Preface

Computational fluid dynamics (CFD) is nowadays applied extensively in all aerodynamics-based topics of aircraft design, development and optimization. Since standard CFD approaches still lack accuracy in areas of highly nonlinear, unsteady flows close to the borders of the flight envelope, the aeronautical industry is increasingly willing to apply more costly scale-resolving methods, if such are able to provide a real predictive alternative for critical situations. While Large Eddy Simulation (LES) may be a viable option in certain areas, it is still far too costly—if not impossible—to apply it to high Reynolds number flows about even moderately complex configurations. Thus, the family of Hybrid RANS-LES Methods (HRLM) currently appears to be the best candidate for the next generation of CFD methods to increase solution fidelity at an industrially feasible expense.

HRLM have been proven to perform considerably better than conventional Reynolds-Averaged Navier-Stokes (RANS or URANS) approaches in situations with strong flow separation, but they are less effective once they have to deal with weakly unstable[1] flows, e.g. thin separation regions or shear layers in general. In such cases, resolved structures develop only very slowly, resulting in areas where the total amount of turbulence (both in modeled and resolved terms) is unphysically low. These so-called "Grey Areas" often lead to results that are worse than those of RANS simulations.

Unfortunately, such grey area situations appear in many of the flows important close to the borders of the flight envelope, e.g. near maximum lift. Accordingly, there is a strong necessity to mitigate the grey area in order to provide the industry with Hybrid RANS-LES approaches that are trustworthy for relevant flow situations. Precisely this was the primary objective of the Go4Hybrid project, which focused on two main aspects: to provide viable extensions to HRLM mitigating the grey area problem in non-zonal approaches and to improve embedded methods, such that they are applicable to arbitrarily complex geometries.

[1]Note, that unstable refers here to an easy switching from an unresolved to a resolved modeling of turbulence.

The improvements derived in the course of the project have been assessed against both fundamental and more complex test cases and thus the editors sincerely hope that this book provides a helpful compendium for the reader interested in this kind of method and grey area mitigation in particular. In this respect also the Common Assessment Platform—to our knowledge a new idea in the framework of European projects—may provide interesting insight into the behavior of the different approaches.

The whole outcome of the Go4Hybrid project described in this book and the goals achieved showcase the excellent cooperation between the partners involved. Their collaboration—fostered by the financial support of the European Union – has not only benefitted the organizations involved, but will also lead to a wide dissemination of the knowledge acquired both through education of students and the close links to the industry. The latter are particularly reflected in the long list of ten Industrial Observers and two Associate Partners of Go4Hybrid.

This volume compiles all technical work and achievements obtained in the Go4Hybrid project, starting with an overview of the project in Part I "The Go4Hybrid Project", followed be the presentation of the approaches used in Part II "Presentation of Approaches". In Part III "Results for Fundamental Test Cases" and Part IV "Results for Complex Test Cases" all relevant results are presented and discussed. An activity was set up within Go4Hybrid referred to as the "Common Assessment Platform" (CAP) with the goal to implement and assess the most promising partner methods developed in the project using a common CFD code. The major findings of this endeavor can be found in Part V "The Common Assessment Platform". Last but not least, Part VI contains the "Conclusions" drawn. All references (used in the different parts and chapters) can be found at the end of the book.

Thanks and congratulations are due to the Go4Hybrid partners, whose expertise and open collaboration made the project both clearly successful as well as highly enjoyable. Special thanks are also due to the Associate Partners and Industrial Observers, some of whom contributed actively to lively discussions in the meetings as well as to the final workshop.

Additional thanks are due to D. Knörzer, the European Commission's Scientific Officer to the project, who was always very supportive of the project and provided every help necessary.

Last but not least, the editors of this book would like to express their gratitude to W. Schröder, the General Editor of the Springer series 'Notes on Numerical Fluid Mechanics and Multidisciplinary Design', as well as to A. Feldhusen-Hoffmann for their help and editorial advice, and of course to the Springer team around L. di Cecco.

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November 2016

http://www.springer.com/978-3-319-52994-3

Go4Hybrid: Grey Area Mitigation for Hybrid RANS-LES Methods
Results of the 7th Framework Research Project Go4Hybrid, Funded by the European Union, 2013-2015
Mockett, C.; Haase, W.; Schwamborn, D. (Eds.)
2018, XII, 280 p. 172 illus., 155 illus. in color., Hardcover
ISBN: 978-3-319-52994-3