11th. World Congress on Computational Mechanics (WCCM2014)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

SPECIAL TECHNOLOGICAL SESSION (STS05)

TRANSITION LOCATION EFFECT ON SHOCK WAVE BOUNDARY LAYER INTERACTION

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Key words: shock wave- boundary layer interaction, laminar flow, flow control, laminar-turbulent transition

ABSTRACT

Vision-2020, whose objectives include the reduction of emissions and more effective transport systems, puts severe demands on aircraft velocity and weight. These require an increased load on wings and aero-engine components. The greening of air transport systems means a reduction of drag and losses, which can be obtained by keeping laminar boundary layers on external and internal airplane parts. Increased loads make supersonic flow velocities more prevalent and are inherently connected to the appearance of shock waves, which in turn may interact with a laminar boundary layer. Such an interaction can quickly cause flow separation, which is highly detrimental to aircraft performance, and poses a threat to safety.

In order to diminish the shock induced separation, the boundary layer at the point of interaction should be turbulent. The main objective of the TFAST project is to study the effect of transition location on the structure of interaction. The main question is, how close to the shock wave the induced transition may be located, while still maintaining a typical turbulent character of the interaction.

The main study cases - shock waves on wings/profiles, turbine and compressor blades and supersonic intake flows - will help to answer open questions posed by the aeronautic industry and to tackle more complex applications. In addition to basic flow configurations, transition control methods (stream-wise vortex generators and electro-hydrodynamic actuators) will be investigated for controlling transition location, interaction induced separation and inherent flow unsteadiness. TFAST for the first time will provide a characterization and selection of appropriate flow control methods for transition induction as well as physical models of these devices.

It must be emphasized that TFAST objective is not to improve knowledge of laminar boundary layers and of transition. The general aim of TFAST is to avoid that the laminar boundary layer is penetrated by the shock wave. The benefits of having laminar boundary layer are so important that the transition should occur as late as possible. The sensitivity of the solution is calling for basic studies before the configurations closer to application may be investigated. It is necessary to carry out advanced experiments and accurate CFD work with the most advanced methods as LES and DNS. The topic of laminar/transitional/turbulent interaction with a shock wave is the most challenging problem in aeronautics, even more when unsteady interaction effects are to be treated.