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EDITORIAL

The European Community on Computational Methods in Applied Sciences, ECCOMAS, was created in 1993 with the aim of providing an intense co-ordination of scientific conferences and other activities in Europe in the field of Computational Methods in Applied Sciences. Its main mission is to favour the exchange of information, and to promote the transfer between research and industry on the European scale. Its main field of interest concerns the applications of mathematics and computational techniques to major areas such as fluid dynamics, structural mechanics, semi-conductor modelling or electromagnetics. Multidisciplinary applications of these fields to critical problems encountered in sectors such as aerospace, car industry, energy or environment are of course particular interest. The main event organised by ECCOMAS was a large joint European Conference, which takes place every 4 years. The second Conference of this type was held in Paris in September 1996, and brought together approximately 700 participants from 43 countries, and was organised around 14 invited talks, 19 technological research industry sessions, 27 mini-symposia and 500 other presentations.

Among the different mini-symposia, at least three of them were specifically devoted to optimal shape optimisation in fluid mechanics. The applications of such a method for the design of new aircraft or turbomachines range from the determination of minimum drag, minimum weight aerodynamic configurations to multipoint design of airfoils. The present volume includes, in a somewhat extended version, a selection of different papers that were presented at those three sessions. These papers describe both the different technical approaches used for solving these minimisation problems and the results obtained on significant industrial cost problems. Most of the techniques and problems described herein still undergo important developments both in the academic and industrial communities.

In more detail, automatic differentiation techniques, as described in the paper of Mohammadi *et al.*, are a very important tool in the industrial environment since they allow the automatic updating of existing codes so that they can perform sensitivity analysis or gradient-based optimisations. Once the user has identified the part in the solver that he needs to differentiate, and the mode of differentiation (direct or adjoint) that he requires, a simple call to a formal differentiation program will update in 2 h a solver whose development has required several years of manpower.

The paper of Nastase describes how the proper use of analytical spectral descriptions of the flying configurations can solve the problem of viscous optimal shape design in supersonic flows.

The next important tool is the choice of a good optimiser. Traditional gradient-based algorithms can lead to local shape improvements around a reference configuration. Genetic algorithms as described in the paper of Mäkinen *et al.* may be a future class of efficient tools in global optimisation, including topology and multicriteria optimisation. The applications presented here (drag minimisation with lift constraint or radar cross-section reduction) are obviously very relevant to key industrial applications and indicate that evolutionary algorithms could be the right tool to develop a general purpose global optimisation methodology.

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Another key ingredient in numerical optimisation is to be able to control the quality and relevance of the grid and discretisation strategy used for computing the flow around a given configuration within the optimisation loop. During this loop, the grid must be updated to take into account the change in shapes and adapted in order to correctly capture the main features of the resulting flow. This problem is addressed by the paper of Bugeda *et al.*, which develops automatic mesh generation tools, *a posteriori* error estimates and mesh control strategies that can be efficiently used in numerical shape optimisation.

The global integration of all these tools (automatic differentiation, adequate shape parametrisation, mesh control, optimiser) in a single strategy performing advanced three-dimensional optimum shape design in aeronautics is then described in the paper of Dervieux *et al.* To improve the efficiency of their prototype, they have also added and described two new key ingredients: hierarchical multilevel shape parametrisation and parallel computing. These last tools spread very rapidly in the community and seem to be very helpful in shape optimisation.

Flow control is a natural complement to shape optimisation. Passive or active flow control mechanisms can improve the performances of a given design and in particular reduce drag by delaying the onset of laminar turbulent transition in a flow around a wing. The paper of Arnal gives an overview of the numerical and experimental investigations performed in this framework. It describes both the transition mechanisms that are likely to occur and different control or design strategies delaying their onset.

The last two papers in this volume complement the description of the major tools being developed in academic centres by providing a very timely and detailed insight of relevant industrial applications. The paper of Melvin *et al.* describes the optimisation methodology being developed at Boeing for aerodynamic design. These developments were done within the production code TRANAIR solving the full three-dimensional potential flow around a complex aircraft with directly coupled strip boundary layers. This methodology includes global Newton-type optimisers, and has been extended to multipoint design in order to better fulfil the requirements of a true reliable industrial design. The paper of Labrujere *et al.* finally gives a survey of the major tools used at NLR for optimising airfoil design using either inviscid flow models or Reynolds averaged Navier–Stokes equations. This concludes the volume by indicating the path to follow for extending the methodology used by Boeing for potential flows to more complex physical flow models.

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