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Book Reviews

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Principles of Helicopter Aerodynamics

J. Gordon Leishman, Cambridge University Press, New York, 2002, 536 pp., $95.00

In the past 50 years, only a handful of books on the subject of helicopter aerodynamics have been published. Because the helicopter is a very complex flying machine, it requires a multidisciplinary approach to solve conflicting requirements for helicopter engineering design. An example of this is how the selection of a low-wave-drag airfoil for transonic speed on the advancing side of the rotor conflicts with the requirement of delaying dynamic stall on the retreating side. Therefore the helicopter designer has to rely on simple theory, experience, and full-scale testing for new designs. It is difficult to write a detailed treatise of helicopter aerodynamics that covers all of these different aspects. Professor Leishman took the challenge, and a well-written book was the result.

This book contains two parts. The first part is in the spirit of Prof. Alfred Gessow's classic book on helicopter aerodynamics, written almost 50 years ago. The first chapter discusses the history of vertical flight, autogiros, helicopters, and other rotorcraft. The second chapter forms the basis for analyzing hover and forward flight performance using momentum theory. Chapter 3 introduces the blade-element moment theory used extensively by the helicopter industry for preliminary design. Chapter 4 discusses how aerodynamic forces affect the response of the rotor blades and the rotor trim. The rotor performance for hover and forward flight conditions is given in Chapter 5. It also includes climb, descent, and autorotation conditions. Chapter 6 shows how to apply the knowledge learned from previous chapters to rotor conceptual design.

The second part of the book discusses research topics in helicopter aerodynamics. Indeed, Prof. Leishman has made great contributions to research in rotor unsteady aerodynamics (Chapter 8) and wakes (Chapter 10). Chapter 7 discusses the general requirements for a helicopter rotor airfoil, which are quite different from those for a fixed- wing airfoil. It is difficult to select one airfoil for all blade sections due to conflicting requirements. Chapter 8 includes classical techniques such as Theodorsen's and Loewy's theories, as well as modern treatments, such as the indicial response method and dynamic inflow considerations. Chapter 9 discusses the more difficult problem of dynamic stall, a technical barrier that prevents conventional helicopters from achieving higher speeds. Different engineering methods to treat dynamic stall are discussed in detail. Chapter 10 discusses the most important aspect of helicopter aerodynamics, the rotor wake: How does the tip vortex form, what is the structure of the tip vortex, and what is the wake geometry?

This is a good textbook not only for graduate students but also for practical engineers and researchers. The chapter review for the first six chapters summarizes what you need to know about helicopter aerodynamics, and the last four chapters point out the research areas in helicopter aerodynamics. I hope the author will one day include two more chapters: interaction aerodynamics and computational fluid dynamics methods, which are omitted in this edition. This book is an excellent addition to the reference library.

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Airplane Stability and Control, Second Edition, A History of the Technologies That Made Aviation Possible

Malcolm J. Abzug and E. Eugene Larrabee, Cambridge University Press, New York, 2002, 414 pp., $80.00

The nature of this book is best described by the authors themselves. In the preface they state, "Accordingly, this book is an informal, popular survey of the art and science of airplane stability and control. As history, the growth of understanding of the subject is traced from the pre-Wright brothers' days up to the present." Most assuredly, this book is not a stability and control textbook, but, as the subtitle clearly calls out, a *history* of technologies that allowed human flight to evolve from the days of Lilienthal, Maxim, and Langley to the present.

The book is composed of 24 chapters, with appropriate subcategories in each. A 15-page index is included. The references for each chapter are presented at the end of the book, as part of a core bibliography. As befitting an historical treatise, the book is, with some exceptions, organized in chronological fashion. The particular problems and technical challenges that arose as flight vehicles increased in performance and sophistication are addressed in roughly the order that they appeared. The thematic chapter titles clearly indicate this philosophy as well as exceptions to it: 1) Early Developments in Stability and Control, 2) Teachers and Texts, 3) Flying Qualities Become a Science, 4) Power Effects on Stability and Control, 5) Managing Control Forces, 6) Stability and Control at the Design Stage, 7) The Jets at an Awkward Age, 8) The Discovery of Inertial Coupling, 9) Spinning and Recovery, 10) Tactical Airplane Maneuverability, 11) High Mach Number Difficulties, 12) Naval Aircraft Problems, 13) Ultralight and Human-Powered Airplanes, 14) Fuel Slosh, Deep Stall, and More, 15) Safe Personal Airplanes, 16) Stability and Control Issues with Variable Sweep, 17) Modern Canard Configurations, 18) Evolution of the Equations of Motion, 19) The Elastic Airplane, 20) Stability Augmentation, 21) Flying Qualities Research Moves with the Times, 22) Challenge of Stealth Aerodynamics, 23) Very Large Aircraft, and 24) Work Still to be Done. The chapters vary considerably in length from the 27 pages of Chap. 18 to the 2- and 3-page treatments of Chaps. 23 and 24, respectively.

A perusal of the first edition of this book, published in 1997, indicates that the second edition has identical chapter titles albeit with additional subcategories. The authors state that the latest offering has benefited considerably from the reviews of the first publication (with particular emphasis on including more work conducted outside the United States) and, of course, from the opportunity to include recent technology developments. The latter entails discussions of new developments in propulsion-controlled aircraft, fly-by-wire technology, redundancy management, and flight safety issues regarding aircraft/pilot coupling.

As with the first edition, this release is replete with figures and photos. The great majority of these are taken from the original reports and papers that treated the particular stability and control problem upon which the authors are focusing. Many date from the early 1940s. The liberal use of these illustrations along with quotes and vignettes from the particular researchers involved contributes significantly to the general readability of the book and to the size of the audience to whom the book will appeal. The "human-oriented" nature of this history is emphasized by a closing section entitled "Short Bibliographies of Some Stability and Control Figures," where the biosketches of over 80 such figures are included. It has been this reviewer's pleasure to be personally acquainted with a fair number of these researchers.

As one who regularly teaches aircraft stability and control courses at the undergraduate and graduate levels, I found this volume informative. I would be inclined to list it as recommended reading in my graduate course on the subject. The potential reader should be reminded, however, that the book is not a rigorous exposition of any of the topics covered in the 24 chapters just delineated. That is, the researcher looking for an in-depth survey of, say, flight control system design techniques in Chap. 20 will be disappointed. Clearly, such treatments were not the authors' intent. The book can be appreciated by nearly anyone with an undergraduate degree in aeronautical/aerospace engineering. It would be recommended reading for the practicing stability and control engineer as well as the academician whose teaching interests include the stability and control area.

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