Proceedings of AWADE-2022

the 4th Seminar

Asian Workshop on Aircraft Design Education

Nanjing, China, 2022, October 21-22

Nanjing University of Aeronautics and Astronautics
Nanjing Association for Science and Technology
Jiangsu Society of Aeronautics and Astronautics · Nanjing Society of Aeronautics and Astronautics

Proceedings of AWADE-2022
the 4th Seminar

Six years have passed since the organization of the Asian Workshop on Aircraft Design Education (AWADE). This form of activities in the field of aircraft engineering in education involves various formats: seminars and student competitions, the implementation of joint projects, the preparation of educational materials, etc. The main goal of the AWADE is to improve the process of training students in the field of aircraft design from both scientific and methodical points of view. AWADE-2022 was held in Nanjing University of Aeronautics and Astronautics (NUAA) on October 21-21. AWADE-2022 included activities for the 70th anniversary of the Nanjing University of Aeronautics and Astronautics.

Proceedings materials include abstracts of 4 keynote and 12 work speeches of the 4th AWADE seminar.

Edited and decorated by Professor Anatoly Kretov and Dmytro Tiniakov

Printed at Nanjing University of Aeronautics and Astronautics

Asian Workshop on Aircraft Design Education

21-22 October, 2022

Work Program
of the AWADE-2022

Online Seminar

22nd October (Sat), morning

Session 1

Session chairs: *Prof. Anatolii Kretov and Prof. Dmytro Tiniakov*

Time (Beij.)	**Kind of work** *Author(s)* ***Topic*** (Organization)	**Report mode**
08:30 – 08:50	**Checking the communication of the 1st session participants**	**Online Online***
09:00 – 09:25	**Opening Ceremony(** hosted by *Prof.Lifeng Wang* **,**Vice Dean of College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing,China) **Welcome Speech to Asian Workshop AWADE-2022 and 70th Anniversary of Nanjing University of Aeronautics and Astronautics** *Prof.Xiaohui Wei* (Dean of College of Aerospace Engineering,Nanjing University of Aeronautics and Astronautics, Nanjing, China) *Mr.Guoquan Zhang* (Vice-Director of International Office, Nanjing University of Aeronautics and Astronautics,Nanjing,China) **Information Speech.***Prof. Anatolii Kretov.* ***Brief speech about AWADE and EWADE history and seminar program*** (College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China)	**Online*** **Online**
09:25 – 10:05	**Keynote speech 1**. *Anthony P. Hays.* ***Hydrogen-Powered Aircraft*** (California, USA)	**Online**
10:05 – 10:40	**Keynote speech 2**. *Prof .Haibo Jin.* ***A New Development on the Design of NUAA's Small Airplanes***,College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China)	**Online***
10:40 – 11:00	**Break**	
11:00 – 11:15	**Work speech 1**. *Clifton Read[1], Anatolii Kretov[2], and Yury Mekhonoshin[3].* ***Aerospace parachutes - as effective means of braking the returnable launch vehicles blocks and aerospace planes***. (1 – Executive Wisdom Consulting Group, Brisbane, Australia. 2 – College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China, 3 – Research and Implementation Center "Atmosphere", Skolkovo, Russia)	**Online***
11:15 – 11:30	**Work speech 2.** *X.Zhao[1]*, W.J.C. Verhagen[2].* ***Aircraft Life Cycle Cost Analysis Supported by Knowledge Based Engineering*** (1 – College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, 2 – School of Engineering, Aerospace Engineering and Aviation, RMIT University, Australia)	**Online**
11:30 – 11:45	**Work speech 3**.*Zhaolin Chen[1], XiaoHui, Wei[1], and Ning Qin[2].* ***Optimization of High-Mach Low-Reynolds Number Airfoil Based on Genetic Algorithm*** (1 – College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China, 2 – Department of Mechanical Engineering, University of Sheffield, UK)	**Online**
11:45 – 12:00	**Work speech 4**. *S. Yeremenko, T. Solianyk.* ***Aerodynamic features of the swept-forward wing*** (Department of Aero and Hydrodynamic, National Aerospace University «Kharkiv Aviation Institute»)	**Online**
12:00 – 12:15	**Work speech 5.** *Mahanned Saleh.* ***Dynamic and Static Stability/Instability of Different Composite Structures*** (State Key Laboratory of Mechanics and Control of Mechanical Structures, University of Aeronautics and Astronautics, Nanjing, China)	**Online***

* All reports will be executed remotely (online) , including speakers from Nanjing University of Aeronautics and Astronautics (online*)

2nd October (Sat), afternoon and evening

Session 2

Session chairs: *Prof. Anatolii Kretov and Prof. Dmytro Tiniakov*

Time (Beij.)	**Kind of work** *Author(s)* ***Topic*** (Organization)	**Report mode**
13:30 – 13:50	**Checking the communication of the 2st session participants**	**Online Online***
14:00 – 14:40	**Keynote speech 3**: *D. Tiniakov[1] and A. Kretov[2]*. ***The Weight and Aerodynamic Efficiency Estimation for a Wing with High Aspect Ratio for Future Civil Aircraft*** (1 – College of Civil Aviation, 2 – College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China)	**Online***
14:40 – 15:20	**Keynote speech 4**: *Dieter Scholz.* ***Tools and Data for the Aircraft Design Community to Optimize Part 25 Jets and Props*** (Hamburg University of Applied Sciences, Hamburg, Germany)	**Online**
15:20 – 15:35	**Work speech 6**. *Liia Makarova*. ***Features of the distance education process in aviation engineering disciplines*** (Department of Helicopter Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China)	**Online**
15:35 – 15:50	**Work speech 7**. *Dennis Camilo, Dieter Scholz.* ***Comparing Aircraft Wake Turbulence with Induced Power Calculations*** (Hamburg University of Applied Sciences, Hamburg, Germany)	**Online**
15:50 – 16:10	**Break**	
16:10 – 16:25	**Work speech 8**. *Pavel V. Zhuravlev and Vladimir N. Zhuravlev*. ***Creating models for early stages of design of families of trunk-route passenger airplanes*** (Moscow Aviation Institute, Department of Pre-Design and Effectiveness of Complex Aviation Systems, Moscow, Russia)	**Online**
16:25 – 16:40	**Work speech 9**. *Dalius MAŽEIKA[1], Piotr VASILJEV[2], Sergejus BORODINAS[1], Arunas STRUCKAS[2], Regimantas BAREIKIS[1,2]*. ***Flat ring-type radial-torsional ultrasonic motor for micro UAV*** (1 – Vilnius Gediminas Technical University, Vilnius, Lithuania, 2 – Vytautas Magnus University, Kaunas, Lithuania)	**Online**
16:40 – 16:55	**Work speech 10**. *V.I. Khaliulin, L.P. Shabalin, V.V. Batrakov, E.A. Puzyretskiy*. ***Simulation of composite molds 3D printing and lattice structures transfer molding*** (Kazan National Research Technical University named after A.N. Tupolev-KAI, Kazan, Russia)	**Online**
16:55 – 17:10	**Work speech 11**. *N. Uddin and R. S. Pant*. ***Design and Sizing of Reusable Indoor Hot Air Balloon (RIHAB) Lighter-than-air*** (Systems Laboratory, Aerospace Engineering Department, Indian Institute of Technology Bombay, Mumbai, India)	**Online**
17:10 – 17:25	**Work speech 12.** *Eiman B. Saheby*. ***Supersonic Drone (design and challenges)*** (College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China)	**Online***
17:25 – 17:40	**Summing up the results. Discussion of AWADE action plans for 2023**	

We will use the "**Tencent Meeting**" platform for our work

Meeting Topic: Prof. Tiniakov Dmytro's Scheduled Meeting
Time: 2022/10/22 08:00-18:00 (GMT+08:00) China Standard Time - Beijing

Click the link to join the meeting or to add it to your meeting list:
https://meeting.tencent.com/dm/6SyJzjKWAPPk

#TencentMeeting：309-681-438

Copy this invitation and open in Tencent Meeting app (V2.13 or later) to join the meeting

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AWADE-2022 Seminar*

* – the papers follow in that sequence in which they were presented at the seminar and in that view in which they were sent by their authors without any additional edit.

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Introduction

Brief History of Asian- and European WADE and program of AWADE 2022 and 70th Anniversary of Nanjing University of Aeronautics and Astronautics

About AWADE-2022

Nanjing University of Aeronautics and Astronautics (NUAA), established in October, 1952, is one of the first aviation universities in China. NUAA is among the first batch of national universities entitled to award doctoral degree. The discipline of aerospace and science and technology at NUAA ranks 3rd among more than 2,500 higher educational institutions in China. NUAA's three engineering disciplines (aerospace and science and technology, mechanical engineering and mechanical manufacturing) are among the best QS discipline ranking 150-200. NUAA offers about 150 educational programs to more than 30 thousand students. Aircraft design is always one of the most important educational programs.

One of the events to celebrate the 70th anniversary of NUAA is the Workshop on Aircraft Design Education (AWADE-2022), which took place on October 21-22, 2022. The main element of which is the seminar held on October 22. Participants from different countries, including colleagues from the European Seminar, were invited to participate in the seminar.

About AWADE History

The Asian Workshop on Aircraft Design Education was initiated by Professor Anatolii Kretov and has been held in Nanjing consecutively in

2016 (https://purl.org/awade/2016),
2017 (https://purl.org/awade/2017)
2018 (https://purl.org/awade/2018).

AWADE has built close working contacts with the European Workshop on Aircraft Design Education (EWADE), headed by Professor Dieter Scholz from Hamburg University of Applied Sciences (HAW Hamburg) – http://EWADE.AircraftDesign.org

AWADE-2022 Aim and Scope

AWADE is conceived as a platform for increasing the level of knowledge of teachers and students in the field of aircraft design. To do this, researchers and representatives of aviation enterprises are involved in the seminar.

AWADE-2022 aims to provide a platform for exchange of ideas and recent progress on topics related to aircraft design and engineering education organization. The topics include but are not limited to:

– methodological issues aimed at improving the engineering educational process;

– scientific problems in aircraft design;

– new requirements arisen from modern aircraft design education deeply integrated with informatization, networking and intelligence;

– research related to aerospace technology.

Teachers, researchers and students from different universitates in the research field of aircraft design and engineering education were welcome to contribute to AWADE-2022.

Due to the pandemic, AWADE-2022 will be in the hybrid form, with both "live, onsite" and "virtual, online" programs. For the work was used the Tencent Meeting platform.

Such authoritative experts in the field of aircraft design were involved in the seminar for key reports as:

– Tony Hays (a well-known specialist with 60 years of experience in aviation design) "Hydrogen-Powered Aircraft";

– Dieter Scholz (Professor of Hamburg University of Applied Sciences): "Tools and Data for the Aircraft Design Community to Optimize Part 25 Jets and Props";

– and others.

All information about **AWADE-2022** is on website:
https://aero.nuaa.edu.cn/2022/0922/c3915a293078/page.htm

Organizing Committee

The seminar was organized by the Committee consisting of:

Xiaohui Wei(Chairman)
Anatolii Kretov (Co-Chairman)
Xiongqing Yu
Yadong Gao
Yang Lu
Haibo Jin
Dmytro Tiniakov
Lifeng Wang
Zhijin Wang
Yin Yin
Xiaojia Zhao(Secretary)
Shixuan Yan(Secretary)
Xinying Zhang(Secretary)

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Hydrogen-Powered Aircraft

Anthony P. Hays

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Abstract

Aviation industry is a sector of hard-to-decarbonize of the transport area due to the strict mass and volume requirements for fuel. It is difficult to replace the high energy content of liquid fuel. Important accent has been set on drop-in Sustainable Aviation Fuels (SAFs) to decrease emissions without decreasing aircraft performance. However, SAFs discharge carbon dioxide in time of combustion and their application has fallen short of expectations due to their high cost, limited supply, etc. It was analyzed application of batteries for VTOL and very short-range aircraft (i.e., small fuel mass fraction). The H2, hybrid gas turbine and fuel cell application for short haul, lower Mcruise operations it was considered. It was obtained that for medium and long range, H2 direct burn is currently the best solution. For long haul aircraft, the hybrid gas turbine and fuel cell may be preferable If fuel cell weight can be reduced.

Keywords

hydrogen-powered; aircraft; emission; jet fuel.

Recent Publications:

1) Aerodynamic design and evaluation of an open-nose supersonic drone. April 2022Proceedings of the Institution of Mechanical Engineers Part G Journal of Aerospace Engineering. DOI: 10.1177/09544100221084389
2) Flow structure of the ridge integrated submerged inlet. September 2021Aerospace Science and Technology 119(4):107136 DOI: 10.1016/j.ast.2021.107136
3) The inlet flow structure of a conceptual open-nose supersonic drone. February 2021Proceedings of the Institution of Mechanical Engineers Part G Journal of Aerospace Engineering 235(12):095441002098304 DOI: 10.1177/0954410020983043

Biography

Anthony P. Hays is aviation engineer and researcher. He was the project engineer for HS 133/141. Designed and supervised construction and rig testing of model thrust deflectors for fan-lift engines for a VTOL airliner. Worked on redesign and modification of the 7ft X 5ft closed jet wind tunnel to an open jet anechoic tunnel. Analyzed short-haul demand to determine markets for the DHC-7, and prepared technical briefs for presentation to government and industry to promote the concept of the quiet STOL system. Prepared route applications for Canadian third level carrier for presentation to Canadian Transport Commission. Worked on noise study at Vancouver International Airport, analysis of airline capacities in Africa, and airport development at Kingston, Ontario. Worked on certification of C-130 to FAR Part 36. Led noise/cost tradeoff studies for SSTs, and SST flight path optimization with respect to

noise, and related studies. Managed design and analysis team in program for far-term L-1011 derivative. Managed NASA study to determine costs/benefits and plans for implementing fuel reducing technologies (aerodynamics, propulsion, systems and materials) in long-range commercial transports. Managed contract with Rolls-Royce to evaluate new engine concepts on short-haul aircraft. Managed NASA contract to determine costs/benefits and plans for implementing a digital flight control system and "all-electric" secondary power systems on commercial aircraft. Worked on performance and sizing programs for National AeroSpace Plane. Chief engineer for High-Speed Civil Transport program. Managed joint project with Korea Commercial Aircraft Development Consortium on design of a 100 passenger aircraft. Worked on crew training and flight manual development for C-130J. Also worked on flight manual for C-5 RERP. Worked on numerous far-term derivatives of C-130, and C-130 replacement.

Specialties: Advanced design, aerodynamics and performance, propulsion, acoustics, flight crew training.

Presenting Author Details and Photo

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Recent Photograph:

A new development on the design of NUAA's small airplanes

Haibo Jin

Ministerial Key Discipline Laboratory of Advanced Design Technology of Aircraft, NUAA, Nanjing, China

E-mail: jinhb@nuaa.edu.cn

Abstract

This topic first introduces the AD100 airplane and AD200 airplane that were successfully developed by the department of aircraft design of NUAA in the 1980s and 1990s. The successful development of these two airplanes has laid a good foundation for the teaching and research of aircraft design in NUAA. After 2000, with the establishment of the ministerial key discipline laboratory of advanced design technology of aircraft, it has successively completed the development of the AC500, a five-seater small airplane and the Angel Bird, a Ground-effect Vehicle.

In 2014, with the establishment of the University Collaborative Innovation Center of "Light General Aviation Aircraft Technology" in Jiangsu Province, together with enterprises, they successfully developed the NH40, which is a four-seater all composite small airplane. The airplane has solved the following two key problems: (1) established a demand driven, multi-objective optimum model, which solved the overall layout problem of low drag and high controllability by multidisciplinary design optimization method; (2) proposed a comprehensive design theory and method, which solved the comprehensive coordination of strength, stiffness, stability, damage tolerance, fatigue aging. Compared with an all-metal structure, the weight coefficient of the all-composite body structure has decreased by 1.5%, and the fatigue performance has been greatly improved. In the face of the new demand for an electric plane design, the laboratory has set up a dedicated research group for designing an eVOTL aircraft, with green power, electric propulsion, distributed high lift, lightweight and large range properties. This aircraft will be more convenient, efficient, green, intelligent and reliable.

Keywords: small airplane; composite structure airplane; eVTOL; multidisciplinary design optimization; composite structure design; light weight design, electric propulsion; green power

Recent Publications:

1. JIN Haibo, CHEN Xuanliang, QIN Xianggui. Open-rotor engine noise analysis based on Mohring acoustic analogy[J]. Journal of Aerospace Power, 2018,33(4):785-791. ZHANG Pengfei, JIN Haibo. Stacking sequence design of composite thin-walled structure based on low energy impact damage resistance[J]. Acta Materiae Compositae Sinica,2014,31(1):18-25.

2. REN Zhiyi, JIN Haibo, DING Yunliang. Flutter analysis based on the piecewise express of aerodynamic forces and the application of mode tracking technology. ACTA Aerodynamica Sinica,2014,32(2):246-251.

Biography

Jin Haibo, male, born in 1974, Doctor of Engineering, associate professor, deputy director of Jiangsu University Collaborative Innovation Center of Light General Aviation Aircraft Technology. He graduated from Nanjing University of Aeronautics and Astronautics with a doctor's degree of flight vehicle design in 2003. For 20 years, he has mainly engaged in the research of small airplane design, composite material structure design, electric plane design, and structure optimum design, etc., published 30 papers and won two ministerial achievement awards. Together with other members, he has designed a four-seater all-composite airplane, which firstly flied in Dec. 2019.

Presenting Author Details and Photo

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Phone No: 0086-18913927032
Recent Photograph:

The Weight and Aerodynamic Efficiency Estimation for a Wing with High Aspect Ratio for Future Civil Aircraft

A. Kretov[1] and D. Tiniakov[2]

[1,2]Nanjing University of Aeronautics and Astronautics, Nanjing, China
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Abstract

The task of improving the fuel efficiency of commercial civil aircraft is becoming increasingly actual. Until nearest time, the evolutionary process of solving this task was related mainly to the continuous growth of fuel costs. The use of the wings with a high aspect ratio for prospective-directed commercial aircraft is being studied. Proposed solution makes it able to improve fuel efficiency by decreasing induced drag. This aim is provided by adjusting the wingspan, for the wings created of composite materials. The aircraft with wings with an increased span hard to arrange in the existing airports conditions. To prevent this problem, the application of folding wingtips was analyzed. The impact of this a folding device on the weight of an aircraft was evaluated. The method to evaluating the weight of composite wing structures with folding wing-tips had been proposed. A principal evaluation of the Boeing 737 and A-320 aircraft with high aspect ratio wings of composite structure was performed. The proposed method is useable to aircraft of various categories. This method is applicable for an aircraft with a twin-fuselage or a blended wing body in the future. These configurations also cause an increase in the wing-span. The method discussed in the research can evaluate the expected weight losses and passes to manage for them, especially for the preliminary design stage.

Keywords

conceptual design; passenger aircraft; composite wings; folding wingtips; numerical examples.

Recent Publications:

1) Kretov A., Tiniakov D. Evaluation of the Mass and Aerodynamic Efficiency of a High Aspect Ratio Wing for Prospective Passenger Aircraft, Aerospace 2022, Volume 9, Issue 9, 497, doi: 10.3390/aerospace9090497
2) Kretov, A., Glukhov V. Alternative Fuel in Transport Aviation and Estimation of Its Application Efficiency. Russ. Aero-naut. 2021, 64, 365–375. https://doi.org/10.3103/S1068799821030016
3) Tiniakov D., Dveirin O., Makarova L. Analysis of The Wings And Powerplant Changes at The Time Of Civil Aircraft Variant Development, 2021 7th International Conference on Mechanical Engineering and Automation Science (ICMEAS), DOI 10.1109/ICMEAS54189.2021.00040

Biography

Kretov Anatolii. Major: Aircraft Design, Manufacturing and Testing. Position: Professor of the Department of Aircraft Engineering, College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics. Background: He graduated from the Kazan Aviation Institute (Kazan national research technical University named after A. N. Tupolev-KAI). A. Kretov has research experience with the Central Aerohydrodynamic Institute (TSAGI) and with the Public Joint Stock company "Tupolev". Since 2015, A. Kretov has been a Professor at the Nanjing University of Aeronautics and Astronautics. His area of expertise is the design of highspeed aircraft and structures, as well as weight designing. Papers – 80, Books – 2. Participated in several research projects.

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Tiniakov Dmytro. Major: Aircraft Design, Manufacturing and Testing. Position: Associate Professor of the Department of Civil Aviation Engineering, College of Civil Aviation, Nanjing University of Aeronautics and Astronautics. Background: Associate Professor in the National Aerospace University of Ukraine, Kharkov. Research projects: 1) The rational designing for aircraft high operational efficiency with according to Airworthiness. 2) The analysis of the structure for reduction noise and emissions of aircraft. Papers – 35, Conference reports – 28, Books – 9, Patent – 1. Participated in some research projects.

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Tools and Data for the Aircraft Design Community to Optimize Part 25 Jets and Props

Dieter Scholz

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Abstract

At Aircraft Design and Systems Group (AERO) of Hamburg University of Applied Sciences, we have accumulated many interesting Aircraft Design resources on the web for everyone to use. Intention is to summarize, what is offered Open Access. The "Aircraft Design Community" should benefit from these resources. Potential users are students and staff at universities and research institutes. Industry is usually working with its own codes and confidential company data. However, "paper aircraft" (i.e. calculated concepts) from outside of industry are very important, because society has to check industry proposals. Everyone with aircraft design knowledge should participate in the public debate about the best way forward for passenger aviation in order to steer government resources towards the most beneficial solutions. Aviation has its part in solving the current energy and environmental crisis. Money is always limited and must only be spent on concepts that really make a difference and can help at best today and not only as late as 2050.

Keywords

hydrogen-powered; aircraft; emission; jet fuel.

Recent Publications:

1) Passenger Aircraft at End-of-Life. 2-Jun-2022. Hamburg Aerospace Lecture Series 2022. DOI: 10.5281/zenodo.6648923
2) Comparing aircraft wake turbulence with induced power calculations. 26-Sep-2022. Deutscher Luft- und Raumfahrtkongress 2022. DOI: 10.48441/4427.558
3) Routes of aircraft cabin air contamination from engine oil, hydraulic and deicing fluid. March 2022. National Institute for Aerospace Research Elie Carafoli: INCAS. DOI: 10.13111/2066-8201.2022.14.1.13

Biography

Dieter Scholz is a professor in Aircraft Design, Flight Mechanics, and Aircraft Systems at Hamburg University of Applied Sciences (HAW Hamburg), Germany, where he is head of the Aircraft Design and Systems Group (AERO). He studied Mechanical Engineering at University Hannover, Germany (Dipl.-Ing.) and at Purdue University, USA (MSME). Prof. Scholz was systems engineer at Airbus in Hamburg, Germany and temporary lecturer at Queens University Belfast (QUB), UK. He obtained his Dr.-Ing. (PhD) at Hamburg University of Technology (TUHH). His academic interests include also Flight Testing, Flight Dynamics, Stability and Control, Flight Control and Hydraulic Systems, Aerodynamics, Simulation, Optimization, Short Courses, Open Access Publishing, and questions related to Aviation & Society.

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Recent Photograph:

Aircraft Design resources on the web for everyone to use:

Tools
http://LectureNotes.AircraftDesign.org
http://OpenVSP.ProfScholz.de
http://PreSToClassic.ProfScholz.de
http://PreSTo.ProfScholz.de
http://SAS.ProfScholz.de
http://Diederich.ProfScholz.de

Data:
Classification for Aeronautics, Astronautics and Aerospace Sciences:
https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero2022-10-06.015
The 50 Most Important Parameters of the 60 Most Used Passenger Aircraft:
https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero2022-10-01.013
Turbofan Specific Fuel Consumption, Size and Mass from Correlated Engine Parameters:
https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero2021-09-15.018

Library:
http://library.ProfScholz.de

Aerospace parachutes – as effective means of braking the returnable launch vehicles blocks and aerospace planes

Clifton Read[1], Anatolii Kretov[2*], and Yury Mekhonoshin[3]

1 – Executive Wisdom Consulting Group, Brisbane, Australia.
2 – Nanjing University of Aeronautics and Astronautics, Nanjing, China
3 – Research and Implementation Center "Atmosphere", Russia
**e-mail: kretov-ac@nuaa.edu.cn*

Abstract

The work is devoted to the analysis of possible ways to rescue the stages of launch vehicles and aerospace planes for their subsequent use and to estimate the specific cost of launching a payload into low Earth orbit. A more detailed assessment was made for the rescue of the first stage of the Falcon-9 launch vehicle. As priority is investigated versions of the application of the aerospace parachute system including helicopter pickup, and also the combination with rocket-dynamic system. It was proposed and developed a well-grounded concept of parachute system application using high-temperature, heat-resistant silica and quartz textile materials (new in parachute building) already brought to a commercial level, which has led to the creation of a new class of aerospace parachuting systems. Some facts, related to the salvation of the launch vehicle are described. It also takes into consideration the economic feasibility and natural resources.

Keywords

conceptual analysis, reusable stages, launch vehicles, rescue methods, specific cost of launching a payload

Recent Publications: Minimum 3 publications to be included

1. Mekhonoshin Yu.G., Chizhukhin V.N., Gvozdev Yu.N., Ivanov PI, Yushkov V.A. RF patent: No. 2495802 dated 17.03.2011. "Method of using SS for rescuing spent stages of ILV".
2. Bolonkin A.A. New Concepts, Ideas and Innovations in Aerospace, Technology and Human Sciences, NOVA, NY, USA, 2006. ISBN-13: 978-1-60021-787-6, ISBN-10: 1-60021-787-7.
3. A. S. Kretov, V. N. Chizhukhin, M. M. Kovalevskii & Yu. G. Mekhonoshin. To Judicious Selection of a Method for the Launch Vehicle Block Rescue Russian Aeronautics volume 64, pages1–10 (2021)

Clifton Read – *Executive Wisdom Consulting Group, Brisbane, Australia*

Anatolii Kretov

Professor of Nanjing University of Aeronautics and Astronautics, Nanjing, China

Yu. G. Mekhonoshin

Research and Implementation Center "Atmosphere", Russia

Lead Project Engineer Aerospace parachutes for rocket stage rescue.

Experience in the development of parachute systems for various purposes - 45 years.

Aircraft Life Cycle Cost Analysis Supported by Knowledge Based Engineering

X. Zhao[1] and W.J.C. Verhagen[2]

[1] College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China
E-mail: xiaojiazhao@nuaa.edu.cn
[2] School of Engineering, Aerospace Engineering and Aviation, RMIT University, Melbourne, Australia

Abstract

A comprehensive method is presented to estimate aircraft life cycle costs using Knowledge Based Engineering (KBE) techniques. A suite of parametrical cost estimation blocks are treated as Cost Primitives (CPs), which contain attributes such as cost types, cost driving parameters, and cost estimation relationships. A CP is associated with a parameterized geometry and a set of specific design parameters including part/assembly types, materials and life cycle processes. The life cycle cost is estimated by aggregating the cost of different CPs within a tree structure integrating both product breakdown and cost breakdown structures. The cost analysis tool is integrated into a KBE application by building Capability Modules (CMs), which provide life cycle process geometric representations for cost estimation and can be used to summarize output reports for further optimization. Case studies concerning stiffened panels and rudders are carried out, verifying the accuracy of the cost estimation method and illustrating the applicability of this method together with the integrated KBE application for various aircraft components. The main contribution of this research is automating the cost integration in the design process to improve the fidelity, repeatability and traceability of cost analysis.

Keywords

aircraft life cycle; knowledge based engineering; design for cost; cost estimation; design optimization

Recent Publications:

1. X. Zhao, W.J.C. Verhagen, and R. Curran, Disposal and Recycle Economic Assessment for Aircraft and Engine End of Life Solution Evaluation, Applied Sciences, vol.10, no.2, pp522，2020.
2. R. Curran, X. Zhao, W.J.C. Verhagen, Concurrent Engineering and Integrated Aircraft Design, book chapter in Concurrent Engineering and Integrated Aircraft Design - Foundations, Developments and Challenges, 2015.Publisher: Springer International Publishing Switzerland，ISBN 978-3-319-13775-9

3. X. Zhao, W.J.C. Verhagen, and R. Curran, Estimation of Aircraft Component Production Cost Using Knowledge Based Engineering Techniques, Advanced Engineering Informatics, vol.29, no.3, pp.616-632, 2015.

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Optimization of High-Mach Low-Reynolds Number Airfoil Based on Genetic Algorithm

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Abstract

Recently, the focus has shifted to Mars's exploration of flying vehicles. Rovers can significantly improve their traveling range, route planning, and maneuverability by providing an aerial view of upcoming paths. However, the low temperature, density, and largely CO2-based Mars's atmosphere bring two major challenges in the design of Mars rotors, including (a) low Reynolds number flows and (b) a lower rotor's maximum tip Mach number. The current work focuses on a Mars rotor design in a high-Mach low-Reynolds number regime, including 2-D airfoils aerodynamic optimization and aerodynamic performance analysis for the 3-D Mars rotor. High-fidelity numerical approaches are applied to obtain higher-accuracy aerodynamic coefficients and reveal unique flow features of this regime. The results show that the conventional airfoil's corresponding drag-divergence Mach number curves present almost a parallel shifting at the entire Mach number range. By contrast, the drag-reduction effect for the unconventional airfoil is significantly improved only at Mach numbers higher than 0.75. Besides, the maximum lift-to-drag ratio is highly influenced by the Mach number because of the formation, movement, type, and strength of a shock wave. In addition, the distinguishing difference was that the conventional airfoil showed an amplified periodic lift fluctuation with increasing Mach number. While as the Mach number increases, the compression effect is enhanced, where a reduction in the lift fluctuation is observed for the unconventional airfoil.

Keywords

High Mach, low Reynolds, airfoil, Mars

Recent Publications: Minimum 3 publications to be included

1. An Open-source Adjoint-based Field Inversion Tool for Data-driven RANS Modelling. Conference: AIAA AVIATION 2022 Forum. DOI: 10.2514/6.2022-4125 (2022)

2. Turbulent Mean Flow Reconstruction Based on Sparse Multi-sensor Data and Adjoint-based Field Inversion. Conference: AIAA AVIATION 2022 Forum. DOI: 10.2514/6.2022-3900 (2022).

3. Vortex-Generating Shock Control Bumps for Robust Drag Reduction at Transonic Speeds. April 2021 AIAA Journal 59(8):1-10. DOI: 10.2514/1.J060528 (2021)

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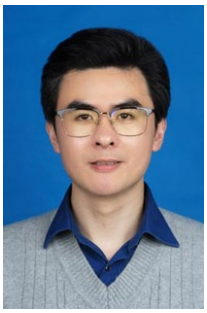

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Aerodynamic features of the swept-forward wing

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Abstract

This paper presents the results of a comparative study of the aerodynamic characteristics of a swept-forward wing in order to determine the advantages and disadvantages of their application for various layout schemes. The studies were carried out using numerical simulation methods. As a result of the analysis, comparative characteristics of the main aerodynamic parameters of the bearing surfaces of the aircraft were obtained. Identified advantages and disadvantages of a swept-forward wing compared to a forward swept wing. Together with the latest technologies for creating aircraft, these results will expand the applicability of the swept-forward wing layout for solving various practical problems in a wide range of altitudes and flight velocities of the aircraft.

Keywords

aerodynamic characteristics; swept-forward wing; critical Mach number; wave drag; inductive drag; sweep along the leading edge of the wing; aerodynamic load on the wing; lift drag ratio.

Recent Publications:

1. Estimation of the lateral aerodynamic coefficients for Skywalker x8 flying wing from real flight-test data. Acta Polytechnica – Vol 58, No 2 (2018). pp. 77-91. Czech Technical University in Prague, 2018 DOI: https://doi.org/10.14311/AP.2018.58.0077

2. Development of the System to Provide Cross-browser Compatibility of Web Application. Conference Proceedings of 2018 IEEE 9th International Conference on Dependable Systems, Services and Technologies DESSERT'2018 Ukraine, Kyiv, May 24-27, 2018. pp. 119-124.

3. SCADA Systems and Augmented Reality as Technologies for Interactive and Distance Learning Proc. of 13th Int. Conf. ICTERI'2017, Kyiv, Ukraine, May 15-18, 2017. - pp. 245-256, CEUR-WS.org

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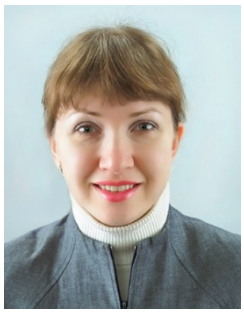

Dynamic and Static Stability/Instability of Different Composite Structures

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Abstract

In many engineering fields, the prediction of properties, behaviour, and performance of various systems is crucial. Furthermore, enhancing the behaviour of various systems has attracted the attention of researchers in electrical engineering, chemistry, materials science, physics, and engineering applications. Plates, disks, annular, and other mechanical systems (MS) serve a variety of roles in medicine, agriculture, and aerospace, as well as mechanical and electrical engineering because some important requirements in science and technology have to be met in order to maximize mechanical performance and response. Composite materials have become increasingly desirable in recent years for applications in aviation, robotics, automobiles, and biomedicine because of their properties, including lightweight, design flexibility, mechanical property retention, durability, and so on. In a class of MS strictures and disks such as resonators and generators, in which the fundamental part of the system oscillates, understanding the dynamic responses of the components of the structure becomes impressive. Also, some researchers tried to predict the static and dynamic properties of different structures and materials via neural network. In this report, we present the modeling of some responses such as natural frequency (free vibration), buckling, phase velocity, wave number, and mode shape of the applicable structures (disk, panel, conical...etc.) with different materials such as Graphene nanoplatelets (GPLs), multi-walled carbon nanotubes (MWCNTs), and multi-hybrid nanocomposite (MHC), and using various theories such as GDQ method, Multiple scales method, and FE method.

Keywords

dynamic and static responses, composite materials, nano/microstructures, MWCNTs, GDQ methods, FE method.

Recent Publications:

1. Presentation. Stability/instability of mechanical structures; HDU; 2019
2. Presentation. Dynamic analysis for applicable structures-ZAFU; 2021

Biography

Mohanned Saleh is an associate professor of engineering. His doctoral degree is from Zhejiang University, China. His research focuses on smart materials, structural mechanics, and numerical methods. Stanford University has listed him in the Top 2% Scientists of the World.

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Features of the distance education process in aviation engineering disciplines

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Abstract

To date, it is possible confidently state the fact that Covid-2019 pandemic has had a huge impact on various spheres of human activity, including education. The huge transformations over the past few years in education related to the pandemic, of course, require the deepest analysis in many aspects, only an extensive collection of information on changes in qualitative and quantitative characteristics will allow us to draw conclusions about changes in this area. This paper presents conclusions obtained empirically on the basis of teaching on the course “Helicopter Aerodynamics” - master's course, as well as the supervising bachelor's theses in the field of Aircraft Engineering at NUAA. All these conclusions may become part of the mosaic in the future, which will fully present the picture of the impact of the Covid-2019 pandemic on educational processes. The article presents an analysis and evaluation of the different aspects of students’ learning.

Keywords

Engineering Education, Distance learning

Recent Publications:

1. Analysis Of The Wings And Powerplant Changes At The Time Of Civil Aircraft Variant Development. October 2021. Conference: 2021 7th International Conference on Mechanical Engineering and Automation Science (ICMEAS) DOI: 10.1109/ICMEAS54189.2021.00040

2. Information Analysis Of Modifications To Increase Fuel Efficiency In Regional Passenger Jets. October 2020. Conference: 2020 6th International Conference on Mechanical Engineering and Automation Science (ICMEAS). DOI: 10.1109/ICMEAS51739.2020.00028

3. Analysis of the specific fuel efficiency for preliminary design stage of transport category aircraft variant. October 2022. Conference: 2022 8th International Conference on Mechanical Engineering and Automation Science (ICMEAS) (2022)

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Comparing Aircraft Wake Turbulence Categories with Induced Power Calculations

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Abstract

Purpose – Definition of new Wake Turbulence Categories (WTC) based on the calculation of induced power of aircraft on approach. This requires the parameters aircraft mass, span, approach speed, air density, and Oswald factor (calculated from wing aspect ratio, wing sweep, wing taper ratio, winglet height, and fuselage diameter). This is considerably more detailed than other metrics based on aircraft mass only or aircraft mass together with wing span.
Methodology – 89 different aircraft are selected which vary significantly in their parameters. Parameters are determined from the Internet; Oswald factor and induced power is calculated. Suitable boundaries of the new WTC (CAT I, II, III, IV) are determined based on induced power. Aircraft with their new categories are presented and compared to FAA, EUROCONTROL, CAA and ICAO WTCs.
Findings – Induced power can be derived not only from induced drag (as a function of lift), but also from the energy in the vortex. When compared to FAA, EUROCONTROL, CAA and ICAO WTC, the new Wake Turbulence Categories seems to offer categorization with more consistency.
Research limitations – New (reduced) wake separation minima are not considered. Physics based separation minima would need a double classification of each aircraft: a) classification related to wake vortex generation as done here and b) classification related to rolling resistance. Wake separation minima would then be allocated from a pairwise comparison.
Practical implications – Physics based WTC may categorize more reliable, which increases safety when applied to given separation minima.
Originality – Induced power has not been used as metric for wake turbulence before.

Keywords

aircraft, turbulence, vortex, EUROCONTROL

Recent Publications:

1. Passenger Aircraft at End-of-Life. 2-Jun-2022. Hamburg Aerospace Lecture Series 2022. DOI: 10.5281/zenodo.6648923
2. Comparing aircraft wake turbulence with induced power calculations. 26-Sep-2022. Deutscher Luft- und Raumfahrtkongress 2022. DOI: 10.48441/4427.558
3. Routes of aircraft cabin air contamination from engine oil, hydraulic and deicing fluid. March 2022. National Institute for Aerospace Research Elie Carafoli: INCAS. DOI: 10.13111/2066-8201.2022.14.1.13

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https://doi.org/10.48441/4427.2414

Creating models for early stages of design of families of trunk-route passenger airplanes

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Abstract

A tight connection exists between Pre-Design and Conceptual Design stages. The configuration and design parameter values of a new airplane depend on its design requirements while the requirements depend on economic characteristics. At the same time economic characteristics depend on aircraft configuration and design parameter values. These interconnections must be taken into the account. An aircraft is designed to fulfill a certain multitude of missions. Taking the aforementioned interconnections into the account allows identifying “extra” unnecessary capabilities of an aircraft at early design stages and fitting it better for the planned operational conditions. This results in design of more optimal aircraft that has the appropriate advantage during operation. Previously the designers had to allocate certain “extra” capabilities (reserves) in the project. Advancement of design, modeling and manufacturing methods allowed to transition to planning (management) of these reserves. Such planned reserves are now used for aircraft family creation and may be considered as new design variables. For passenger airplane family these include wing area, tail surface area and height of the landing gear legs. The presented model incorporates reserves management into the creation of new trunk-route passenger airplanes. It is intended for usage within the framework, which solves the problem of creation of passenger airplane fleet at Pre-Design stage as well as for optimization of passenger airplane families. The created model was verified by using the available data for the following airplanes: A320-200, B767-300 and B777-200. At that the wing area was determined (sized) for the largest family versions. The verification demonstrated good correlation between the calculation results and the available statistics. It also showed that the model can be used for sizing the families of all types of trunk-route passenger airplanes (short-, medium- and long-range).

Keywords

passenger airplane design; airplane family; fleet creation; pre-design; conceptual design.

Recent Publications:

1. Zhuravlev P. and Zhuravlev V. Significance of modifications for development of passenger airplanes. Aircraft Engineering and Aerospace Technology. Vol. 84, Iss: 3, Bingley: Emerald Group Publishing Limited, Guildford: Banner Managed Communication, 2012, pp. 172-180.

2. Zhuravlev P. V. Application of Fleet Creation Problems in Aircraft Pre-Design. Proceedings of the 29th Congress of the International Council of the Aeronautical Sciences, Saint-Petersburg, 7-12 September 2014. Saint-Petersburg, 2014.

3. Zhuravlev P.V. Analysis of significance of modifications and families for the design of modern passenger airplanes. Moscow: Nauchnyy Vestnik MGTU GA, Seriya Aeromekhanika i prochnost [Civil Aviation High Technologies, Aeromechanics and strength series], no 188 (2). pp. 121-125.

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Flat ring-type radial-torsional ultrasonic motor for micro UAV

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Abstract

Small unmanned aerial vehicles (UAV) are used for civil and military defense purposes. The main problem for such UAV's is the size and weight. The main components that determine the weight of the UAV are motors, flying direction control systems, transmissions, and power supply. A new rotational type flat ultrasonic actuator is introduced in this paper. The actuator was developed to rotate two coaxial rotors. The actuator has a very simple design, and the operating principle is based on radial – torsional vibrations of the disc. The piezoelectric actuator consists of two beryllium bronze rings with the thickness of 0.3 mm and an outer diameter of the ring is 12 mm. Piezoelectric PZT-8 ring with the thickness of 0.2 mm is located between beryllium bronze rings. The first radial vibration mode is excited under 135 kHz and depends on the load. The central part of the top and bottom bronze rings have 16 non-symmetrical thin (0.2mm) cutouts. The central part of the top rings is concave at a small angle (up to 20 degrees) while the central part of the bottom ring is convex. It is done to implement a transformation of radial vibrations of a PZT ring into rotational vibrations at the contact points. Such configuration of the rings allows increasing axial force generated by the actuator. Small alumina ring with the dimensions of 2x1.2x0.6mm has glued at the contact surface of both rings. The glued ring by means of ultrasonic vibrations moves along the elliptic trajectory and contacting with an alumina rotor, forcing it to spin. The rotor is connected to the shaft, and rotation of the propeller is obtained. It must be mentioned that the design of the presented actuator allows us to drive two rotors, clockwise and counterclockwise simultaneously. The possibility to variate the rotational speed of each rotor is outlined. Numerical and experimental analyses are performed to validate the operating principles of the ultrasonic actuator. Electrical and mechanical parameters of the proposed piezoelectric actuator are obtained. The obtained experimental results show that flat ring-type actuator can be beneficially used implementing it into a small aerial UAV.

Keywords

micro UAV, weight, piezoelectric

Recent Publications:

1. An Approach to Migrate a Monolith Database into Multi-Model Polyglot Persistence Based on Microservice Architecture: A Case Study for Mainframe Database June 2022Applied Sciences 12(12):6189 DOI: 10.3390/app12126189

2. Modeling 3D Droplet Movement Using a Drop-on-Demand Inkjet Printhead Model. July 2022Processes 10(8):1467 DOI: 10.3390/pr10081467

3. A Disc-Type High Speed Rotary Ultrasonic Motor with Internal Contact Teeth. March 2021Applied Sciences 11(5):2386 DOI: 10.3390/app11052386

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Simulation of composite molds 3D printing and lattice structures transfer molding

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Abstract

Digital twin technology, calculations, and technological process simulation are necessary steps in composite parts production. They provide a possibility to predict and optimize technological parameters and ensure high quality and precision of the final parts. Besides, a series of simulations leads to a significant reduction of time and financial expenses due to a decrease in a number of full-scale tests and process adjustments. The main feature of production process calculation and simulation is a so-called “technological heredity”, which is an accumulation of parameters’ deviations at manufacturing steps. This study examines the following manufacturing steps: – Mold manufacturing: simulation of a robot-aided layer-by-layer 3D printing of a mold blank from reinforced polymer composites; shrinkage and residual stress simulation; mechanical treatment and residual strain simulation. – Lattice structure manufacturing: manufacturing of carbon fiber preforms using unidirectional tape; heating of the mold with the preform taking into account transient thermal field; impregnating the preform with resin; cure and buckling assessment; prevention of mold shape distortion. – The result of the study is an approved approach to development and verification of simulation models of 3D printing of composite molds and transfer molding of lattice structures. The method used in the study may be applied to any configuration of the molds and composite parts.

Keywords

digital twin, technological heredity, 3D printing, composite material, lattice structure.

Recent Publications:

1. Shabalin LP, Puzyretskii EA, Sidorov IN, Girfanov AM. A Method for Calculating Process-Induced Stresses to Prevent Warping of Products of Composite Materials. Journal of Machinery Manufacture and Reliability. 2021.50(2):133-42.

2. Shabalin LP, Khaliulin VI, Shanygin AN, Batrakov VV. Curved Composite Tubes: Stress-Strain Behavior Analysis and Design. Russian Aeronautics. 2021. 64(4):630-5.

3. Samipour SA, Khaliulin VI, Batrakov VV. Manufacturing Technology of Braided Lattice Aircraft Structures. Journal of Machinery Manufacture and Reliability. 2020. 49(9):787-95.

4. Puzyretskiy EA, Shabalin LP, Sidorov IN, Girfanov AM. Numerical Simulation of Composite Structures Polymerization and Determination of Residual Deformations. Mesh Methods for Boundary-Value Problems and Applications. Cham: Springer International Publishing; 2022. p. 403-13.

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Design and Sizing of Reusable Indoor Hot Air Balloon (RIHAB)

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Abstract

Hot Air Balloon (HAB) is a Lighter-Than-Air (LTA) system that uses hot air as a lifting gas. HABs do not have any control system, hence their flight is totally on the mercy of ambient wind. The aim of this exercise is to carry out sizing of a Reusable Indoor Hot Air Balloon (RIHAB) by choosing appropriate shape and material for the envelope, and the fuel to heat the air inside the envelope. In this paper we discuss a sizing methodology for a Reusable Indoor Hot Air Balloon (RIHAB). We present results of a comparative study of various shapes and material for the envelope and fuels used to heat the air inside the balloon. This exercise is very useful in teaching principles of Aerostatics and Design to students new to the field of LTA systems. Design and sizing of a Lighter-than-Air system is an iterative approach which eventually results in the desired output. There are two approaches that can be used for the sizing of RIHAB, which are adopted from the methodology provided by Pant for sizing of Non-Rigid Airships. These approaches differ in what is assumed as an input, and what is the desired output.

Keywords

lighter-than-air systems; hot air balloon; RIHAB; LTA

Recent Publications: Minimum 3 publications to be included

1. Pant, R. S., A methodology for determination of baseline specifications of a non-rigid airship. In: AIAA's 3rd Annual Aviation Technology, Integration, and Operations (ATIO) Forum (2003).

2. Multi-objective multidisciplinary design analyses and optimization of high altitude airships MI Alam, RS Pant, Aerospace science and technology 78, 248-259 (2018)

3. Research and advancements in hybrid airships—A review M Manikandan, RS Pant, Progress in Aerospace Sciences 127, 100741 (2021)

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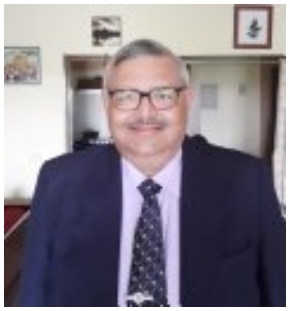

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Supersonic Drone (design and challenges)

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Abstract

The objective of this project is to investigate the efficiency of a proposed supersonic drone configuration, in the term of drag, ram recovery and fundamental flight performance factors. Sustainable supersonic cruise at Mach 1.6 was the major segment of the mission profile which affects the overall geometry resulting from the conceptual design phase; a tailless delta drone with an open-nose forebody, lofted around the inlet which consists of an analytical compression surface and a S-duct diffuser. Because the aerodynamics of this unconventional configuration is unknown, a series of CFD simulations is coupled to the design process to predict both internal and external aerodynamics as a proof of the concept. Although the baseline fuselage is not area-ruled, the drag polar comparison shows that the open-nose concept is highly efficient at the supersonic design point and its zero-lift drag coefficient is about 0.0226, which is lower than that of the F-106. Exceeding M=1 without afterburner is possible at altitudes greater than 10 km but reaching the design point requires afterburner. The simulations indicate that the drone's overall drag is significantly lower than the other configurations with side or underside integrated inlets while the inlet pressure recovery is adjusted to maximize the engine thrust. Although the subsonic diffuser is highly curved, the flow quality indices are in the required range and pressure recovery over 0.97 at AoA=0^{o} is reachable by using a concentric boundary layer bleed gap at the end of the diffuser. These comparative studies, with a developed thrust model, shows that the configuration satisfies mission requirements and exceeds them at transonic and supersonic flight phases.

Keywords

conceptual supersonic drone; open-nose-configuration; delta wing aerodynamics; supercruise; inlet-startability

Recent Publications: Minimum 3 publications to be included

1. Saheby, E. B., Shen, X., Huang, G., & Hays, A. P. (2021). "Flow Structure of the Ridge Integrated Submerged Inlet", Aerospace Science and Technology, 119, 107136. https://doi.org/10.1016/j.ast.2021.107136
2. Saheby, E. B., Hays, A. P., & Xing, S. (2022). "Aerodynamic design and evaluation of an open-nose supersonic drone", Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 095441002210843. https://doi.org/10.1177/09544100221084389
3. Saheby EB, Shen X, Hays AP, Jun Z. "The Inlet Flow Structure of a Conceptual Open-Nose Supersonic Drone", Proceedings of the Institution of Mechanical Engineers, Part G:

Journal of Aerospace Engineering. February 2021.
https://doi.org/10.1177%2F0954410020983043

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CONCLUSIONS

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Common Conclusions

1. Work of AWADE for four times has shown the importance of this direction.
2. The use of modern computer technology can significantly expand the geography of participants and allows for various forms of the workshop with minimal financial costs and minimal loss of time.
3. Attracting students to AWADE has increased their interest to the aircraft design.

AWADE-2022 Conclusions

4. The geography of the seminar participants has expanded: 12 reports were presented at the Seminar. The number of authors was 31 from 8 countries.
5. The number of reports related to the methodological problems of the organization of education in the field of aircraft design has increased significantly.
6. Ties with European associations in aircraft design continue to be strengthened.