Aerodynamic Design of Aircraft

a Computational Approach with Software

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Preface

The Royal Institute of Technology (KTH, Kungliga Tekniska Högskolan) has been the prime seat of aeronautical education in Scandinavia, granting degrees in aeronautics continuously for a century. Generations of engineers have been trained for careers in the aerospace industry, designing and producing outstanding aircraft at Saab AB as well as at other manufacturers.

The origins of this book date back to the late 1980s when the authors participated in the Center for Computational Mathematics and Mechanics at KTH, under the tutelage of Professors Heinz Kreiss and Mårten Landahl. Our contribution was a series of courses on aircraft aerodynamics and CFD. The starting point for the aerodynamic design lectures were the classical tracts on the subject in the 1970s by, for example, Ryle and Küchemann. In our research work we connected CFD, a then emerging tool, with the design tasks. Over the years, the computational aerodynamic tools and the computer hardware matured so that today students can run meaningful CFD on their laptops and apply it to aerodynamic design.

CFD is a process including a sequence of techniques, and any tool is only as good as the user's ability to handle it skillfully. A twofold aim of this book, therefore, is to *inform* students about CFD applications to aerodynamic design, what we term *user awareness* of applying the tools to the design tasks, and CFD *due diligence* in wielding the tools. Furthermore, it is our firm conviction that CFD should not be taught as a *spectator sport* with dazzling eye-catching examples computed by professionals who know their codes intimately, and have extensive experience in generating grids. Instead we encourage students, neophytes, and amateurs to be inspired by what the pros can do, and, continuing the sports analogy, get themselves a ball, a pair of shoes, and go out on the practice field and *learn by doing*. Try to *Bend it Like Beckham*, or if your sport is basketball, *Be like Mike*. Practically all of the examples shown in this book are results that the students, with the software available, and starting from a three-view drawing of the configuration, can produce on their own.

In this sense, our approach follows advice given by Murray Gell-Mann, Nobel Laureate in Physics, about the role of instructors:

We need to move from the sage on the stage to the guide on the side.

This Learning-by-Doing approach to teaching aerodynamic design is accomplished by working with exercises, tutorials and extended projects, using the computational tools under guidance. Experience gained in carrying out these exercises will help the student when doing a term project, a capstone design course, or writing a senior-year or masters or PhD thesis. The hands-on assignments are presented not in the book itself, but on the book website, `http://CUP.com/aerodesignsoftware/handson/`. Useful public domain software, used

for computing many examples in the book, is found on
`http://airinnova.se/education/aerodynamic-design-of-aircraft/`. It provides downloads and also links to the home and developer pages for the different packages.

The material in the book is suitable for a final-year undergraduate course, or a first-year graduate course. A student should have entry knowledge from a basic course in the fundamentals of flight and in elementary numerical methods. We hope the book will remain a guide on the side even in future work.

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Jesper Oppelstrup March 2020