# Wing Design Nasa Plane Wing Parts

This modern text presents aerodynamic design of aircraft with realistic applications, using CFD software and guidance on its use. Tutorials, exercises, and mini-projects provided involve design of real aircraft, ranging from straight to swept to slender wings, from low speed to supersonic. Supported by online resources and supplements, this toolkit covers topics such as shape optimization to minimize drag and collaborative designing. Prepares seniors and first-year graduate students for design and analysis tasks in aerospace companies. In addition, it is a valuable resource for practicing engineers, aircraft designers, and entrepreneurial consultants.

Few technological advances have affected the lives and dreams of individuals and the operations of companies and governments as much as the continuing development of flight. From space exploration to package transport, from military transport to passenger helicopter use, from passenger jumbo jets to tilt-rotor commuter planes, the future of flying is still rapidly developing. The essays in this volume survey the state of progress along several fronts of this constantly evolving frontier. Five eminent authorities assess prospects for the future of rotary-wing aircraft, large passenger aircraft, commercial aviation, manned spaceflight, and defense aerospace in the post-Cold War era.

In the Pacific War's early years, Japanese air power was dominant. The only way for the Allies to defeat their enemy was to know it. This made the task of maintaining productive intelligence gathering efforts on Japan imperative. Establishing Technical Air Intelligence Units in the Pacific Theatre and the Technical Air Intelligence Center in Washington DC, the Allies were able to begin to reveal the secrets of Japanese air power through extensive flight testing and evaluation of captured enemy aircraft and equipment. These provided an illuminating perspective on Japanese aircraft and aerial weapon design philosophy and manufacturing practice. Fully illustrated throughout with a wealth of previously unpublished photographs, Mark Chambers explores Allied efforts to evaluate the strengths and weaknesses of Japanese air power during the war years, and how this intelligence helped them achieve victory in the Pacific.

Multidisciplinary Design Investigation of Truss-Braced Wing Aircraft. Phase 4

A Supersonic Area Rule and an Application to the Design of a Wing-body Combination with High Lift-drag Ratios

Flight Test of the F/a-18 Active Aeroelastic Wing Airplane

The X-48 Blended Wing-Body and NASA's Quest to Reshape Future Transport Aircraft

The F-18 Active Aeroelastic Wing Project

Sweeping Forward

Most lifting bodies, or "flying bathtubs" as they were called, were so ugly only an engineer could love them, and yet, what an elegant way to keep wings from burning off in supersonic flight between earth and orbit. Working in their spare time (because they couldn't initially get official permission), Dale Reed and his team of engineers demonstrated the potential of the design that led to the Space Shuttle. Wingless Flight takes us behind the scenes with just the right blend of technical information and fascinating detail (the crash of M2-F2 found new life as the opening credit for TV's "The Six Million Dollar Man"). The flying bathtub, itself, is finding new life as the proposed escape-pod for the Space Station.

Traces the history of NASA research into lifting bodies, and describes the research's impact on the Space Shuttle and its future replacements

Green Aviation is the first authoritative overview of both engineering and operational measures to mitigate the environmental impact of aviation. It addresses the current status of measures to reduce the environmental impact of air travel. The chapters cover such items as: Engineering and technology-related subjects (aerodynamics, engines, fuels, structures, etc.), Operations (air traffic management and infrastructure) Policy and regulatory aspects regarding atmospheric and noise pollution. With contributions from leading experts, this volume is intended to be a valuable addition, and useful resource, for aerospace manufacturers and suppliers, governmental and industrial aerospace research establishments, airline and aviation industries, university engineering and science departments, and industry analysts, consultants, and researchers.

Historical Background and Design Evolution of the Transonic Aircraft Technology Supercritical Wing

Beyond Tube-and-Wing

Active Flight Controls

Thinking Obliquely

FLYING W/O WINGS

Developing and Flight Testing the Grumman X-29A Forward Swept Wing Research Aircraft

Fluid mechanical aspects of separated and vortical flow in aircraft wing aerodynamics are treated. The focus is on two wing classes: (1) large aspect-ratio wings and (2) small aspect-ratio delta-type wings. Aerodynamic design issues in general are not dealt with. Discrete numerical simulation methods play a progressively larger role in aircraft design and development. Accordingly, in the introduction to the book the different mathematical models are considered, which underlie the aerodynamic computation methods (panel methods, RANS and scale-resolving methods). Special methods are the Euler methods, which as rather inexpensive methods embrace compressibility effects and also permit to describe lifting-wing flow. The concept of the kinematically active and inactive vorticity content of shear layers gives insight into many flow phenomena, but also, with the second break of symmetry---the first one is due to the Kutta condition---an explanation of lifting-wing flow fields. The prerequisite is an extended definition of separation: “flow-off separation” at sharp trailing edges of class (1) wings and at sharp leading edges of class (2) wings. The vorticity-content concept, with a compatibility condition for flow-off separation at sharp edges, permits to understand the properties of the evolving trailing vortex layer and the resulting pair of trailing vortices of class (1) wings. The concept also shows that Euler methods at sharp delta or strake leading edges of class (2) wings can give reliable results. Three main topics are treated: 1) Basic Principles are considered first: boundary-layer flow, vortex theory, the vorticity content of shear layers, Euler solutions for lifting wings, the Kutta condition in reality and the topology of skin-friction and velocity fields. 2) Unit Problems treat isolated flow phenomena of the two wing classes. Capabilities of panel and Euler methods are investigated. One Unit Problem is the flow past the wing of the NASA

Common Research Model. Other Unit Problems concern the lee-side vortex system appearing at the Vortex-Flow Experiment 1 and 2 sharp- and blunt-edged delta configurations, at a delta wing with partly round leading edges, and also at the Blunt Delta Wing at hypersonic speed. 3) Selected Flow Problems of the two wing classes. In short sections practical design problems are discussed. The treatment of flow past fuselages, although desirable, was not possible in the frame of this book.

The X-29 was an unusual aircraft with a truly unique silhouette. It combined many features that challenged the technologies of its day and represented special problems for the developers and the team of testers responsible for documenting its features and design goals. This book is a look at the "big picture" of what this team accomplished in a relatively fast-paced test program involving the truly unique X-29.

The problem of the minimum induced drag of wings having a given lift and a given span is extended to include cases in which the bending moment to be supported by the wing is also given. Expressions for the spanwise load distribution and the minimum drag in terms of the lateral position of the load centroid are given. The results show a 15-percent reduction of the induced drag with a 15-percent increase in span over that for an elliptic loading having the same total lift and bending moment.

A New Twist in Flight Research

The Future of Aerospace

A System in Peril

And Its Impact on Flying Machines

Aeronautical Technologies for the Twenty-First Century

Wind Tunnels of NASA

The main challenge of this project was to design an aircraft that will achieve stability while flying without a horizontal tail. The project focused on both the design, analysis and construction of a remotely piloted, elliptical shaped flying wing. The design team was composed of four sub-groups each of which dealt with the different aspects of the design, namely aerodynamics, stability and control, propulsion, and structures. Each member of the team initially researched the background information pertaining to specific facets of the project. Since previous work on this topic was limited, most of the focus of the project was directed towards developing an understanding of the natural instability of the aircraft. Once the design team entered the conceptual stage of the project, a series of compromises had to be made to satisfy the unique requirements of each sub-group. As a result of the numerous calculations and iterations necessary, computers were utilized extensively. In order to visualize the design and layout of the wing, engines and control surfaces, a solid modeling package was used to evaluate optimum design placements. When the design was finalized, construction began with the help of all the members of the project team. The nature of the carbon composite construction process demanded long hours of manual labor. The assembly of the engine systems also required precision hand work. The final product of this project is the Elang, a one-of-a-kind remotely piloted aircraft of composite construction powered by two ducted fan engines. Unspecified Center...

As recently as the summer of 2001, many travelers were dreading air transportation because of extensive delays associated with undercapacity of the system. That all changed on 9/11, and demand for air transportation has not yet returned to peak levels. Most U.S. airlines continue to struggle for survival, and some have filed for bankruptcy. The situation makes it difficult to argue that strong action is urgently needed to avert a crisis of undercapacity in the air transportation system. This report assesses the visions and goals for U.S. civil aviation and technology goals for the year 2050.

As an extension of the transonic area rule, a concept for interrelating the wave drags of wing-body combinations at moderate supersonic speeds with axial developments of cross-sectional area has been derived. The wave drag of a combination at a given supersonic speed is related to a number of developments of cross-sectional areas as intersected by Mach planes. On the basis of this concept and other design procedures, a structurally feasible, swept-wing--indented-body combination has been designed to have relatively high maximum lift-drag ratios over a range of transonic and moderate supersonic Mach numbers. The wing of the combination has been designed to have reduced drag associated with lift and, when used with an indented body, to have low zero-lift wave drag. Experimental results have been obtained for this configuration at Mach numbers from 0.80 to 2.01. Maximum lift-drag ratios of approximately 14 and 9 were measured at Mach numbers of 1.15 and 1.41, respectively.

An introduction to the preliminary design of subsonic general aviation and transport aircraft, with emphasis on layout, aerodynamic design, propulsion and performance

The Aerodynamic Design of Wings with Cambered Span Having Minimum Induced Drag

Robert T. Jones, the Oblique Qing, NASA's AD-1 Demonstrator, and Its Legacy

Securing the Future of U.S. Air Transportation

Basic Principles and Unit Problems

The subject grant was in effect from 7/1/99 to 10/31/99. The objective of this grant was to complete a strut-braced wing study which began, which was in effect from 6/27/96 until 9/15/99. While the initial grant was on-going, we were also under subcontract to Lockheed-Martin, Aerospace Systems Division, Marietta, GA to do additional studies related to the strut-braced wing grant "A Structural and Aerodynamic Investigation of a Strut-Braced Wing Transonic Aircraft Concept", 4/1/98-11/15/98. Lockheed-Martin was under contract to NASA Langley. Finally the research under this grant has led to a joint proposal from NASA Langley, Locheed-Martin, Virginia Tech and NASA Dryden to develop a transonic strut-braced wing demonstration aircraft in response to Flight Research for Revolutionary Aeronautical Concepts (REVCON). This final report summarizes the research done, augmented by the additional concommitant research projects mentioned above.Grossman, B. and Kapania, R. K. and Mason, W. H. and Schetz, J. A.Langley Research CenterTRUSSES; WINGS; MULTIDISCIPLINARY DESIGN OPTIMIZATION; AIRCRAFT DESIGN; SUPERSONIC AIRCRAFT; STRUTS; AERODYNAMIC INTERFERENCE; CONSTRAINTS; SENSITIVITY

"This book details the remarkable efforts to develop a new aircraft configuration known as the Blended Wing-Body (BWB). Responding to a challenge from NASA, McDonnell Douglas Corporation initiated studies in the early 1990s to determine if this new configuration could bring about significant advantages over conventional sweptwing, streamlined tube, and swept-tail designs. Research precipitated the design and construction of two small-scale demonstrators: the X-48B. After McDonnell Douglas' merger with Boeing, the X-48B flew 92 test flights before modification into the X-48C, which in turn flew 30 flights under the auspices of NASA's Environmentally Responsible Aviation Program"--

DIVClear, concise text covers aerodynamic phenomena of the rotor and offers guidelines for helicopter performance evaluation.

**Originally prepared for NASA. Prefaces. New Indexes. 10 black-and-white photos. 537 figures. /div**
**The History of the XV-15 Tilt Rotor Research Aircraft**
**Large Commercial Aircraft and Civil Helicopters**
**Design and Development of the Blackbird**
**Aircraft Aerodynamic Design with Computational Software**
**Uncovering the Secrets of Japanese Fighters and Bombers of World War II**
**Orders of Magnitude**

*"The basic aerodynamic relations needed for the design of wings with cambered span having a minimum induced drag at specified flight conditions are developed for wings of arbitrary spanwise camber. Procedures are also developed for determining the physical wing form required to obtain the maximum value of lift-drag ratio at cruise, when the wing spanwise camber-line and section profiles are specified, by optimizing the wing chord and twist distributions with respect to both profile and induced drags. The application of the design procedure is illustrated by determining the physical wing form for a circular-arc spanwise camber line. The efficiency of this cambered wing is compared with that of an equal-span, flat wing of elliptical planform which satisfies the same set of fright operating conditions as does the cambered wing. The wing pitching- moment equations for optimally loaded cambered-span wings at design flight conditions are also developed for use in trim analyses on complete aircraft designs."--Page 1.*
*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*

*Beyond Tube-and-WingThe X-48 Blended Wing-Body and NASA's Quest to Reshape Future Transport AircraftNASA*

*From Concept to Flight*

*The Evolution of Modern Aircraft*

*Quest for Performance*

*A History of the NACA and NASA, 1915-1990*

*Automated Optimum Design of Wing Structures*

*The Bird Is on the Wing*

Prepared at the request of NASA, Aeronautical Technologies for the Twenty-First Century presents steps to help prevent the erosion of U.S. dominance in the global aeronautics market. The book recommends the immediate expansion of research on advanced aircraft that travel at subsonic speeds and research on designs that will meet expected future demands for supersonic and short-haul aircraft, including helicopters, commuter aircraft, "tiltrotor," and other advanced vehicle designs. These recommendations are intended to address the needs of improved aircraft performance, greater capacity to handle passengers and cargo, lower cost and increased convenience of air travel, greater aircraft and air traffic management system safety, and reduced environmental impacts.

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.

The National Aeronautics and Space Administration (NASA) is currently developing advanced technologies to form the foundation for the next breakthrough in civil aviation: an economically viable, environmentally acceptable supersonic transport. NASA's High Speed Research Program works in conjunction with industry to identify and address critical technological challenges to initiating commercial development of a practical supersonic transport. The key technical areas investigated are engine emissions, fuel efficiency, service life, and weight; community noise; aircraft range and payload; and weight and service life of airframe structures. Areas of particular interest include the ability of technologies under development to meet program goals related to noise, emissions, service life, weight, range, and payload. This book examines aircraft design requirements, assesses the program's planning and progress, and recommends changes that will help the program achieve its overall objectives.

Probing the Sky

Deterministic and Probabilistic Approaches

Variational Analysis and Aerospace Engineering

Separated and Vortical Flow in Aircraft Wing Aerodynamics

U.S. Supersonic Commercial Aircraft

NASA Advanced Design Program. Design and Analysis of a Radio-Controlled Flying Wing Aircraft

**Since the education of aeronautical engineers at Delft University of Technology started in 1940 under tae inspiring leadership of Professor H.J. van der Maas, much emphasis has been placed on the design of aircraft as part of the student's curriculum. Not only is aircraft design an optional subject for thesis work, but every aeronautical student has to carry out a preliminary airplane design in the course of his study. The main purpose of this preliminary design work is to enable the student to synthesize the knowledge ob tained separately in courses on aerodynamics, aircraft performances, stability and con trol, aircraft structures, etc. The student's exercises in preliminary design have been directed through the years by a number of staff members of the Department of Aerospace Engineering in Delft. The author of this book, Mr. E. Torenbeek, has made a large contribution to this part of the study programme for many years. Not only has he acquired vast experience in teaching airplane design at university level, but he has also been deeply involved in design-oriented re search, e.g. developing rational design methods and systematizing design information. I am very pleased that this wealth of experience, methods and data is now presented in this book.**

**The high cost of aviation fuel has resulted in increased attention by Congress and the Air Force on improving military aircraft fuel efficiency. One action considered is modification of the aircraftâ € ™s wingtip by installing, for example, winglets to reduce drag. While common on commercial aircraft, such modifications have been less so on military aircraft. In an attempt to encourage greater Air Force use in this area, Congress, in H. Rept. 109-452, directed the Air Force to provide a report examining the feasibility of modifying its aircraft with winglets. To assist in this effort, the Air Force asked the NRC to evaluate its aircraft inventory and identify those aircraft that may be good candidates for winglet modifications. This reportâ € "which considers other wingtip modifications in addition to wingletsâ € "presents a review of wingtip modifications; an examination of previous analyses and experience with such modifications; and an assessment of wingtip modifications for various Air Force aircraft and potential investment strategies.**

**The airplane ranks as one of history ' s most ingenious and phenomenal inventions—and surely one of the most world-shaking. How ideas about its aerodynamics first came together and how the science and technology evolved to forge the airplane into the revolutionary machine it became is the epic story James R. Hansen tells in The Bird Is on the Wing. Just as the airplane is a defining technology of the twentieth century, aerodynamics has been the defining element of the airplane. Hansen provides an engaging, easily understandable introduction to the role of aerodynamics in the design of such historic American aircraft as the DC-3, X-1, and 747. Recognizing the impact individuals have had on the development of the field, he conveys not only a history of aircraft technology, but also a collective biography of the scientists, engineers, and designers who created the airplanes. From da Vinci, whose understanding of what it took to fly was three centuries too early for practical use, to the invention of the airplane by the Wright brothers, Hansen explores the technological matrix from which aeronautical engineering emerged. He skillfully guides the reader through the development of such critical aerodynamic concepts as streamlining, flutter, laminar-**

**flow airfoils, the mythical “ sound barrier, ” variable-sweep wing, supersonic cruise, blended body, and much more. Hansen ’ s explanation of how vocabulary and specifications were developed to fill the gap between the perceptions of pilots and the system of engineers will fascinate all those interested in how human beings have used aerodynamics to move among, and even beyond, birds on the wing.**

**A Transonic-small-disturbance Wing Design Methodology**

**Aircraft Energy Efficiency Laminar Flow Control Wing Design Study**

**Assessment of Wingtip Modifications to Increase the Fuel Efficiency of Air Force Aircraft**

**Morphing Wing Technologies**

**The Lifting Body Story**

**Wingless Flight**

With the development of supersonic aircraft, the X-plane era ushered in a new and challenging phase of flight. Researchers found that much of the knowledge accumulated from the previous, subsonic flight era did not apply to the emerging supersonic aircraft. These turbojet-powered planes also outpaced the usefulness of the wind tunnel, previously an indispensible tool of aeronautic research.This book explores the development of the X-series research aircraft, the planes that helped bridge the gap between subsonic flight and hypersonic flight.

The Lockheed Blackbirds hold a unique place in the development of aeronautics. In their day, the A-12, YF-12, M-21, D-21, and SR-71 variants outperformed all other jet airplanes in terms of altitude and speed. Now retired, they remain the only production aircraft capable of sustained Mach 3 cruise and operational altitudes above 80,000 feet.This is the first book to address the technical aspects of these incredible aircraft. The author describes the design evolution of the Blackbird, from the Archangel to the Senior Crown (the Air Force's SR-71.) He describes in detail the construction and materials challenges faced by Lockheed, as well as the Blackbird's performance characteristics and capabilities.A NASA historian, the author describes NASA's role in using the aircraft as a flying laboratory to collect data on materials, structures, loads, heating, aerodynamics, and performance for high-speed aircraft. The reader will benefit from the technical and programmatic lessons learned.This volume was produced in cooperation with

the National Aeronautics and Space Administration.
More than 75 years have passed since the Wright brothers' historic first flight of a powered, heavier-than-air aircraft at Kitty Hawk, North Carolina, on December 17, 1903. During this relatively brief period, the airplane has developed from a useless freak to a highly significant force in modern society. The transformation of the airplane during this period must be ranked as one of the great engineering accomplishments of all time. The magnitude of the achievement is emphasized by the nature of the vehicle and the rigorous requirements for precise design of every element. In no other type of machine, with the possible exception of space vehicles, do the often conflicting requirements of performance, safety, reliability, and economic viability place such a high premium on detailed design optimization, based on quantitative data and analysis. This volume traces the technical development of the airplane from a curiosity at the beginning of World War I to the highly useful machine of today. Included are significant aircraft that incorporated important technical innovations and served to shape the future course of aeronautical development, as well as aircraft that represented the state of the art of aeronautical technology in a particular time frame or that were very popular and produced in great numbers. In order to reduce the scope of material under consideration, primary emphasis has been placed on aircraft originating in the United States. No adverse reflection on the quality of the many fine foreign designs developed over the years is intended by their exclusion. The aircraft described certainly do not include all the significant types designed in the time period 1914-80, but they do illustrate the primary features of the technical evolution of the airplane. If the reader's favorite aircraft is not included, the reference lists at the end of this volume include publications that catalog data and photographs for a wide variety of aircraft. The discussion is related primarily to aircraft configuration evolution and associated aerodynamic characteristics and, to a lesser extent, to developments in aircraft construction and propulsion. The material is presented in a manner designed to appeal to the nontechnical reader who is interested in the evolution of the airplane, as well as to students of aeronautical engineering or others with an aeronautical background. The use of engineering terminology

has been kept at a minimum, consistent with accuracy and the intent of the text; where unavoidable, suitable physical explanations have been included.

Selected NACA/NASA Research Airplanes and Their Contributions to Flight

From Archangel to Senior Crown

Wings of the Rising Sun

Synthesis of Subsonic Airplane Design

NASA Technical Paper

Assessing NASA's High Speed Research Program

Authoritative, highly readable history of aerodynamics and the major theorists and their contributions.

Successful flight-testing of the Active Aeroelastic Wing airplane was completed in March 2005. This program, which started in 1996, was a joint activity sponsored by NASA, Air Force Research Laboratory, and industry contractors. The test program contained two flight test phases conducted in early 2003 and early 2005. During the first phase of flight test, aerodynamic models and load models of the wing control surfaces and wing structure were developed. Design teams built new research control laws for the Active Aeroelastic Wing airplane using these flight-validated models; and throughout the final phase of flight test, these new control laws were demonstrated. The control laws were designed to optimize strategies for moving the wing control surfaces to maximize roll rates in the transonic and supersonic flight regimes. Control surface hinge moments and wing loads were constrained to remain within hydraulic and load limits. This paper describes briefly the flight control system architecture as well as the design approach used by Active Aeroelastic Wing project engineers to develop flight control system gains. Additionally, this paper presents flight test techniques and comparison between flight test results and predictions.Clarke, Robert and Allen, Michael J. and Dibley, Ryan P. and Gera, Joseph and Hodgkinson, JohnArmstrong Flight Research CenterAEROELASTICITY; FLIGHT CONTROL; FLIGHT TESTS; AEROELASTIC RESEARCH WINGS; AIRCRAFT CONTROL; FLIGHT CHARACTERISTICS; AIRCRAFT DESIGN; AERODYNAMIC CHARACTERISTICS; WING OSCILLATIONS

Chapter 1 reviews the life of NASA aerodynamicist Robert T. Jones andhis path to the oblique wing. Chapter 2 covers the extensive wind tunnel,model, computer-code, and simulation testing, first at Langley and later atAmes, as well as a number of NASA industry design contracts undertakenby Boeing and Lockheed. Chapter 3 reviews the design and fabrication ofthe AD-1 Oblique Wing Research Aircraft

and its subsequent proposeduse as a joined-wing demonstrator. Chapter 4 describes the flight testingand flight evaluation of the AD-1. Chapter 5 reviews the supersonicF-8 followup oblique-wing program. And, finally, chapter 6 reviews thesubsequent oblique-wing plans and proposals.

A History of Aerodynamics

Green Aviation

The Spanwise Distribution of Lift for Minimum Induced Drag of Wings Having a Given Lift and a Given Bending Moment

Rotary-Wing Aerodynamics

Aerodynamics and the Progress of the American Airplane