Computational Fluid Dynamics 2004

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Preface

This book contains the Proceedings of the Third International Conference on Computational Fluid Dynamics (ICCFD), held in Toronto, Ontario, Canada from July 12 through 16, 2004. The ICCFD series has evolved into the leading international conference series for scientists, mathematicians, and engineers interested in the computation of fluid flow. Invited keynote lectures were given by renowned researchers in the areas of detached-eddy simulation, micro-flow simulations, control of shocks, multiscale models of the circulatory system, and high-end computing in aerospace.

Abstracts were received from 23 countries. The executive committee, consisting of C. Bruneau, J.-J. Chattot, D. Kwak, N. Satofuka, K. Srinivas, and myself, was responsible for selection of papers. Each of the members had a separate subcommittee to carry out the evaluation. As a result of this careful peer review process, 123 papers were selected for oral presentation and a further 67 for poster presentation. The conference was attended by 172 delegates from 22 different countries.

Thanks are due to our sponsors, NASA and the Institute for Aerospace Research of the National Research Council of Canada. In particular, the generous grant from NASA is a key factor in the success of this conference series. I would also like to thank the staff at the Westin Harbour Castle, all who participated in the organization of the conference, including the review process, and the students of the CFD group at the University of Toronto Institute for Aerospace Studies for the tremendous help they provided toward the success of this conference.

These Proceedings contain a snapshot of the field of computational fluid dynamics as of 2004. They present a vibrant field with strong capabilities in many areas of application and a myriad of opportunities for future contributions to science and engineering.

Toronto, Canada
September 2004

David W. Zingg
Conference Chair

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Invited Lectures

Topics in Detached-Eddy Simulation

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The paper re-visits the motivation of DES, and then touches on its diffusion in CFD codes; grid concerns including both users' mis-conceptions and actual DES issues; the use of DES as a pure LES with wall modeling; and possible long-term improvements.

1 Introduction

The DES approach to high-Reynolds-number separated flows is seven years old [1], although the first true results appeared only five years ago [2]. Its best description is in [3], and a broader review in [4]. The central motivation is the observation that Large-Eddy Simulation (LES) is powerful in regions of massive separation and other free shear flows such as jets, but much too costly in the large areas of thin boundary layers (BL's) which cover aircraft and vehicles. Therefore, affordable CFD approaches need to treat these with Reynolds-Averaged modeling. No theoretical rebuttal has been made by LES proponents of this pessimistic statement, which has had an influence at least in Europe. Even as a "grand challenge" and with generous assumptions, the estimated readiness date of pure LES for a wing remains at the year 2045.

On the other hand, progress in Reynolds-Averaged Navier-Stokes (RANS) models outside thin shear flows has remained very modest, whether in terms of the numerical practicality of the models, or their accuracy. The two dominant models are 12 years old. This field being idea-limited, a "readiness date" cannot be projected. The pessimistic view is that a general RANS model with certain engineering accuracy is out of reach of human intelligence. However, keeping the other sources of error in CFD below engineering accuracy will never be certain either, considering the users' training and their need for rapid answers. In any case, RANS has its place, especially for attached flows which place low demands both on the models' physics and the users' competence.

The LES cost estimates of 1997 [1] can be confronted with recent findings. Even forceful studies such as LESFOIL found that in 2002 the limit on the spanwise domain size for LES of an airfoil was near 1% of its chord [5, 6] which is insufficient when the BL thickness δ exceeds 8%. Over the trailing edge, even the best Reynolds stresses were not very close to experiment. Now, extrapolating to the wing considered in [1, 4], its turbulent domain is 2,000