

# **Aircraft Design**

Papers Presented at the AIAA SciTech Forum and Exposition  
2023

National Harbor, Maryland, USA and Online  
23-27 January 2023

Volume 1 of 2

ISBN: 978-1-7138-7558-1

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwytkug'Xcmg{'Ftkxg.'Uwky'422, Reston, VA 20191, USA.

# TABLE OF CONTENTS

## VOLUME 1

### **AERO-PROPULSIVE ANALYSIS METHODS**

Aerodynamic Characterization of Wing-Wing Interactions for Distributed Lift Applications .....	1
<i>Nevin Jestus, Sidaard Gunasekaran, Michael P. Mongin, Aaron Altman</i>	
Extended High Lift Characteristics of Distributed Lift Configurations.....	17
<i>Michael P. Mongin, Aaron Altman, Sidaard Gunasekaran</i>	
Drag Reduction Techniques for eVTOL Configuration with Shrouded Rotors.....	35
<i>Wanzheng Zheng, Jason M. Merret</i>	
Multhopp's Method for the Pitching Moment of Bodies Revisited.....	46
<i>Bruno Moorthamers, Willem A. Anemaat</i>	

### **NOVEL PROPULSION SYSTEM ARCHITECTURES**

A Conceptual Sizing Tool for Regional and Commuter Aircraft with Hybrid-Electric Propulsion.....	58
<i>Gala Licheva, Susan Liscouet-Hanke</i>	
Conceptual Investigation on Performance of Short-Medium Range Aircraft with Liquid Hydrogen Propulsion and Different Airframe Architectures .....	71
<i>Giuseppe Palaia, Karim Abu Salem, Vittorio Cipolla, Davide Zanetti, Vincenzo Binante</i>	
Conceptual Design of a Next Generation Supersonic Airliner for Low Noise and Emissions .....	90
<i>Cristina Villena Munoz, Giordana Bonavolontà, Craig Lawson, Atif Riaz</i>	
Aerothermodynamic Assessment of Conceptual and Detail Configuration Changes to a Rocket Propelled Aircraft .....	119
<i>Jack A. Griffin, Timothy T. Takahashi, Patrick E. Rodi</i>	

### **FLIGHT MECHANICS, CONTROL, AND DESIGN**

Genetic Algorithm Optimization of Lift-Plus-Cruise VTOL Aircraft with Electrified Propulsion.....	132
<i>Rajan Bhandari, Aashutosh A. Mishra, Imon Chakraborty</i>	
Flight Control System Architecture for Urban Air Mobility Simplified Vehicle Operations .....	165
<i>Anthony M. Comer, Imon Chakraborty</i>	
Flight Simulation Based Assessment of Simplified Vehicle Operations for Urban Air Mobility .....	207
<i>Imon Chakraborty, Anthony M. Comer, Rajan Bhandari, Aashutosh A. Mishra, Ross Schaller, David Sizoo, Robert McGuire</i>	
VTOL Freewing Design and Adaptive Controller Development.....	272
<i>Rachel M. Axten, Thanakorn Khamvilai, Eric N. Johnson</i>	

Experimental Study of the Impact of Folding Wingtip Devices on Aircraft Flight Mechanics and Handling Qualities.....	288
<i>Huaiyuan Gu, Ronald C. Cheung, Fintan Healy, Djamel Rezugui, Mark H. Lowenberg, Jonathan E. Cooper</i>	

## **STABILITY AND CONTROL**

Linearized Rigid-Body Static and Dynamic Stability of an Aircraft with a Bio-Inspired Rotating Empennage.....	306
<i>Austin J. Kohler, Christian R. Bolander, Douglas F. Hunsaker, James J. Joo</i>	
Hybrid Wing Body Pitch Control with a Surface-Vorticity Solver.....	350
<i>Griffin A. Dimaggio, Roy J. Hartfield, Vivek Ahuja</i>	
Static Trim of a Bio-Inspired Rotating Empennage for a Fighter Aircraft.....	364
<i>Christian R. Bolander, Austin J. Kohler, Douglas F. Hunsaker, David Myszka, James J. Joo</i>	

## **AIRCRAFT DESIGN STUDIES I**

Multi-Fidelity Predictions for Control Allocation on the NASA Ikhana Research Aircraft to Minimize Drag.....	410
<i>Justice Schoenfeld, Jeffrey D. Taylor, Douglas F. Hunsaker</i>	
A Cloud-Based Environment for Collaborative Aircraft Sizing Supported by a Full Parametric Geometry.....	443
<i>Yuqian Qi, Wenbin Song</i>	
Multi-Disciplinary Design of an LH2 Powered Regional Jet.....	465
<i>Maxwell T. Stauffer, Michael Backlund, Zachary Gonzales, Timothy T. Takahashi</i>	
Concept Design of Broadside UAV Ship Landing System.....	498
<i>Zihao Dong, Cees Bil</i>	

## **AIRCRAFT CONFIGURATION DESIGN AND OPTIMIZATION**

Configuration Optimisation of Aircraft with Electric Propulsion.....	521
<i>Fergus C. Flanagan, Jerome Jarrett</i>	
Configuration Optimization of a Hydrogen-Kerosene Hybrid Combustion Aircraft Retrofit.....	538
<i>Caleb Akhtar Martinez, Jerome Jarrett</i>	
A Parametric Design Process Based on Optimization-Guided Incremental Design Decisions.....	561
<i>Dongjoon Lee, Cody Karcher, Robert Haines, Marshall C. Galbraith, John Dannenhoffer</i>	
Evaluation of a Collaborative and Distributed Aircraft Design Environment, Enabled by Microservices and Cloud Computing.....	603
<i>Xin Chen, Adriano Isoldi, Atif Riaz, Christos Mourouzidis, Akin Keskin, Dale Smith, Marin D. Guenov, Vassilios Pachidis</i>	
Direct Software Coupling for Aeroplane Sizing and Integrated Aeroplane-Engine Mission Performance Simulations.....	623
<i>Aleksandar Joksimovic, Spurthy Subramanya, Jean-Baptiste Chaudron, Xavier Carbonneau</i>	

## **AIRCRAFT DESIGN STUDIES II**

Continued Exploration of the Electrified Aircraft Propulsion Design Space .....	651
<i>Jason Kirk, Zachary J. Frederick, Mark D. Guynn, Nathaniel J. Blaesser, Ben D. Phillips, Kenneth Fisher, Steven J. Schneider, Peter Frederic</i>	
Sky Cruiser – A Design Study in Space Tourism .....	666
<i>Joshua H. Heinz, Kevin P. O'Brien, Tyler L. Hatch, Timothy T. Takahashi</i>	

## **VOLUME 2**

Novel Approach for Wing Design in Conceptual Overall Aircraft Design.....	698
<i>Tim Effing, Florian Schuelcke, Yves Heuschling, Paul Mauerer, Eike Stumpf</i>	
Top Level Aircraft Requirements Relaxation for a Single-Aisle Aircraft: A Case Study on Fleet-wide CO <sub>2</sub> Emissions and Economic Impacts .....	723
<i>Antoine Salgas, Scott Delbecq, Thomas Planès, Gilles Lafforgue</i>	
Surrogate-Based Multi-Objective Optimization of Commercial Aircraft for the Minimization of Noise and Emissions .....	744
<i>Cuyler Dull, Jimmy C. Tai, Dimitri N. Mavris</i>	

## **ADVANCED AIR MOBILITY AND DISTRIBUTED ELECTRIC PROPULSION I**

Urban Air Vehicle Mission Sizing and Performance Estimation Using Pacelab APDTM .....	758
<i>Anna Occhipinti, Aleksandar Joksimovic, Mathias Emeneth</i>	
Physics-Based Surrogate Models for Urban Air Mobility Vehicle Weight Prediction .....	783
<i>Thomas Nascenzi, Timothy Cuatt, Tyler F. Winter, Marius L. Ruh, Darshan Sarojini, John T. Hwang, Sarina Kiani</i>	
Systems Integration Considerations for Hybrid-Electric Commuter Aircraft: Case Study for the DO-228.....	796
<i>Vijesh Mohan, Andrew K. Jeyaraj, Susan Liscouet-Hanke</i>	

## **DESIGN METHODS, TOOLS, AND PROCESSES IN SUPPORT OF AIRCRAFT DESIGN**

Estimation of Battery Pack Layout and Dimensions for the Conceptual Design of Hybrid-Electric Aircraft .....	812
<i>Zachary Heit, Susan Liscouet-Hanke</i>	
PoETS: A Proposed Powertrain Topology Encoding Scheme .....	825
<i>Laminn McLay, James Scanlan, Andras Sobester</i>	
MDO Framework for DEP Aircraft Design Including Flight Controls .....	842
<i>Abhinav Sharma, Jeffrey D. Keller, Joaquim R. Martins</i>	
Optimization of the Multi-Bubble Passenger Cabin Stiffening Scheme of a Hypersonic Aircraft.....	858
<i>Clara Cid Bengoa, Aitor Baldomir García, Miguel Rodríguez-Segade, Santiago Hernández</i>	

## **UNMANNED AERIAL SYSTEMS I**

- Multi-Material Topology Optimization of an Urban Air Mobility Vehicle Battery Pack ..... 868  
*Olivia Blair, Shayan Jalayer, Jaesung Huh, Sangkook Jun, Ilyong Kim*

## **DESIGN AND ANALYSIS METHODS I**

- A History and Commentary on Thrust/Drag Bookkeeping ..... 884  
*Maxwell T. Stauffer, Timothy T. Takahashi*
- Parametric Analysis for Structural Design and Weight Estimation of Cantilever and Strut-Braced Wing-Boxes ..... 912  
*Murat Taflan, Howard Smith, Joseph Loughlan*
- Validation of an Approach Towards Fuselage Optimization for Effective Boundary Layer Ingestion ..... 937  
*Diwan U. Odendaal, Lelanie Smith, Ken Craig, Drewan Sanders*

## **MODELING METHODS FOR VTOL CONCEPTS**

- Semi-Empirical Aerodynamic Modeling Approach for Tandem Tilt-Wing eVTOL Control Design Applications ..... 956  
*Marc S. May, Daniel Milz, Gertjan Looye*
- Scheduled Flight Control System of Tilt-Rotor VTOL PAV ..... 974  
*Namuk Kang, James Whidborne, Linghai Lu, Julien Enconniere*
- Energy Augmentation Concepts for Advanced Air Mobility Vehicles ..... 993  
*Kapil Sheth, Nhan T. Nguyen, Seth Schisler, Todd Stinchfield, David Pike, Thomas Lavelle*

## **UNMANNED AERIAL SYSTEMS II**

- Design and Fabrication of a Low-Cost, Low-Speed, Self-Deploying sUAS Motor Glider ..... 1006  
*Thomas Jones, Julia Cole, Simon Miller, Michael A. Yukish*
- Flight Test Driven Development of Low Cost UAVs - Pitfalls and Opportunities ..... 1025  
*Adrian B. Weishaeupl, James Scanlan, Andras Sobester*
- Electric Propeller Configuration and Efficiency Analysis for Long Range Small UAS ..... 1040  
*Cole Callahan, Tristan Denholm, Joshua McConnell, Charles F. Wisniewski, Nidal M. Jodeh*
- Effect of Motor-Rotor Geometry on the Performance of Electric VTOL UAVs ..... 1057  
*Oliver Westcott, Swathi Krishna, Mario Ferraro, Robert Entwistle*
- Development of a Hydrogen-Powered UAV System for Crossing the Atlantic Ocean ..... 1079  
*Nikola Gavrilovic, Jean-Marc Moschetta, Quentin Barascud*

## **ADVANCED AIR MOBILITY AND DISTRIBUTED ELECTRIC PROPULSION II**

- Trends in eVTOL Aircraft Development: The Concepts, Enablers and Challenges ..... 1099  
*Osita Ugwueze, Thomas Statheros, Mike A. Bromfield, Nadjim Horri*

Thermal Packaging Optimization of a UAM Nacelle Using a Dynamic Acceleration Methodology .....	1112
<i>W. C. Moffatt, Shayan Jalayer, Jaesung Huh, Sangkook Jun, Ilyong Kim</i>	
Distributed Hybrid-Electric Propulsion Benefits for Span-Limited Aircraft.....	1120
<i>Vincent Bonnin, Maurice Hoogreef, Reynard De Vries</i>	

## **DESIGN AND ANALYSIS METHODS II**

VR Assisted Design of High-Lift Devices with Model-based Approach .....	1138
<i>Xiaoniao Liu, Wenbin Song</i>	
Improved Waverider Vehicle Optimization with Volumetric and Lift Constraints for Shaped Sonic Booms.....	1156
<i>Patrick E. Rodi</i>	
Development of a Parametric Structural Analysis Environment to Support the Design, Manufacturing, and Production of a Composite UAV Wing .....	1180
<i>Marcos Dos Santos, Adam Cox, Olivia J. Pinon-Fischer, Dimitri N. Mavris</i>	
Investigating Aileron Design for Ultra-High Aspect Ratio Wings .....	1192
<i>Yiyuan Ma, Morteza Abouhamzeh, Ali Elham</i>	

## **HYPERSONIC APPLICATIONS**

Hypersonic Aerial Gunnery: New Missions, Aircraft Design Opportunities.....	1209
<i>Ronald M. Barrett-Gonzalez, Nathan Wolf</i>	
Maneuvering Capabilities of Hypersonic Airframes .....	1223
<i>Timothy T. Takahashi</i>	
Hypersonic Aircraft Performance Limitations Arising from Aerodynamic Control Limits .....	1240
<i>Timothy T. Takahashi, Jack A. Griffin</i>	

## **AEROSPACE STRUCTURES, MATERIALS, AND SYSTEMS**

Design, Manufacturing and Testing of a Wing Pivot Mechanism .....	1257
<i>Drew Priest, Matthew P. Snyder, Catherine McAlister, Beckett Andersen, Charles Lo, Joshua Schmidt, Hugh C. Briggs</i>	
Simplified Mass and Inertial Estimates for Aircraft with Components of Constant Density .....	1275
<i>Ben Moulton, Douglas F. Hunsaker</i>	
A Form-Finding Approach to the Geometric Modelling of Aircraft Sub-Systems .....	1316
<i>Hau Kit Yong, Robert Marsh, Edmar Silva, Neil Bressloff, András Sóbester</i>	
The Aerial Gunnery Gap: Challenged Programs, New Combat Aircraft Opportunities and Designs .....	1324
<i>Ronald M. Barrett-Gonzalez, Nathan Wolf</i>	
A Multidisciplinary Analysis of a Stratospheric Airborne Climate Observatory System for Key Climate Risk Areas.....	1343
<i>Annick Dewald, R J. Hansman</i>	

## **Author Index**