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SPECIAL TECHNOLOGICAL SESSION

TURBOMACHINERY CHALLENGE

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ABSTRACT

The performance improvement of the aero-engines currently used in the regional and longer-range airliners is one of the topics of utmost interest when the sustainability of the global aeronautical transportation system is addressed. The expected improvements stay on a few pillars: increase of the overall engine efficiency, reduction of CO_2 emission, reduction of the engine weight, improvement of its reliability and reduction of the maintenance costs.

In all of these actions, the challenge of the further development of turbomachines plays a key role; in fact, it is well known that any increase in the turbine/compressor efficiency results in a direct reduction of the specific fuel consumption. Indeed, improving the already very high standards is difficult, and, therefore, major efforts are required in both innovation and research and development activities.

The standard route followed to enhance the engine efficiency relies on the simultaneous increase of the turbine entry temperature (TET) and of the overall pressure ratio. The challenge to increase TET is strongly related to the capability of improving cooling system performance while maintaining high aerodynamics efficiency. The actual cooling technology is now permitting temperature levels that have been considered unattainable for a long time, and are now embodied in most of the advanced high-pressure turbine stages. While many concerns on the reliability and life of the hot components remain, there seem to exist some further space for development because of the recent technological leaps on MEMS and manufacturing technologies.

These two main items have stimulated and promoted most of the research activities of the past decades, and some of the major achievements will be addressed in the STS from both the numerical and the experimental point of view.

Very appealing also appears the possibility to reduce the strong interactions between the combustion chamber and the high-pressure vane, an objective that can only be achieved using sophisticated numerical tools. Computational fluid dynamics could describe in a coupled manner the reactive field of the combustor and the cooled turbine flow. Efforts have also been directed towards the creation of a virtual engine concept, i.e. the development a single analysis tool that could, via CFD, allow for the simulation of the whole engine. Most of the aero-engine manufacturers are currently heavily investing in this strategic technology challenge.

Other areas of major interest deal with the stability and control of the flow both in the compressor and in the turbine, at take-off and cruise flight conditions. The extension of the operating envelope of the engine has also to be compromised with the never-ending ambition to increase the aerodynamic load in order to reduce the blade count, and ultimately the engine weight. On the propulsion side, acoustic and efficiency constraints have led to dramatic increase of the bypass ratio, with new challenges for both the fan and the low-pressure turbine. Simultaneously, contra-rotating open rotor technologies are also being explored in details, and chances are that if the aero-acoustic concerns will be managed they will quickly replace high by-pass ratio technologies.

What are the long range strategy of propulsion industry should encourage research entities to focus their activity to Future and Emerging technologies as well, and on the other side should stimulate public agency to invest in pioneering, high gain/high risk researches.