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ENHANCEMENTS OF NUMERICAL SCHEMES FOR AND WITH TETRAHEDRAL-BASED MESH ADAPTATION

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Flows involved in aerospace, naval, train and automotive industries are composed of complex features and multi-scales phenomena: shocks waves, boundary layers, turbulence, etc. When dealing with complex geometries, all these features may be present in the flow field and interact. If each subject is studied on its own, an unified approach to generate the best discretization for each component of the flow is still a challenge. Indeed, many numerical examples have proved that the performance of a numerical scheme is bounded by the quality and the features of the discretization [1]. For instance, anisotropic meshes may be preferred to capture accurately shocks [2, 3] while cartesian grids may be preferred at a turbulent regime to allow high-order capturing of vortices [4]. In the vicinity of bodies, quasi-structured grids are employed to capture the boundary layer in viscous simulations [5].

This talk deals with the problematics of handling all the previous requirements to predict flows around complex geometries. We first review the tetrahedral-based numerical schemes used in the flow solver with an emphasis on the features needed to handle anisotropic meshes. Then, we show how anisotropic mesh adaptation is used to enhance theses numerical schemes. In particular, we show that second order accuracy is recovered even in the presence of discontinuities in the flow field. This approach is exemplified with several 3D simulations ranging from sonic-boom study and blast simulation to the study of boundary layer shock interactions, see Figures 1, 2 and 3.

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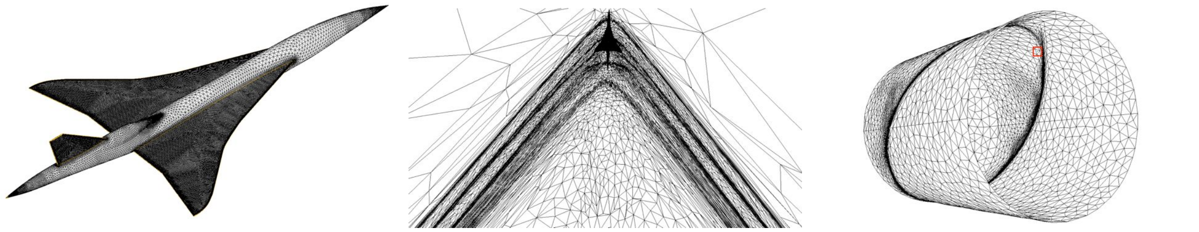

Figure 1: Full scale adaptive sonic boom simulation. Left: geometry of the aircraft. middle: cut in the volume mesh below the aricraft. Right: trace of the shocks generated by the 40-meter aircraft onto the 10-km computational domain.

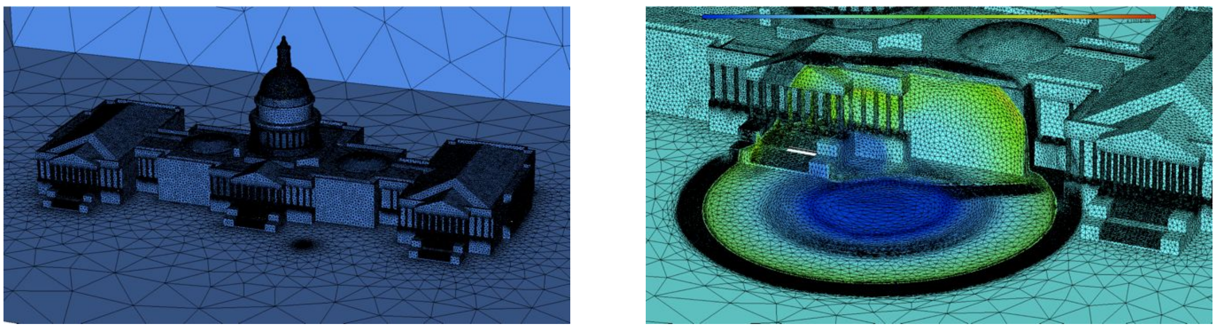

Figure 2: Unsteady blast simulation. Left: the initial surface mesh. Right: pressure field on the adapted surface mesh at time 0.1s.

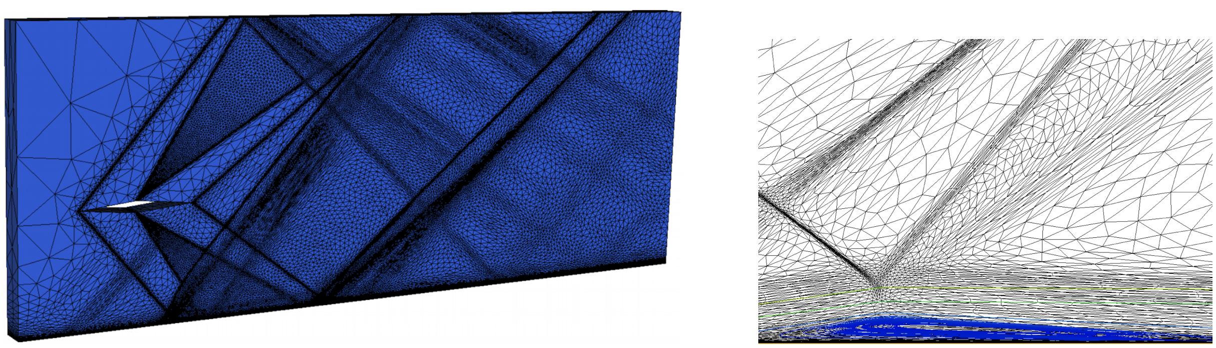

Figure 3: Unstructured mesh adaptation of a shock/boundary layer interaction. Left: the final adapted mesh. Right: close view of the interaction between the shock and the boundary layer.

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