

Optimization and Computational Fluid Dynamics

Dominique Thévenin · Gábor Janiga
Editors

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 Springer

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Preface

The idea of this book was born during the “Conference on Modelling Fluid Flow” held in Budapest at the beginning of September 2006. During this occasion, we had decided to propose and thus hold a workshop entitled “Coupling CFD with Optimisation”, based on our rapidly increasing experience with this highly interesting topic. We were nevertheless surprised to see the resonating enthusiasm displayed throughout the workshop by the conference participants.

From the discussions with all the speakers present at this workshop as well as the survey of the scope of the available books and review articles on this subject, it became easier to understand this great interest. While there is a wealth of new research projects that deal with the coupling of *Computational Fluid Dynamics* (CFD) and modern *Optimization* techniques, it is however difficult to find reference publications on this topic. There are indeed a few, excellent books available (see also the Introduction), but they are mostly restricted to aerodynamics, since this has been the first field of CFD for which optimization has become a tool of major importance. Moreover, the connection between CFD and Evolutionary Algorithms, often required when considering more complex systems of equations and physical models, has not been documented extensively.

Therefore we decided, together with the support of almost all workshop participants and a few internationally renowned newcomers, to gather and recount our experience concerning Optimization based on evaluations obtained through Computational Fluid Dynamics (a procedure abbreviated in this book as *CFD-O*), in order to prepare a book covering most of the relevant aspects and issues. Thanks to the hard work and constant support of all contributors, it has been finally possible to release this publication almost exactly one year after the workshop in Budapest. We hope that the interested readers will find here appropriate answers to the main questions: “What is indeed CFD-O? What simulation is today possible using CFD-O? How can I rely on CFD-O for my own applications and which approach should I choose?”

Our first research project on CFD-O was connected with the Ph.D. supervision of Mr. R. Baron at the École Centrale in Paris. He is the creator of our Optimization library (Opal) and must be thanked here for the quality of his work and for his unsurpassed motivation. The authors would furthermore like to thank Ms. Imelda Pasley for her thorough corrections of the manuscript. The quality of many graphical illustrations has been greatly enhanced by Mr. Imre Ferencsin.

Magdeburg,
August 2007

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Acronyms

AGA	Approximated Genetic Algorithms
AHM	Adaptive Hybrid Method
ANN	Artificial Neural Network
BFGS	Broyden, Fletcher, Goldfarb and Shanno
CC	Cross-Corrugated
CFD	Computational Fluid Dynamics
DNS	Direct Numerical Simulation
DOE	Design of Experiment
DOF	Degrees Of Freedom
EA	Evolutionary Algorithm
ES	Evolution Strategies
FEA	Finite Element Analysis
FOPD	Fiber Orientation Probability Distribution
GA	Genetic Algorithm
HOCS	Headbox Optimization Control Simulator
LES	Large-Eddy Simulation
LSD	Low Solidity Diffuser
MD	Machine Direction
MDO	Multi-disciplinary Design Optimization
MG	Multigrid
MOEA	Multi-objective Evolutionary Algorithm
MOGA	Multi-objective Genetic Algorithm
NSGA	Nondominated Sorting Genetic Algorithm
NURBS	Non-Uniform Rational Basic Splines
OF	Objective Function
PDE	Partial Differential Equation
POF	Pareto Optimal Frontier
RANS	Reynolds-Averaged Navier Stokes
RBF	Radial Basis Function
RSM	Reynolds-Stress Model
SA	Simulated Annealing
VEGA	Vector Evaluation Genetic Algorithm