

# **17th AIAA-ISSMO Multidisciplinary Analysis and Optimization Conference 2016**

Held at the AIAA Aviation Forum 2016

Washington, D.C., USA  
13 - 17 June 2016

Volume 1 of 2

ISBN: 978-1-5108-2733-2

**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

### MAO-01: DESIGN OPTIMIZATION OF AIRCRAFTS AND OTHER COMPLEX SYSTEMS

<b>Parallel Aircraft Trajectory Optimization with Analytic Derivatives (AIAA 2016-3207)</b> .....	1
<i>Robert D. Falck, Justin S. Gray, Bret Naylor</i>	
<b>Multi-Disciplinary, Multi-Fidelity Discrete Data Transfer Using Degenerate Geometry Forms (AIAA 2016-3208)</b> .....	15
<i>Erik D. Olson</i>	
<b>Aerostructural Design Optimization of a Continuous Morphing Trailing Edge Aircraft for Improved Mission Performance (AIAA 2016-3209)</b> .....	29
<i>David A. Burdette, Gaetan K. Kenway, Joaquim Martins</i>	
<b>A Methodology for Probabilistic Analysis of Distributed Multidisciplinary Architecture (PADMA) (AIAA 2016-3210)</b> .....	44
<i>Sayan Ghosh, Dimitri N. Mavris</i>	
<b>Evaluation of the Impacts of the Objective Function Definition in Aircraft Conceptual Design (AIAA 2016-3211)</b> .....	60
<i>Davi Bianchi, Tarik H. Orra, Flavio J. Silvestre</i>	

### MAO-02: SHAPE AND TOPOLOGY OPTIMIZATION I

<b>Topology Optimization of Nonlinear Cellular Materials (AIAA 2016-3212)</b> .....	80
<i>Josephine V. Carstensen, James K. Guest, Reza Lotfi</i>	
<b>Topology Optimization for Additive Manufacturing: New Projection-based Design Algorithms (AIAA 2016-3213)</b> .....	90
<i>Mikhail Osanov, Josephine V. Carstensen, Emmanuel M. Tromme, James K. Guest</i>	
<b>Topology Optimization of 3D Woven Micro-lattices using a Projection-based Ground Structure Approach (AIAA 2016-3214)</b> .....	99
<i>Seunghyun Ha, James K. Guest</i>	
<b>Efficient Modal Design Variables Applied to Aerodynamic Optimization of a Modern Transport Wing (AIAA 2016-3215)</b> .....	107
<i>Christian B. Allen, Daniel J. Poole, T. Rendall</i>	
<b>Broadband Shape and Topology Optimization of Acoustic Metamaterials and Phononic Crystals (AIAA 2016-3216)</b> .....	122
<i>Weiyang Lin, James C. Newman, William K. Anderson, Xueying Zhang</i>	

### MAO-03: DESIGN OPTIMIZATION OF AIRCRAFTS AND OTHER COMPLEX SYSTEMS

<b>Control Power Optimization Using Artificial Intelligence For Forward Swept Wing And Hybrid Wing Body Aircraft (AIAA 2016-3361)</b> .....	135
<i>Moustaine Adegbindin, Nathan Love, Rakesh K. Kapania, Joseph A. Schetz</i>	
<b>Comparing Different Off-the-Shelf Optimizers' Performance in Conceptual Aircraft Design (AIAA 2016-3362)</b> .....	155
<i>Andrew Wendorff, Emilio Botero, Juan J. Alonso</i>	
<b>Development of a Multidisciplinary Design Analysis and Optimization Toolset for Integrated Spacecraft Subsystem Models (AIAA 2016-3363)</b> .....	169
<i>Tyler Winter, Brynne Coleman, Henry Pernicka</i>	
<b>Topology Optimization of a Blended-Wing-Body Aircraft Structure (AIAA 2016-3364)</b> .....	182
<i>Garima Singh, Vassili Toropov, James Eves</i>	
<b>Efficient Framework for Missile Design and 6DoF Simulation using Multi-fidelity Analysis and Data Fusion (AIAA 2016-3365)</b> .....	202
<i>Nhu Van Nguyen, Maxim Tyan, Jae-Woo Lee, Anh Bao Dinh</i>	
<b>Multidisciplinary Design Optimization Research of Overall Aero-engine based on Flow Path (AIAA 2016-3366)</b> .....	216
<i>Xiuli Shen, Wentong Hu</i>	

## **MAO-04: SHAPE AND TOPOLOGY OPTIMIZATION II**

<b>A Multifidelity Multiobjective Optimization Framework for High-Lift Airfoils (AIAA 2016-3367)</b> .....	229
<i>Jean Demange, A Mark Savill, T. Kipouros</i>	
<b>Comparison and Combination of Experience-based Parametrization with Vertex Morphing in Aerodynamic Shape Optimization of a Forward-Swept Wing Aircraft (AIAA 2016-3368)</b> .....	247
<i>Daniel Baumgärtner, Andrea Viti, Antoine Dumont, Gérald Carrier, Kai-Uwe Bletzinger</i>	
<b>An Efficient Unsteady Aerodynamic and Aeroacoustic Design Framework Using Discrete Adjoint (AIAA 2016-3369)</b> .....	267
<i>Beckett Y. Zhou, Tim A. Albring, Nicolas R. Gauger, Thomas D. Economon, Juan J. Alonso, Carlos R. Ilario Da Silva</i>	

## **MAO-05: DESIGN OPTIMIZATION OF AIRCRAFTS AND OTHER COMPLEX SYSTEMS**

<b>High Fidelity Aerodynamic Optimization in Distributed Overall Aircraft Design (AIAA 2016-3508)</b> .....	285
<i>Xiangyu Gu, Pier Davide Ciampa, Björn Nagel, Jonas Jepsen</i>	
<b>Multi-Objective Optimization of Stiffened, Fiber-Reinforced Composite Fuselages for Mechanical and Vibro-Acoustic Requirements (AIAA 2016-3509)</b> .....	299
<i>Gokhan Serhat, Tiago Goncalves Faria, Ipek Basdogan</i>	
<b>Combined Aerostructural Wing and High-Lift System Optimization (AIAA 2016-3510)</b> .....	313
<i>Koen T. Van Den Kieboom, Ali Elham</i>	
<b>Aeroservoelastic Optimisation of an Aerofoil with Active Compliant Flap via Reparametrisation and Variable Selection (AIAA 2016-3511)</b> .....	328
<i>Jacob J. Broughton-Venner, Andrew Wynn, Rafael Palacios</i>	
<b>Aero-structural Approach Coupled with Direct Operative Cost Optimization for New Aircraft Concept in Preliminary Design (AIAA 2016-3512)</b> .....	343
<i>Andrea Viti, Thierry Druot, Antoine Dumont</i>	
<b>A Probabilistic Parameter Sensitivity Analysis Approach For An Aircraft (AIAA 2016-3513)</b> .....	361
<i>Selim Selvi</i>	

## **MAO-06: SHAPE AND TOPOLOGY OPTIMIZATION III**

<b>RANS-based Shape Optimization of Dual-Rotor Wind Turbines using Variable-fidelity Models (AIAA 2016-3514)</b> .....	377
<i>Andrew S. Thelen, Leifur T. Leifsson, Anupam Sharma, Slawomir Koziel</i>	
<b>Efficient Multi-Objective Aerodynamic Optimization by Design Space Dimension Reduction and Co-Kriging (AIAA 2016-3515)</b> .....	395
<i>Anand Amrit, Leifur T. Leifsson, Slawomir Koziel, Yonatan Afework Tesfahunegn</i>	
<b>Topology Optimization of a Bi-Stable Cardiovascular Stent with Snap-Through Response (AIAA 2016-3516)</b> .....	415
<i>Kai A. James, Cian Conlan-Smith, Haim Waisman</i>	
<b>Efficient Aerodynamic Design using the Discrete Adjoint Method in SU2 (AIAA 2016-3518)</b> .....	427
<i>Tim A. Albring, Max Sagebaum, Nicolas R. Gauger</i>	

## **MAO-07: DESIGN OPTIMIZATION OF AIRCRAFTS AND OTHER COMPLEX SYSTEMS IV**

<b>A Risk-Aversion-Based Project Valuation Method to Determine Optimal Technology Infusion in Aircraft Design (AIAA 2016-3664)</b> .....	442
<i>Frederic Burgaud, Jean-Guillaume Durand, Dimitri N. Mavris</i>	
<b>A Methodology to Evaluate Tradeoffs between Individual Architecture Development and Numerality to Achieve Group Performance in Robotics Swarms (AIAA 2016-3665)</b> .....	454
<i>Jean-Guillaume Durand, Frederic Burgaud, Dimitri N. Mavris</i>	
<b>Optimal Spacecraft Hardware Placement to Minimize Required Power Input for Hibernation Survival (AIAA 2016-3666)</b> .....	467
<i>Ryan Pitre, Il-Yong Kim</i>	
<b>Assessment of Airframe-Subsystems Synergy on Overall Aircraft Performance in a Collaborative Design (AIAA 2016-3667)</b> .....	476
<i>Prajwal S. Prakasha, Pier Davide Ciampa, Luca Boggero, Marco Fioriti</i>	

<b>Adjoint Approach based on Reduced-order Model for Steady PDE Systems (AIAA 2016-3668)</b> .....	492
<i>Jichao Li, Kun Qu, Jinsheng Cai, Changqiang Cao</i>	

**MAO-08: SHAPE AND TOPOLOGY OPTIMIZATION IV**

<b>Topology Optimization Formulations for Circuit Board Heat Spreader Design (AIAA 2016-3669)</b> .....	503
<i>Danny J. Lohan, Ercan Dede, James Allison</i>	
<b>Wing Airfoil Geometric Parametrization Method for Efficient Aerodynamic Design Optimization (AIAA 2016-3670)</b> .....	511
<i>Rodrigo F. De Souza, Ana Paula C. Cuco, Tarik H. Orta</i>	
<b>A Hybrid Aerodynamic Optimization Algorithm Based on Differential Evolution and RBF Response Surface (AIAA 2016-3671)</b> .....	526
<i>Kaiwen Deng, Haixin Chen</i>	

**MAO-10: SHAPE AND TOPOLOGY OPTIMIZATION V**

<b>Thermal Topology Optimization in OptiStruct Software (AIAA 2016-3829)</b> .....	544
<i>Xueyong Qu, Narayanan Pagaldipti, Raphael Fleury, Junji Saiki</i>	
<b>Shape Optimization of Acoustic Metamaterials and Phononic Crystals with a Time-Dependent Adjoint Formulation: Extension to Three-Dimensions (AIAA 2016-3830)</b> .....	553
<i>Weiyang Lin, James C. Newman, William K. Anderson, Xueying Zhang</i>	
<b>CAD-based Aerodynamic Shape Optimization Using Geometry Surrogate Model And Adjoint Methods (AIAA 2016-3831)</b> .....	564
<i>Kamil Bobrowski, Holger Barnewitz, Esteban Ferrer, Eusebio Valero</i>	
<b>Multidisciplinary, Multiobjective Analysis and Optimization for the Design of Missile Jet Vane (AIAA 2016-3832)</b> .....	574
<i>Can Citak, Mustafa Akdemir, Mine Yumusak</i>	

**VOLUME 2**

<b>Transonic Nacelle Aerodynamic Optimization Based on Hybrid Genetic Algorithm (AIAA 2016-3833)</b> .....	587
<i>Xiaoming Fang, Yufei Zhang, Shangze Li, Haixin Chen</i>	

**MAO-11: STRUCTURAL OPTIMIZATION I**

<b>A Robust Analytical Sensitivity Analysis for Coupled Aero-Structural Systems (AIAA 2016-3992)</b> .....	596
<i>Koorosh Gopal, Ramana V. Grandhi, Christopher M. Koehler</i>	
<b>Analysis and Sensitivity Calculation using High Fidelity Spectral Formulation-Based FSI and Coupled Adjoint Method (AIAA 2016-3993)</b> .....	615
<i>Rachit Prasad, Hyun Soon Kim, Dongkyun Im, Seongim Choi, Seulgi Yi</i>	
<b>Aeroservoelastic Optimization of Wing Structure Using Curvilinear Spars and Ribs (SpaRibs) (AIAA 2016-3994)</b> .....	627
<i>Joe H. Robinson, Steven Doyle, Grant Ogawa, Myles Baker, Shuvodeep De, Mohamed Jrad, Rakesh K. Kapania</i>	
<b>Active Aeroelastic Alteration to Reduce Off-Design Induced Drag (AIAA 2016-3995)</b> .....	642
<i>Jiguan G. Lin</i>	
<b>Wing Aerostructural Optimization Using the Individual Discipline Feasible Strategy (AIAA 2016-3996)</b> .....	660
<i>Jan E. Hoogervorst, Ali Elham</i>	

**MAO-12: SURROGATE MODELING AND NON-DETERMINISTIC DESIGN – METHODS AND APPLICATIONS I**

<b>Using the Multiple Adjusted R-Squared Reduction Method (MARR-M) to Reduce Large Planetary EDL Monte Carlo Based RSM Produced Quadratic Models (AIAA 2016-3997)</b> .....	677
<i>Narcrisha Norman, Sonya Smith</i>	
<b>Uncertainty Quantification of Material Mechanical Properties Using Surrogate Models (AIAA 2016-3998)</b> .....	692
<i>C. Frederic Smith, Braden Lapp, Michael Glavicic</i>	

<b>Integrating Aerodynamic Uncertainty into Aircraft Maneuvers During Conceptual Design (AIAA 2016-3999)</b> .....	699
<i>Andrew Wendorff, Juan J. Alonso, Stefan R. Bieniawski, Brian T. Whitehead</i>	
<b>Adding Flight Mechanics to Flight Loads Surrogate Model using Multi-Output Gaussian Processes (AIAA 2016-4000)</b> .....	716
<i>Ankit Chiplunkar, Emmanuel Rachelson, Michele Colombo, Joseph Morlier</i>	
<b>Improvement of Efficient Global Optimization with Application to Aircraft Wing Design (AIAA 2016-4001)</b> .....	727
<i>Nathalie Bartoli, Mohamed-Amine Bouhleb, Igor Kurek, Rémi Lafage, Thierry Lefebvre, Joseph Morlier, Rémy Priem, Vivien Stilz, Rommel Regis</i>	
<b>A Sequential Sampling Strategy for Kriging Metamodel Based on Delaunay Triangulation and Topsis (AIAA 2016-4002)</b> .....	755
<i>Ping Jiang, Yahui Zhang, Qi Zhou, Leshi Shu</i>	

## **MAO-13: STRUCTURAL OPTIMIZATION II**

<b>Design of Thermally-Stressed Panels Subject to Transonic Flutter Constraints (AIAA 2016-4119)</b> .....	772
<i>Manav Bhatia, Philip S. Beran</i>	
<b>On the Trade-off between Stress and Dynamic Responses in the Design of Thermal Structures (AIAA 2016-4120)</b> .....	787
<i>Joshua D. Deaton, Philip S. Beran, David M. Pratt</i>	
<b>An Uncoupled Approach to Compute Aero-Structure Gradients Using High-Fidelity CFD-CSM (AIAA 2016-4121)</b> .....	802
<i>Timothée Achard, Christophe Blondeau, Roger Ohayon</i>	
<b>Aeroelastic Optimization of Variable Stiffness Composite Wing with Blending Constraints (AIAA 2016-4122)</b> .....	826
<i>Marco Tito Bordogna, Terence Macquart, Dimitri Bettebghor, Roeland De Breuker</i>	
<b>A Linear Aerodynamics-based Preconditioner for High-fidelity Aeroelastic Analysis and Sensitivity Analysis (AIAA 2016-4123)</b> .....	841
<i>Kristofer Jovanov, Roeland De Breuker, Mostafa M. Abdalla, Christophe Blondeau</i>	

## **MAO-14: EMERGING METHODS, ALGORITHMS, AND DYNAMIC DATA DRIVEN SYSTEMS**

<b>Methodology for Path Planning with Dynamic Data-Driven Flight Capability Estimation (AIAA 2016-4124)</b> .....	860
<i>Victor Singh, Karen E. Willcox</i>	
<b>A Dynamic Data-Driven Approach to Multiple Task Capability Estimation for Self-Aware Aerospace Vehicles (AIAA 2016-4125)</b> .....	882
<i>Brian Burrows, Benson Isaac, Douglas L. Allaire</i>	
<b>Dynamic-Data-Driven Damage Prediction in Aerospace Composite Structures (AIAA 2016-4126)</b> .....	895
<i>Artem Korobenko, Marco Pigazzini, Victor Singh, Hyonny Kim, Douglas L. Allaire, Karen E. Willcox, Alison Marsden, Yuri Bazilevs</i>	
<b>Adjoint-based Mesh Adaptation Techniques for Aggregation Functionals in Structural Design Optimization (AIAA 2016-4127)</b> .....	905
<i>Graeme Kennedy</i>	
<b>Route-Planning for Real-Time Safety-Assured Autonomous Aircraft (AIAA 2016-4128)</b> .....	917
<i>Raghvendra V. Cowlagi, Jeffrey T. Chambers, Nikola Baltadjiev</i>	
<b>Real-Time Safety-Assured Autonomous Aircraft (AIAA 2016-4129)</b> .....	930
<i>Jeffrey T. Chambers, Nikola Baltadjiev, Raghvendra V. Cowlagi</i>	

## **MAO-16: SURROGATE MODELING AND NON-DETERMINISTIC DESIGN – METHODS AND APPLICATIONS II**

<b>Polynomial Chaos Decomposition with Differentiation Operation (AIAA 2016-4288)</b> .....	942
<i>Mishal Thapa, Sameer B. Mulani, Robert W. Walters</i>	
<b>A Probabilistic Multi-Fidelity Aero-Engine Preliminary Design Optimization Framework: Technical and Commercial Perspectives (AIAA 2016-4289)</b> .....	961
<i>Jakub J. Gramatyka, Murat Hakki Eres, James Scanlan, Michael Moss, Peter Holloway, Ron Bates</i>	

<b>Reliability Based Design Optimization of Structures Considering Several Incomplete Configurations (AIAA 2016-4290)</b> .....	975
<i>Clara Cid, Aitor Baldomir, Santiago Hernandez, Luis E. Romera</i>	
<b>Reliability Estimation for Low Cycle Fatigue Life of a Gas Turbine Disk (AIAA 2016-4291)</b> .....	987
<i>Huanhuan Feng, Yanrong Wang, Xianghua Jiang</i>	
<b>Aeroelastic Optimization of Flap-Gliding Micro Air Vehicle Wings (AIAA 2016-4292)</b> .....	998
<i>Dong Xue, Bifeng Song, Wenping Song, Wenqing Yang, Zhonghua Han</i>	

**MAO-17: EMERGING METHODS, ALGORITHMS, AND LARGE SCALE APPLICATIONS IN MAOI**

<b>Multi-Fidelity Design Optimization via Low-Fidelity Correction Technique (AIAA 2016-4293)</b> .....	1010
<i>Christopher C. Fischer, Ramana V. Grandhi</i>	
<b>On Active Subspaces in Car Aerodynamics (AIAA 2016-4294)</b> .....	1028
<i>Carsten Othmer, Trent W. Lukaczyk, Paul Constantine, Juan J. Alonso</i>	
<b>Design Space Dimensionality Reduction for Single- and Multi-Disciplinary Shape Optimization (AIAA 2016-4295)</b> .....	1041
<i>Matteo Diez, Andrea Serani, Emilio F. Campana, Silvia Volpi, Frederick Stern</i>	
<b>A Deterministic Constrained Global Optimization Algorithm Without Penalty Function (AIAA 2016-4296)</b> .....	1056
<i>Jiaxun Kou, Teng Long, Zhu Wang, Yonglu Wen, Li Liu</i>	
<b>Optimization of Turbine Engine Cycle Analysis with Analytic Derivatives (AIAA 2016-4297)</b> .....	1067
<i>Tristan A. Hearn, Eric Hendricks, Jeffrey Chin, Justin S. Gray, Kenneth T. Moore</i>	
<b>Adaptive Cell Network Design Using S.A.N.D.Y For A Battery Pack</b> .....	1078
<i>Jainendra Mishra</i>	

**MAO-18: SURROGATE MODELING AND NON-DETERMINISTIC DESIGN – METHODS AND APPLICATIONS III**

<b>Sequential Robust Design of a Ram Air Turbine (AIAA 2016-4408)</b> .....	1092
<i>Miguel Walter, Dimitri Mavris</i>	
<b>Sensitivity Analysis of Chaotic Problems using a Fourier Approximation of the Least-Squares Adjoint (AIAA 2016-4409)</b> .....	1106
<i>Anthony S. Ashley, Jason E. Hicken</i>	
<b>Efficient Aircraft Routing Algorithm Based on Ant Colony Optimization (AIAA 2016-4410)</b> .....	1120
<i>Ricardo M. Entz, Heitor Andrade Porto, Rafael Fernandes De Oliveira, Rodrigo Alves De Lima</i>	
<b>A Kriging-PDD Surrogate Model for Low-cost Sensitivity Analysis (AIAA 2016-4411)</b> .....	1133
<i>Andrea Francesco Cortesi, Pietro Marco Congedo</i>	
<b>Reliability Estimation Using MCMC Based Tail Modeling (AIAA 2016-4412)</b> .....	1148
<i>Erdem Acar, Gamze Bayrak</i>	
<b>Composite Structure Optimization for Satellite Using Discrete Dynamic Radial Basis Function Metamodel (AIAA 2016-4413)</b> .....	1159
<i>Liu Jian, Teng Long, Renhe Shi, Bin Yuan, Li Liu</i>	
<b>Author Index</b>	