Preface to the first edition

When I joined the staff of the College of Aeronautics some years ago I was presented with a well worn collection of lecture notes and invited to teach *Aircraft Stability and Control* to postgraduate students. Inspection of the notes revealed the unmistakable signs that their roots reached back to the work of W.J. Duncan, which is perhaps not surprising since Duncan was the first Professor of Aerodynamics at Cranfield some 50 years ago. It is undoubtedly a privilege and, at first, was very daunting to be given the opportunity to follow in the footsteps of such a distinguished academic. From that humble beginning my interpretation of the subject has continuously evolved to its present form which provided the basis for this book.

The classical linearised theory of the stability and control of aircraft is timeless, it is brilliant in its relative simplicity and it is very securely anchored in the domain of the aerodynamicist. So what is new? The short answer is; not a great deal. However, today the material is used and applied in ways that have changed considerably, due largely to the advent of the digital computer. The computer is used as the principal tool for analysis and design, and it is also the essential component of the modern flight control system on which all advanced technology aeroplanes depend. It is the latter development in particular which has had, and continues to have, a major influence on the way in which the material of the subject is now used. It is no longer possible to guarantee good flying and handling qualities simply by tailoring the stability and control characteristics of an advanced technology aeroplane by aerodynamic design alone. Flight control systems now play an equally important part in determining the flying and handling qualities of an aeroplane by augmenting the stability and control characteristics of the airframe in a beneficial way. Therefore the subject has had to evolve in order to facilitate integration with flight control and, today, the integrated subject is much broader in scope and is more frequently referred to as *Flight Dynamics*.

The treatment of the material in this book reflects my personal experience of using, applying and teaching it over a period of many years. My formative experience was gained as a Systems Engineer in the avionics industry where the emphasis was on the design of flight control systems. In more recent years, in addition to teaching a formal course in the subject, I have been privileged to have spent very many hours teaching the classical material in the College of Aeronautics airborne laboratory aircraft. This experience has enabled me to develop the material from the classical treatment introduced by Duncan in the earliest days of the College of Aeronautics to the present treatment, which is biased towards modern systems applications. However, the vitally important aerodynamic origins of the material remain clear and for which I can take no credit.

Modern flight dynamics tends be concerned with the wider issues of flying and handling qualities rather than with the traditional, and more limited, issues of stability

and control. The former is, of course, largely shaped by the latter and for this reason the emphasis is on dynamics and their importance to flying and handling qualities. The material is developed using dimensional or normalised dimensional forms of the aircraft equations of motion only. These formulations are in common use, with minor differences, on both sides of the North Atlantic. The understanding of the dimensionless equations of motion has too often been a major stumbling block for many students and, in my experience, I have never found it necessary, or even preferable, to work with the classical dimensionless equations of motion.

The dimensionless equations of motion are a creation of the aerodynamicist and are referred to only in so far as is necessary to explain the origins and interpretation of the dimensionless aerodynamic stability and control derivatives. However, it remains most appropriate to use dimensionless derivatives to describe the aerodynamic properties of an airframe.

It is essential that the modern flight dynamicist has not only a through understanding of the classical theory of the stability and control of aircraft but also, some knowledge of the role and structure of flight control systems. Consequently, a basic understanding of the theory of control systems is necessary and then it becomes obvious that the aircraft may be treated as a *system* that may be manipulated and analysed using the tools of the control engineer. As a result, it is common to find control engineers looking to modern aircraft as an interesting challenge for the application of their skills. Unfortunately, it is also too common to find control engineers who have little or no understanding of the dynamics of their *plant* which, in my opinion, is unacceptable. It has been my intention to address this problem by developing the classical theory of the stability and control of aircraft in a systems context in order that it should become equally accessible to both the aeronautical engineer and to the control engineer. This book then, is an aeronautical text which borrows from the control engineer rather than a control text which borrows from the aeronautical engineer.

This book is primarily intended for undergraduate and post graduate students studying aeronautical subjects and those students studying avionics, systems engineering, control engineering, mathematics, etc. who wish to include some flight dynamics in their studies. Of necessity the scope of the book is limited to linearised small perturbation aircraft models since the material is intended for those coming to the subject for the first time. However, a good understanding of the material should give the reader the basic skills and confidence to analyse and evaluate aircraft flying qualities and to initiate preliminary augmentation system design. It should also provide a secure foundation from which to move on into non-linear flight dynamics, simulation and advanced flight control.

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