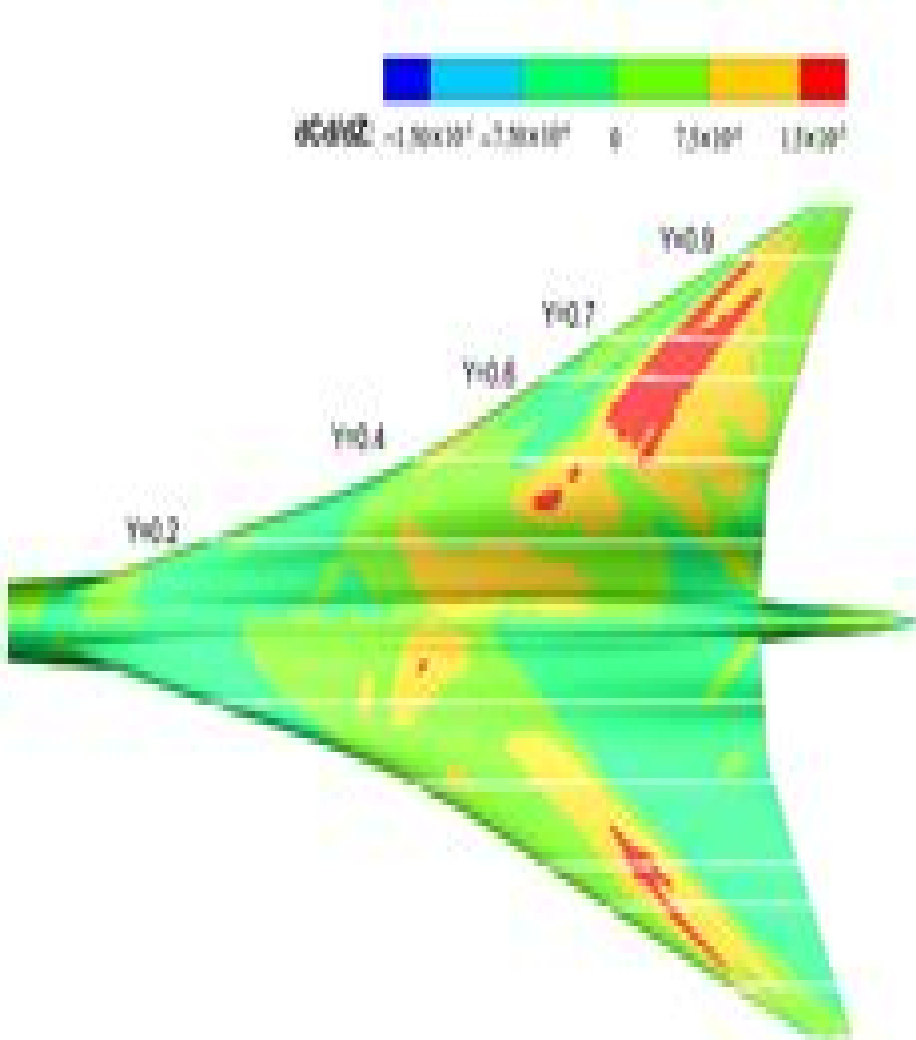
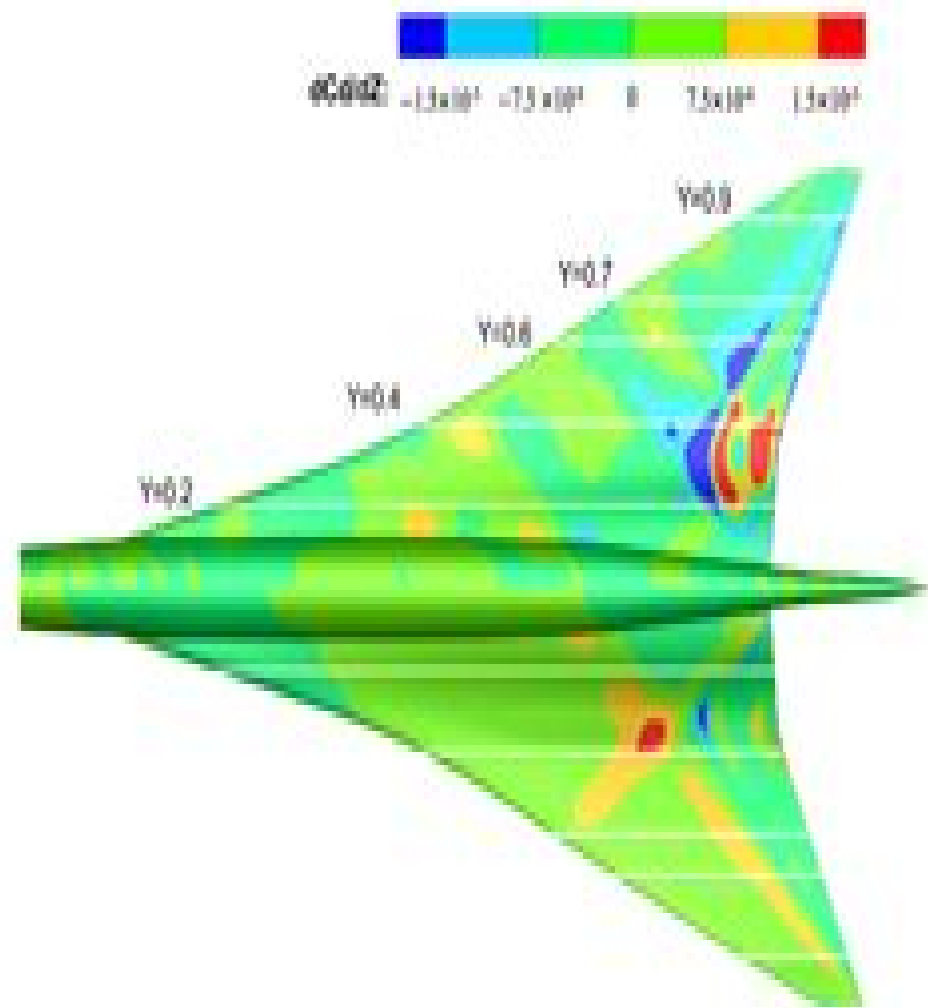




(a) Upper



(b) Lower

# Aerodynamic Shape Optimization With The Adjoint Method

**Shiquan Zhou, Aragona Patty, Shiming  
Chen**



## **Aerodynamic Shape Optimization With The Adjoint Method:**

**Adjoint Methods for Aerodynamic Shape Optimization** Gábor Povorai, 2020 This master thesis investigated the applicability of the Hicks Henne bump functions and Free Form Deformation as shape deformation methods used for aerodynamic shape optimization by the adjoint method In order to alleviate user effort in the setup of simulations and post processing of results a MatLab framework has been developed This framework integrated shape definition meshing file management flow solver and post processing tools The external tools were open source software to allow the use of arbitrary cell and processor core numbers The computational fluid dynamics solver SU2 was used to obtain direct flow and adjoint solutions and to perform shape deformations using the built in nonlinear constrained optimization function Automatic mesh generation was done using GMSH The thesis focused on inviscid and viscous 2D problems in the transonic and supersonic flow regimes The definition of the initial aerodynamic shapes was done using the Class Shape Transformation method The test cases optimization problems with the NACA0012 airfoil as the initial airfoil for deformation with drag reduction as the objective function The test cases involved different constraints e g airfoil thickness lift coefficient and pitching moment coefficient Comparisons were made between the two methods in terms of performance in the minimization of the objective function The results of the optimization problems were compared to reference airfoils from literature Both deformation methods proved to be effective clear superiority of one method over the other could not be shown This master thesis investigated the applicability of the Hicks Henne bump functions and Free Form Deformation as shape deformation methods used for aerodynamic shape optimization by the adjoint method In order to alleviate user effort in the setup of simulations and post processing of results a MatLab framework has been developed This framework integrated shape definition meshing file manage

*Optimization and Computational Fluid Dynamics* Dominique Thévenin, Gábor Janiga, 2008-01-08 The numerical optimization of practical applications has been an issue of major importance for the last 10 years It allows us to explore reliable non trivial configurations differing widely from all known solutions The purpose of this book is to introduce the state of the art concerning this issue and many complementary applications are presented

*MEGADESIGN and MegaOpt - German Initiatives for Aerodynamic Simulation and Optimization in Aircraft Design* Norbert Kroll, Dieter Schwamborn, Klaus Becker, Herbert Rieger, Frank Thiele, 2009-11-18 This volume contains results of the German CFD initiative MEGADESIGN which combines CFD development activities from DLR universities and aircraft industry Based on the DLR flow solvers FLOWer and TAU the main objectives of the four years project is to ensure the prediction accuracy with a guaranteed error bandwidth for certain aircraft configurations at design conditions to reduce the simulation turn around time for large scale applications significantly to improve the reliability of the flow solvers for full aircraft configurations in the complete flight regime to extend the flow solvers to allow for multidisciplinary simulations and to establish numerical shape optimization as a vital tool within the aircraft design process This volume highlights recent improvements and

enhancements of the flow solvers as well as new developments with respect to aerodynamic and multidisciplinary shape optimization Improved numerical simulation capabilities are demonstrated by several industrial applications *ICGG 2020 - Proceedings of the 19th International Conference on Geometry and Graphics* Liang-Yee Cheng,2020-12-01 This book covers various aspects of Geometry and Graphics from recent achievements on theoretical researches to a wide range of innovative applications as well as new teaching methodologies and experiences and reinterpretations and findings about the masterpieces of the past It is from the 19th International Conference on Geometry and Graphics which was held in S o Paulo Brazil The conference started in 1978 and is promoted by the International Society for Geometry and Graphics which aims to foster international collaboration and stimulate the scientific research and teaching methodology in the fields of Geometry and Graphics Organized five topics which are Theoretical Graphics and Geometry Applied Geometry and Graphics Engineering Computer Graphics Graphics Education and Geometry Graphics in History the book is intended for the professionals academics and researchers in architecture engineering industrial design mathematics and arts involved in the multidisciplinary field *Advanced Computational Methods and Design for Greener Aviation* Tero Tuovinen,Jacques Periaux,Dietrich Knoerzer,Gabriel Bugada,Jordi Pons-Prats,2024-07-30 This book presents a selection of scientific and technical results utilizing new computational methods tools and technologies in Aeronautical Design Delve into the forefront of aerospace technology with this collection of articles featuring insights from the from the ECCOMAS CM3 2021 Thematic Conference in Barcelona and from the Special Technology Sessions of the ECCOMAS Congress 2022 in Oslo Explore advancements in aeronautics design numerical methods and industrial technologies including aerodynamic optimization and additive manufacturing with contributions from leading experts and from research projects funded by the European Union Whether you re a seasoned professional or a student this volume offers invaluable insights into the future of aviation and transportation **Flow-Based Optimization of Products or Devices** Nils Tångefjord Basse,2020-11-13 Flow based optimization of products and devices is an immature field compared to the corresponding topology optimization based on solid mechanics However it is an essential part of component development with both internal and or external flow The aim of this book is two fold i to provide state of the art examples of flow based optimization and ii to present a review of topology optimization for fluid based problems *Proceedings of 4th 2024 International Conference on Autonomous Unmanned Systems (4th ICAUS 2024)* Lianqing Liu,Yifeng Niu,Wenxing Fu,Yi Qu,2025-04-24 This book includes original peer reviewed research papers from the 4th ICAUS 2024 which provides a unique and engaging platform for scientists engineers and practitioners from all over the world to present and share their most recent research results and innovative ideas The 4th ICAUS 2024 aims to stimulate researchers working in areas relevant to intelligent unmanned systems Topics covered include but are not limited to Unmanned Aerial Ground Surface Underwater Systems Robotic Autonomous Control Navigation and Positioning Architecture Energy and Task Planning and Effectiveness Evaluation Technologies Artificial Intelligence

Algorithm Bionic Technology and their Application in Unmanned Systems The papers presented here share the latest findings in unmanned systems robotics automation intelligent systems control systems integrated networks modelling and simulation This makes the book a valuable resource for researchers engineers and students alike

**Advances in Evolutionary and Deterministic Methods for Design, Optimization and Control in Engineering and Sciences** Edmondo

Minisci,Massimiliano Vasile,Jacques Periaux,Nicolas R. Gauger,Kyriakos C. Giannakoglou,Domenico Quagliarella,2018-07-02

This volume presents up to date material on the state of the art in evolutionary and deterministic methods for design optimization and control with applications to industrial and societal problems from Europe Asia and America EUROGEN 2015 was the 11th of a series of International Conferences devoted to bringing together specialists from universities research institutions and industries developing or applying evolutionary and deterministic methods in design optimization with emphasis on solving industrial and societal problems The conference was organised around a number of parallel symposia regular sessions and keynote lectures focused on surrogate based optimization in aerodynamic design adjoint methods for steady unsteady optimization multi disciplinary design optimization holistic optimization in marine design game strategies combined with evolutionary computation optimization under uncertainty topology optimization optimal planning shape optimization and production scheduling

**Computational Optimization, Methods and Algorithms** Slawomir Koziel,Xin-She Yang,2011-06-17 Computational optimization is an important paradigm with a wide range of applications In virtually all branches of engineering and industry we almost always try to optimize something whether to minimize the cost and energy consumption or to maximize profits outputs performance and efficiency In many cases this search for optimality is challenging either because of the high computational cost of evaluating objectives and constraints or because of the nonlinearity multimodality discontinuity and uncertainty of the problem functions in the real world systems Another complication is that most problems are often NP hard that is the solution time for finding the optimum increases exponentially with the problem size The development of efficient algorithms and specialized techniques that address these difficulties is of primary importance for contemporary engineering science and industry This book consists of 12 self contained chapters contributed from worldwide experts who are working in these exciting areas The book strives to review and discuss the latest developments concerning optimization and modelling with a focus on methods and algorithms for computational optimization It also covers well chosen real world applications in science engineering and industry Main topics include derivative free optimization multi objective evolutionary algorithms surrogate based methods maximum simulated likelihood estimation support vector machines and metaheuristic algorithms Application case studies include aerodynamic shape optimization microwave engineering black box optimization classification economics inventory optimization and structural optimization This graduate level book can serve as an excellent reference for lecturers researchers and students in computational science engineering and industry

**2023 Asia-Pacific International Symposium on Aerospace**

**Technology (APISAT 2023) Proceedings** Song Fu, 2024-07-04 This book is a compilation of peer reviewed papers from the 2023 Asia Pacific International Symposium on Aerospace Technology APISAT2023 The symposium is a common endeavour among the four national aerospace societies in China Australia Korea and Japan namely Chinese Society of Aeronautics and Astronautics CSAA Royal Aeronautical Society Australian Division RAeS Australian Division Japan Society for Aeronautical and Space Sciences JSASS and Korean Society for Aeronautical and Space Sciences KSAS APISAT is an annual event initiated in 2009 It aims to provide the opportunity to Asia Pacific nations for the researchers of universities and academic institutes and for the industry engineers to discuss the current and future advanced topics in aeronautical and space engineering This is the volume II of the proceedings      **Advances in Mechanical Engineering and Material Science** Ketul C. Popat, S. Kanagaraj, P. S. Rama Sreekanth, V. M. Ravindra Kumar, 2022-04-22 This book presents select proceedings of the 1st International Conference on Advances in Mechanical Engineering and Material Science ICAMEMS 2022 It discusses about the diverse technological advancements innovations and achievements in the areas of mechanical engineering and material science It also covers the developments and challenges in the field of machine design manufacturing thermal and fluid engineering Important topics covered in the conference include advanced manufacturing processes machining product design and development mechatronics and robotics non conventional energy resources green energy and energy harvesting tribology materials and characterization The book also discusses advanced research areas in material science such as smart materials bio materials and advanced energy materials Given the contents the book will be a valuable reference for students researchers and industrialists interested in advanced research areas of mechanical engineering and material science      **Advances in Energy Science and Equipment Engineering** Shiquan Zhou, Aragona Patty, Shiming Chen, 2015-11-05 Advances in Energy Equipment Science and Engineering contains selected papers from the 2015 International Conference on Energy Equipment Science and Engineering ICEESE 2015 Guangzhou China 30 31 May 2015 The topics covered include Advanced design technology Energy and chemical engineering Energy and environmental engineering Energy science      **Frontiers of Computational Fluid Dynamics 2006** David A. Caughey, M. M. Hafez, 2005 The series of volumes to which this book belongs honors contributors who have made a major impact in computational fluid dynamics This fourth volume in the series is dedicated to David Caughey on the occasion of his 60th birthday The first volume was published in 1994 and was dedicated to Prof Antony Jameson The second dedicated to Earl Murman was published in 1998 The third volume was dedicated to Robert MacCormack in 2002 Written by leading researchers from academia government laboratories and industry the contributions in this volume present descriptions of the latest developments in techniques for numerical analysis of fluid flow problems as well as applications to important problems in industry      *The Best of COMVEC 2016 Select Technical Papers from the SAE Commercial Vehicle Engineering Congress* Kevin Jost, Corina Sandu, Ryan Gehm, 2016-09-24 This special collection highlights some of the best technical papers that

represent the breadth of the entire technical program. Leading industry perspectives are reflected by the corporate contributions that are included in this group along with a specific focus on connectivity, the theme of the 2016 event. The commercial vehicle industry has always been focused on improving efficiency. These ten characteristic offerings present cutting edge trends, technologies and solutions that provide greater benefit and the application of knowledge to solve problems and guide future innovation. These studies are presented by experts from industrial, governmental and academic partners on topics that include Autonomous commercial vehicles, Computational fluid dynamics and aerodynamics for heavy duty on road applications, Fuel and emissions efficiency of medium duty powertrain configurations, Intelligently controlled air suspension systems, Improving total cost of ownership by gains in thermal efficiency, New simulation and testing techniques enabling next generation commercial vehicle technology. The leadership team has focused on bringing in a broad mixture of participants to COMVEC to discuss current technologies and the future challenges of the commercial vehicle industry. This first of its kind special publication draws on the strength of the event's program and features ten of the best technical papers from the SAE International Congress.

**Morphing Wing Technologies** Sergio Ricci, Ferri M.H. Aliabadi, Ruxandra Botez, Fabio Semperlotti, 2017-10-27. Morphing Wings Technologies: Large Commercial Aircraft and Civil Helicopters offers a fresh look at current research on morphing aircraft including industry design, real manufactured prototypes and certification. This is an invaluable reference for students in the aeronautics and aerospace fields who need an introduction to the morphing discipline as well as senior professionals seeking exposure to morphing potentialities. Practical applications of morphing devices are presented from the challenge of conceptual design incorporating both structural and aerodynamic studies to the most promising and potentially flyable solutions aimed at improving the performance of commercial aircraft and UAVs. Morphing aircraft are multi role aircraft that change their external shape substantially to adapt to a changing mission environment during flight. The book consists of eight sections as well as an appendix which contains both updates on main systems evolution, skin structure, actuator, sensor and control systems and a survey on the most significant achievements of integrated systems for large commercial aircraft. Provides current worldwide status of morphing technologies, the industrial development expectations and what is already available in terms of flying systems. Offers new perspectives on wing structure design and a new approach to general structural design. Discusses hot topics such as multifunctional materials and auxetic materials. Presents practical applications of morphing devices.

Advances in Evolutionary and Deterministic Methods for Design, Optimization and Control in Engineering and Sciences António Gaspar-Cunha, Jacques Periaux, Kyriakos C. Giannakoglou, Nicolas R. Gauger, Domenico Quagliarella, David Greiner, 2020-11-23. This book presents improved and extended versions of selected papers from EUROGEN 2019, a conference with interest on developing or applying evolutionary and deterministic methods in optimization of design and emphasizing on industrial and societal applications.

Simulation-Driven Modeling and Optimization Slawomir Koziel, Leifur Leifsson, Xin-She Yang, 2016-02-12. This edited

volume is devoted to the now ubiquitous use of computational models across most disciplines of engineering and science led by a trio of world renowned researchers in the field Focused on recent advances of modeling and optimization techniques aimed at handling computationally expensive engineering problems involving simulation models this book will be an invaluable resource for specialists engineers researchers graduate students working in areas as diverse as electrical engineering mechanical and structural engineering civil engineering industrial engineering hydrodynamics aerospace engineering microwave and antenna engineering ocean science and climate modeling and the automotive industry where design processes are heavily based on CPU heavy computer simulations Various techniques such as knowledge based optimization adjoint sensitivity techniques and fast replacement models to name just a few are explored in depth along with an array of the latest techniques to optimize the efficiency of the simulation driven design process High fidelity simulation models allow for accurate evaluations of the devices and systems which is critical in the design process especially to avoid costly prototyping stages Despite this and other advantages the use of simulation tools in the design process is quite challenging due to associated high computational cost The steady increase of available computational resources does not always translate into the shortening of the design cycle because of the growing demand for higher accuracy and necessity to simulate larger and more complex systems For this reason automated simulation driven design while highly desirable is difficult when using conventional numerical optimization routines which normally require a large number of system simulations each one already expensive

Computational Fluid Dynamics 2000 Nobuyuki Satofuka, 2012-12-06 This volume constitutes the Proceedings of the First International Conference on Computational Fluid Dynamics held at the Kyoto Research Park Kyoto Japan on 10-14 July 2000 The conference is the first one at which the International Conference on Numerical Methods in Fluid Dynamics ICNMF and the International Symposium on Computational Fluid Dynamics ISCFD were merged The purpose of the conference was to bring together scientists mathematicians and engineers to review and share recent advances in mathematical and computational techniques for modeling fluid dynamics The conference had the following format Each day of the conference except Wednesday July 12 started with a plenary session at which an invited lecture was delivered During the rest of the day there were three sessions in parallel in which oral presentations were made Poster presentations were also made on Monday Tuesday and Thursday afternoons A total of 205 abstracts were submitted from all over the world and were evaluated by five paper selection committees chaired by J J Chattot USA KW Morton UK M Napolitano Italy K Srinivas Austraria and myself Out of 136 papers accepted for oral presentations 17 were withdrawn and out of 46 papers accepted for poster presentation 14 were cancelled

**Recent Progress in Flow Control for Practical Flows** Piotr Doerffer, George N. Barakos, Marcin M. Luczak, 2017-05-11 This book explores the outcomes on flow control research activities carried out within the framework of two EU funded projects focused on training through research of Marie Skłodowska Curie doctoral students The main goal of the projects described in this monograph is to assess the potential of



the passive and active flow control methods for reduction of fuel consumption by a helicopter The research scope encompasses the fields of structural dynamics fluid flow dynamics and actuators with control Research featured in this volume demonstrates an experimental and numerical approach with a strong emphasis on the verification and validation of numerical models The book is ideal for engineers students and researchers interested in the multidisciplinary field of flow control     Variational Analysis and Aerospace Engineering Giuseppe Buttazzo,Aldo Frediani,2009-08-21 The Variational Analysis and Aerospace Engineering conference held in Erice Italy in September 2007 at International School of Mathematics Guido Stampacchia provided a platform for aerospace engineers and mathematicians to discuss the problems requiring an extensive application of mathematics This work contains papers presented at the workshop

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