AEROSPACE-2024

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PANGEA GLOBAL EVENTS

2nd International Conference on

Aerospace and Aeronautical Engineering

Dates : March 21-22, 2024

Venue : Florence, Italy

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 Aerospace & Aeronautical Engineering (AEROSPACE-2024) and the 2nd International Conference and Expo on 3D Printing and Additive Manufacturing (3DPAM2024), scheduled to take place in Florence, Italy from March 21-22, 2024.

AEROSPACE-2024 & 3DPAM2024 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 AEROSPACE-2024 & 3DPAM2024 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 Aerospace & Aeronautical Engineering, as well as 3D Printing and Additive Manufacturing . 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 Aerospace & Aeronautical Engineering & 3D Printing and Additive Manufacturing .

COMMITTEE

Organizing Committee Members

Daniele Iannarelli	Sapienza University of Rome, Italy
Nicolae Crainic	Polytechnic University of Timisoara, Romania
Darren McKnight	LeoLabs University, USA
Ioan SzÃ¡va	University of Brasov, Romania
Rima Hleiss	CESI Graduate School of Engineering, France
Matteo Benedetti	University of Trento, Italy
Shi-chune Yao	Carnegie Mellon University, USA
Ana Beatriz Lopez	EWF, Portugal
Maj Mirmirani	Ohio University, USA
Teodor Lucian Grigorie	University POLITEHNICA Bucharest, Romania

Cyberpsychology, and Its Influence on the Aviation Sector in the Future

Ian McAndrew
Dean at Capitol Technology University, USA

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:

An internationally recognized leader in research and expert on low-speed flight, Dr. McAndrew has five degrees: a PhD, two master's degrees and two bachelor's degrees. He is a Fellow of the Royal Aeronautical Society. Dr. McAndrew chairs several international conferences and journals and is invited to give keynote speeches all over the world. He started his career in the automotive industry as an engine designer, and has worked at several universities across the globe. Dr. McAndrew is Dean of doctoral programs at Capitol Technology University. An external examiner on the world wide stage (UK USA, Germany, Italy, Jordan, Japan, Australia, Greece and Kenya) his experience includes over 115 successful Doctorate successes.

Digitalisation of Material Science – Advancing Additive Manufacturing

Geoffrey Mitchell
Polytechnic Institute of Leiria, Portugal

Abstract:

The technology of 3D printing has moved rapidly from rapid prototyping to rapid manufacturing within the framework of Industry 4.0. Additive manufacturing based on metals is now widely deployed in the aerospace industry and in the tooling industry due to the significant weight savings which can be made using additive manufacturing and through topology optimization as well as the freedom in design. Plastic parts manufactured using 3D printing are now common place with the capability to produce large sized plastic parts from a range of high-performance materials. There are now growing applications in dentistry and medicine. This increased rate of use of direct digital manufacturing to produce commercial products takes place within the backdrop of the major societal challenge of climate change. There is now an increased realization of the need to make wider use of sustainable materials in the manufacturing of products with a much-reduced carbon footprint.

One of the key advantages of digital processes is the ability to optimize the design and fabrication with respect to a target function. In current 3D printing it is common to perform optimisation to minimize the mass of the part. In a full digital work flow, thiscan be performed with respect to other targets such as carbon footprint, or product lifetime. To perform such upgrades it will be necessary to incorporate the materials in to that digital workflow. It is a major challenge to develop a universal approach to the digitalization of Materials. This is particularly the case given the broad range of materials in use. Moreover, in the 20th century we have realized that that the properties and performance of a material not only critically depend on its chemical composition, but also on the distribution of those atomic elements in the microstructure of the material and the texture of the microstructure. Although there are promising developments with simulations of metal alloys and polymers, there is no method which is available for such material optimisation to be incorporated and automated in the work stream of direct digital manufacturing. In other words, current digital tools, such as computer-aided engineering software, do not predict the local properties nor the morphologies of a material within a defined product geometry produced by a specific manufacturing processes. Instead, their approach centres on the simple and often incorrect assumption of isotropic and homogenous properties

throughout the part.

This presentation is focused on the development of a structure which enables the integration of the processes of material synthesis, characterization, material enhancement, product design and fabrication into a single automated workflow. We will identify the topics where considerable development is required, and how current methodologies can be adapted. We will introduce the concept of morphology or property mapping. We explore how we can use this approach to raise the scope and standards of the full manufacturing process from synthesis to fabrication to yield high value products with novel designs closely linked to the spatially resolved digital specification of the material. This approach will clearly enable the development of digital twins for the whole manufacturing cycle from raw materials selection, synthesis, characterization, product design and fabrication, which we believe in the future will extend to the future life cycle and end of life processes of reuse and recycle. The presentation will be illustrated with data from biopolymers. This work was financially supported by the Fundação para a Ciência e a Tecnologia FCT/MCTES (PIDDAC) through the following Projects: MIT-EXPL/TDI/0044/2021, UIDB/04044/2020; UIDP/04044/2020; Associate Laboratory ARISE LA/P/0112/2020; PAMI - ROTEIRO/0328/2013 (Nº 022158), plus EcoPlast, Materiais compósitos eco-sustentáveis para substituição dos plásticos convencionais, ref POCI-01-0247-FEDER-069002, and INNOV-AM funded by National Agency of Innovation).

Keywords: Industry 4.0, Design, Digitalisation of Materials, Digitalisation Polymers

Biography:

Geoffrey Mitchell is Professor and Vice-Director of the Centre for Rapid and Sustainable Product Development at the Polytechnic of Leiria in Portugal. He is Adjunct Professor at the Sri Jayachamarajendra College of Engineering, Department of Polymer Science and Engineering in Mysore Indiaand Visiting Medical Physicist Oxford Univeristy Hospitals NHS Foundation Trust, Oxford UK. Geoffrey Mitchell carried out his doctoral work at the University of Cambridge in the UK and subsequently held a post-doctoral fellowship at Cambridge and a JSPS Fellowship at Hokkaido University in Japan. Prior to his current position he was Professor of Polymer Physics at the University of Reading, UK and from2005 the founding Director of the Centre for Advanced Microscopy at Reading. His research work bridges physics, biology, chemistry and technology and he is passionate about the opportunities afforded by Additive Manufacturing. He is a Fellow of both the Institute of Physics and the Royal Society of Chemistry as well as the Royal Society for the Encouragement of Arts, Manufactures and Commerce and a Member of the Institute for Physics and Engineering of Medicine.

Demystifying Orbital Debris Hazard Trends in Low Earth Orbit (LEO)

Darren McKnight
LeoLabs University, USA

Abstract:

The accumulation of space debris in low Earth orbit (LEO) is a complicated exercise that is obscured by news headlines of massive constellations "darkening the skies." In reality, the orbital debris hazard trends have been obfuscated by a lack of empirical data and analytic tools resulting in public misconceptions being promulgated even to the point of driving regulatory and policy efforts to potentially counterproductive positions. Three key areas of contention will be covered: (1) the lack of regulatory and policy instruments to keep pace with technology advancements; (2) the lack of rigor when dealing with collision risk (i.e., people forget that risk is equal to probability times consequence); and (3) recent trends in poor mitigation practices are overshadowed by the historical stockpile of "Cold War" derelicts abandoned in LEO. A fact-based discussion will be provided clarifying how constellations of operational satellites, clusters of derelict objects, and clouds of breakup fragments have evolved over the lasty 66 years to create a treacherous debris environment in LEO.

Biography:

Dr. Darren McKnight is currently Senior Technical Fellow for LeoLabs. Working closely with partners and customers throughout the industry, he creates new data depictions, develops risk algorithms, and leads space incident investigations.

As a member of the International Academy of Astronautics' Space Debris Committee, Darren has been active in position paper development, selection of symposia papers, and execution of the annual International Astronautical Congress. His current focus is on developing technical solutions and encouraging global behavior that leads to sustained space operations assurance through limiting the risk of debris collision hazard to space systems in Earth orbit.

Thixotropic Metal Processing and 3D Printing of Zinc and Magnesium Bio-Alloys for Biomedical Implant Applications

Jack Zhou
Drexel University, Philadelphia, USA

Abstract:

This research is to explore a novel manufacturing system that is capable of thixotropically processing and 3D printing of zinc and magnesium bio-alloys. Zinc and magnesium bio-alloys are highly demanded in medical implanted devices for their biodegradability and high strength. However, current 3D printing techniques encounter a substantial difficulty in fusing powders from such bio-alloys owing to vaporization and oxidization under high power laser. Lack of a direct printing process greatly hampers the use of zinc and magnesium bio-alloys in customer-tailored treatment and cure. To overcome this hurdle, a new thixotropic 3D printing methodology is proposed to allow zinc and magnesium bio-alloys to be directly printed into accurate 3D shapes. The new technology is expected to dramatically impact skeletal and soft tissue fixation tools, vascular inflation stents, and bone tissue scaffolds. This would lead to a revolutionary improvement particularly in orthopedic, spinal and vascular surgery by providing patient-tailored medical devices that are strong and biodegradable/absorbable in vivo. The new process may also be adapted to fabrication of aluminum-based alloys for broad industrial applications.

Biography:

Jack G. Zhou received the B.S. and M.S. Degrees mechanical engineering and automation from Jiaotong University, China. And the Ph.D. degree in mechanical and industrial engineering from the New Jersey Institute of Technology, USA, in 1993. He is currently a Professor of Mechanical Engineering and Mechanics with Drexel University, Philadelphia, PA., and His research interest are CAD/CAM, computer integrated manufacturing systems, rapid prototyping, system dynamics, and automatic control. He was elected as an ASME Fellow in 2011.

Sustainable Aerospace Talent Pipeline; Training Tomorrow's Workforce, Today

Tammera L. Holmes
Aerostar Avion Institute, USA

Abstract:

Tammera L. Holmes is an award-winning, international presenter and inspirational speaker. Her solutions for youth aviation and aerospace education as a way to kickstart early workforce development, and dramatically increase matriculation into high-skilled, in-demand employment opportunities amongst diverse candidates, has established her a global thought leader in aviation workforce sustainability. With an aviation career spanning nearly three decades, Dr. Holmes has studied the cyclical woes of recruiting, hiring then retaining a strong aviation workforce. And for all of it's ups and downs, aerospace has yet remained at an altitude that is unparalleled amongst industries; encompassing technology, science, social ethics, advanced mathematics and even popular culture. The critical workforce issues facing our world are surmountable, only if we start NOW and start YOUNG!

The International Aerospace Engineering Conference is thrilled to present this session dedicated to the ever-evolving landscape of aerospace employment and industry demands. As we stand at the cusp of major technological and economic shifts, the aerospace and aviation sectors are primed for transformative growth. This growth, however, demands a parallel evolution in workforce readiness, diversity, skills, and education.

Dr. Holmes' comprehensive dialogue will navigate through the most recent industry demand forecasts, painting a realistic picture of the future employment opportunities and challenges within aviation and aerospace. Essential to meeting these challenges is the strategic alignment of recruitment and training processes to attract a diverse cadre of professionals, reflective of the globalized nature of our industry.
In a sector defined by its rapid technological advancements, possessing the right skill set is paramount. Our discussion will shed light on the divergent skills vital for industry-critical roles, elucidating on the blend of technical acumen and soft skills indispensable for tomorrow's leaders. A focal point of this session will be the exploration of job recruitment and training strategies, highlighting the licenses, certifications, and credentials which are becoming ever more essential in a competitive market. Exploring the role of higher education coupled

with this will be an examination of best practices in training, a comprehensive overview of associated education costs, and the return on investment for both individuals and corporations. The conversation will further emphasize the imperative of establishing robust funding mechanisms to ensure a seamless transition from academic realms to industry floors. This 'school-to-work' pipeline is a cornerstone for nurturing future aerospace talents, and its importance cannot be overstated.

Lastly, we urge corporations to recognize their pivotal role in this ecosystem. Their active involvement in inspiring, training, and mentoring is not just a corporate responsibility but a necessity for the continued growth and innovation of the aerospace sector.

We invite individuals with a deep understanding of these dynamics, a forward-thinking perspective, and actionable insights to attend this thought provoking and awe-inspiring presentation. Dr. Holmes urges global industry to grasp this unique opportunity to shape the future of the aerospace workforce and to empower industry leaders to take meaningful steps toward ensuring a resilient, diverse, and skilled workforce for generations to come.

Biography:

Tammera L. Holmes has served as President & CEO ofAeroStar Consulting Corporation in Chicago, Illinois since 2008, and in 2016, Holmes launched her non-profit, The AeroStar Avion Institute to begin opening doors for youth in a career field that for most is still very foreign. Her focus is to get more youth and young adults, African Americans, females, and other under-represented populations onto pathways in STEM careers, particularly in the Aerospace industry. Her workforce strategies and innovative thought leadership has been proven to promote access to, and persistence in jobs within Aviation and Aerospace. She is an upstanding role-model in the community and a global leader in the Aviation industry. Her programs and strategic solutions are literally giving "Wings to Dreams."

Primary Photochemical Processes Involved in 3D Printing by VAT Photopolymerization

Xavier Allonas
Laboratory of Macromolecular Photochemistry and Engineering, France

Abstract:

Photopolymerization reaction is developed and studied for a long time and has led to important industrial achievements. Although that many photoinitiating systems have been proposed over the years and that the photopolymerization mechanism has been understood since a long time, one can quite often observe a real difficulty to link the primary processes occurring in the excited states and the actual properties of the materials created [1-2]. This paper aims to give some examples on how the photochemical processes control the properties of the photopolymers obtained through vat photopolymerization. In this paper, it is shown that the photopolymerization of a photosensitive resin containing various concentrations of photoinitiator and photoabsorber allows the prediction of the depth of penetration Dp [35]. Real-time FTIR kinetics of photopolymerization allows the evaluation of the critical energy Ecexp. More interestingly, the in-depth conversion can be predicted from conversion-time curve over a multi-layer printed object. As shown by measurement performed by confocal Raman microscopy, the z-anisotropy in conversion can be predicted from RT-FTIR kinetics curves. Similarly, the effect of overcure can be taken into account, showing the interest of this approach.

Biography:

Xavier Allonas, PhD in 1995 on photoinduced electron transfer mechanism at the Department of Photochemistry in Mulhouse (France). Short post-doctoral training at the Institute of Physical Chemistry of Fribourg in Switzerland on picosecond transient grating spectroscopy. In 1996, Assistant Professor at the Chemistry Institute of Mulhouse (Ecole Nationale Supérieure de Chimie de Mulhouse). Full Professor at the University of Haute Alsace in Mulhouse in 2003. Since 2006, head of the Laboratory of

Macromolecular Photochemistry and Engineering. Current research interests are the processes involved in photopolymerization studied through time resolved laser spectroscopies, real-time FTIR and molecular modelling. A particular interest is paid to the study of photoinitiating systems reactivity and photopolymerization kinetics for different applications such as laser imaging, paints and coatings, photocomposites, 3D printing.

Strategies for the Airline Industry on the African Continent

Tilmann Gabriel
African Aviation and Aerospace University, Nigeria

Abstract:

The African Continent is lacking behind in air traffic and therefore all related industries. The European and Middle-Eastern Airlines are dominating the international air traffic in Africa, inner-continental connections are marginal. While the aviation industry is providing 3-5% of a countries GDP on average, most African countries have less than 1% GDP contribution from the aviation industry. One outstanding exception is Ethiopia, with its very successfully managed Ethiopian Airline, as a group providing meanwhile more than 7% to the country's GDP.

The African Union with its 2063 agenda is pursuing an open-sky Afrika for all African registered airlines, to promote the air traffic in Africa and together with visaless borders, envisions a continent with free trade and easy travel for all Africans.

The paper will analyze the risks and opportunities for African states and its airlines, and how the rest of the world can contribute to this endeavour, without being seen as another colonializing force. What is the secret of Ethiopian Airlines, its strategies, and which African countries could copy this strategy.
For all aviation industry partners, Africa becomes a highly interesting market, not in the sense of a 'student' society using the older equipment, but as partners who need the appropriate support, financing and entrepreneurial innovations suitable for Africa.

The author uses his long-standing and current experience in Africa aviation to develop key strategies. As founding Vice Chancellor of the first public African Aviation & Aerospace University (AAAU), the author is developing research capabilities amongst the many highly skilled Africans who want to bring their nation and continent forward, starting in aviation and aerospace.

Biography:

A former senior aviation executive and Training Captain for 20 years with 12,500 hours, Prof. Tilmann Gabriel has managed sustained growth for leading airlines, as well as start-ups, Airports, MRO, business jet, helicopter operations, aircraft manufacturers and large training operations. As Director of the renowned Master Programmes for Aviation Management of CITY, University of London, Prof. Gabriel has led hundreds of aviation employees to a Master degree. As member of the ICAO CBTA Task Force to design the new pilot licenses based on Core Competencies, Gabriel focuses on the combination of Bachelor programmes with the ICAO Annex 1 licenses. In Nigeria, he currently serves as the founding Vice Chancellor of the first African Aviation & Aerospace University, opening in September 2023.

With leadership experience in European, African, American, and Middle Eastern markets, Gabriel remains a key innovator in airlines and aviation companies and reinforces a safety culture environment while cultivating leadership, integrity and individual responsibility. Gabriel was contracted as transaction advisor to the Nigerian Government for the business plan, privatisation and start-up of Nigeria Air.

Urban Air Mobility, Challenges, and Promise

Maj Dean Mirmirani
Ohio University, USA

Abstract:

Urban Air Mobility (UAM) refers to the use of small, near autonomous flight vehicles to carry passenger or cargo at low altitudes in urban and suburban areas, which requires them to have certain features and characteristics including vertical-takeoff-and-landing (VTOL), distributed electric or hybrid-electric propulsion, and near autonomy for navigation and control. They typically use multiple electrically powered rotors or fans for lift, propulsion, and attitude control. They must be quiet and extremely reliable and safe to be able to operate in urban environment. In addition, significant ground and operations infrastructure must be envisioned and developed to enable their commercially viable operation.

For UAM to fully realize its promise, it requires the confluence of autonomy and other enabling technologies - including high-energy density batteries, distributed and quiet electrified propulsion. For it to become commercially viable, a supportive ground infrastructure must be developed. It must also achieve extreme operational reliability to satisfy stringent aviation regulatory requirements, be certifiable, and gain public acceptance. This paper presents high-level insightful perspectives on all aspects of UAM, as well as challenges to overcome for this potentially disruptive technology to become a reality.

An examination of the underlying physics that will enable the flight of a UAM vehicle, two critical technologies appear as major barriers to surmount. First, the energy density per weight of the current batteries would not allow battery-only-powered aircraft to go at the combination of speed and range for practical application. Significant progress has been made in battery technology and manufacturing in recent years. State-of-the-art in lithium solid state batteries, which use thin electrolytes that carry lithium ions between electrodes can pack a lot more energy per weight and volume. Innovative fabrication processes such as additive manufacturing have enabled production of batteries with energy and power density 2-3 times what is available today, however still insufficient for a practical all-electric air vehicle. Also, for attitude control of heavy eVTOL aircraft, the distributed propulsion must also produce adequate control authority with sufficient bandwidth, placing significant demand on batteries as well as

design and engineering of the rotors. Unfortunately, such improvements in battery output is not on the near horizon. A combination of batteries and highly efficient internal combustion engine into a smartly designed, multidisciplinary-optimized hybrid electric powerplant is the answer in the near term. In a recent Boeing-sponsored project, an interdisciplinary team of researchers at Embry-Riddle Aeronautical University's Eagle Flight Research Center developed a prototype of such powerplant with larger than four times demonstrated energy and power density of the best battery technology in existence. As more than 250 companies around the world race to develop and produce commercially viable UAM, Embry-Riddle has been able to demonstrate the UAM viability by building a manned experimental aircraft with distributed electrical propulsion and helicopter rotor blades, the PAV-ER, an eVTOL with a distributed propulsion system of 8-rotors, which employs cyclic propeller pitch for transition between vertical to horizontal flight modes – one of the main challenges for such vehicles.

Also, a perquisite to achieving high levels of reliability and autonomy is having onboard fault management (FM) capabilities. An onboard fault management system must be able to detect anomalies, faults, or failures, identify the type when they occur, and through onboard algorithms and real-time computations determine their severity and take action to achieve continued acceptable system performance – all in real time. Although significant advances have been made in failure detection, identification, and recovery (FDIR) systems, including the ongoing research at Embry-Riddle on immune system inspired FDIR, these systems are not ready for prime time and FAA certification in UAM. Additional research and development need to be done before UAM certifiable full or near-full autonomy could be achieved.
In 1943, a LIFE Magazine writer proclaimed that "After the war is over… the helicopter may well become the average man's flying machine to be used — not right away but inevitably — much as the average man uses his automobile." There are several reasons that seventy-seven years onward this prediction has not yet been realized. Chief among them are that the helicopter is not as easy to control compared with the automobile and thus not safe enough for UAM type application and more importantly, rotor noise remains a persistent problem – the same main barriers to the widespread use of UAM.

Like their close sisters, helicopter, rotor noise remains a persistent problem in widespread use of UAM. Rotor noise (when blade tip Mach numbers are below transonic) results from four different effects: thickness noise (fluid displacement by the rotor blade), loading noise (rotating of the blade forcing lift and drag), blade-vortex interaction (blade interacting with the tip vortex of the preceding blade), and broadband noise (due to ingestion of atmospheric turbulence, interactions with rotor wake turbulence, and scattering of turbulence over the trailing edge). UAM vehicles have lower Mach numbers and Reynolds numbers compared to a regular helicopter resulting in higher amounts of loading noise and, most importantly, broadband noise. That is why design and engineering of the blades for low noise remain an important engineering endeavor for widespread use of UAM. It is estimated that a 15 dB reduction compared to a helicopter of the same weight class must be achieved to bring UAM noise to the level of automobile traffic in an urban environment. To achieve such significant reduction, noise must be accounted for in preliminary/conceptual design phase. It is also unclear if new FAA noise certification regulations will be introduced, which will significantly delay the widespread use of UAM.

Finally, UAM, when it surmounts the above-mentioned technological challenges, will become a global phenomenon and tremendous business opportunity, more akin to commercial airline flight than general aviation. As most of the largest and congested cities in the world are outside the U.S., they are the most desirable early markets for UAM. Even if its market will remain limited to just the premium business travel segment, a fleet of more than 500 aircraft would be needed to serve the demand in a typical major city. This may represent a small fraction of the total travel needs and have negligible impact on surface travel volumes, but it represents a major growth market for aerospace. The premium business travel market segment alone could utilize more than 200,000 aircraft globally -- gigantic from a conventional aerospace perspective, but modest number of vehicles when looked at from an automotive viewpoint. Indeed, supply chains for UAM aircraft will look more like McLaren or Ferrari production than Ford or Toyota's manufacturing. The market will likely require up to $20 B of annual aircraft production and sale upon maturity, our research at Embry-Riddle indicates.

Biography:

Dr. Maj Mirmirani is currently serving as the Interim Dean of the Russ College of Engineering and Technology at Ohio University, a position he has held since June 2022. Prior to assuming his leadership role at Ohio University, he was the dean and a professor of Mechanical Engineering at Embry-Riddle Aeronautical University's (ERAU) College of Engineering at Daytona Beach Florida from 2007-2022. Embry-Riddle is the world's largest and most prestigious university specializing in aviation and aerospace. Prior to joining ERAU, Dr. Mirmirani was a professor of Mechanical Engineering at California State University, Los Angeles (CSULA). At CSULA, in addition to serving as the chair of the department for twelve years, he was also a co-director of the NASA-funded SPACE Center and the director of the Multidisciplinary Flight Dynamics and Control Laboratory, which he founded in 2000 – a laboratory funded by multi-year multi-million-dollar grants and contracts from the Air Force Office of Scientific Research, NASA Armstrong Center, Jet Propulsion Laboratory, and the National Science Foundation.

3D Printing Technology as an Accelerator for Education

Maria Mavri
University of the Aegean, Greece

Abstract:

Three-dimensional (3D) printing refers to a technological procedure that turns computer-based digital files into solid objects. This study attempts to explore to what extend 3D printing could be used as a learning and educational tool, assisting students to understand mathematics, history and raise their awareness about culture and environment. We claim that the use of 3D printing in education will revolutionize the methods and concepts related to education and will assist students to gain a better understanding of scientific and experimental concepts. In this paper, we present the results of two distinct projects, funded by European Commission, which run at three primary schools in Greece, Italy and Portugal during the last four years (2019-2023).

The first project with acronym name 3D-ReMath, aims at assisting students from three European countries to better understand mathematics and raise their environmental awareness, through the use of innovative technologies and applications. Students participating in the program were not only able to better understand mathematics but also got acquainted with 3D printing technology and recycling, as they were encouraged to reduce-reuse-recycle products and familiarize themselves with an innovative fabrication technology. In other words, 3D-ReMath creates a synergy among potentially different educational models, demonstrating that concepts such as collaboration and innovation can coexist to serve a common purpose.

The second project, named 3D4CE, was taking actions that helped raise pupils' awareness on the importance of cultural heritage through education, learning and participation of pupils in activities of manufacturing 3D monuments using 3D printing and 3D scanning technology. 3D printing is an innovative technology that encourage pupils to increase their imagination and empowered their skills and creativity as it increases their ability of thinking - designing and producing. Via 3D printing kids learn the concepts of measure, scale, sketch, manufacture and they tried to print small or large objects, identical objects, or objects with small differences from the initial object.

A total number of 1300 students and 55 teachers participated in these two experiments and as indicated by the research results, 3D printing could modify both mathematical literacy and cultural heritage syllabus and improve the students' capabilities and skills.

Biography:

Maria Mavri is Professor of Quantitative Methods in the, Department of Business Administration at University of the Aegean at Greece. She is currently Member of Board of Directors at the University of the Aegean, while from 2018-2022 was Vice Rector of Research and Life Long Learning at the same University. She holds a first degree in Mathematics from the University of Athens, a MSc degree in Decision Sciences from Athens University of Business & Economics and a PhD in Operational Research from the same University. Her scientific interests apply in the field of 3D Printing, Operational Research, Linear and non-linear Programming. She has presented her research work in international conferences and she has published research papers in scientific journals such as 3D Printing and Additive Manufacturing, Omega, Journal of Science and Technology Policy Management, International Transactions in Operational Research, Knowledge and Process Management, International Journal of Consumer Studies. She is project coordinator at four projects, related on the role of 3D printing at education, funded by European Commission. Since 2022 she is member of the Regional Board of Research and Innovation of North Aegean, She had also worked as Scientific Advisor at National Strategic Reference Framework 2007-2013, and as Project manager in Greek Information Society Observatory in projects which are funded from the operational program "Information Society" and "Digital Convergence".

Enhancing Runway Incursion Prevention Strategies Using Multi-Actor Multi-Criteria Analysis (MAMCA) Model

Awad Khireldin
Singapore Institute of Technology, Singapore

Abstract:

Runway Incursion (RI) is a serious safety incident that could lead to a catastrophic consequence. it can occur due to a variety of factors, such as miscommunication between pilots and air traffic controllers, confusion about assigned runway, failure to follow procedures, and inadequate training. Although not all runway incursions are reported or even unnoticed, the International Civil Aviation Organization reported that there was a total of 665 runway incursions worldwide in 2019 (ICAO,2020). Pilots, air traffic controllers, airport operations specialists, air navigation aids engineers, among many other aviation main players have been participated through group discussions and interviews for this research. A Multi-Actor Multi-Criteria Analysis (MAMCA) model has been established to assist the decision makers for proposing the best mitigation strategies and to prioritize the different defences to eliminate and/or mitigate the arise risk to save passengers, crew, aircraft, and assets.

Biography:

Dr. Awad currently is an assistant professor at Singapore Institute of Technology (SIT), he was an assistant professor at Embry-Riddle Aeronautical University (ERAU-Asia), Singapore, March 2016 till 2019. He has been working as an aviation instructor for more than 20 years in the Middle East, Africa, and the Asia for many aviation academies/authorities. He supervised many M.Sc. & Ph.D. dissertation at many universities. He was a general manager of training at the Egyptian Aviation Academy (EAA) in 2009, general manager of Air Traffic Management (ATM), Vice head of operations at Cairo international airport (CAI), Egypt, he had joined the aviation industry for more than 25 years as an airport operations officer and been selected by the Airport Council International (ACI) as “Airport Operations and Safety Assessor”. He has a Ph.D. in Operations Research, a master’s degree in airport modeling & simulation, Cairo University, Egypt.

Exploiting Machine Learning Techniques to Predict the Stainless Steel Density Produced by Selective Laser Melting Additive Manufacturing

Rima Hleiss
CESI Graduate School of Engineering, France

Abstract:

Porosity is one of the inherent defects that results from the Selective Laser Melting (SLM) additive manufacturing technique. The porosity related to fusion-solidification kinetics, results most often from non-optimally or poorly controlled manufacturing parameters. The density, a porosity indicator, affects the mechanical properties of the manufactured material (fatigue strength, cracks, deformations, etc.). Stainless steels are among the first materials developed by SLM because of their various industrial applications. Therefore, obtaining high-density steels remains very challenging and important to minimize the porosity impact on the mechanical properties. Nowadays, researchers are using machine-learning models to predict the rate of porosity or the maximum density of these materials as a function of the manufacturing parameters.

This work brings the advantage of machine-learning-based techniques such as artificial neural network, K Nearest Neighbor algorithm, and auto-encoder into additive manufacturing. The authors propose advanced techniques to develop their models, which predict the density of stainless steels given manufacturing parameters including laser power, scanning speed, hatch spacing and layer thickness. They validate their models using two indicators: the mean squared error and the coefficient of determination.

Keywords: Smart Additive Manufacturing, Selective Laser Melting, Machine Learning, Stainless Steels, Density Prediction.

Biography:

Rima Hleiss is a lecturer/researcher in computer engineering and Additive manufacturing with a passion for climate and environment. Over the course of my career, I have had the privilege to develop skills in Big Data, Machine learning, Artificial Intelligence, Networking, and I thrive on teamwork and research. With almost twenty years of experience in the higher education, I am proud of maintaining positive classroom atmosphere, having a significant impact on the education of my students, guiding and supporting them to succeed in their academic and professional journeys. I am also proud of building positive relationships with my colleagues and fostering collaborative and supportive academic environment. I am motivated to stay up to date with advancements in the engineering higher education and I am eager to take on new challenges. My colleagues often describe me as positive, collaborative, innovative, critical thinker, problem solver and elegant. I kindly welcome connecting with like-minded professionals and explore potential collaborations.

GPV - Geocosmic General Planetary Vehicle for Near Space Industrialization (THE USPACE PROGRAM)

Anna Telegina
Astroengineering Technologies, LLC, USA

Abstract:

Astroengineering Technologies, a perspective and ambitious company is managing the global geocosmic program uSpace aimed at saving the Earth from ecological disaster by taking all the harmful industry out of the planet. Despite the project's globality and scale all its reasons and preconditions are formed by absolutely Earthly needs – the environmental problems humanity has already faced. Exactly space is the principal focus of current eco problems solution and the main vector of further industrial development. However, it will be possible only if there is an energy-efficient, environmentally friendly and safe geocosmic transport system that will be able to provide industrial-scale cargo and passenger transportation while reducing its cost compared to rockets by at least a thousand times. Astroengineering Technologies company has an effective solution for such transport system which is General Planetary Vehicle (GPV) designed to promote the industrialization of space by using its advantages: vacuum, extremely low and high temperatures, weightlessness, energy and raw materials. The launch of the GPV will start a new era of civilization development by near space industrialization and will open new challenges for transnational policy and governance.

Biography:

The coordinator of global geospace project - program uSpace aiming at providing conditions for transportation of global harm industry into near space by non-rocket transport. Information & Communications Bachelor - Belarussian State University.

The uSpace program will make a tremendous breakthrough in space exploration. The unique concept will be interesting for scientists, production business owners and managers, technologists, environmentalists and investors - people who are searching for innovative unique solutions to invest, work and collaborate effectively for the benefit of our common goal - saving life on the Earth.

Welding of Thermoplastic Composites at TWI

Chris Worrall
TWI Ltd, UK

Abstract:

The recent years have seen a renewed interest in thermoplastic composites for high-end applications, especially aerospace, where their high performance is required and higher material cost is affordable when amortised over high volumes. The predicted production rates for single-aisle aircraft exceed the current economic production capabilities of thermoset composites, which rely on long autoclave cycles to cure the thermoset composite parts. The aircraft manufacturers face the dilemma of choosing between meeting the high production rates by returning to heavier, mainly metal structures and finding and developing a new, alternative, out-of-autoclave technique suitable for composite materials. Compared to thermosets, thermoplastic composites (TPCs) can offer shorter processing times to meet rising production rates, with potential additional benefits of good solvent resistance, unlimited shelf life and better toughness (impact resistance). Whereas thermoset composites contain resin systems that must go through a lengthy chemical cure process in order to produce a structural cross-linked composite matrix, thermoplastic composites can be processed more rapidly by heating the polymer matrix sufficiently to permit thermo-forming, in a process similar in concept to stamping of sheet metal components.

This makes TPCs an attractive option for the aerospace industry, but as yet there has not been a significant uptake of TPCs for structural applications. One reason behind this has been joining. Although the use of composite materials can offer near net-shape manufacturing, there is often a requirement for joining of components, for various reasons such as; it is more cost effective, components are too large to be produced as a whole, hybrid materials are used that require different production conditions, or parts are made in different physical locations. In aircraft, thermoset composite parts are traditionally joined by mechanical fastening; a process that requires making a hole and inserting a fastener to transfer the load between the parts. The fastening methods currently in use have been adapted from those used to join metal structures, as the aircraft industry has considerable performance data and confidence in the techniques.
Unlike thermosets, however, TPCs can be joined by fusion bonding (welding); a process that does not cause damage by making holes (and therefore cutting load bearing fibres) for the

fasteners, and offers further advantages in terms of weight saving, through removal of the fastener, and speed, through removal of a hole-drilling step. Welding of thermoplastic composites is any process that heats the interface to a temperature above the glass transition temperature, Tg (for amorphous polymers) or the melting point, Tm (for semi-crystalline polymers). Under the application of pressure, the polymer chains are able to diffuse across the interface, forming a welded joint on cooling. The process can be quick, and requires little or no surface preparation. Since the introduction of thermoplastic composite materials such as APC-2 (AS4 carbon fibre reinforced Polyetheretherketone, or PEEK) in the 1980s, many studies have been carried out on fusion bonding of TPCs using techniques such as induction, resistive implant and ultrasonic welding. Out of the many fusion bonding techniques available these three have been the subject of many research studies as they are considered most suitable for industrial applications. The three commonly referenced applications of welded thermoplastics in the aerospace industry are; the J-nose leading edges of the Airbus A340 and A380, the vertical stabiliser of the Gulfstream G650 jet, and the A380 fixed wing leading edge skins.

Resistive implant welding involves trapping an electrically conducting implant between the two parts to be joined, and then resistively heating the insert by passing an electric current through it. The implants are frequently made of metal in wire, braid or mesh form, although they can be non-metallic materials such as carbon fibres. The equipment is relatively simple, comprising a power supply and pressure application system. However, as with any implant welding technique there is a consumable, the implant, which remains in the weld after completion. This may cause performance issues and may create problems with non-destructive testing (NDT) of the joint during manufacturing and routine maintenance inspections.
Ultrasonic welding is a fast, clean and reliable process well suited to mass production. It involves the use of high frequency mechanical sound energy to melt the thermoplastic parts at the joint line. Although a very successful process for joining unreinforced thermoplastic parts, ultrasonic welding has limitations when applied to large reinforced composite structures. The technique is best suited for small area joining such as a spot welding.

In induction welding, heat is generated through Joule losses from the induced eddy currents formed in a susceptor implant in response to the applied alternating magnetic field. Many composite structures rely on a quasi-isotropic layup to achieve the required mechanical performance. Consequently, there are often sufficient conducing paths for eddy current to form and induction heating to take place. As the aerospace industry makes extensive use of carbon fibre composites due to their excellent specific properties, induction welding is ideally suited as a joining technique for aerospace components. However, induction welding of carbon fibre containing thermoplastic composites causes heat generation throughout the laminate, with more heat generated in the layers closer to the work coil (depending on the layup). This non-uniform heat distribution can lead to degradation of the surface of the composite if not controlled.

TWI has investigated composite welding techniques for the past 40 years. As a member based organisation, these projects were confidential and none of the results have been published, until now. This presentation will discuss several welding techniques and show how TWI has contributed to the growth in aerospace joining technologies, and plans to continue this in the years to come.

Biography:

For the last 13 years Chris has been responsible for helping TWI's Industrial Members solve some of the problems they face with exploiting the benefits of composite materials, using his experience and expertise to deliver composites joining, and structural integrity projects. He has spent 10 years in Japan working in the automotive, aerospace, renewable energy and rail transport industries, and lecturing at a university. Before leaving the UK, Chris worked in a research laboratory on the processing of novel thermoplastic composite materials, manufacturing failure analysis, and developing novel testing and analysis methods for composite materials.

Additive Manufacturing in Architecture Focus on Robotic Printing and Joint Fabrication Case Studies

Hiroki AWAJI
Asahi Building-Wall CO., LTD.

Abstract:

Overview of 3D printing and additive manufacturing in architecture

Analysis of past cases:

Twenty-six cases of 3D printing and additive manufacturing in architecture over the past 10 years were extracted and analyzed. From the analysis of these cases, we focus on four aspects specific to additive manufacturing in architecture: "Creation and Remake of End-effector," "Continuous Process from Design to Fabrication," Expansion of Scale" and "Application to Joints" (Chapter 1). In addition, two projects conducted by the author as examples of putting these aspects into practice are described in detail in Chapters 2 and 3.

Table 1: Analysis of past cases

Year	Project	Material	Scale	Machine type
2014	Stik Pavilion	wood	M	original
2014	Remote material composition	clay	M	original
2017	Ceramic INformation Pavilion	clay	S	industrial robot
2017	Communication Landscapes	plastic	S	gantry
2013	Mini Builders	cement	S	original
2017	Gemert bicycle bridge	cement	L	gantry
2017	Madrid 3d-printed bridge	cement	L	gantry
2018	Cloud Pergola	bio material	M	industrial robot
2018	Cloud Village	plastic	M	industrial robot
2018	Apis Core 3D Printer	cement	L	gantry
2018	MX3D Bridge	metal	L	industrial robot

Year	Project	Material	Scale	Machine type
2018	Large-Scale 3D Printing	cement	S	industrial robot
2018	Rock Print Pavilion	stone	M	original
2019	Concrete Choreography	cement	M	industrial robot
2019	Deciduous	plastic	M	gantry
2019	Aguahoja	plastic	M	industrial robot
2019	On Site R0botics	clay	M	industrial robot
2019	Architecture of Continuity	clay	M	industrial robot
2019	Slim-crete	cement	M	gantry
2020	Digital Bamboo	metal	M	gantry
2020	ITE Shotcrete 3d Printing	cement	M	industrial robot
2020	Cobod 3d printing	cement	L	gantry
2020	LACTM	cement	S	industrial robot
2021	Striatus Bridge	cement	L	industrial robot
2021	Tecla	bio material	L	gantry
2021	Branch technology 3d printing	cement	L	industrial robot
2022	Core Winding Reinforcement for SC3DP	cement	M	industrial robot

Creation and Remake of End-effector

One of the characteristics of projects using additive manufacturing in architecture is that they "make or modify their own tools. Unlike other industries, architecture is a one-product industry, requiring different materials, construction methods, and shapes for each project. For this reason, designers and engineers do not continue to use a single high-performance tool, but rather adjust tools (industrial robots, self-made tools, etc.) on their own to achieve their ideal design.

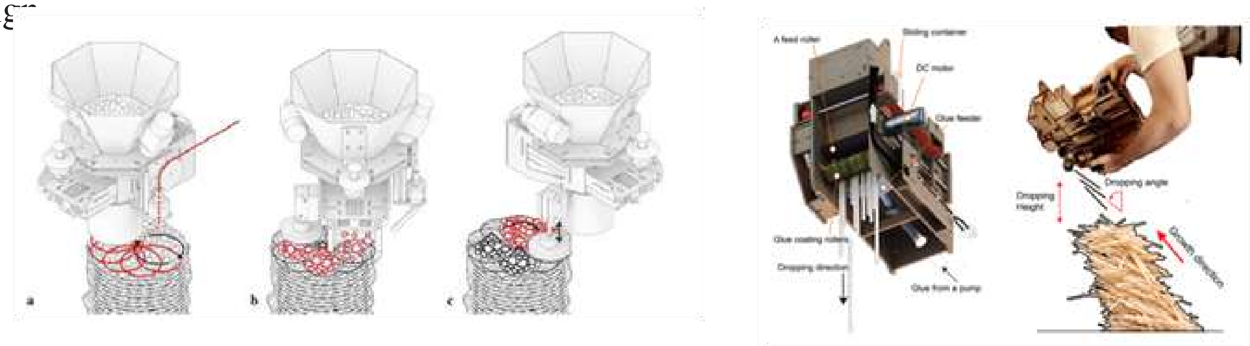

Figure 1: Creation of End-effector (Rock Print Pavilion , Stik Pavilion)

Continuous Process from Design to Fabrication

Additive Manufacturing in construction often uses industrial robots such as KUKA and ABB with end-effectors to perform extrusion. Rhino+GH is beginning to be used as software to operate such industrial robots. Rhino+GH is also software that architectural designers and engineers use for 3D modeling and visual coding, enabling an integrated process from design to 3D printing. For example, it is possible to parametrically modify the print geometry while taking into account the possibility of fabrication by 3D printing.

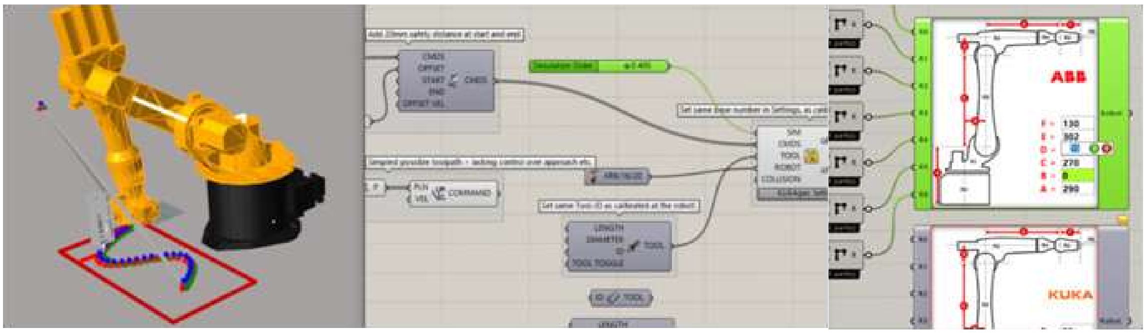

Figure 2: Robotic control using Grasshopper Plug-ins

Expansion of Scale

One of the most significant challenges for additive manufacturing in architecture is the limitation imposed by scale. A solution to this scale problem is to make the machine that prints mobile, which would enable the fabrication of large-scale structures by attaching tires or caterpillars to the 3D printing robot to expand its printable range. In addition, by increasing the number of robots to print, printing time can be reduced even when the scale is large.

Figure 3: Mortar printing using cooperative mobile robots (Nanyang technological Univ. , Technical Univ. of Berlin)

Application to Joints

From an economic point of view, it is often reasonable to use additive manufacturing to manufacture some parts of a building instead of using additive manufacturing to manufacture the entire building. In architecture, joints where various components are connected tend to be complex, and if these joints can be fabricated by 3D printing, the flexibility of the overall shape of the building can be dramatically improved.

Figure 4: 3D printed metal joint connecting different shape bamboo rod

Case 1: Robotic fabrication for Clay Printing

What follows is an example of an integrated process from design to manufacturing and the use of multiple robots to enable new way of additive manufacturing practiced by the author. One of the challenges in additive manufacturing is the difficulty of making apertures. To solve this problem, a new additive manufacturing method (Model II and Model III) was tried using collaboration between a robot and a human (Model I) and two robots, one to install the aperture and the other to print accordingly.

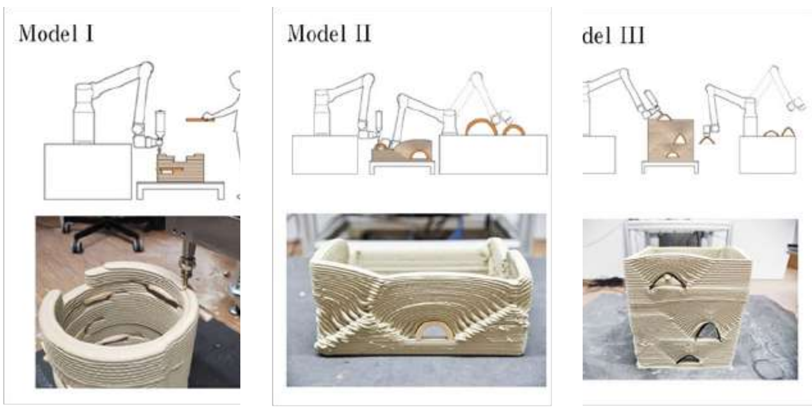

Figure 5: Trial of three different printing methods

Form definition, such as defining the position of the arch and designing the print shape, is connected to the fabrication program through an API called "compass fab" that can be run on Rhino+GH, realizing a consistent process from design to manufacturing. This continuous process, along with the designer's ability to program and adjust tools to match the shape, enables digital craftsmanship in which materials, tools, and forms are integrated.

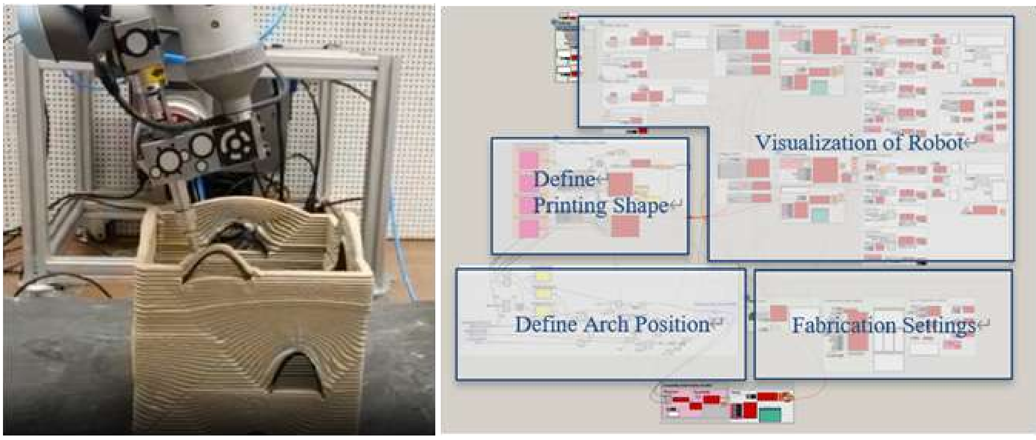

Figure 6: Adjustment of the printer head angle (left), Design and Robot Control UI (right)

Case2: Joints of Membrane Tensegrity Pavilions

The following examples illustrate the application of 3D printing to joints with complex geometries. In the first, Pavilion FUGU, more than 50 joints with different shapes were manufactured by 3D printing TPU to realize a complex membrane tensegrity structure inspired by the pufferfish skeleton. All these joints were designed semi-automatically using Rhino+GH to match the number and shape of the rods.

Figure 7: Membrane Tensegrity Pabiliion (FUGU, 2023)

One of the problems with the joints produced in FUGU was that they took too long to print. Therefore, a method to reduce the volume of the joint by generative design and shorten the printing time was tried in the pavilion at IASS2023. By inputting the loads applied to the joints, an organic shape was found that minimized the volume to the extent that the resulting stresses were below acceptable values, and that shape was printed. This generative design approach reduced the material cost and print time per joint by more than half.

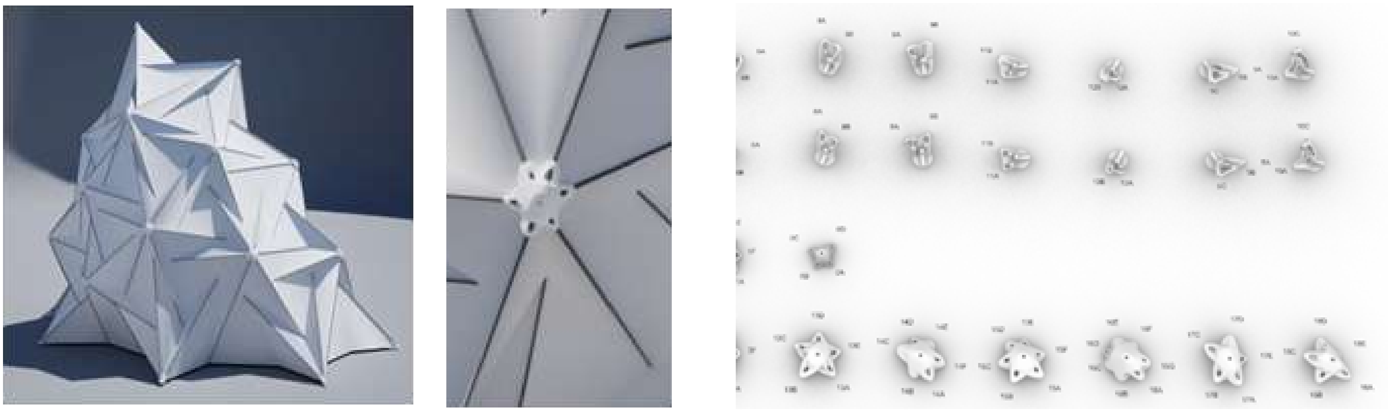

Figure 8: Design of Generative Designed Joints

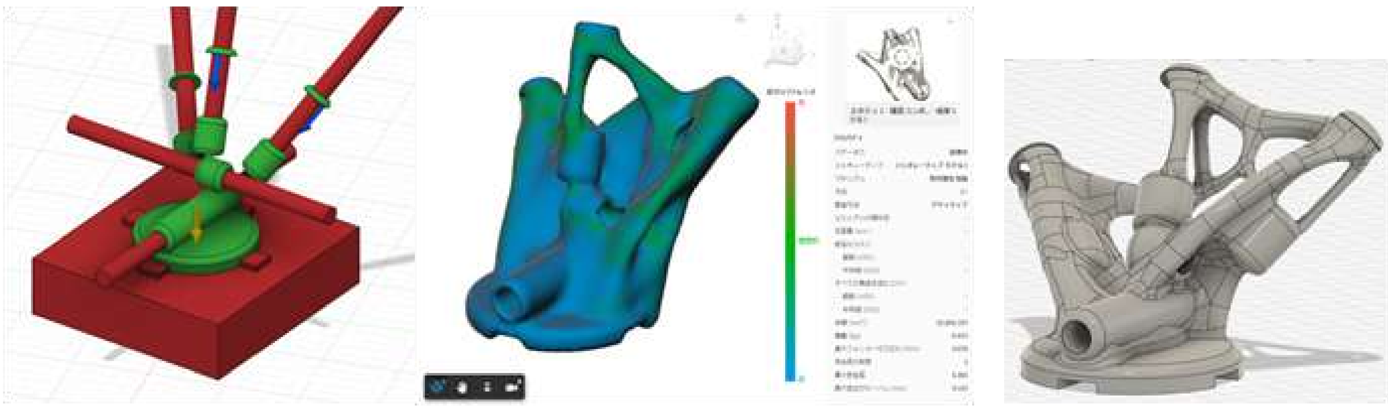

Figure 9: Design Process of Generative Design

Finally, a 3m square pavilion with membrane tensegrity + TPU joints was constructed. While the effectiveness of the generative design was confirmed, several issues were discovered, including the consideration of stresses applied during construction and the anisotropic nature of the 3D printed materials.

Figure 10: IASS Pavilion 2023

Biography:

Hiroki Awaji is a faÃ§ade engineer, designer, researcher in Asahi Building-Wall Co., Ltd. He received the M.E. degree in architectural application of digital fabrication from University of Tokyo in 2022. During an exchange program at the Technical University of Munich, he studied additive manufacturing, primarily clay printing. His master thesis received several awards from Architectural Institute of Japan, Architectural Informatics Society and so on. He is currently engaging in design, engineering and technological development of complex shaped faÃ§ade elements using smart manufacturing methods. The main theme is the reorganization of design, engineering, and craft using digital technology, thereby opening to society a craft-like, instinctive, and tactile architecture that until now could only be realized under some special conditions.

CMCs as Promising Materials for the Aircraft Gas Turbine

Edvin Hevorkian
University of Life Sciences in Lublin, Poland

Abstract:

The structure and properties of composite materialsfor engine gas turbine based on nanopowders alumina, zirconium dioxide and silicon carbide in the process of hot pressing by electroconsolidation are investigated. The results of researches of the influence of structure parameters and phase composition on the microstructure, physical and mechanical properties of zirconium dioxide composites obtained by electrosintering (electroconsolidation) are described. It has been established that the formation of a composite structure due to the introduction of nanopowders of alumina and zirconium dioxide into the nanopowder of silicon carbide makes it possible to increase some of the physico-mechanical properties of the obtained composite materials for gas turbine engines.

Biography:

Edvin Hevorkian Doctor of Engineering Sciences, professor of the Faculty of Production Engineering, University of Life Sciences in Lublin. Research interests: development of multifunctional composite materials based on refractory compounds and metals, powder metallurgy. Processing, Nanomaterials Synthesis, Nanostructured Materials, Nanoscience, Nanofabrication, Functional Materials, Ceramic cutting tools, Engine material.

Preliminary Results on Additive Manufacturing Improvements by means of the Advantages of the Modern Dimensional Analysis

Ioan Szava
University of Brasov, Romania

Abstract:

One of the most significant requirements of a given product's competitiveness design consists of its optimal correlation between its stiffness and the utilized amount of material. In this respect, the design engineers are looking for different theoretical and experimental methods in order to obtaining the best solution. The Additive Manufacturing technology offers wide range of 3D printing modalities, not only to involve different kind of materials, but also, between others, foreseeing different fibre-arrangement and deposition. The authors conceived, based on the incontestable advantages of the Modern Dimensional Analysis, elaborated in 90's by prof. Thomas Szirtes, an original approach of this products' stiffness optimisation. The elaborated model law, validated by several meticulous experimental investigations, offers several useful correlations between the prototype's (i.e.: the final product) and the assigned reduced scale model's geometrical parameters and mechanical behaviours. By performing searching experimental investigations on the assigned model, by applying the model law, became possible to foreseen (to predict) the real-scale prototype's response on the applied mechanical or thermal loading. The model law also assures the stiffness optimisation of the final product by means of changing of the involved ribs geometry and orientation, the filling percentage as well as the utilizable (usable) material. The authors' further goal consists in extending the research area on the optimisation of mould-forms used in plastic material components fabrication, mainly for in demand spare parts.

Biography:

Ioan Száva is retired professor since 2019. Between 2000 and 2019 was full professor in Mechanical Engineering Department from Transilvania University of Brasov, Romania. In 1993, he got his PhD in Internal Combustion Engines for Automotive Engineering, from the Transilvania University of Brasov, Romania. In 2001 became PhD leader, having eight finalized PhD thesis and one actual/active PhD student. He was active educational staff member along 45 years at the same Transilvania University of Brasov, starting from the assistant, lecturer, associate professor, as well as full professor. He performed lectures and applications in Strength of

Materials, Mechanical Vibrations and Experimental Methods of the Solid Bodies. His research interest include: (a) stress-strain states of solid bodies subjected to loads applied in static-, quasi-dynamic and dynamic conditions; (b) classical experimental methods (strain gauges-, Moiré-fringes-, etc.), as well as modern ones (ESPI/Shearography, Video Image Correlation) involved in mechanical characteristics evaluation of steel, human tissues, wood-based, and composite materials; (c) fire resistance evaluation of the unprotected- and protected (with intumescent paint) steel structural elements, involving different experimental methods as well as of the Modern Dimensional Analysis; (d) Additive Manufacturing products' stress-strain states- and stiffness optimisation by means of the Modern Dimensional Analysis. He is author and co-author of more than 75 journal papers and 153 conference articles. He gave some invited and plenary lectures abroad. He currently activates as PhD leader at the same university, having also several international scientific co-operations based on the afore-mentioned topics.

Numerical Dissipation Control in High Order Methods for Compressible Turbulence: Recent Development

Helen M.C. Yee
NASA Ames Research Center, USA

Abstract:

This paper describes recent advances in high order finite difference method (FDM) development for adaptive numerical dissipation control in long time integration of direct numerical simulation (DNS), large eddy simulation (LES) and implicit LES (ILES) computations of compressible turbulence for gas dynamics and MHD. The focus is on turbulence with shock waves numerical simulations using adaptive blending of high order structure-preserving non-dissipative methods (classical central, Pade (compact) and dispersion relation preserving (DRP)) with high order shock-capturing methods in such a way that high order shock-capturing methos are active only in the vicinity of shocks/shear waves, and high gradient and spurious high frequency oscillation regions guided by flow sensors. Any efficient and high-resolution high order shock-capturing methods are good candidates for the blending of methods procedure. Typically, the adaptive blending of more than one method falls under two camps: Hybrid methods and nonlinear filter methods. They are applicable for unstructured finite volume, finite element, dis-continuous Galerkin and spectral element methods. This work represents the culmination of over 20years of higher order FDM developments and hands-on experience by the authors and collaborators in adaptive numerical dissipation control by the "high order nonlinear filter approach". Extensions of these FDM versions to curvilinear nonuniform, freestream preserving moving grids and time-varying deforming grids were also developed. By examining the construction of these two approaches the nonlinear filter approach is more efficient and less CPU intensive while obtaining similar accuracy. A representative variety of test cases which compare the various blendings of high order methods with standalone standard methods will be illustrated.

Biography:

Her work concentrated on numerical algorithm development in high order high-resolution shock-capturing methods and low dissipative high order methods for highspeed shock/turbulence/combustion interactions for gas dynamics and MHD systems. She and her international collaborators also worked extensively in the area of "Dynamics of Numerics for Computational Physics", which has important implications on the interpretation and reliability of complex nonlinear numerical simulations in general and on the numerical prediction of flow transition by DNS in particular.

Graphene based Inks for 3D-printed Scaffold for Bone Tissue Engineering

Mariana Ionita
Politehnica University of Bucharest, Romania

Abstract:

The overall objective of the current work is to improve health in society by introducing unique approaches to bone regenerative medicine that not only improve implementation of existing bone substitute therapy for the serious complication of bone grafting / regeneration of functional tissue / bone augmentation but provide transition from conventional regenerative medicine to integrative, personalized regenerative medicine.

Several tissue engineering strategies attempt to overcome limited self-regenerating capacity of human skeleton. The most common mimics the natural process of bone repair by delivering a source of progenitor cells and three dimensional biocompatible, bioresorbable and osteoconductive scaffolding matrices.
In this context we targeted fabrication of individual patient right bone substitute for the enhancement of bone healing and prevention of bone non-unions with a very promising market potential using on the one hand simple fabrication technique i.e. lyophilization and on the other hand the more complex 3D printing method. The aforementioned methods were used for the fabrication of new forms of scaffolds that not only imparts osteoconductive properties but can more specifically control multilineage differentiation through specific features thus providing osteoinductive properties.

Several, 3D scaffolds potentially attractive for bone repair based on biopolymers (gellan, chitosan, or gelatin), and graphene derivatives were proposed and investigated under the complex condition envisaged by real-life bone repair application. Our studies demonstrated that graphene derivatives act as a supporter of osteogenesis in virtue of two grounds, cell friendly chemistry and cell-detectable micromechanical stimuli distributed across the matrix. Our research focused also on developing novel printable formulations using our previous experience based on different biolopolymer e.g. gelatin, chitosan and gellan matrix that integrate graphene oxide (GO) particles for mechanical properties reinforcement. Using 3D printing technology and the aforementioned composite inks we fabricate bone-like scaffolds. The addition of GO

to hydrogel inks enhanced not only the compressive modulus but also the printability and scaffold fidelity compared to the pure biopolymer system.
The authors would like to thank for the financial support provided by a grant of the Ministry of Research, Innovation and Digitization, Executive Agency for Higher Education, Research, Development and Innovation, project number PCE 103/2022.

Keywords: Bone regeneration, Ink formulation, 3D printing

Biography:

Prof. Mariana Ionita - Steering Commitee member, was educated at top level universities (Politecnico di Milano, Technical University of Denmark, Universita degli Studi di Milano) and gained her PhD in Chemistry and in Bioengineering (Politecnico di Milano, 2008). She has carried out very active research mirrored by 78 published peer reviewed papers (ISI), has over 1800 citations and h-index 22. As a result of her research activity, she also published 4 book chapters and is the editor of a book all of them related to biomedical field. She has coordinated 8 scientific grants/project and participated as project coordinator in more than 10 national and international grants (FP6-NMP3-CT-2005-013644, FP6-MEST-CT-2004-504465 and FP5 HPMT-CT-2001-00314). Prof. Ionita was the co-coordinator GRABTOP (A novel graphene biosensor testing osteogenic potency; capturing best stem cell performance for regenerative medicine), one of the most important project in medical engineering field, co-financed from the European Regional Development Fund with the main objective to improve the health status in society by creating an innovative medical device, biosensor type, as a foundation in the development of Products for Advanced Medical Therapies. Her research interests are related to design and development of biomaterials for medical applications, 3D modelling platform and biomaterial-cell interaction, computer aided material design and characterization, design of separation membranes for biomedical applications, graphene-based biomaterials for bone regeneration.

Nano Magnetic Composite Materials with Polymer Matrix Obtained with the Help of Magnetic Nano Fluids

Nicolae Crainic
Polytechnic University of Timisoara, Romania

Abstract:

The presentation will outline the particularities through which our research team managed to provide systems and methods for the dispersion of nanostructures in composite materials with the help of Magnetic Nano Fluids (MNF).

The researches have started with the idea to exploit the possibility to achieve the new materials in the context of Nanotechnology Constructions, with the aid of the inclusion of Magnetic Nano Fluids.

The present work addresses a new category of nanocomposite materials obtained using Magnetic Nano Fluids and polymer resins. The samples were prepared from combinations of an unsaturated polyester resin and Magnetic Nano Fluids with different carrier liquids.

Magnetic fluids, also known as ferrofluids, are ultra-stable colloidal suspensions of ferromagnetic particles – e.g., magnetite (Fe3O4) – in various carrier liquids. The ultra-fine magnetic particles in the (30 –150)Å range, "integrate" themselves within the carrier liquid structure. The colloid stability is assured even in strongly non-uniform magnetic fields.

The objective of our research is to give insight into future research using MNF's in composites processing technologies. It is important to understand how the MNF interacts with the host material, both at the level of induced changes in processing variables and final property changes in the resulting nanocomposites.

The motivation for this research was the possibility of obtaining new nanostructured materials, introducing Magnetic Nano Fluids in a conventional composite material, using the resin transfer moulding (RTM) process and to take advantage of magnetic nanoparticle orientation during processing, by action of an external magnetic field. Therefore, the anisotropy of the material could be tailored to adjust to a specific application of the part being processed.

Several reasons support the use of Magnetic Nano Fluids to introduce the nanostructured phase

during processing. Magnetic Nano Fluids contain magnetic nanoparticles with the required dimensional distribution and are very well dispersed in a resin compatible carrier liquid. Additionally, in the presence of a magnetic field during the polymerization process and as a result of, magnetic field - magnetic dipole and, dipole – dipole interactions with the fluid nanoparticles, composites with a chain-like ordering of nanoparticles, may arise.

The polymerization process took place with and without magnetic field. We investigated the magnetic properties of these solid samples with the measurement of magnetic field parallel and perpendicular to the polymerization magnetic field, the microstructure of the samples, and, the mechanical properties (three points bending test, elastic properties, gel time determination, etc.) corresponding to different preparation methods.

The target of these investigations is to obtain new materials having magnetically controllable mechanical properties.

Biography:

Her work concentrated on numerical algorithm development in high order high-resolution shock-capturing methods and low dissipative high order methods for highspeed shock/turbulence/combustion interactions for gas dynamics and MHD systems. She and her international collaborators also worked extensively in the area of "Dynamics of Numerics for Computational Physics", which has important implications on the interpretation and reliability of complex nonlinear numerical simulations in general and on the numerical prediction of flow transition by DNS in particular.

Plasma Source Design Method for a Nagoya Type III Geometry

Daniele Iannarelli
Sapienza University of Rome, Italy

Abstract:

The current study aims to propose a rational method for designing a plasma source made with a Nagoya type III antenna. Starting from the study made by Chen [1] on the plasma ionization by helicon waves, a new method for the design of a Nagoya type III antenna is proposed based on the helicon waves theory [2]. A realistic geometry for the antenna is considered within electromagnetic simulations made with the COMSOL software. The full-wave simulations are made to estimate the electric and magnetic fields distributions inside the antenna and to find the optimal dimensions of the Nagoya type III antenna. A parametric analysis of the antenna dimensions is performed from which it is selected the antenna's geometry with the maximum coupling with the plasma, the latter estimated by the maximization of the real part of the antenna's impedance. The optimum geometry of the helicon source is chosen for the design of the plasma source itself that is at the basis of an helicon thruster design.

Biography:

Bachelor degree in aerospace engineering at La Sapienza University of Rome with thesis on 'Performance and trajectory analysis of sounding rockets' Master degree in space and astronautical engineering at La Sapienza University of Rome with thesis on 'Simulations of the optimum truncated real nozzle, in presence of viscous turbulent boundary layer'

Second level master degree in space transportation systems: launchers and re-entry vehicles at La Sapienza University of Rome with stage in AVIO and thesis on: 'Functional model of H2O2 monopropellant attitude control system' Research period (PhD) Horizon 2020 at FAU University on the project: 'optical measurements for fuel mixing in constant volume chamber (CVC)'

Special master degree in aerospace engineering at the School of Aerospace Engineering at La Sapienza of Rome with thesis on 'Optimization of the combustion efficiency for hybrid rocket engines' PhD at La Sapienza Uniersity of Rome with thesis on 'Plasma thrusters design for sustainable space transportation'.

Leveraging Science Payloads through the Lens of Microgravity

Pedro J. Llanos
Embry-Riddle Aeronautical University, USA

Abstract:

Stepping beyond the bounds of Earth's gravity opens new frontiers in scientific exploration. 'Leveraging Science Payloads through the Lens of Microgravity' provides an in-depth overview of how research conducted in microgravity environments—aboard platforms such as Zero-G aircraft, suborbital flights, and prospective orbital missions—is revolutionizing our approach to scientific discovery, technological innovation, and human spaceflight.

This presentation ventures into the unique realm of experiments conducted in the near absence of gravity. It highlights how parabolic flights aboard Zero-G aircraft offer brief yet valuable periods of weightlessness, fostering preliminary investigations and the development of proof-of-concept studies. We then examine how suborbital flights act as a pivotal bridge, facilitating extended durations of microgravity that enable more comprehensive research, ultimately leading to the consistent microgravity conditions afforded by orbital missions.

A focal point of our discussion centers on the technological innovations aimed at mitigating sloshing dynamics in microgravity—a paramount challenge for fluid management in space vehicles and systems. Additionally, we delve into life science payloads that are pivotal for enhancing human spaceflight. These payloads provide crucial insights into human physiology, health, and performance in microgravity, informing the development of countermeasures and support systems essential for the safety and well-being of astronauts on prolonged missions.

From the realms of biological sciences, where microgravity unmasks fundamental life processes, to the intricate technological challenges, such as sloshing dynamics, that demand creative and sophisticated engineering solutions, attendees will gain insights into the multifaceted impact of microgravity research. The talk will trace the trajectory of science payloads, from the meticulous preparation and customization needed to withstand the unique stresses of microgravity, to the execution of experiments and the nuanced interpretation of data that is only attainable beyond Earth's gravitational embrace. Through the lens of these innovative platforms, we are not just advancing science payloads into space; we are propelling our scientific

understanding, technological prowess, and the frontier of human spaceflight into an unprecedented era of discovery and innovation.

Biography:

Dr. Llanos currently serves as an Associate Professor (Tenured) in Space Operations at the Applied Aviation Sciences department at Embry-Riddle Aeronautical University (ERAU). Over the past 10 years, he has mentored over 25 undergraduate and graduate students with various backgrounds in Space Operations, Aerospace Engineering, Mechanical Engineering and Physics.

Pedro has been immersed in the trajectory mission design, navigation, and orbit determination of space weather missions to the Lagrange points L5 and L4, and the development of software to investigate the flight dynamics of the James Webb Space Telescope. He also served as a trajectory analyst for a prospective Near-Earth Asteroid mission at the Keck Institute for Space Studies at Caltech while he was a JPL Visiting Student Researcher (JVSRP) at the Jet Propulsion Laboratory.

General Planetary Transport System is the Tool of Non-rocket Space Industrialization to Prevent Planetary Ecological-resources Catastrophe and to Ensure the Further Technocratic Development

Arsen Babayan
Astroengineering Technologies, LLC, USA

Abstract:

An ecological-resource catastrophe is inevitable, since the Earth civilization has chosen a technocratic path of development and objectively cannot refuse it. The basic industries of the Earth's technosphere, which has the most harmful anthropogenic impact on the Earth's biosphere, must be eliminated by newly build-up space industries. Boundless outer space, inexhaustibility of energy resources, as well as fundamentally new and unique technological conditions (weightlessness, deep vacuum, absolute purity, etc.) - determine the absolute price & quality competitive superiority of the upcoming space industry over the Earth's technosphere. So, we are talking about the ordinary market competitive mechanism of reindustrialization. As for the multibillion civilization of people, it should stay to live in its biospheric home Earth, since the human body, as one of the systems of a complex biospheric complex, has been ideally "adapted" to earthly conditions over billions of years of evolution of living matter.

The feasibility of space vector of industrialization depends on many newly developed technologies, but the principal of them is geospace transport system, which should be distinguished by energy efficiency close to 100% efficiency, absolute environmental friendliness, cleanliness and safety, as well as the ability to develop the scale of cargo and passenger transportation, estimated at millions of tons of cargo and cargo. million passengers a year when the challenge of global reindustrialization is set.

Biography:

"The expert coordinator of global geospace project – program uSpace aiming at providing conditions for transportation of global harm industry into near space by non-rocket transport. One of the key promoters of unique, complex program "EcoSpace" striving to unite people from around the globe with a common goal: building a new future for humanity and the Earth's biosphere. «Research Engineer» - Moscow Automechanical Institute, PRE MBA - California State University.

Fiber Optic Ice Detector Potential Application in Determining the Local Freezing on Wings of Aircraft

Aris Ikiades
University of Ioannina, Greece

Abstract:

Ice accretion on the wings of aircraft affects the aerodynamic performance by disrupting the airflow, thus increasing drag, altering its flight characteristics, ultimately causing stalling of the wing. Current ice detectors usually located on the nose of aircraft relay on of ambient conditions to determine icing conditions, thus having no information on ice action on the actual main or tile wings. This presentation is focused on the development and testing of a fiber-optic-array ice sensor, capable of detecting the accretion rate, thickness and type of ice accreting on the leading edge of the wing. The principle of the measurements is based on the ice morphology which is influenced by the rate of freezing of the droplets impacting the wings, partially or totally trapping the dissolved gasses in the droplets, thus affecting the local Freezing Fraction (FF) on the wing. Using the fiber optic sensor, the ice thickness can be measured, as well the correlation of the optical diffusion with the local FF of the ice on a wing surface.

Biography:

Aris Ikiades obtained his PhD in Optical Communications from the University of Kent (UK), having received an MSc in 1987 in Laser Physics and Non-Linear Optics from the University of Essex, and a BSc. (Hons) in Applied Physics from the University of South Bank, London in 1984. He is currently employed as an Assistant Professor in Physics department, University of Ioannina, prior to which, from 1993 to 2004 he was a Research Scientist at FORTH IESL, Iraclion, Crete. In the early 90s he was Development Engineer at York Sensors Ltd and before this was a Research Fellow at University of Kent He has published over 40 publications in fibre optics and telecommunication journals and conferences. His research interests are fibre optic sensing, and FBG, LPG Whispering gallery Modes and mirroring evanescent sensing and fibre optic ice detection . His experience includes FBG-based distributed strain / temperature sensor, , fibre lasers and amplifiers, Raman fibre optical Distributed Temperature Sensor and a Q-switched fibre laser. He has participated and coordinated many national and European research projects.

New Modern Dimensional Analysis Approaches on the Plastic Materials' Additive Manufacturing

Zsolt Asztalos
Sorin Vlase, Ioan Száva

Abstract:

It is well-known fact that the Additive Manufacturing nowadays represents one of the most efficient modality in obtaining both low-cost and quickly manufactured spar parts and prototypes with relative difficult configurations. Several spar parts, but mainly in the case of complex prototypes one are required one optimised design, consisting in minimal material consumption, correlated with high stiffness and as well as lower prime costs. In this complex and difficult task, the engineers involve more and more the obtainable information on relatively low cost reduced-scale models, which afterward will be transferred to the real-scale components by means of the so-called model laws of the dimensional methods. The authors in their previous works started to involve in this optimisation process the advantages of the Modern Dimensional Analysis, conceived in 90's by Prof. Thomas Szirtes. In this contribution, based on the obtained experience, they offer several useful dimensional model laws, validated by meticulous experimental measurements. The above-mentioned model laws take into consideration several modalities in reaching the optimised components.

Biography:

Zsolt Asztalos is PhD student from 2021 in Mechanical Engineering Department from Transilvania University of Brasov, Romania. In 2021, he got his MSc in Simulation and Testing in Mechanical Engineering, from the Transilvania University of Brasov, Romania. His thesis is focusing on the influence of printing parameters on mechanical properties of printed parts. His research is based on alternative method named Modern Dimensional Analysis. Parallel he was production engineer at a tool production company for 3 years, and now he is head of production at a sheet metal processing company. Therefore, he is also interested about the 3D printed tooling, for example: moulds and fixtures.

Additive Manufacturing-Enabled Architected Lattices for Water Quality Monitoring

Sara Fateixa
University of Aveiro, Portugal

Abstract:

The contamination of natural waters with organic compounds, specifically dyes and pesticides, has raised widespread concern due to their ecological impact and potential risks to human health.[1] Traditional methods for detecting residual water pollutants are typically time-consuming, expensive, and involve complex laboratory procedures. However, spectroscopic techniques based on surface-enhanced Raman scattering (SERS) have emerged as valuable analytical tools for identifying water pollutants in recent years.[2] These methods offer high sensitivity, spectroscopic fingerprints, simple sample preparation, and non-destructive analysis, being of great utility when combined with analytical kits and portable equipment. Conventional substrates based on rigid solid substrates or metal hydrosols are not suitable for sample extraction, limiting their application in water quality monitoring. The fabrication of SERS platforms that allow the rapid collection and analysis of vestigial analytes is quite challenging but desirable.

Here, a hybrid SERS sensor enabled via additive manufacturing of architected lattices coated with metallic nanoparticles (Au and Ag nanoparticles (NPs)) has been developed to detect organic dyes and pesticides in complex water samples.[3] First, the fused filament fabrication (FFF) technique was used to fabricate periodic cellular nanocomposite architectures and fully dense nanocomposites by combining multi-walled carbon nanotubes with polypropylene as the matrix.[4] The resulting hybrid 3D-printed periodic cellular structures were used for the absorption and SERS detection of trace amounts of methylene blue (MB). The spatial distribution of MB and Ag NPs on the hybrid 3D-printed lattices was confirmed using SERS imaging. Finally, the performance of FFF-enabled test strips in detecting small quantities of pesticides present in real water samples, such as Estuary Aveiro water and tap water, using a portable Raman spectrometer, was demonstrated. Importantly, this method has the potential to be extended to the detection of other pesticides or bioanalytes.

Biography:

Sara Fateixa is a Researcher at CICECO - Aveiro Institute of Materials. In 2013, she completed her PhD in Nanosciences & Nanotechnology at the University of Aveiro. Since then, she has begun a research line at CICECO that combines nanomaterials chemical synthesis and Raman spectroscopy applied to sustainable nanotechnologies. In 2017, her work was internationally recognized by WITec Silver Award-2017 for original and innovative research using Confocal Raman microscopy, and she was awarded the Best Scientific project 2022 Award by CICECO-UA. Her interests include Spectroscopy imaging techniques, hybrid materials containing 2D materials and metallic nanoparticles, and health and environmental applications. She co-authored 52 papers, 2 conference articles, and 1 book chapter. She gave 2 invitation oral presentations and 1 keynote lecture. She has 1 patent under the subject of paper-based SERS substrates for water quality monitoring.

Radio Protection for Astronauts: Shielding Materials Effectiveness

Filomena Loffredo
University of Naples Federico II, Italy

Abstract:

Many space missions are currently ongoing e many others are being planned for the next decade. These missions will not only concern low-Earth orbit (LEO) but will be extended to the exploration of the whole solar system. Among the main risks for the colonization of the solar system is the exposure of astronauts to cosmic radiation. On the Earth, the radiation is completely different from that in space and consists mainly of γ and X rays, α and β particles and there are three possible countermeasures can limit exposure, i) reduce the exposure times, ii) increase the distance between the source and the target, iii) use shielding specific to the type of radiation. Conversely, in the space, the radiation is predominantly composed of high-energy charged particles ranging from protons (H+) to heavy charged nuclei (HZE) such as U and the only countermeasure that can be adopted is passive shielding. The main goal of a radiation protection program in space is to minimize crew exposure to ionizing radiation. As a result, the protection actions should have specific features, such as limited production of emerging secondary radiation that could be even more harmful to astronauts' health. This work shows the results of numerical simulations performed with the Geant4 toolkit-based code DOSE. Calculations to evaluate the performance of materials target, with high mechanical resistance, in terms of dose reduction to crews, were performed considering the interaction between protons with an energy spectrum ranging from 50 to 1100 MeV and a target slab of 20 g/cm2. The analyses focused on both the properties of secondary products obtained from the interaction between space radiation and the target and the properties of the secondary particles that come out the shield. The results show that Nomex can be considered a good shield candidate material in terms of dose reductions. Furthermore, for the Nomex material, we also verified that the secondary particles providing the greatest contribution to the dose are protons, neutrons and, in a very small percentage, α-particles and Li ions.

Biography:

Filomena Loffredo is a Researcher at the University of Naples Federico II. Filomena got her PhD in Innovative Technologies for Materials, Sensors and Imaging in 2015. Her research activity is focused on the exposure of humans to ionizing radiation and therefore also concerns space dosimetry for the radiation protection of astronauts during space missions. In this framework, Filomena has developed and validated a code allowing to perform numerical tests with the aim of evaluating the interaction secondary products and their contribution to the dose.

The Hawai'i Space Exploration Analog and Simulation Habitat and Emmihs 2023/2024 Missions

Kato Claeys
Hawaii Space Exploration Analog and Simulation, Belgium

Abstract:

Space analogue missions on Earth are used to prepare humankind for the challenges involved in settling the Moon or Mars. One of the places to explore these challenges is the Hawaii - Space Exploration Analog and Simulation (HI-SEAS) habitat. HI-SEAS is located on the Mauna Loa volcano on the big island of Hawaii, a very remote site fully surrounded by a lava field. The habitat itself can host 6 crewmembers. It is provided with a lab, an engineering room, a kitchen, two bathrooms, 6 individual bedrooms and an airlock. For extravehicular activity (EVA) outside, crewmembers wear an analog spacesuit and simulated oxygen reservoir, and go through full EVA protocols before leaving the habitat. Food provided on the missions is fully dehydrated. HI-SEAS is used to conduct research on crew dynamics, health and other topics, and to test new technologies for space. Research to date has included: growing algae in different circumstances; investigating the composition of nonliving matter microbiological life around the habitat; cognitive performance and the psychological effects of isolation; and the effect of the use of an AI support robot. A broad range of technologies have been tested here, including tool connection points on analog spacesuits as well as actual space suits; the transportation of medication by drone; hololens interactions; and portable Infrared Device (PORIS) for geological applications.

Biography:

Kato has a background in architectural engineering and space studies. She has been a pilot for over 10 years. Her passion for aviation started as a glider pilot with the Belgian Air Cadets. During her master's degree in space studies, her focus shifted from aviation to space. Kato has been an analogue astronaut on several missions where she performed the roles of Vice-Commander and Commander. In early 2023, she began her role as Director of Operations for the HI-SEAS habitat. The Lunar-like lava field and analog space research are a very exciting and interesting work environment for her. Her hobbies include hiking, traveling and all kinds of adventures.

Effects of High Gravity Conditions on Additive Manufacture by Fused Deposition Modeling

Xin Jiang
Kanagawa Institute of Industrial Science and Technology, Japan

Abstract:

Additive manufacturing (AM) technology is constantly evolving, characterized by continuous progress in materials, printing methodologies, and applications. Fused deposition modeling (FDM) is a widely used additive manufacturing technology that fabricates objects by depositing layers of material, FDM is a prominent technology known for its numerous benefits and distinct attributes. High-gravitational fused deposition modeling (HG-FDM) system becomes especially valuable in extraterrestrial applications where gravitational forces differ significantly from earth. This entails the application of increased gravitational forces during the material extrusion phase, with the aim of heightening the quality of the manufactured parts. Through a concentrated effort on the development and subsequent evaluation of HG-FDM system, we have successfully ascertained the feasibility and advantages of HG-FDM system. The effect in high gravity field of additive manufacturing holds significant promise for improving the properties of fabricated products.

Keywords: Additive manufacturing, High gravity, Objects, Fused deposition modeling.

Biography:

Jiang Xin, Researcher in the Research and Development Department, Kanagawa Institute of Industrial Science and Technology. Ph.D. in mechanical engineering. The research field is Additive manufacturing, Highgravity, Objects, and Fused deposition modeling.

INS-MEMS/GPS Integrated Systems based Artificial Intelligence Algorithms for Navigation in GPS Challenging Environments

Ruxandra Mihaela Botez
ÉTS Higher Technology School, University of Quebec, Canada

Abstract:

GPS is the most widespread GNSS in the world and applies successfully in so many fields such as positioning, navigation, geodesy, mapping, timing and so on. Unfortunately, navigation accuracy and integrity of GPS are degraded in the presence of radio frequency interference, hostile jamming and high dynamical situations, when the satellite signals may get lost due to signal blockage. On the other hand, INSS can address this problem and overcome the non-availability of GPS signals for a short period of time due to the inherent sensors errors. The main shortcoming is that the INS accuracy degrades greatly over time. In such case, INSS can benefit from aiding such as GPS. As the increasing use of low-cost Micro-Electro-Mechanical System (MEMS) inertial sensors to navigation applications, however, the traditional Kalman filter methodology was found insufficient due to poor quality of the MEMS inertial measurements. To overcome or reduce the impact of the Kalman filter limitations an identified solution in the literature is related to the incorporation of artificial intelligence algorithms for developing INS/GPS integration. The current presentation targets to expose a way to overcome the limitations of current INS/GPS integration schemes and to improve the positioning accuracy during GPS signal blockages. The proposed solution is fitted in a new research trend regarding the using of Adaptive- Neuro-Fuzzy-inference system (ANFIS) techniques to obtain high precision low-cost INS/GPS integrated navigation systems. Some intelligent data fusion algorithms based ANFIS are developed in order to predict the mislaid GPS reading data and the positioning errors during GPS signal outages.

Biography:

Dr Ruxandra Botez is Full Professor at École de technologie supérieure ÉTS, University of Quebec in Canada since 1998. Ruxandra is the Canada Research Chair Tier 1 Holder in Aircraft Modeling and Simulation Technologies since 2011, and she is the Head of the Laboratory of Applied Research in Active Controls, Avionics and AeroServoElasticity LARCASE since 2003. Ruxandra is AIAA Associate Fellow, CASI (Canadian Aeronautical Society Institute)

Fellow, CAE (Canadian Academy of Engineering) Fellow and Royal Aeronautical Society (RAeS) Fellow. Ruxandra is Member of the Adaptive Structures committee and Faculty Advisor of the AIAA Branch at ÉTS. She is Editor-in-Chief of the INCAS Bulletin and Associate Editor of various journals (The Aeronautical Journal, etc.). Ruxandra graduated more than 24 PhD students, 120 Master's students (projects and theses) and 300 Internship students in her academic career. Ruxandra published more than 185 archival original journal articles, 300 conference papers and 7 invited book chapters. Ruxandra and her team have obtained more than 40 awards; she also gave more than 50 invited speaker presentations. Ruxandra works in collaboration with various aerospace companies in Canada, such as Bombardier Aerospace, CAE Inc., Esterline CMC Electronics, Bell Helicopter Textron, Thales Aerospace, GlobVision, FLIR Systems, Tristar and IAR-NRC, in the USA with Presagis and NASA, in Italy with Alenia and CIRA, in Mexico with Hydra Technologies, in Germany with DLR and in Romania with the National Institute for Aerospace Research "Elie Carafoli" (under the aegis of The Romanian Academy).

Numerical Analysis of Mechanical Behaviour of a Separation Mechanism Structure under Random Vibrations

Smahat Amine
Satellite Development Center, Oran, Algeri

Abstract:

The separation system plays a critical role in ensuring the successful release of payloads from the launcher. It serves as the supporting structure for the satellite and facilitates the interface with the launch vehicle. Therefore, it is essential to thoroughly verify the stiffness and strength of the interface structure, considering the launch environment loads and payload mass. In this paper, we present a detailed analysis of the separation system structure, which consists of two ring parts. Our approach involved modelling the structure and performing modal analysis to extract eigenfrequencies, thereby avoiding any potential coupling phenomena. Additionally, we assessed the stress levels induced by random vibrations imposed by the launcher. To conduct the study, we utilized the finite element method, which allowed us to accurately simulate and evaluate the system's behaviour. The results of our analysis demonstrated that the structure possesses the required stiffness and strength necessary for a successful mission, while also satisfying the stringent requirements imposed by the launcher. By comprehensively assessing the structural integrity of the separation system, we contribute to ensuring the mission's success and maintaining payload security during launch.

Keywords: Structure, launcher, vibration, modal, random.

Biography:

SMAHAT Amine was born in Oran, Algeria, in 1987. He received his engineering degree in mechanics from USTO of Oran (Algeria) in 2010. He received his magister and PHD degree in mechanical behaviour of structure from UDL of Sidi Bel Abess (Algeria) in 2012 and 2016 respectively. He is currently searcher in the satellite development center (CDS) of the Algerian space agency (ASAL). His research interests are behaviour of structure under impact loading and dynamic analysis of structure.

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