Jet Induced Effects: the Aerodynamics of Jet and Fan Powered V/STOL Aircraft in Hover and Transition

R.F.E. Kuhn, R.J. Margason and P.Curtis

Progress in Aeronautics and Astronautics series Vol 217. R.E. Kuhn et al. American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, USA. 2006. 203pp. Illustrated. $54.95 (AIAA members), $79.95 (non-members). ISBN 1-56347-841-2.

One has only to consider the popularity of Harrier displays at airshows to realise the widespread fascination for Vertical/Short Take-off and Landing (V/STOL) aircraft. This unique aerodynamic ability for a fixed wing aircraft was not achieved easily, and the book by Kuhn, Margason and Curtis describes the complex technical problems that had to be overcome to realise an operational aircraft with V/STOL performance, and which have also been the subject of much research, design and testing work for the latest example of this type of aircraft, the STOVL version of the F-35B Joint Strike Fighter. The three authors are very well qualified to write on this topic, since they have worked on the aerodynamics of such aircraft at NASA Langley (where much experimental work on powered lift aerodynamics was conducted), Lockheed Martin, and BAE Systems; they are therefore able to write convincingly and in a readable style as acknowledged experts in the field.

After a short historical introduction and explanation of the particular aerodynamic problems experienced by V/STOL aircraft (e.g. multiple impinging jets, suckdown forces in ground effect, fountain and ground vortex formation, hot-gas-ingestion), the main focus of the book is aimed at outlining the (predominantly) semi-empirical methods that were developed to predict the complex aerodynamic effects peculiar to V/STOL operation and which allowed successful configuration design of such aircraft as the McDonnell-Douglas/British Aerospace AV-8B Harrier and its future replacement the Lockheed-Martin F-35B STOVL JSF. The methods are built up in several stages, dealing in turn with an increasing complexity of aerodynamic challenges: lift loss in hover, transition out-of-ground-effect, transition In-ground-effect, hot-gas-ingestion (HGI), and the consequences of these aerodynamic flows on the ground environment in which the aircraft operates. The design methods are laid out in great detail. This leads sometimes to rather long listings of the various equations and correlations deduced from wind tunnel experiments. However, the text goes to great lengths to justify (convincingly for this reader) the need for this in order to capture the large range of aerodynamic subtleties involved. The descriptions are also accompanied by many helpful illustrations extracted from the test data contained in the very extensive references quoted in the book.

The final chapter deals with the possibility that, in future, computational fluid dynamics (CFD) could contribute more to addressing the analysis of STOVL aircraft configurations than it did in previous decades, although it is acknowledged that it was used more for the JSF than for the Harrier. On the whole the authors express a cautiously optimistic note here. They point out that more research is necessary to validate the computational methods so that they can be used with confidence in understanding the flow physics. Some STOVL aerodynamic problems, e.g. HGI are particularly challenging here, and the authors surmise (correctly in the view of this reader) that this will require use of advanced techniques such as Large Eddy Simulation (LES) rather than the more conventional Reynolds-Averaged-Navier-Stokes (RANS) CFD. Such techniques are also more expensive of computing power and time, although industry needs to adopt a similar view of such expense as taken for experimental work – if it provided the answers needed, the expense may well be justified. They identify some impressive examples of work carried out in the last years or so to predict complete Harrier configurations, both in transition and in ground effect.

The readership of this book is likely to be quite varied. The detail provided and the specialist nature of the subject mean that it will probably be best suited to practising engineers, but students interested in aerodynamic design and researchers looking for a review of the development of STOVL aerodynamics will all find this a very useful reference text.

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Environmentally Conscious Manufacturing

Edited by M. Kutz

John Wiley and Sons, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ. 2007. 394pp. Illustrated. £70. ISBN 978-0-471-72636-4.

This is the second volume in the Wiley series in Environmentally Conscious Engineering, a valuable addition to reference books for students and those involved in the manufacturing processes. Whilst not aimed specifically at aviation, the subject matter includes many activities related to it. It is aimed at production procedures, and raising awareness of alternative or greener methods of satisfying consumer demand.

The book consists of contributions, mostly of North American origin, and uses North American O.S.H.A.W. (Occupational Safety and Health Act 1970) as a guide. This should present no difficulties for a European reader. Many of these requirements are now international, and supply useful references to engineers looking for answers to reduce costs, improve a facility or process. The essays are a good source of practical advice, well researched by practical consultants, specialists in their fields. Environmentally friendly design is also discussed: whilst impact can be minimised, penalties will always be present. Changes in behaviour and attitudes can produce positive change.

The book covers machining, casting, joining, and forming, identifying the pollutants and the precautions necessary, and discusses processes from concept to customer. The re-design of the fluid systems used in metalworking is encouraged, to encompass 'green' materials and processes. The resultant health impact on workers is also considered, as is the overall working environment.

The electronics industries' contribution by banning lead and other hazardous materials is acknowledged, and interestingly the increasingly problematic end of life disposal of electronic components is covered; many agencies are now looking at end use disposal before starting the manufacturing process.

Overall, the book gives a sound over-view of the problems of being green, and reaching an acceptable level of pollution in an ever more aware environment. There is a growing awareness amongst both developed and developing nations of the impact of manufacture for an increasingly consumerist population. The book is a very useful handbook to every Systems, Manufacturing and Maintenance Engineer with a concern for the planet's health.

John Sawyer, EngTech, MRAeS.

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