augmented reality (AR), and industrial internet of things (IIoT) have evolved as the 'cutting edge' technologies of the present. Many of its applications are bringing a new era and unique values to many design, automation, and control tasks.

In this keynote speech, Dr. Srivastava will first start with the concept of perfect design, automation, and control of God's creation based on Vedic scriptures and the abductive reasoning within the human mind that is evolving and being used by scientists and engineers in hypothesis generation and evaluation, designing, automating, and developing new control strategies. Finally, Dr. Srivastava will consider the application of 'abductive reasoning' applicable to design, automation, and control of an intelligent robotic grinding process.

## Biography:

Anil Srivastava is currently a Star Professor in the Department of Manufacturing and Industrial Engineering at UTRGV. He received his doctoral degree in Mechanical Engineering from Indian Institute of Technology Kanpur, India. Dr. Srivastava has 30+ years of industry and academic research and leadership experiences in the areas of advanced manufacturing and materials, mainly, focusing on Precision Machining, Sustainability, Composite Materials, Smart Manufacturing, and Sensor Applications to Manufacturing Processes. Dr. Srivastava is member of SME and ASME and also, a Fellow of SME and Fellow of ASME.

# Experimental Study and Numerical Simulation of Heat Transfer Performance of Metal Oxides Nano-PCM Applied in Latent Heat Storage System

**Zulfiqar Khan**
*Bournemouth University, England*

## Abstract:

This paper presents technological and commercial prospects of metal oxides as nano-Phase Change Materials for latent heat storage applications. Both charging and discharging cycles were simulated in a shell-and-tube heat exchanger at controlled temperatures. A horizontal shell-and-tube heat exchanger was fabricated with acrylic shell container and stainless-steel tubes. Paraffin based nano metal oxides were employed for this study. Both charging and discharging performance was investigated at varying of nano additives proportion. Physical model and computational domain were set by choosing phase change temperature, latent heat fusion, density, thermal conductivity, specific heat capacity and volumetric heat capacity. A significant number of nano additives have been studies of which a selection of fourteen nano additives are presented here in terms of their effective thermal conductivity performance with respect to volume concentration. Time step and grid independency tests results in terms of liquid fraction are discussed. Natural convection has demonstrated a significant influence on nano-PCM melting behaviour in a shell container. Peak heat flux showed a corresponding behaviour with an increase in volume concentration. An economic evaluation in terms of commercial significance is presented.

## Biography:

Zulfiqar Khan is a distinguished figure in the field of engineering and research. With a career marked by leadership and innovation, he has served as the Associate Dean of Research & Enterprise and the Director of the University Sustainable Design Research Centre (SDRC). His expertise led him to spearhead the Unit of Assessment 12 (Engineering) during REF2021 and he is currently guiding preparations for REF2027.In 2015, Professor Khan founded the Nano-

Corr, Energy & Modelling (NCEM) research group, fostering a multidisciplinary approach to Nanoengineering & Energy Systems (NES®) in collaboration with industry and academic partners. Professor Khan's contributions to tribology and sustainable development have been recognized with prestigious awards such as the Distinguished Researcher in Tribology Award and the Albert Nelson Lifetime Achievement Award.

# Emerging Innovations in Robotics and Assistive Technologies

**Redwan Alqasemi**
*University of South Florida, USA*

## Abstract:

Recent advances in robotics and assistive technologies offer persons with disabilities new options to expand their abilities to perform activities of daily living and work-related tasks independently or with minimum help. In this keynote, we discuss some of the recent projects at the Center for Assistive, Rehabilitation, and Robotics Technologies (CARRT) at the University of South Florida (USF), including Virtual Reality for Vocational Rehabilitation (VR4VR), Wheelchair-Mounted Robotic Arms (WMRA), Assistant Humanoid Robot, Smart Glasses for Persons with Vision Impairments, and other projects.

## Biography:

Redwan Alqasemi is a distinguished research professor at the University of South Florida's Mechanical Engineering Department and a leading figure at the Center for Assistive, Rehabilitation and Robotics Technologies (CARRT). With a comprehensive educational background, earning his BSc, MSc, and PhD in Mechanical Engineering in 1994, 2001, and 2007 respectively, Dr. Alqasemi has made significant contributions to the field of robotics and assistive technologies.

# Mechatronics for Harsh Environments: A Step-by-Step Approach

**Andrea Cammarano**
*University of Glasgow, UK*

## Abstract:

In the past decades we have experienced more and more the need for sensing and actuation capabilities that can be suitable in harsh and unforgiving environments. The intensification of natural catastrophes (hearth quakes, fires, floods) combined with a renewed attention to the space race, has prompted the design of mechatronic system that can be operated in extreme conditions.

This talk will explore cutting-edge solutions in mechatronics that play a pivotal role in ensuring mission success, efficiency and safety, accounting for the unforeseen and the unknown. Together we will explore how we can exploit the latest finding in material, manufacturing, sensing and actuation to devise innovative solutions that can survive harsh environments. In the research of those solutions will stress the importance of interdisciplinary collaborations and show that machine learning can be a powerful tool to bring together different branches of science and engineering to identify optimised solutions. This talk is complemented by a two-hour workshop where we will explore some of the concepts introduced here in more detail.

## Biography:

I am senior lecturer in System Dynamics and I am part of the SPE group. I graduated from the University of Naples in Aerospace Engineering in 2006. After my degree I worked for two years in acoustics and noise reduction for Ansaldo Breda (high speed train V250) and Piaggio Aeronautica (P180 Avanti). During this period, I nurtured my passion for research and I finally decided to continue my studies by joining the University of Bristol for a PhD. My PhD dissertation was titled “Increasing the bandwidth of vibration-based Energy harvesters”. During these years I developed an interest for nonlinear dynamical systems. After working for the university of Bristol on three projects on nonlinear dynamics, I was appointed as a lecturer in System Dynamics in January 2015.

# Kinematic Dynamic and Energy Characteristics of Three-Dimensional Flow from Ventricle to Descending Aorta

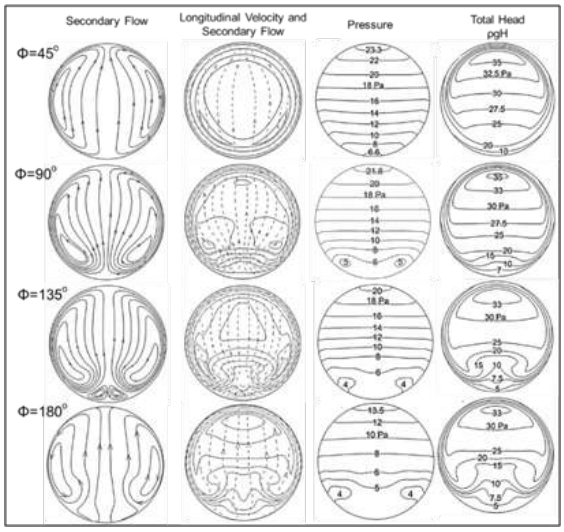
**Tin-Kan Hung**
*University of Pittsburgh, USA*

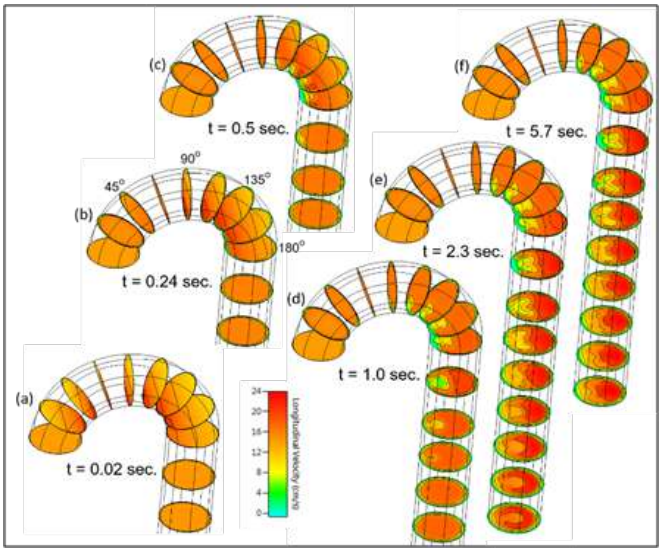
## Abstract:

Numerical solutions of the Navier-Stokes equations are analyzed by longitudinal flow patterns on a sequence section. The effects of acceleration and deceleration during diastole and systole are demonstrated with the ventricle motion. The complexity of 3D hemodynamics is further studied from the transfer of momentum and energy for ventricular contraction and dilation. The non slipping viscous flow does not produce much shearing stress, nor energy losses for normal cardiac pumping. The momentum flux produced by the ventricle wall motion is practically delivered to the aortic root. A ring vortex is formed at the end diastole.

The 3D computational analysis is further compared with a two-dimensional model. Three-dimensional pulsating flow to a 180-degree bend tube without branching flow nor the diameter change is modeled as aorta for acceleration, deceleration, and reversed flow. The secondary flow across sections shows the centrifugal effects associated with the curvature and boundary layer development. The 3D boundary layer development with curvature effects is further studied and compared with the flow establishment by the onset acceleration to steady flow of a Reynolds number Re = 1476. Column 1 in the figure below shows the secondary flow across various sections.

It is also placed with the longitudinal velocity in column 2, the third and fourth columns are pressure and total head distribution. The second figure summarizes three-dimensional boundary layer development for comparing with pulsatile flow in the aorta. The time t=0.02 sec. is the onset acceleration




## Biography:

Hung is a venerated professor of Bioengineering and Civil & Environmental Engineering, with a storied career beginning with a B.S. from National Cheng Kung University in 1959. His pioneering research since 1963 in computational fluid mechanics has earned him the Walter L. Huber Civil Engineering Research Prize and recognition in hydraulics history. A Founding Fellow of AIMBE and Fellow of ASME, Dr. Hung's work spans from heart valve dynamics to neonatal respiratory support systems. His contributions have significantly advanced the understanding and application of fluid mechanics in bioengineering.

# Hand Rehabilitation Robotics

**Fong-Chin Su**
*National Cheng Kung University, USA*

## Abstract:

The hand receives sensory stimuli and executes motor commands that are integrated in the various functional manipulations for daily tasks. Awkward and inefficient finger movements, poor force coordination and strength, sensation deficit of motor control of the affected hands are most common phenomena in patients.

Therefore, our research team developed a series of hand function control training systems to explore characteristics of force patterns when conducting functional tasks and to enable training and assessment of finger force control in functional postures. Patients' motivation is boosted through interactive games, while visual and auditory feedback are integrated for better intervention outcomes. As for the patients with carpal tunnel syndrome, they grasped with greater digit force associated with weaker pair-digit correlation and higher force variability on specific digits in different task demands. Also, the custom-designed computerized evaluation and re-education biofeedback prototype was developed to analyze hand grasp performances, and monitor the training effects on hand coordination for stroke patients with sensory disturbance and without motor deficiency. Finally, training in patients with mild cognitive impairment significantly enhanced hand dexterity and cognitive function, consistent with previous findings that fine motor performance can distinguish patients with cognitive impairments from healthy individuals.

## Biography:

Fong-Chin Su is currently the Executive Vice President and a Distinguished Professor of biomedical engineering, National Cheng Kung University, Tainan City, Taiwan., Mr. Su received several honors and awards including the Life Achievement Award from the Taiwanese Society of Biomechanics in 2018, the National Industrial Innovation Award in 2017, the AIMBE Fellows in 2016, the Fellow of International Academy of Medical and Biological Engineering (IAMBE) in 2013, the Han Wei Medal from the Taiwanese Society of Biomedical Engineering in 2015, and the You-Li Chou Medal from the Taiwanese Society of Biomechanics in 2007. He was the President of the World Association for Chinese Biomedical Engineers from 2017 to 2019 and the Councilor of the World Council of Biomechanics from 2014 to 2026.

# The Innovation and Practice of Green Hydrogen Technology in China Under the Goal of Carbon Neutrality

**Yang Fuyuan**
*Tsinghua University, China*

## Abstract:

China plays an important role in the global development of renewable energy. This speech will discuss the current status and trends of China's photovoltaic and wind power development, innovation in industrial alkaline electrolysis hydrogen production technology, and practical applications of renewable energy wind/solar-hydrogen-storage-utilization P2X engineering. It will share with the participantsthe research progress of Tsinghua University, and display China's efforts to address global climate change issues under the guidance of carbon neutrality goals.

## Biography:

Yang Fuyuan is a prominent educator and researcher at Tsinghua University, Beijing, China. He has an extensive academic background with a B.S. and M.S. in internal combustion engine engineering and a Ph.D. from Tsinghua University. His academic journey at Tsinghua began in 1990, and he has since become a Professor and the Deputy Head in education within the Department of Automotive.

# Simulation and Optimization of Small Solar Thermal Storage Heating System

**Zhenqian Chen**
*Southeast University, China*

## Abstract:

Seasonal thermal energy storage heating technology can store excess solar energy after summer for winter ultilization, which can solve the problem of mismatch between supply and demand of solar energy, also improve the stability of solar system and increase the utilization rate of renewable energy. In this work, a combined long-term and short-term storage heating system with water-to-water heat pump and its operation mode are proposed. The study is carried out by combining theoretical analysis with numerical simulation, and an evaluation index is proposed according to the energy balance among the subsystems. A numerical simulation platform of the system is established and verified by modular modeling. The system operation characteristics throughout the year are analyzed by dynamic simulation.

**Keywords:** Solar energy, Seasonal thermal energy storage, Heat pump, Heating.

## Biography:

Zhenqian Chen is a professor at School of Energy and Environment of Southeast University and the director of Jiangsu Key Laboratory of Solar Energy Technology. He received his PhD in thermal energy engineering from Southeast University in 1995. He has performed postdoctoral research at the Hong Kong University of Science and Technology, Worcester Polytechnic Institute, University of Washington, and University of Toronto. He is also a member of the American Society of Refrigeration and Air Conditioning Engineers, a member of the American Society of Mechanical Engineers. He has published more than 200 journal papers.

# Achieving High Precision Metal Additive Manufacturing with Ultraprecision Machining Enhanced by Mechanochemical Effect

**Hao wang**
*National University of Singapore, Singapore*

## Abstract:

Additive Manufacturing (AM) technology offers an efficient solution for producing functional parts with intricate structures and exploring novel materials. However, the widespread application of AMed parts is impeded by the inherent challenges of poor surface quality and limited dimensional accuracy. Consequently, post-processing and/or in-situ additive/subtractive processes become indispensable. The challenging machinability characteristics of additively manufactured metal parts further hinder quality improvement.

In this presentation, we delve into our recent investigation focused on the machinability of maraging steel fabricated through laser powder bed fusion (LPBF) in ultraprecision machining processes. Our examination encompasses variations in microstructure and mechanical properties achieved through heat treatment and mechanochemical effects. Notably, the cutting forces in machining as-built and solution-treated SLMed samples exhibit a substantial reduction of up to ~53%. This breakthrough offers a promising avenue to enhance the machinability of additively manufactured metal parts.

The findings from this study pave the way for improved integration and the closed-loop nature of additive/subtractive hybrid manufacturing systems. Ultimately, this contributes to the overarching goals of reducing energy consumption and enhancing manufacturing efficiency.

## Biography:

Hao Wang is an Assistant Professor at the Department of Mechanical Engineering, National University of Singapore. He is an Alexander von Humboldt fellow (Germany), JSPS fellow (Japan) and visiting professor at Université Paris 13 and Université Paul Sabatier Toulouse France. Dr Wang has a persistent dedication to research in the physics of ultra precision micro cutting, additive manufacturing, and intelligent manufacturing. His research themes are centralized on pushing the envelope of state-of-the-art precision machining and bridging the gap between additive manufacturing and ultra-precision machining technology.

# Designing Dust-Resilient Robotic Systems for Space Exploration: The Application of Compliant Mechanisms in Extra-Vehicular Activities

**A Cammarano[1*], D. Buszyn[2], K Worrall[1]**
*1 James Watt School of Engineering, University of Glasgow*
*2 ATG Europe / European Space Agency*

## Abstract:

The harsh environmental conditions encountered in space exploration of celestial bodiespresent unique challenges for the design and operation of robotic systems. This study addresses the complications arising from regolith (un-weathered particles found in the Lunar and Martian environment), specifically focusing on their impact on the functionality of robotic equipment during extra-vehicular activities.

The Apollo missions highlighted the detrimental effects of lunar regolith on conventional rigid-body mechanisms, and their effects on exploration activities. To overcome these obstacles, this paper introduces the concept of integrating compliant mechanisms into robotic systems for extra-vehicular use. Compliant mechanisms offer enhanced flexibility, reduce the risk of abrasion and wear, and eliminate the risk of clogging, making them ideal for mitigating regolith-related issues.

The paper explores the advantages and limitations of compliant mechanisms obtained by analytical modelling and topology optimization approaches in connection to robotic solutions. A robotic manipulator arm is used as a case study to evaluate the effectiveness of these design strategies in creating mechanisms that are resilient to particle interference. Our findings not only demonstrate the practicality of compliant mechanisms for robotics in surface missions but also contribute to the broader discussion of dust mitigation techniques for future lunar and planetary missions paving the way to compliant and soft robotics for terrestrial applications in extremely dusty environments.

## Biography:

Experienced researcher and technologist with particular expertise of space systems, control algorithms, and mechatronics for extreme and precision environments, in both academic and industrial environments. My research is related to developing mechatronic systems for extreme (space, underground, Antarctica), precision (medical), and agricultural environments. This work includes research covering control theory to machine learning and work on robotic manipulators to satellites. To date the work carried out has mainly involved collaboration with industry, either working alongside them to create a new solution or supporting ongoing developments

# Multivariable-Multi Objective Optimization of Energy Systems

**Amedeo Amoresano**
*University of Naples, Italy*

## Abstract:

Today, the practice of producing energy from multiple sources is increasingly wide spread. Large and medium-sized enterprises cover their energy needs by purchasing it from the grid and, in part, but with increasing percentages, self-produce it. The most common way to self-produce energy may be to equip oneself with a cogeneration plant. Initially, the tendency of companies was to use internal combustion engines. Today, however, the sources of self-generation present are increasingly diversified thanks to green transition policies and technology that is always ready to provide solutions.

We therefore come across companies that diversify energy production by purchasing it certainly from the grid but also by self-producing it from different types of plants such as an aerobic digesters, fuel cells, photovoltaic plants, etc... An industrial production system therefore has the difficult task of managing as best as possible the different sources on whichit depends. It is therefore necessary to think about energy management that can provide instant-by-instant trade-off solutions with respect to the variables involved.

This is possible through the use of advanced algorithms supported by Muli Objective Genetic Algorithm (MOGA) type systems and/or neural networks supported by Artificial Intelligence (AI) systems that can provideoptimal solutions for managing the different sources. This document presents some applications that illustrate the benefits of managing energy systems using the methods presented.

## Biography:

Experienced Professor with a demonstrated history of working in the renewables and environment industry. Skilled in English, Management, Project Management, Matlab, and Microsoft Excel. Strong education professional with an Engineer's Degree focused in Mechanical Engineering from University of Naples "Federico II".

# The ABC's of DED (Directed Energy Deposition)

**Jill Urbanic**
*University of Windsor, Canada*

## Abstract:

3D Printing, or additive manufacturing (AM), has captured the world's imagination. Complex component designs in the automotive, aerospace and medical industries, jewelry designs, fashion, archeological artifact reconstructions have all shown to be exciting growth areas for AM solutions. However, it is perceived that large, functional metal components can be 'done in one' using a one-button fabrication process, but the reality is not so optimistic. This presentation will introduce you to the directed energy deposition (DED) AM processes family. DED is a bead-based deposition process that is capable of fabricating complete components as well as performing repair activities. DED processes use a heat source to melt and deposit material, which comes in either powder or wire feedstock.

There are four DED subcategories which are characterized by their energy source: laser beam, electron beam, wire arc (WAAM), and plasma arc. DED systems are machine tool or robotic based. Therefore, with DED processes, multi-axis deposition can occur and depending on the system, machining operations can be interlaced. This presentation will discuss processing planning challenges and research opportunities associated with DED AM.

## Biography:

Jill Urbanic is a Professor in the Department of Mechanical, Automotive, and Materials Engineering at the University of Windsor. Dr. Urbanic received her BASc. in Mechanical Engineering at the University of Waterloo. After graduating, she pursued opportunities to work in various advanced manufacturing environments. She has been involved with design, implementation, and support for several types of manufacturing, material handling, testing, gauging and assembly equipment for a variety of engine components and vehicle styles.

# 3D Printing of Field's Metal for Wearable Sensors and Flexible Electronics

**Jerry Y.H. Fuh**
*National University of Singapore, Singapore*

## Abstract:

3D printing technologies can build functional 3D structures with high resolution, high precision, and low cost. Among them, extrusion-based direct ink writing (DIW) is one of the most attractive 3D printing methods, as they have excellent compatibility with a variety of printable materials with various viscosity.

However, traditional DIWs are restricted by low printing speed and are typically unable to print high- aspect-ratio free-standing 3D structures without support. Moreover, conventional printable inks exhibit low electrical conductivity and require post treatments to enhance conductivity, hindering their applications in high performance multifunctional electronics. To address all the gaps, herein, a DIW approach is presented to directly print complex free-standing structures with liquid Field's metal. Field's metal is a eutectic alloy with a low melting point of 62 °C and high electrical conductivity of 2 × 104 S cm-1.

To avoid the beading issue due to the high surface tension of molten metal, the DIW is driven by shear for 2D planar writing and by tension for 3D out-of-plane printing. This technique achieves a high printing speed of up to 100 mm s-1 and shows excellent compatibility with various rigid and soft substrates. Furthermore, rapid solidifying of Field's metal after printing enables direct printing of free- standing structures without support. Free-standing metal wires can be printed at any slope angles from 0° to 90° with high aspect ratio of up to 750 and even horizontal over-handing structures can be printed readily. Various free-standing 3D architectures have been printed, such as vertical letters, cubic frameworks, and scalable helical structures, exhibiting high electrical conductivity, self-healing capability, and recyclability.

To illustrate its versatility in the fabrication of 3D electronics, a multilayer circuit was created for battery-free temperature sensing and hemispherical helical antennas for contact- free vital sign monitoring. The developed DIW printing technology can facilitate the development of high-performance multifunctional electronics

## Biography:

Jerry Fuh, a distinguished professor at National University of Singapore, is a pioneer in Additive Manufacturing, with a focus on biomedical applications since 1995. As the Founding Director of AM.NUS, he has spearheaded cross-faculty research and established advanced laboratories. A Fellow of SME and ASME, and a PE from California, Prof. Fuh has an impressive scholarly output, including 450 papers and 30 patents, and has mentored over 100 graduate students, contributing significantly to the field of advanced manufacturing.

# Studies of Energy Absorption for Interpenetrating Phase Composites with 3D Printed Triply Periodic Minimal Surface (TPMS) Lattice Structures

**Lu Wen Feng**
*National University of Singapore, Singapore*

## Abstract:

The need for highly robust and adaptable structural materials with exceptional strength, energy absorption, and lightweight characteristics has become increasingly essential. Cellular solids are thus often infilled with a soft secondary material, which hence constitutes interpenetrating phase composites (IPCs), to attain improved mechanical properties. Through its continuous morphology, each constituent of the IPCs can effectively contribute their unique characteristics to the macroscopic properties of the IPCs.

Thus, in comparison to traditional composites, the co-continuous nature of the phases in IPCs can provide superior properties. As a result, IPCs have attracted attention of researchers in a diverse range of engineering applications. Inspired by biological systems, the triply periodic minimal surface (TPMS) structures based IPCs is investigated to study the potential of co-continuous polymer materials for enhanced mechanical properties such as energy absorption under different loading conditions. To achieve superior specific energy absorption (SEA) enhancements in the composites, an optimised Schwarz primitive lattice (P-lattice) structure is used by redefining the shell opening diameter with a shape parameter. The compression deformations were modelled using ABAQUS/Explicit to characterize the elastoplastic response of IPCs and investigate interactions between the reinforcement lattice and the soft matrix.

The quasi- static simulations are carried out to extract stress–strain curves subjected to compression. The simulation results show that the internal energy of both lattice and epoxy in composites is 136% and 21%, respectively, higher than that of single structures due to the interaction effects. Further, the influences of fabrication defects, along [100], [110], and [111] lattice directions, on the mechanical responses of the P-lattices and IPCs are studied.

Compression results reveal that the modified P-lattices outperform the original P-lattices with superior compressive strength and SEA. The P-lattices also display the lowest strength and SEA along [100] as compared to that of [110] and [111]. As for the IPCs, up to a 52% increase, from the linear addition of the two-component phases has been achieved for SEA. The IPCs also exhibit a superior specific energy absorption of 49.6 J/g, a 1109% improvement from that of the pure lattice structure, which is attributed to the high strength and large plateau strain of the composites. These findings presented the mechanical response of IPCs under multiple testing methods could pave the way for further exploration into advanced architected composites.

## Biography:

Wen Feng Lu received the Ph.D. degree in mechanical engineering from the University of Minnesota, USA. He was a Faculty Member with the University of Missouri, USA, for ten years. He was also a Group Manager and a Senior Scientist with the Singapore Institute of Manufacturing Technology for six years. He is currently an Associate Professor with the Department of Mechanical Engineering, National University of Singapore (NUS). His research interests include IT in product design, sustainable design and manufacturing, 3-D printing, and intelligent manufacturing. He was a recipient of 1997 Ralph R. Teetor Educational Award from the Society of Automotive Engineers of USA and 2011 ASME Virtual Environments and Systems Technical Committee Best Paper Award.

# Energy Initiatives for Carbon Neutrality in Subtropical Small Islands

**Jun-Ichiro Giorgos Tsutsumi**
*University of the Ryukyus, Japan*

## Abstract:

Carbon neutral is an essential issue in the world. It should be realized in 2050. Okinawa is isolated islands with population of 1.4millions in Japan. It is a suitable district for the case study of carbon neutral islands. Solar energy and biomass energy are suitable for subtropical island environment from geographical viewpoints. Clean energy strategies were made in 2021 to achieve carbon neutrality in 2050 from administrative and political viewpoints, which included high level of solar and other clean energy resources.

The outline of the initiatives is to be reported. However, there is not practical prospect to realize real projects for clean energy. Therefore, some additional examination was considered mainly from macro-viewpoints of energy resources in the whole islands. Transportation fuel or electricity was also examined from CO2 emission. Finally, the results are as follows: Photovoltaic electricity by solar cells of 1.6% of the land area of Okinawa is enough to supply all the electricity. EVs are not always better than HV or PHV from the viewpoint of CO2 emission. Carbon neutral fuels for motor vehicles, vessels and airplanes would be better solution in 2050.

## Biography:

Jun-ichiro Giorgos Tsutsumi was born in Nagano, Japan, in 1954. He graduated from Kyushu Institute of Design, completing his master's program and from the graduate school of Kyushu University's Doctoral program. He was conferred a doctoral degree in engineering in 1987 and was a post-doctoral research fellow at the Japanese Society for the Promotion of Sciences for two years. He was an associate professor at the University of the Ryukyus since 1993 and a full professor since 2002. He worked as a visiting researcher at University of Freiburg, Germany and North Carolina State University in 1996 and as a research fellow at East West Centre, Hawaii in 2001. He retired as a professor in March 2020 and was conferred Professor Emeritus.

# Offshore Energy Utilization and Storage

**Kristina Terheiden**
*University of Stuttgart, Germany*

## Abstract:

The increasing share of renewable energy sources such as solar and wind contributing to the European electricity generation defines the need for effective and flexible energy storage solutions.

The high intermittency and uncertainty of variable renewable energy (VRE) sources limits the predictability and defines ambitious goals with their massive incorporation [1]. Thus, a profound energy storage deployment is needed to compensate for energy curtailments or surpluses in the grid [e.g. 2, 3, 4, 5]. Especially in lowland countries, low head pumped hydro storages in shallow coastal areas are a promising solution to balance peak values of the variable renewable energy supply by simultaneously increasing the flexibility of the energy system [6]. Therefore, promising technologies as e.g. contra- rotating, variable-speed reversible pump/turbines (CR-VS-RPT) are optimized towards a high efficient, sustainable and resilient plant design. The optimization of the RPT units targets the most compact design of the dam/powerhouse construction under highly flexible operating conditions.

Hence, pumped hydro storages become economically viable for grid stabilizing services even in lowland countries. It thus coincidentally contributes to a robust renewable energy system throughout Europe meeting future requirements.

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## Biography:

Kristina Heike Terheiden is a respected academic and researcher currently leading the Working Group on Structural Engineering and Hydropower at the University of Stuttgart. As the Deputy Head of the Department and Head of the group, she focuses on hydraulic structures and hydropower within the Institute for Modelling Hydraulic and Environmental. Dr. Terheiden's work is pivotal in advancing research in energy systems, particularly in the context of renewable energies and their integration into existing infrastructures.

# Design and Implementation of a Bionic Hand, Wrist and Forearm Prosthesis, with Manipulation and Rotation Capabilities, Controlled by Artificial Intelligence Through Myoelectric Signals, Using a Training System in a Virtual Environment to Facilitate Adaptation

**Edwin Alejandro Quinaluisa**
*University of the Armed Forces ESPE, Ecuador*

## Abstract:

This work details the design, construction, and implementation of a bionic hand, wrist, and forearm prosthesis with manipulation and rotation capabilities controlled by artificial intelligence through myoelectric signals, using a training system in a virtual environment to facilitate its adaptation.

A hand, wrist, and right forearm prosthesis was designed by applying computerized mechanical design techniques that resemble the articulated movement of the fingers and the rotation of the wrist, allowing manipulate and rotate objects; The construction of the prosthesis was developed through 3Dprinting using PLA and electric actuators to generate the movements, through the use of myoelectric sensors signals were obtained based on themuscle movement of the patient, these signals were applied in the development of the control logic of the prosthesis through aneural network for autonomy in the movements of the prosthesis, a simulator was designed for training the user by setting a daily environment with activities of daily living of the user, to facilitate their coupling and use of the prosthesis before placing the artificial limb to the user.

After its construction and implementation, functional tests were carried out, obtaining a positive success rate of 85% in the basic movements of the user after training in the virtual simulator.

**Keywords:** Bionic prosthetics, artificial limb, neural networks, myoelectric signals, manipulating and rotating objects.

## Biography:

This Mechatronics Engineer boasts an impressive academic and professional background. With a Master's degree in Automation and Robotics from the Universidad Politécnica de Madrid, he currently enriches the academic community as a Professor at the Universidad de las Fuerzas Armadas ESPE SedeLatacunga. His expertise extends to advising both the ASME Student Branch and the Robotics & Automation Society RAS Chapter of the IEEE Student Branch at the university. Specializing in Automation, Robotics, and Mechatronics, he is a pivotal figure in advancing these fields within the Department of Energy Sciences and Mechanics. His dedication to education and innovation is evident in his commitment to guiding the next generation of engineers.

# Advanced Methods for Battery Storage Optimization with Respect to Electric Grid Flexibilities

**Jan Dahlhaus**
*TWT GmbH Science & Innovation Industries, Germany*

## Abstract:

Electric grids develop an increasing dependence on flexible consumers and providers of electric energy. Combined with smart charging functionalities, the fast responses of battery storage solutions - both stationary and vehicle based – can effectively mitigate this challenge. In this talk we will present solutions developed at TWT in this field, addressing the challenges regarding battery load profiles and the lifetime optimization of battery storages. The application of advanced simulation methods in combination with AI-based approaches to effectively develop and test optimization strategies is the focus of this presentation.

## Biography:

Jan Patrick Dahlhaus has been managing engineering teams for system simulation and Data Science at TWT GmbH Science & Innovation since 2019. His teams' work has been focussed around energy and e-mobility topics for premium automotive OEM customers and innovative research projects in the aviation sector like Clean Sky 2 project LiBAT and OPsTIMAL. His career as an engineer included work in system simulation, data science, function development, rapid control prototyping, software development and project management.
With a PhD in theoretical nanoelectronics from Leiden University and research experience at the University of California, Berkeley, with close to 20 publications in physics he has come a long way from is scientific roots.

# Comparative Analysis of in Situ Ionic Activators for Energy Efficiency Process in Alkaline

**Sladjana Maslovara**
*University of Belgrade, Serbia*

## Abstract:

The ongoing need to reduce hydrogen production cost and increase energy efficiency of the process in the alkaline electrolysersimplied the remarkable research efforts in investigations of cathode performance improvement by in situ addition of ionic activators based on d-metals. The proper selection of d-metals involved and careful optimization of the ionic activator concentration play a vital role in production cost and cathode performance. Therefore, it is important to determine its optimal values via the combination of experimental analysis with DFT modeling, enabling the target design of cathode systems based on understanding of theoretical background and the fundamental properties. The present contribution deals with binary (two d-metals) and ternary (three d-metals) ionic activator systems based on Ni, Co/Cu/Fe and Mo salts on nickel mesh, carbon cloth, stainless steel and nickel plate cathodes. A reduction in the energy needed to produce certain amounts of hydrogen by about 15-20% compared with standard 6M KOH electrolyte, was obtained by the simplified process of the in-situ activation with binary and ternary based ionic activators. Enhancement of kinetics of hydrogen evolution reaction was confirmed in all cases. The DFT modelling of the cathode surface was employed to explain the roles of each metal involved in the observed performance improvement.

## Biography:

Sladjana Maslovara is an experienced Research Associate with a demonstrated history of working in the research laboratory. Skilled in Research and Development (R&D), Hydrogen Production and Storage, Chemistry, Battery and Energy Storage. Strong research professional graduated from Faculty of Technology and Metallurgy, University of Belgrade.

# Filtering Efficiency of Pollutants in Heavy-Duty Vehicle Cabins

**K. Dimic-Misic a,** A. Brkicb, V Spasojevic-Brkic, E. Barcelo Rodrigezd, M. Imania, P. Gane

*a Aalto University, School of Chemical Engineering, Espoo, Finland*
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*cGestamp, Madrid, Spain*
*a,d Mirka Oy, Pietersaari, Finland*

## Abstract:

Quality of air in the cabin of transportation vehicle is of high importance due to increase in globalization that hinders rise of transportation of goods worldwide1,2. The largest source of streets pollution in urban areas is vehicular combustion, constituted mainly of gaseous pollutants such as CO2, CO, oxides of nitrogen (NOx), ozone, and particles such as ultrafine particulate matter (UFP) 3,4. Drivers of heavy-duty vehicles ( HDV) are spending both their working and free time in vehicle cabins, making then highly exposed to toxic gases and hazardous aerosols5. Intensive industrial development is more concentrated in metropolitan areas, and since it still relies on fossil fuels energy, it results in high pollution of air with traffic-related air pollutants (TRAPs)6. Primary sources of UFPs in the urban environment near road sites are caused by HDV, and they enter cabin air through windows, accumulating in the cabin air and on the surfaces, resulting of up to three times higher concentration of TRAPs in cabin than outdoor air7. Exposures to high CO2, NOx and UFP can significantly reduce decision-making performance and is main cause of premature deaths of HDV drivers. i development is to improve use of human-machine interactions3, 6. Sedimentation of UFP onto filter surfaces, long filter exposure times, and high temperatures within cabins cause decrease of air-flow within the filter and drastic decrease of filtering efficiency. By combining experimental results obtained from in-filed measurements performed in the city of Belgrade, during peak traffic hours, for filtration systems (AFS) placed at different positions within the cabins, obtained master present role of air filtration systems3,4,6.

Using analytical approach of experimental results, we propose mathematical model that describes AFS efficiency on cabin pollution mitigation. Predicted results are in close agreement with the experimental data showing that outdoor to cabin pollutants concentration is possible to estimate as it depends on and terrain design, filtration time and thermodynamic parameters within cabin. We hope that this research rises organizational attention to the health and welfare of HDV drivers.

**Keywords:** Heavy-duty vehicle, HDV, air filtration system, AFS, HDV cabins.

## Biography:

Katarina born and educated in Belgrade, Serbia, I graduated from the Faculty of Mechanical Engineering, specializing in Process Technology. As my initial job after graduation was as a sales engineer assistant for Finnish paper producer agent office in Belgrade, where I became interested in paper technology and biomaterials. Upon moving to Finland in 1996, I began postgraduate studies in the field of pulp and paper technology. In 2001, I completed a one-year Linkage Program in Pulp and Paper Engineering at Helsinki University of Technology (HUT), now known as Aalto University. I finished my Licentiate degree in 2012, and Doctoral Degree in 2014, both in the field of rheology and gel phase separation of nanocellulose containing paper making suspension and dewatering.

# Integration of CSI Inverters in Grid Connected Photovoltaic Power Systems, State of the Art

**Roberto Giacomobono,**
*University of Salerno, Italy*

## Abstract:

Inverters are a key part of any grid connected photovoltaics ¬system as they are the interface component between the photovoltaics panels and the grid itself. These converters provide two key functionalities. The first is the capability of working with a sufficiently wide range of voltage and current input to perform Maximum Power Point Tracking (MPPT). The second characteristic is the ability to provide output voltages and currents in compliance with the power grid requests.

The typical topologies for Current Source inverters (CSI), such as single-phase H-bridges, have been present in literature for many years. Still, the adoption of this category of inverters lags behind the more typical voltage source, Z source and quasi-Z source counterparts. One general advantage of the CSI topologies lies in the capability of the inductive DC-link to work as a current filter, thus enabling better overall good power quality on current waveforms, but this is just the most basic advantage. By implementing special topologies, high voltage boost becomes facilitated by the characteristics of the DC link enabling single stage high voltage gain.

Transformerless operation is also achieved in several topologies, enabling lower cost solutions due to less magnetic components. Several multi-level topologies have also been presented, mostly for bigger non domestic applications. Control strategies for CSIs have some peculiarities that in the photovoltaic case also have to account for the interaction with Maximum Power Point Tracking algorithms. This work aims at showcasing the advantages of this class of inverters. The aspects discussed are related to topology, control performance, introduced distortion and general power quality. On the power quality side, compliance to standards such as IEEE 1547 and IEC 61727 is assessed.

## Biography:

Roberto Giacomobono is currently a PHD student in the National Photovoltaics programme managed by the University of Salerno, within this programme.

His current research is focusing on grid connected inverters in Photovoltaics applications.

He has received his bachelor and master's degree in mechatronic engineering at the university of Modena and Reggio Emilia in 2019 and 2022.

Other past and current research activities have involved the development and studies of different topologies of power converters such as LLC and PFC converters and the study of particular topologies of synchronous motors. Industry wise he has collaborated with Tetra Pak packaging solutions on experimental methods for vibration measurements and modal analysis methods in 2018-19 and with the Italian railway system (RFI) for the development of various AC-DC and DC-AC converters (2022).

He is also currently collaborating with the Xenon-nT dark matter experiment, situated in the Gran Sasso national laboratories, for matters concerning the electrical structure of the experiment since march 2023. Furthermore, he is involved in the teaching of electrical machines and drives in collaboration with the electrical machines group of the university of Cassino and Southern Lazio.

# Improving the Fatigue Design of Mechanical Systems Such as Refrigerator

**Seongwoo Woo**
*Ethiopian Technical University, Ethiopia*

## Abstract:

To enhance the lifetime of mechanical system such as automobile, new reliability methodology – parametric Accelerated Life Testing (ALT) – suggests to produce the reliability quantitative (RQ) specifications—mission cycle—for identifying the design defects and modifying them. It incorporates: (1) a parametric ALT plan formed on system BX lifetime that will be X percent of the cumulated failure, (2) a load examination for ALT, (3) a customized parametric ALTs with the design alternatives, and (4) an assessment if the system design(s) fulfil the objective BX lifetime. So, we suggest a BX life concept, life-stress (LS) model with a new effort idea, accelerated factor, and sample size equation.

This new parametric ALT should help an engineer to discover the missing design parameters of the mechanical system influencing reliability in the design process. As the improper designs are experimentally identified, the mechanical system can recognize the reliability as computed by the growth in lifetime, LB, and the decrease in failure rate.

Consequently, companies can escape recalls due to the product failures from the marketplace. As an experiment instance, two cases were investigated: 1) problematic reciprocating compressors in the French-door refrigerators returned from the marketplace and 2) the redesign of hinge kit system (HKS) in a domestic refrigerator. After a customized parametric ALT, the mechanical systems such as compressor and HKS with design alternatives were anticipated to fulfil the lifetime – B1 life 10 year.

## Biography:

Woo has a BS and MS in Mechanical Engineering, and he has obtained PhD in Mechanical Engineering from Texas A&M. He majors in energy system such as HVAC and its heat transfer, optimal design and control of refrigerator, reliability design of thermal components, and failure Analysis of thermal components in marketplace using the Non-destructive such as SEM & XRAY. In 1992.03â€“1997 he worked in Agency for Defense Development, Chinhae, South Korea, where he has researcher in charge of Development of Naval weapon System. He was working as a Senior Reliability Engineer in Refrigerator Division, Digital Appliance, SAMSUNG Electronics. Now he is working as associate professor in mechanical department, Ethiopian Technical University.

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