

THE PRE-PROCESSING PRIORITY IN FLUID-DYNAMICS DESIGN

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ABSTRACT –

In the last years, thanks to the development of computational capabilities, the CAE methodology has become an essential tool in the design especially in the preliminary phase and configuration analysis. This happens also and above all in the fluid dynamic design by using CFD codes, which have reached high levels of reliability.

In recent years the simulation times have significantly reduced, and this means that the pre-processing phase has become the real bottleneck within the project.

The engineering consulting companies can face trouble to define standard methodologies for the analysis, because of the wide range of application fields, and need to reduce operational costs and response times to be competitive. This kind of problems induce us to find a strategy to automate the entire design process as much as possible.

This work aims at showing the use of ANSA tools for our cases, and the development of pre-processing automation methods easily adaptable to most of them

TECHNICAL PAPER -

1. TEAM

Our Working Group was born from the Department of Aerospace Engineering of the University of Pisa with the idea to lend the knowledge of fluid dynamics matured in years of research to the industry. For this reason, we have created a working group within Cubit, spin off of the University of Pisa, and these two realities collaborate actively bringing together the know-how and technology. Within the university the future engineers are trained, new methodologies are developed through the research in the computational and experimental fields carried out during thesis and postgraduate activities. Cubit has the possibility to draw on these resources by making available its own technology and the necessary computational power, in particular a Cluster of 9216 cores dedicated to the calculation.



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Figure 1 – The Team

2 COMPUTATIONAL FLUID-DYNAMICS

In the last few years the computational capabilities have been developed in a significant way, this has meant a more and more intensive use of the numerical approach that is become essential in the preliminary phase of the design process. An analysis of the calculation

resources at our disposal in the last 20 years has allowed us to highlight a reduction in the calculation times of an order of magnitude every 4 years, and at the same time an increase in the number of cells through which is possible to discretize the models (figure 2).

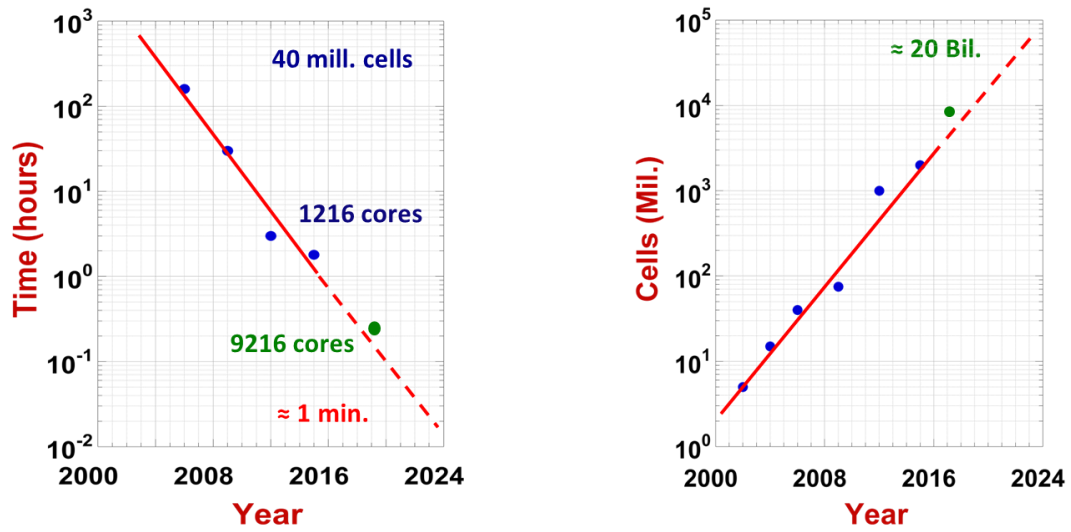


Figure 2 – Computational capabilities development

This explains how, within a fluid-dynamic design (figure 3), the pre-processing is the bottleneck in the perspective of a reduction in project times.

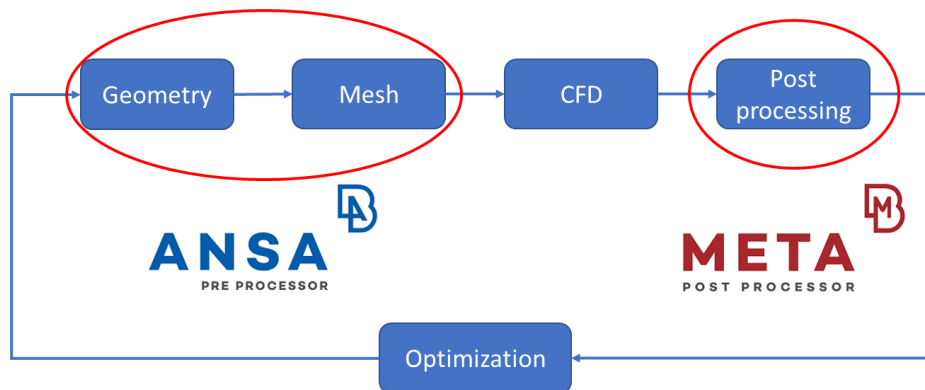


Figure 3 – Fluid-dynamic design

3 PRE-PROCESSING

Ansa is one of the most versatile software in this phase of the project, in our opinion, and it allows us to take advantage of its many tools for the preparation of geometries and of the calculation grids.

Surface Management

This tool allows us to manage the surfaces in order to clean up the geometry and to adapt it to the fluid-dynamic simulation. Moreover, it is possible to replace elements without any additional operations from the user thanks to its matching tools: this allows to make faster editing on the cad and therefore to analyse multiple configurations in a short time.

Wrapping

Involving octree-based techniques, the Wrap tool can be applied to complex objects to recognize internal/external surfaces that are relevant for the CFD analysis and generate an approximate shell mesh that is directly usable in our simulations.

Meshing

The meshing tool is necessary for generation of the calculation grid, making them suitable for our analysis.

Morphing

It allows us to make changes to the reference geometry by intervening directly on the nodes of the calculation grid.

4 GOAL

For engineering consulting companies, where delivery times are a priority, being able to cut the complexity of pre-processing becomes the primary goal. The multiplicity of problems of different nature which can be faced by the users, makes this very complex. The sectors to which the fluid-dynamic approach can give support are many; among the main we can find aeronautics and automotive (figure 4), naval and HVAC (figure 5) and problems of different nature (figure 6).

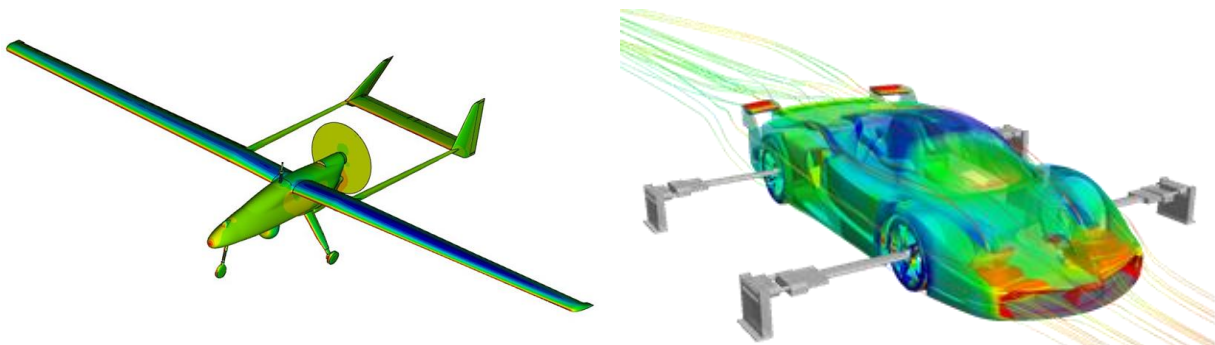


Figure 4 – Aeronautics and automotive

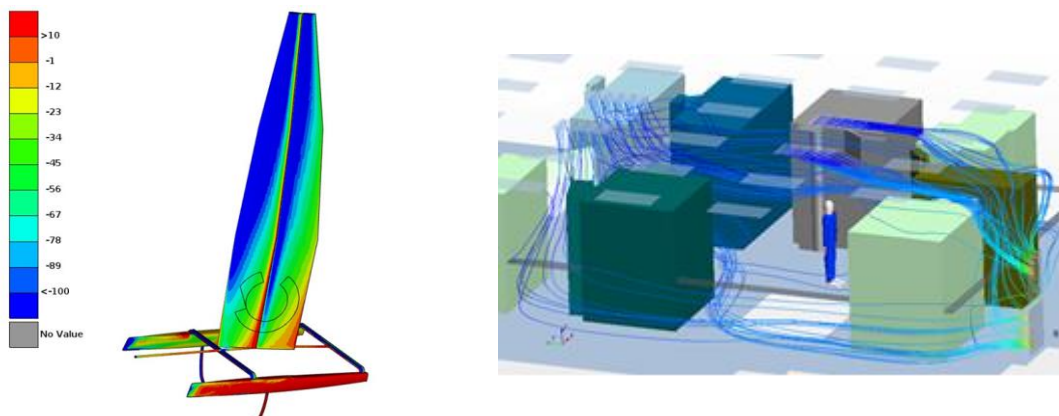


Figure 5 – Naval and HVAC

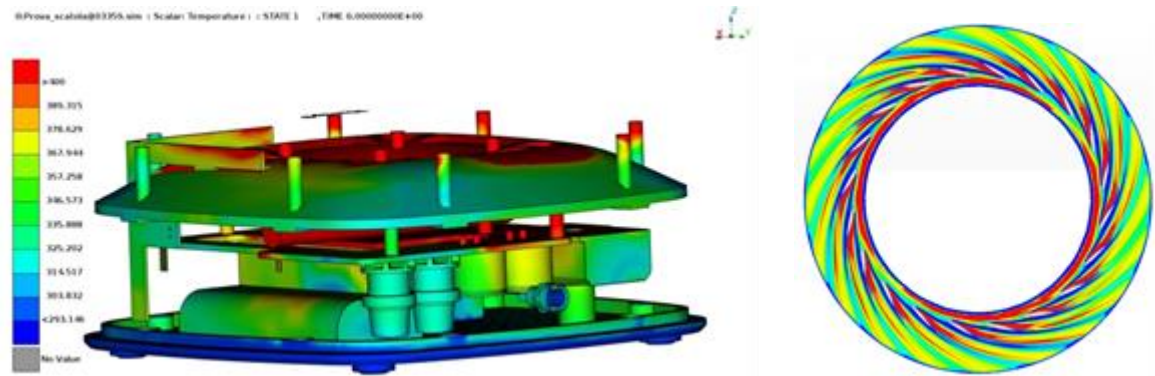


Figure 6 – Special applications

Our goal has become to provide an automatic procedure adaptable to any kind of design able to minimize pre-processing timing. Using the Batch Mesh tool and the parametrization of mesh specifications with some of the characteristic length of the model to be examined, we have reduced the generation time of high-quality CFD mesh (shell, layers and volume) and optimized the application of the Wrap tool to very complex geometries that required much clean-up work.

5. CONCLUSIONS

The essential priority for the engineering consulting companies is the response time, the technology has always made the calculation times smaller, so in the fluid dynamic project, the bottleneck remains the pre-processing. What we have done, and we are still developing, is to try to automate this phase of the work in order to enhance the efficiency of the process and so to reduce the running times.

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