International Symposium On Electric Aircraft & Autonomous Systems

ISEAS

19th-21st JULY 2022

University of Maribor
Maribor, SLOVENIA

Abstract Book

Editors

T. Hikmet Karakoc - Tomislav Letnik - Maršenka Marksel - İsmail Ekmekçi - Ali Haydar Ercan - Alper Dalkıran

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Betül Özcan - Dilara Patatur Kılıç - Kemal Keleş

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International Symposium on Electric Aviation and Autonomous Systems 2022

ISEAS'22 Abstract Book

International Sustainable Aviation and Energy Research Society

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International Symposium on Electric Aviation and Autonomous Systems (ISEAS – 2022)

Edited by Prof. Dr. T. Hikmet Karakoc, Asst. Prof. Dr. Tomislav Letnik, Asst. Prof. Dr. Maršenka Marksel, Prof. Dr. İsmail Ekmekçi, Asst. Prof. Dr. Ali Haydar Ercan, Asst. Prof. Dr. Alper Dalkıran.

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Tomislav Letnik

Symposium Chair

Maršenka Marksel

Symposium Chair

İsmail Ekmekçi

Symposium Chair

Message from the Symposium and Course Chairs

It is our great pleasure to invite you to the International Symposium on Electric Aviation and Autonomous Systems (ISEAS) which will be held on Online Platform ZOOM on July 19 – 21, 2022.

Aviation is considered as one of the major sources of environmental problems and considered a prominent cause of sustainability. Future trends in aviation could constitute a major impediment to having sustainable development in economic, social and environmental perspectives. Sustainable aviation is a long-term strategy aiming to offer innovative solutions to the challenges facing the aviation industry.

As we are in an era in which there is a continuous progress in aviation, we would like to invite researchers, scientists, engineers, practitioners, policymakers, and students to this international Symposium and Course to exchange information, present new technologies and developments, and discuss the future direction, strategies and priorities in the field of sustainability.

ISEAS aims to handle a broad range of electrification of aerial vehicles all-electric aircraft, electric generation and storage in aerial vehicles, and so on.

ISEAS will include several keynote presentations, specialized sessions, and oral and poster presentation sessions from the participants on different subjects related to electric use in aviation.

We look forward to welcoming you to this remarkable event in July 2022.

Best wishes,

T. Hikmet Karakoç, Tomislav Letnik, Maršenka Marksel, İsmail Ekmekçi

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KS01
New Clean Aviation Trends and Their Influence on Balance Approach Achievements to Aircraft Noise Management Around the Airports

Oleksandr Zaporozhets, Professor, Dr.Sc.

Łukasiewicz Research Network – Institute of Aviation, Warsaw, Poland

Abstract: Aircraft noise (AN) exposure management on the population around the airports is defined by ICAO Balanced Approach (BA). ICAO guidance on BA (Doc 9829) recommends defining the efficiency of all the four fundamental elements with an assessment of noise index DNL at a point (area) of noise control. Overall AN exposure around the airport is usually calculated in a form of AN contours – the contour DNL = 65 dBA is defined as inappropriate (prohibited) for residential development. Requirements for AN calculations are defined by ICAO guidance Doc 9911, noise zoning and land use – by Airport Planning Manual (Doc 9184), aircraft noise itself – by Annex 16, vol. 1 'Aircraft Noise' to ICAO Convention. Evolutionary approach to aircraft development consider the continuous reduction of noise at the main acoustic sources (engines and airframe sources), but this approach is not appropriate to reach the ACARE goals as for noise reduction, as for engine emission reduction – especially for climate impact reduction. Electrification of the aircraft (revolutionary approach) including full and/or hybrid electric thrust production may contribute sufficiently in reaching the ACARE goals as for noise as for GHG reduction by aircraft. Also alternative fuels including the hydrogen fuels (or hydrogen fuel cells) have big potential for the impact reduction. This trend will influence the progress positively. At the same moment the big demand exists for supersonic transportation, where the electrification will not be considered currently, so the development is possible due to evolutionary approach only. The task to fulfill the ICAO Chapter 14 noise requirements are looking very difficult to reach for new supersonic aircraft, and if it will be reached what will be their contribution to following BA achievements in aircraft noise management? These two different trends are discussed for their contribution in ACARE and ICAO goals till 2050 progress.

KS02
Certifying Artificial Intelligence for Aviation

Prof. Dr. Umut Durak

German Aerospace Center (DLR)

Abstract: Electric Vertical Take-off and Landing (eVTOL)aircraft equipped with high levels of automation and autonomy are providing new horizons that are now leading to new segments, namely Advanced Air Mobility (AAM) and Urban Air Mobility (UAM) in aviation. The future of these segments relies on Artificial Intelligence (AI) for realizing required automation and autonomy functions. Nevertheless, the safety concerns and challenges regarding compliance to the existing software standards are more pressing than ever before. Existing regulatory framework for hardware and software items fail to provide adequate acceptable means of compliance for AI-based systems. Hence, there are currently a number of ongoing efforts to update and augment the current standards. This talk will give an overview of the existing and upcoming regulatory framework for certifying AI-based systems. It will elaborate the EASA documents, artificial intelligence roadmap, Concepts of Design Assurance for Neural Networks (CoDANN), CoDANN II, as well as the concept paper on first usable guidance for level I machine learning applications.

KS03
Air Emissions from EU-27 aviation fleet in 2021

Assist. Prof. Rok Kamnik

University of Maribor, Maribor, Slovenia

Abstract: The aviation industry remains one of the main polluters of the environment. There are successful attempts of alternative propellant fuels and hybrid engines in the segment of smaller aircraft, but unfortunately this does not directly address the segment of medium-sized and large aircraft. The number of passengers in the EU-27 is increasing, as are the demands to reduce emissions, which in principle represents a kind of a paradox. The reduction of emissions should therefore be gradual and probably only introduced during certain phases of the flight. The LTO cycle also contributes significantly to air emissions, which is one of the first steps where cleaner fuel or engines could be introduced. The paper analyses what this contribution is.

KS04
The Use of the Academic Flight Simulator in the Flight Mechanics Course at the RheinMain University of Applied Sciences

Danyck Nguewo, Prof. Dr.

RheinMain University of Applied Sciences

Abstract: The flight mechanics courses are taught in the fourth and fifth semesters at the RheinMain UAS. The topics are flight performances and static stability (fourth semester) and dynamics characteristics and automatic flight control systems (fifth semester). In order to allow the aerospace students to practically experience the above-mentioned topics of the theoretical courses related to flight mechanics, but also related to aerodynamics and aircraft design, the RheinMain UAS has integrated a flight simulator into these courses. My presentation deals with the description of the methodology adopted for the use of the academic flight simulator in the flight mechanics courses and its benefit.

KS05
Hybrid-Electric Propulsion and Box-Wing Architecture: Analysis of the Operational Potential for Regional Aircraft

Dr. Vittorio Cipolla

University of Pisa, Pisa, Italy

Abstract: The introduction of hybrid-electric propulsion systems in air transport is seen as a possible driver to pave the way towards the envisaged climate neutrality goals, which – according to the European Commission – can be summarized in a 55% reduction of greenhouse gas emissions by 2030 and climate neutrality by 2050. Although the recent progress in batteries and fuel cells technologies, the low gravimetric energy densities of such energy accumulators make the development of medium-to-long range hybrid-electric aircraft very unlikely in a time horizon compatible with the given goals, whereas it appears achievable for short range, or regional, aircraft categories. Another possible strategy for reaching the climate neutrality of air transport is the introduction of more efficient breakthrough architectures, which can have a multiplier effect in the reduction of fossil fuel consumption. The box-wing is one of the promising architectures, since recent research have shown that in the short-to-medium range and without any improvement of the propulsion system, its capability of reducing fuel consumption and CO2 is higher than 20%. Following research applied to a 50-pax regional aircraft have investigated the integration with hybrid-electric propulsion, resulting in a CO2 reduction between 30% and 70%. The present paper aims to show how the synergy between box-wing architecture and hybrid-electric propulsion can further improve the "green potential" for the case of regional aircraft, providing details about the associated operational potential and highlighting the changes of perspective on aircraft design.

KS06
Electric planes: Student Pilot Perceptions and Flight School Opportunities for New Aviation Technologies

Professor Paul Parker

University of Waterloo, Canada

Abstract: Students represent the future of an industry, so their perception of a new technology may indicate the appeal of the innovation. Electric propulsion was first certified in aviation in Europe in 2020. One of the first e-plane markets is flight training so student pilot perceptions are examined. 148 student pilots in Canada, Australia and India completed a survey to rate their perceived knowledge, barriers and motivations to fly an e-plane. Knowledge levels were generally low. However, trust in the technology and safety authorities was higher, with Australian students reporting the highest levels of trust. The desire to fly a certified e-plane was extremely high while an experimental e-plane had lower appeal, except to Canadian students who rated it highly as well. The strongest motivation to fly e-planes was to reduce emissions. All student cohorts reported at least moderate levels of guilt regarding carbon emissions, with Indian students reporting the highest levels. Female students also indicated higher levels of emission guilt. Male students reported a higher level of knowledge about e-planes and a stronger desire to fly them because they are a technology for the future and have a growing market share. Battery endurance was the strongest reason not to fly e-planes, especially among males. Older student pilots reported a higher level of e-plane knowledge and a stronger desire to fly an experimental e-plane. Younger student pilots had higher concerns about the safety of electric motors / controllers and battery safety. Overall, the desire to fly e-planes was rated 9 on a 10 point scale, indicating a strong desire to adopt the new technology.

KS07
Comparison of Battery Technologies and Sustainable Fuels in Aviation

Nadir Yilmaz, Professor and Department Chair

Howard University

Abstract: The aviation industry faces significant challenges including fuel costs, along with environmental and energy security problems arising from the use of petroleum-based jet fuel. At present, there are numerous strategies to improve energy efficiency, while also tackling environmental problems, including alternative fuel solutions and innovative battery technologies. Alternative fuels are attractive because they help address energy and environmental challenges, allowing for the advancement of sustainable aviation. They hold the potential to improve air quality and slow down global climate changes, while expanding access to domestic energy sources with the diversification of fuel supplies. Alternative fuels may also contribute to price and supply stability, and help to stimulate economic development in rural communities. Electrification and decarbonization of aircrafts also offer numerous advantages, including less energy consumption, lower GHG emissions, less noise production compared to conventional aircrafts, and more reliable electric subsystems. However, production rates of available sustainable aviation fuel (SAF) technologies can meet only a portion of the market size of the commercial aviation industry. Similarly, short-range all-electric aircrafts, while having great potential to reduce environmental impacts, will still require significant improvements in battery technologies to remain cost-competitive. The purpose of this study is to make a comparative assessment of alternative fuels used in the aviation industry and electric aircrafts designed in accordance with battery technologies for the purpose of emission reduction.

KS08
Verification of U-Space Solutions Using a Digital Twin

Tomaž Kramberger, full. Professor,

University of Maribor

Abstract: Although the use of drones in logistics is already close to reality, some obstacles remain unresolved. Drone technology per se is not enough, it needs to be upgraded and designed in a way that will allow a kind of drone shift, which means that it will allow the development of business models that were not possible without its upgrade. In the paper, we present a system of automatic control, management and control of drone traffic for flights over urban areas (UATM). The system is designed according to the principles of U-Space presented in the EU Blue Book and tentatively corresponds to Phase 4 U-Space. The UATM system was designed as a digital twin of the real-life system pilot, drone and space where the digital part of the twin takes the lead and first performs a virtual mission and only later maps it into reality.

KS09
Numerical Analysis of Active Wingtip Vortex Cancellation in Propeller-Driven Electric Aircraft/UAV

Ramesh K. Agarwal

Washington University in St. Louis

Abstract: As battery and electric motor technology continues to advance rapidly, propeller-driven electric aircraft/UAV is likely to become a significant part of the aviation market in the near future. One proposed design configuration for electric aircraft/UAV involves using large, wing-tip mounted propellers to actively cancel wingtip vortices; a method called active wingtip vortex cancellation (AWVC). By reclaiming part of the kinetic energy that would otherwise be lost to tip vortex formation, drag is decreased. In addition, the induced span-wise flow and up-wash from the propeller causes the span-wise lift distribution to remain more uniform at the wingtips, thus increasing the lift. Previous wind tunnel testing of this configuration has shown a significant increase in lift and decrease in drag, particularly in low-aspect-ratio configurations. In this paper the wind tunnel UAV configuration is simulated by employing the tools of Computational Fluid Dynamics (CFD) in the ANSYS Fluent software. Several test cases are computed using 3D, transient, viscous, sliding mesh computational approach for the solution of Reynolds-Averaged Navier-Stokes (RANS) equations with SST k-ω turbulence model. CFD results match the wind tunnel data within approximately 1%, validating the CFD approach. For the wind-tunnel configuration, CFD results show that 18.1% increase in lift and 5.1% increase in net thrust is possible solely through the phenomenon of AWVC. This talk demonstrates that the CFD technology can be used for the analysis of more exotic UAV and aircraft configurations involving active wingtip vortex cancellation as well as distributed propulsion involving more propellers mounted on the wing.

KS10
Active Fault Tolerant Control Against Actuator Failures Applied to UAV Dynamics

Chingiz Hajiyev, Prof.Dr.

Istanbul Technical University, Istanbul, Turkey

Abstract: In this study, an active fault tolerant controller (AFTC) based on two-stage Kalman filtering (TSKF) is designed to deal with actuator faults occurring in unmanned aerial vehicle (UAV) dynamics. The TSKF is used as a fault detection and isolation (FDI) system for estimating the control effectiveness factors corresponding to the flight surface control actuators and an estimator to provide the best state estimates to the control system. Using bias estimation statistics, the fault in the system is detected. Reconfiguration is performed using the determined new control distribution matrix. The controller gains of the considered UAV model are updated using pole placement/LQR methods. Faulty actuator scenarios including change in elevator and aileron control effectiveness factors are considered in the simulations. It is shown that the estimation of the states and control effectiveness factors can be efficiently realized. The results of the post-reconfiguration system show the effectiveness of the built AFTC against actuator faults.

KS11
Aeroelastic Modeling and Analysis of Electric Aircraft Wings With Distributed Electric Propulsors: Wing-Body and Box-Wing Aircraft Configurations

Prof. Seyed Ahmad Fazelzadeh

Shiraz Universityi Shiraz, Iran

Abstract: Recently, due to climate change problems, the electrification of transport has received a lot of attention. Although electric propulsion for aircraft applications forms a very small portion of current standard aviation due to its limitations, this technology has the potential to be integrated into a wide range of future aircraft. The distributed electric propulsion (DEP) concept considered in this speech is composed of several electrical motors to generate the required lift and thrust. In this presentation, the effect of distributed electric propulsion on the aeroelastic stability of wing-body and box-wing aircraft configurations is investigated. The electric propulsors with different properties, are attached to the aircraft wing in different positions. The wing structural dynamics is modelled by using geometrically exact beam equations, while the aerodynamic loads are simulated by using an unsteady aerodynamic theory. The electric propulsors are modelled by using a concentrated mass attached to the wing, and the motor's thrust and angular momentum are taken into account. It can be seen that electric engine arrangement has considerable effect on the wing flutter boundary. Results of these researches which shows that using DEP instead of original propulsion systems reduces the aircraft emissions and increases the stability region, extremely, leads to the idea of Persian Sky Program. Persian Sky is a family of all-electric air taxies commuting between nearby cities and short distances using distributed electric propulsion.

KS12
Functional Safety as a Key Subject in the Study Program 'Electrical and Aeronautical Engineering'

Peter Dannenmann, Prof. Dr. rer. Nat.

Rhein Main University of Applied Sciences

Abstract: The study program 'Electrical and Aeronautical Engineering' at RheinMain University of Applied Science's Department of Engineering prepares students for positions in the aviation industry that require knowledge in Electrical Engineering. This includes knowledge about electrical propulsion systems as well as general knowledge about electrical systems in aircraft. Moreover, the study program deals both with manned and unmanned aircraft, the latter flying possibly autonomously. For all these different kinds of aircraft, Functional Safety is an important property that on the one hand is required for certification and on the other is a prerequisite for a safe operation of such aircraft. For these reasons, the subject 'Functional Safety' is an integral part of this study program. This presentation shows how the subject is linked to other elements of the study program, where students can apply the knowledge in this subject already during their studies and which kind of perspective for future employment this subject offers. The presentation also describes the specific techniques in the domain of Functional Safety that are taught within the study program and how they are practically implemented. The presentation concludes with an outlook how the domain of Functional Safety may change with an increase in the usage of autonomously operating Unmanned Aerial Vehicles

KS13
Electrical Motors and Batteries for Aircraft, A Thermodynamicists Perspective

Dr John Olsen

The University of New South Wales, Sydney, Australia

Abstract: Electrical motors will replace reciprocating piston, spark-ignition, internal combustion engines, in light aircraft, provided that the gravimetric specific energy and power of batteries (or other energy storage devices) increases so that both are approximately double the values they are today. I believe that this is only a matter of time. It is therefore time for aerospace and mechanical engineers to delve into the world of electrical motors which are as fascinating as reciprocating piston engines. I would like to share my experiences with coming to terms with some of these machines as well as aspects of their speed control. I would also like to clearly distinguish between direct current brushless machines and permanent magnet, synchronous machines as this is rarely done in the literature. Fully electric aircraft have the advantage that they will produce less harmful emissions, will be significantly quieter and more reliable than existing aircraft. Axial flux, permanent magnet, synchronous machines can run at efficiencies of over 80% throughout much of their operating range. The properties of these machines are such that electrically controlled variable speed propellers should increase the propulsive efficiency of these aircraft at all airspeeds.

KS14
Model Based Certification of Modern Vehicles

Ravi Rajamani, PhD, FSAE, FIMechE

drR2 consulting and University of Connecticut

Abstract: The design of aircraft systems is highly dependent on modeling and simulation. Within the next decade or so this will become the primary means of certifying aircraft as well. Electric and autonomous vehicles will depend on these methodologies even more than traditional ones. This talk will describe the progress being made in the field of model-based certification, with an emphasis on what leading standards setting organizations such as SAE, ASTM, and AIAA are doing to support this.

KS15
Role of Electrification in Decarbonising Aviation

Nikhil Sachdeva

Roland Berger

Abstract: Aviation's emissions are a major challenge to resolve. However, as a hard-to-abate sector, a key challenge is a lack of certainty on what the right solution to decarbonisation is. SAFs offer a decarbonisation lever, but only work on a net-zero basis (not gross-zero or true zero) and still produce non-CO2 effects. Hydrogen could be a gross-zero solution but is likely to be extremely technically and commercially complex to deliver, involving a potential revamping of the entire global ecosystem. Electric aircraft offer potential fuel burn reductions in the form of hybrids, or genuinely true zero solutions as battery electric aircraft, but are likely to require serious electrification and battery breakthroughs to be relevant for large aircraft which are responsible for the bulk of emissions .What role can electrification play and how ?

KS16
The Effect of Constant Power Loads on More Electric Aircraft Power Systems

Associate Professor Dr. Kongpan Areerak

Suranaree University of Technology, Thailand

Abstract: The More Electric Aircraft (MEA) is an essential concept and tendency in modern aerospace engineering. Most loads of electrical power system on a MEA are regulated power converters. These loads behave as constant power loads that can significantly affect system stability. The system will become unstable and will be unstable to operate at the rated power. Therefore, the stability issue is very important. In this presentation, the concept of stability analysis is introduced with the example research works. The results indicate that the proposed stability analysis can predict the unstable point and can provide the dominant system parameters in term of stability margin. Moreover, the adaptive stabilization technique designed by the artificial intelligence algorithm to provide the considered aircraft power system always stable is also presented. The intensive time-domain simulation and experiment were used to validate the results from the theory.

ISS01
Future Prospects for Fuel-Cell Aircraft – Challenges and Opportunities

Anita Prapotnik Brdnik, Asis. Prof. Dr

University of Maribor, Transportation Engineering and Architecture

Abstract: To achieve the European Union's goals of reducing CO_2 and nitrogen oxide emissions on the one hand, and good connectivity and fast transportation methods on the other, a technological breakthrough in aircraft technology must be achieved. In the category of small regional aircraft, a fuel cell aircraft represents a possible solution. The first prototypes of fuel cell aircraft have already completed their maiden flights. Nevertheless, the road to commercialization of the fuel cell aircraft is still long. Although fuel cell aircraft can boast with advantages such as the high energy density of hydrogen fuel and no emissions except the water vapor, many challenges still need to be overcome, such as insufficient or non-existent ground infrastructure, technological readiness, safety issues, and economic viability. This talk will present the advantages and disadvantages of fuel cell aircraft compared to conventional aircraft and other solutions, and discuss the prospects for future commercialization of regional fuel cell aircraft.

ISS02
North Pole Expedition By Airship: Unlocking A New Era Of Sustainable Aviation

Carl-Oscar Lawaczeck

CEO of OceanSky Cruises

Abstract: Airships are energy efficient because they don't consume energy to keep aloft. The lower speed, compared with airplanes, also reduces energy consumption. The piece of the puzzle that we want to bring, as OceanSky Cruises, is to scale the airship industry, to catalyst the technology into an industry, using experiential travel as a stepping stone. The world is in dire need of an airborne transportation system that can cross both land and sea using the atmosphere as infrastructure, in a sustainable way. We want to lead the new era of sustainable aviation through large-scale airships. We are an airline of airships. We need to transform aviation and, with our first expedition to the North Pole, we're going to show the world that lighter-than-air technology is robust and safe and can produce a business model that generates attractive margins. Through a blend of modern technology and lifestyle we are able to offer a level of comfort that has not been seen in air transport in almost 80 years. Being able to travel from point to point, to remote places, without the need of airports, enjoying the flight and the landscape with total immersion in the environment, surrounded by silence and calm. We believe there is a different way to travel; slowly and consciously, enjoying the journey, the space, the comfort and the services of a flying luxury hotel - all provided by a large-scale airship

ISS03
Zero-Emission Aviation — The Roadmap For Hydrogen Fuel Cell Technology

Dr. Alex Ivanenko, co-founder and CEO of HyPoint

Business Development Manager

Abstract: Globally, aviation produced 2.4% of total CO2 emissions in 2018. While this may seem like a relatively small amount, consider that if aviation was a country, it would rank 6th in the world between Japan and Germany in terms of total CO2 emissions. Non-CO2 effects, such as warming induced by aircraft contrails and other pollutants, bring aviation's combined total contribution to global warming to approximately 5%. Because airplanes purchased today will be in operation for decades, this 5% is expected to grow to roughly 25% by 2050 if nothing is done. The core challenge to bringing zero-emission aviation to the marketplace is specific power and energy density. Batteries can't deliver enough power, they die too quickly, they're too heavy/take too much space, and they require frequent charging — and similarly, existing hydrogen fuel cell systems can't be used for air transportation because they require a heavy liquid-cooling system that is as much as two times heavier than the fuel cells themselves. Last year, HyPoint unveiled its NASA award-winning hydrogen fuel cell system designed for aviation, which is expected to begin shipping after further testing by the U.S. Department of Energy's National Renewable Energy Laboratory. HyPoint's breakthrough approach to cooling hydrogen fuel cells is entirely new, providing aircraft makers for the first time with a viable hydrogen power option years earlier than expected. * HyPoint's revolutionary approach utilizes compressed air for both cooling and oxygen supply to deliver a high-temperature fuel cell system that is three times lighter than existing fuel cell systems — representing a total weight reduction of more than 60%. It also leverages a number of technical innovations including lightweight bipolar plates and a highly conductive, corrosion-resistant coating in order to radically outperform existing systems. * Testing has shown that HyPoint's current prototype can achieve up to 2,000 watts per kilogram of specific power (which is more than triple the power-to-weight ratio of traditional hydrogen fuel cells systems) and up to 1,500 watt-hours per kilogram of energy density, enabling longer-distance journeys. In August 2021, HyPoint announced a new partnership with BASF — the global chemical giant — to develop a cutting-edge hydrogen fuel cell membrane that will ultimately increase HyPoint's system level power significantly as well as increase durability and operating temperature. The new system will be able to deliver 3,000 W/kg of specific power — a 50% increase — which is enough to satisfy the requirements of narrow-body aircraft. * HyPoint's premiere customer is ZeroAvia, which made news last year with the maiden flight of its hydrogen-electric passenger plane. It is on track to launch its fully-hydrogen plane in 2024 while companies like Airbus (via ZEROe) plan to have hydrogen passenger aircraft in their fleet by 2035. * In August 2021, HyPoint announced a partnership with Piasecki Aircraft to co-develop hydrogen fuel cell systems for eVTOL applications including its PA-890 Compound eVTOL Helicopter. The PA890 will become the first-ever hydrogen-powered manned helicopter.

ISS04
SAE International Aircraft Charging Standards and Smart Hangar Airport Infrastructure

Joshua Portlock, CTO, Co-Founder

Electro.Aero Pty Ltd

Abstract: Electro Aero has been supporting the emerging electric aviation industry for nearly a decade, including the development of chargers, electrical management systems, battery management systems and electric propulsion systems to numerous electric aircraft development projects. During that time, it was identified that the industry needed standardization, especially regarding the charging coupler, so the SAE AE-7D committee was founded by Joshua Portlock in 2018 to help standardize electric aircraft charging and energy management. The AS6968 standard for light conductive charging of electric aircraft was the first standard the committee worked on and is now approaching completion through this year. Furthermore, while the charging coupler standard was proving to be of high priority to the industry, there has also been a noticeable trend that typical airport hangars don't have sufficient electrical power to charge the growing power demands of future electric vertical take-off and landing (eVTOL) aircraft. Therefore, Electro.Aero developed SmartHangar technology, whereby the limited grid connectivity is supplemented by solar and stationary battery energy storage systems to help deliver the peak power demands of electric aviation charging, whilst also helping airports and vertiports transition to more self-sufficient sustainable energy.

ISS05
Implementation of A 2-Seat Hybrid Electric Aircraft Demonstrator for Reducing Carbon Emissions

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Abstract: The goal of these studies should be to develop a two-seat aircraft, suitable for everyday use, that can considerably lower the fuel consumption and carbon emissions compared to state-of-the-art available aircraft of the same category. It should also reveal the engineering approach to design and build such an aircraft to support similar endeavors and help enable development of larger low emission aircraft for commercialization and therefore relevant environmental impact. The battery electric aircraft e-Genius was used as a basis for the serial hybrid-electric conversion described in the following work. A serial hybrid propulsion chain was added and battery capacity significantly reduced. For operation, an extensive control algorithm was implemented to enable optimized control and improved safety. Flight testing is currently ongoing, but preliminary results show a fuel flow reduction of approx. 60% compared to best in class conventional aircraft. With the given reduced fuel requirements, the anticipated higher prices of renewable fuels can be offset to obtain a carbon neutral high-performance aircraft.

ISS06
Urban Air Mobility As a New Form of Mobility Infrastructure

Felipe Varon

Founder & CEO, Varon Vehicles Corp

Abstract: Varon Vehicles is developing a New Form of Mobility Infrastructure that does not require a cost per-mile to generate connections in regions, suburbs and cities. Ours is a solution to the pervasive problem of Lack of Proper Mobility Infrastructure. Our company will be providing novel Transportation Services to different markets by implementing and operating the Next Generation of Aviation, which is Electric, Silent, Green and for Urban use.

ISS07
Airships as a Sustainable Transport Solution

Proux Thibault

Airworthiness Leader FLYING WHALES

Abstract: Airships have long been considered as dangerous, under-performing and non-competitive. The current worldwide situation with regards to climate change is making airships an interesting solution that should be investigated. Indeed, with today's technologies, regulations and aerospace industry, airships can address several applications and markets. Also, by lowering the environmental impact of its operations while providing highly competitive capacities at an unprecedent level of safety, airships are a perfect solution to the indisputable need for a revolution of the Aviation in front of the climate change. Today is the best time for airships to make a comeback.

ISS08
Solid Oxide Fuel Cell Systems and its Potential Applications in The Aviation Industry and Beyond

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Abstract: In this chapter, the reader is introduced to Solid Oxide fuel Cell (SOFC) technology, the different cell designs involved in SOFCs, the different architectures in which single cells can be made and the different system architectures currently designed with SOFCs. Further, since SOFC is a flex-fuel device, the most promising fuels to be used in SOFC systems for the most promising applications in the next decade are also discussed. Aviation or the aerospace industry is a hard to abate sector in terms of emissions and there is ample scope for new powertrain designs, electrification architectures and much more that can be accomplished to cut down emissions. SOFCs and systems built around it are one possible choice for several applications in the aerospace industry. Hence a complete section is dedicated to first discuss the needs for of the aerospace industry and then discuss where and how SOFC based systems can provide a suitable solution.

001
Thermal Analysis of ASTINSAT-1

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Abstract: Today, cubesat applications are increasing with the developing technology. The use of cubesat has increased as the number of launch vehicles increases and the cost required decreases. In this study, the missions and design of the Astin Sat 1 cubesat, which is planned to be built in the near future, are stated; thermal analysis was carried out. Astin Sat 1 cubesat subsystems are exposed to high temperatures and cold during missions. High and instantaneous temperature changes affect the operating efficiency of the subsystems. The temperatures to which the subsystems will be exposed were determined by the thermal analyzes performed on the Astin Sat 1 cubesat. The suitability of the Astin Sat 1 cubesat, designed in the light of thermal analysis, was evaluated.

Keywords: CubeSat, Thermal, Analysis, Design.

002
Numerical Examination of Different Flow Channel Fractions Effects in a Vanadium Redox Flow Battery with Serpentine Flow Field

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Abstract: The effects of channel fractions in a vanadium redox flow battery (VRFB) are investigated for two-dimensional and steady-state. The numerical model is analyzed with conservation mass, charge, momentum, and species equations using COMSOL Multiphysics 5.5. In numerical models, the channel height is kept constant for all channel fractions. For this purpose, the effects of channel fractions on electrode and electrolyte potential, velocity, and pressure distribution are investigated in the serpentine flow field. In the positive electrode, the highest electrode potential is occurred in the high channel fractions, while in the negative electrode the highest electrode potential is occurred in the low channel fractions. The highest electrolyte potential is occurred in the channel fractions of 0.8, 0.6, 0.4, and 0.2 for both electrodes, respectively. In addition, in cases where the electrode mostly consists of ribs, the velocity values is decreased, while the pressure drop from the inlet channel to the outlet channel is increased.

Keywords: Vanadium redox flow battery, electrode/electrolyte potential, velocity /pressure distribution.

003
Flutter Analysis of a 3-D Box Wing with Distributed Electric Propulsion

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Abstract: Research into green aviation technology, including reduced noise and emissions has grown quickly in recent years. In order to meet these goals, several new technology ideas are being investigated by aircraft designers, such as distributed electric propulsion (DEP) wings and box wing aircrafts (BWA). The present work evaluates the effects of electric engines arrangement on the box wing flutter boundary. Eight electric motors are placed on the front and rear wings. The governing equations are extracted using Hamilton's Principle. The resulting partial integro-differential governing equations are solved by semi-analytical methods. To apply the aerodynamic loading on the front and rear wings, Wagner unsteady model is used. Five different arrangement of electric motors are studied and their effects on the flutter boundaries are presented. The analysis shows that for a pair of motors shut down, the maximum flutter speed occurs when motors No. 1, 2 and 3 are working. Also, for two and three pairs of motors shut down, the maximum flutter speed take place when motors No. 1 and 3 and No. 2 are working, respectively.

Keywords: Flutter, 3-D Box Wing, Distributed Electric Propulsion.

004
Force Attenuation Properties of Multilayer Polyurethane and 3D Fabric Composites

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Abstract: Developing Vertical Take-off and Landing (VTOL) vehicles for the Urban Air Mobility (UAM) markets presents a need for lightweight vehicle structures with effective occupant and internal equipment protection capabilities. Force attenuation is one of the important properties in this type of application particularly for cabin interiors or seats. Polyurethane (PU) pads and warp-knitted spacer fabrics (WKSF) are promising lightweight materials for high-energy damping applications. In this study, we investigated the impact attenuation properties of polyurethane pads and WKSF for potential applications in some parts of the VTOL, UAM, or also automotive industry that damping force can be critical. Constant mass was established for the multi-layer composite design configurations, and they were subjected to a drop hammer-based test system. The results of this study show that the combination of polyurethane pad and WKSF can reduce the reaction force by up to 35% compared to using them in complete WKSF or PU form.

Keywords: Force attenuation, Impact properties, Spacer fabric, Polyurethane pad.

005
Transport Operators Total Load Comparison by Analytical Hierarchy Process (AHP)

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Abstract: The duties of the transport operators have changed in the current transport environment from active engagement to information management and oversight and supervision. Transport operators should adapt to the revolutionary rapid technology development in the current transport systems, particularly when making judgments in both land and air transportation. Alongside these changes, the operator's total load system (information, communication, mental, task, and workload) is also in noticeable dynamic alteration to fit with the developments in the highly automated systems. the aim of the research is to highlight the critical factors in the total operators loads model by comparing both air transport operators and land transport operators, Analytical hierarchy process (AHP) survey was conducted for Four categories of transport operators: (i) less skilled pilots; (ii) skilled pilots; (iii) less skilled vehicle drivers; and (iv) skilled vehicle drivers. To analyze and weigh the crucial elements of the operators' total loads model, the AHP was implemented by developing a two-level hierarchy with five primary criteria and 19 sub-criteria.

Keywords: Operators total loads, pilot, vehicle driver, multi-criteria decision-making (MCDM), analytic hierarchy process (AHP).

006
Analysis of Safety Risks Related to Alternative Aviation Fuels

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Abstract: The transport industry is highly turbulent and dynamic and is considered one of the fastest growing. The aviation industry is one of the greatest contributors to the Greenhouse Gas emissions which are expected to grow significantly over the upcoming years. Over the past decades, aviation industry is searching for alternatives to the fossil-based fuels and thus reduce its emissions and environmental impact and thus move towards the fulfilment of its commitments in the fight of climate change. This paper provides introduction to the topic of alternative aviation fuels, overview of the potential sustainable alternatives to fossil fuels that are currently under development, their potential and limitations, and analyze the risk that may arise and are related to use of alternative fuels in aviation.

Keywords: Aviation, Fuels, Alternative Fuels, Sustainability, Risk.

007
Additive Manufacturing Opportunities in the Aviation Industry

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Abstract: Additive manufacturing is a relatively new direction in modern industry and has already taken its place in various industries. If you start to study this process, it immediately becomes clear that its main benefits fit well with the main requirements for technologies in aircraft construction. It is for this reason that the technology of additive manufacturing so quickly entered this industry and continues to develop in it. This article provides a brief introduction to additive technologies and an overview of their possible use in aircraft construction.

Keywords: Additive manufacturing; Topological Optimization.

008
Comparison of The Speed Change and Vector Maneuver Techniques for the Conflict Resolution Problem: Fuel and Flight Time Analysis

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Abstract: Three different techniques are used to solve the conflicts between aircraft in the air traffic management system. These are speed change (SC), vector maneuvering (VM), and flight level change (FLC). The safe separation between aircraft is ensured using these techniques. Literature handles determining and applying the most efficient approach to the conflict resolution problem (CRP). Several optimization algorithms are proposed to solve the problem. While some studies handled the conflict resolution methods separately, some make comparisons or consider them together. This study enhances a mixed integer conflict resolution model previously presented in the literature to validate and improve these efforts. SC and VM techniques are handled separately and compared to each other regarding fuel and flight time efficiency. In addition, more advanced speed constraints, calculated based on aircraft types, were integrated into the model. Linear regression equations were also integrated into the model, and speed and flight, level-dependent fuel calculations, were performed for each aircraft type. As a result, although average flight time increased by 4% in the SC method, it provided 1.84% average fuel savings compared to VM change.

Keywords: Aircraft conflict resolution problem, Speed change, Vector maneuvering, Mixed integer programming, Fuel consumption.

009
Assessing Battery Characteristics During a Full Discharge in an Electric Aircraft

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Abstract: As electric aircraft emerge as a sustainable solution in aviation, the understanding of both performance and battery state of health is critical to aeronautical decision making and safety. Battery performance is crucial for an electrically propelled flight. The energy required to propel an electric aircraft is predicated upon the performance of the battery back that powers the drive systems. As a battery pack operates on the basis of an efficient conversion of the stored energy to power the engine, access to relevant information, including battery state of charge (SOC) and flight time remaining is crucial for decision making. This study presents the findings of an initial test in which both battery packs of a single engine electric aeroplane were discharged to 0% using a minimum cruise power and periodically testing maximum engine power. The SOC and time remaining decreases as expected until approximately 30% charge. At low SOC, less power was produced than expected. This raises concerns for pilot decision making and range anxiety in electric aircraft as the discharge curve is not linear and may have unexpected characteristics at low charge levels.

Keywords: Electric aircraft, battery SOC, engine power.

010
The Autonomous Air-Sea-Interface-Vehicle Is It the Key to Abundant Green Energy?

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Abstract: Attention is drawn to the fact that the winds over the oceans contain energy that exceeds the global energy consumption by an order of magnitude. Converting this wind energy into usable energy therefore offers the possibility to transition from fossil-based to renewable emission-free power generation. To accomplish this objective, it is proposed to abandon the widely accepted power generation concept of converting wind or water flows into electricity by means of stationary power plants. Instead, it is proposed to use the ocean wind power to propel an autonomous "air-sea-interface vehicle" that is equipped with hydrokinetic turbines. This concept offers several advantages, namely drastic reduction of the hydrokinetic turbine size compared to the wind turbine with equivalent power output, significantly increased capacity due to the ability to operate in ocean areas with persistent high winds, yet being able to avoid dangerous storms, and the ability to produce storable energy in the form of compressed or liquefied hydrogen. Most importantly, it provides every nation unlimited access to the ocean wind energy source, thus eliminating the problems caused by the unequal distribution of the fossil-based resources among the nations.

Keywords: Green Energy, Climate Change, Aerospace Engineering, Energy Ship, Hydrokinetic Turbine, Air-Sea-Interface Vehicle.

011
Development of Viscous CFD Analysis Model Including Real Gas Effects for Nose Optimization at Hypersonic Speeds

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Abstract: This study aims to develop a computational fluid dynamics (CFD) analysis model to be used in the nose optimization at hypersonic speeds and to validate the model. While creating the analysis model, standard hyperballistic-1 (HB-1) geometry, whose tests were made in the wind tunnel, was used. Base equation used in the study is compressible real gas Navier-Stokes equations. Generated structured grids were analyzed in METACOMP CFD++. During the model validation, aerodynamic coefficients obtained from the CFD analysis were compared with the wind tunnel test results for HB-1. Comparing CFD results and wind tunnel data for axial force coefficient indicated that CFD analysis estimates this coefficient 5% lesser. Examining normal force coefficient and pitching moment coefficient showed that the results obtained from CFD analysis had a similar trend to the wind tunnel results.

Keywords: Hypersonic flow, Structured grid, Computational fluid dynamics, Validation.

012
Real World Path Planning Using RRT* and Google Earth for UAVs

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Abstract: Rapidly exploring random tree (RRT) and Rapidly exploring Random Tree Star (RRT*) are one of the most widely known path planning methods but the instantaneous turns present in their paths make them unfit for use in path planning for non-holonomic systems. RRT and RRT* 3D have not been merged with any real-world maps. Taking these as challenges, this paper created a new path-planning algorithm, which generates the path for non-holonomic systems with obstacle avoidance and in real-world scenarios using Google Earth. RRT* 3D which is an optimized version of RRT 3D was taken to generate an initial path then using our program of "plane of intersection" the path to avoid obstacles was developed. This new version considers any real-world obstacles, which are converted into cubes or cuboids. The path created by general RRT and RRT* cannot be used by non-holonomic systems because of the instantaneous turns present in the path so the new version generates a path for non-holonomic systems where the turns are not instantaneous. The simulation and experiment results are given to show the robustness of the improved RRT and RRT* compared to the regular algorithms in MATLAB.

Keywords: RRT, RRT*, UAV, Google Earth.

013
Structural Synthesis of Euclidean Parallel Robot Manipulators of Spacecraft Docking System

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Abstract: Octahedral and hexagonal interface spacecraft docking systems with new Euclidean support-guide legs which provide free relative motion of spacecraft and its docking unit are proposed. Structural syntheses of new Euclidean space manipulators are described.

Keywords: Spacecraft docking system; Euclidean manipulators; Structural synthesis; Mobility; Docking unit.

014
Future Prospects for Fuel-Cell Aircraft – Challenges and Opportunities

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Abstract: To achieve the European Union's goals of reducing CO2 and nitrogen oxide emissions on the one hand, and good connectivity and fast transportation methods on the other, a technological breakthrough in aircraft technology must be achieved. In the category of small regional aircraft, a fuel cell aircraft represents a possible solution. The first prototypes of fuel cell aircraft have already completed their maiden flights. Nevertheless, the road to commercialization of the fuel cell aircraft is still long. Although fuel cell aircraft can boast with advantages such as the high energy density of hydrogen fuel and no emissions except the water va-por, many challenges still need to be overcome, such as insufficient or non-existent ground infrastructure, technological readiness, safety issues, and econom-ic viability. This talk will present the advantages and disadvantages of fuel cell aircraft compared to convection aircraft and other solutions and discuss the pro-spects for future commercialization of regional fuel cell aircraft.

Keywords: Fuel cell aircraft, New aircraft technologies.