3rd Workshop on Uncertainty Analysis, Lisbon, October 2008

Overall Comments on the Workshop

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The Workshop included for the first time all three components of Verification & Validation: Code Verification; Solution Verification and Validation. For the latter, a simplified version of the ASME V&V 20 procedure was tested.

We have summarized our main observations below:

- There was a general agreement about the usefulness of Manufactured Solutions for Code Verification of RANS solvers. As in the second edition of the Workshop, there were examples confirming the need to include the transport equations of the turbulence model in the Code Verification exercise. It was demonstrated again by different codes that the order of accuracy of the turbulence quantities solution may affect the order of accuracy of the mean flow quantities, i.e. velocity and pressure.
- It was demonstrated, at least by one of the participants (using wall functions, grid adaptation and a third-order accurate code), that it is possible to reach the asymptotic range in RANS solutions of the flow over a backward-facing step. As suspected, the number of grid nodes required is impressive and the level of the estimated errors too small for practical purposes.
- The previous observation raised once more the question of the performance of the current uncertainty estimators outside the asymptotic range. RANS solvers with eddy-viscosity turbulence models do not converge always with the theoretical order of accuracy of the schemes adopted in the discretization of the equations. Nevertheless, it was shown that it is possible to use methods based on a least-squares version of the GCI combined with the data range for the so-called practical level of grid refinement, i.e. coarse grids, assuming that the data are outside the asymptotic range. Inevitably, the estimated uncertainties are not small.
- To demonstrate/conclude that a data set is in the asymptotic range remains a problem.
- Although the goal of this edition was self-consistency, it was rewarding to observe the favourable evolution of the inter-group comparisons along the three editions of the Workshop.
- The inclusion of the Validation exercise was an excellent addition to the Workshop. The ASME Validation procedure is clearly a step forward compared to the 'standard' graphical comparison between experiments and numerical predictions. It is interesting to observe that it allowed to point out limitations in the modelling, but also to show deficiencies in the numerical simulations and/or in the experiments.

It can be stated that the goals that were defined when this series of Workshops started in 2004 (at the time focusing on Solution Verification only) have been reached at this third edition, with the bonus of the Validation exercise. This series has therefore come to an end. We trust that it has promoted the awareness of Verification and Validation playing an essential role in the application of Computational Fluid Dynamics.

Needless to say that V&V is a never-ended task. Therefore, a follow up to these Workshops might be included in the forthcoming ECCOMAS CFD Conference, to be held in Lisbon in 2010, but inevitably with an adjusted format.

We would like to thank all the participants of the three editions of the Workshop and in particular our distinguished guest speakers: Patrick Roache who attended all three editions and contributed significantly to the success of these events; and Hugh Coleman who accepted to participate in this last edition of the Workshop to share the outcome of the ASME V&V 20 Committee that he led. We conclude by saying that it has been a privilege to organize and host these three workshops in Lisbon.