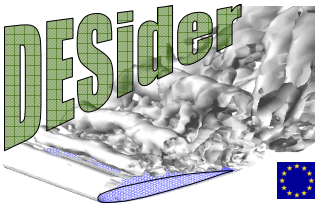
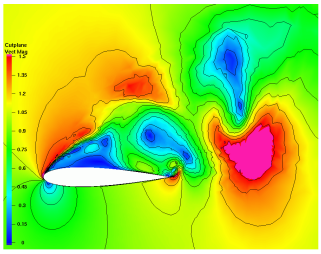
DESider

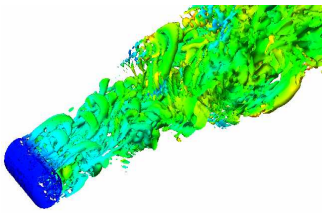
Detached Eddy Simulation for Industrial Aerodynamics



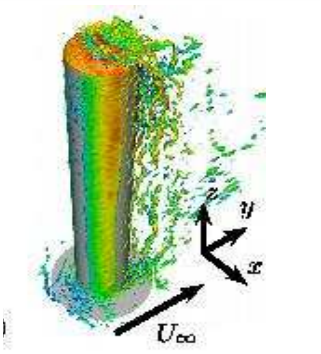
The DESider project, running from 01.01.2004 until 30.06.2007 as project/contract AST3-CT-2003-502842, was motivated by the increasing demand of the European aerospace industries to improve their CFD-aided design procedure and analysis on turbulent inherently unsteady aerodynamic flows. Thus, the major aim of the project was to overcome known weaknesses in the different turbulence-resolving approaches (Detached-Eddy Simulation or DES, other RANS-LES hybrids, and Scale Adaptive Simulation or SAS) in order to support the European aeronautics industry with simulation methods that offer increased predictive accuracy for complex turbulent flows.



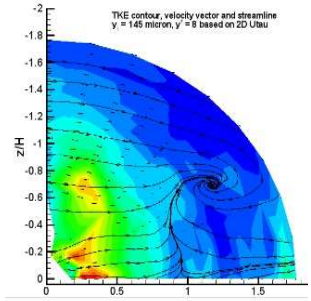
The main objectives that were achieved by gathering expertise from European experts in the field of aerodynamics, turbulence modelling and numerical analysis up to multi-disciplinary (aero-elastic and aero-acoustic) design, can be summarised as follows:



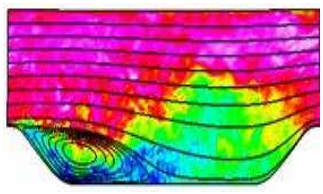
1. Based on the previously developed DES approach, advanced modelling approaches were investigated and developed for unsteady flow simulations as a compromise between URANS and LES, which are now able to produce LES-comparable results for real aeronautical applications, yet with less costly computational resources compared to full LES for an employment in industrial design environments.
2. The project demonstrated the capabilities of hybrid RANS-LES approaches in solving industrially relevant applications with a focus on aerodynamic flows that are characterised by flow separation, wakes, vortex interaction and buffeting, i.e. flows, which are inherently unsteady.
3. It was further investigated that hybrid RANS-LES methods can be well applied to multi-disciplinary topics as there are aero-acoustics (noise reduction) and aero-elastics (reduced weight, unsteady loads, fatigue issues, improved safety), improving by this both a cost-effective design and increased predictive accuracy.



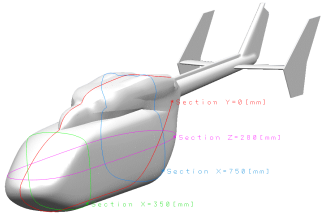
4. The DESider project strengthened co-operation between European industries, research establishments and universities, fostered co-operation, improved dissemination, and achieved cross-fertilisation between different industries as there are airframe, turbo-machinery, helicopters, power generation as well as turbo-engines and ground transportation by setting up a so-called “observer group”. The latter being a group of industries plus one additional university (Liverpool University), were linked to the project - but not paid by it. All observers were allowed to attend technical meetings and some of these observers even provided own results as a “gift in return”.



Major studies performed in the course of DESider in terms of development and assessment of the turbulence-resolving approaches, include:



- investigation of a role of a background RANS model in DES in terms of accuracy and robustness,
- improvement of RANS-LES switching in DES and, particularly, elimination of premature switching which may occur inside the boundary layer with a grid that is not sufficient for the well-resolved LES,
- extension of SAS modelling to two-equation turbulence models and a thorough assessment of the SAS approach against standard URANS and



DES methods,

- development of DES-based approaches for the near-wall treatment in LES which would enable DES application to flows without any separation zone,
- assessment of DES, RANS-LES hybrids, and SAS capabilities in aero-acoustics and aero-elastics analysis, i.e., proof-of-applicability of new models in multi-disciplinary design environments,
- development of a new experimental data base for channel flow, with measurements carried out by ONERA and data post-processing by University Lille. Results have been used to test the hybrid RANS-LES methods investigated in the DESider project. Furthermore, as added value (i.e. not funded totally by DESider), cylinder measurements in the critical regime were performed by IMFT. Data of the latter experiment have also been used and validated in the DESider project.

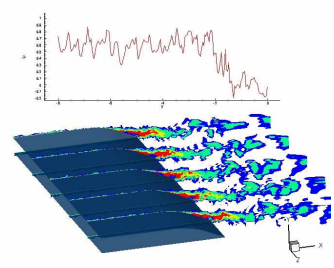
All the findings made in the course of the above studies were supported by application of the different approaches to a wide range of thoroughly selected generic and industrial test cases. Based on this, model limitations were established, best practice recommendations were formulated and, most important, the predictive capabilities of the in-house CFD codes of the partners, and in particularly industry, were enhanced significantly.

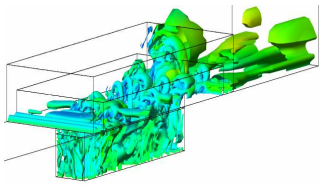
To a certain extent, figures presented on the right-hand side of this report reflect several of the different, scientifically as well as industrially relevant applications.

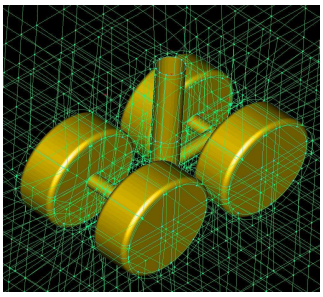
Concerning knowledge dissemination to the "outside world", DESider had set up a first conference on "Hybrid RANS-LES Methods", taking place on 14/15 July 2005 at FOI in Stockholm in association with ERCOFTAC and sponsored by EADS-MAS, ANSYS, FOI and NUMECA. A second symposium followed on Corfu, 17/18 June 2007, again with the aim to both present the outcome of the DESider project – which terminated at the end of June 2007 – and to consider ongoing research worldwide. Results have been published as a Springer book in the NNFM series (Peng, Haase, 2008). Sponsors of the symposium were EADS-MAS, ANSYS, FOI and NUMECA, accompanied by EUROCOPTER Deutschland GmbH and Airbus Deutschland GmbH via the European KATnet-II project.

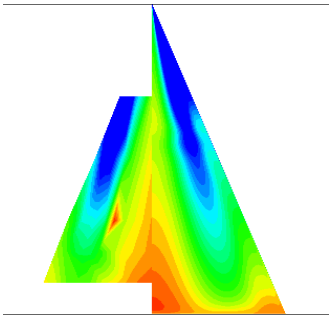
Last but not least it should be mentioned that the DESider project was making Europe and, hence, the European research community in the area of aeronautics, a world-leading group on the improvement and application of hybrid RANS-LES methods. Having pointed out that the results are of major concern for the aeronautics industry with respect to the improved predictive accuracy of CFD results, it should be of high interest not spoil that leadership. This strongly indicates to continue – on European level – with activities on flow-physics modelling.

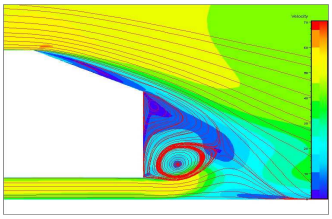
All DESider project results have been published by Springer as part of the NNFM series (Haase, Braza, Revell, 2009)

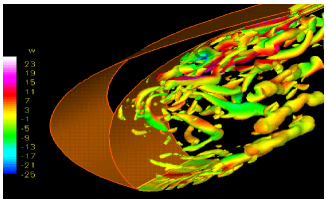


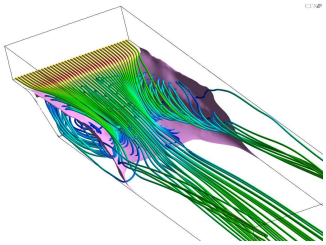












References

Peng, S-H, and Haase, W. (eds.) (2007): Advances in Hybrid RANS-LES Modelling", Notes on Num. Fluid Mech. And Multidisciplinary Design, Volume 97, Springer.

Haase, W., Braza, M., Revell, A. (eds.) (2009): DESider – A European Effort on Hybrid RANS-LES Modelling. Notes on Numerical Fluid Mechanics and Multidisciplinary Design. Vol. 103, Springer-Verlag.