"Large-Eddy Simulation for Turbine Heat Transfer"

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Abstract
High pressure turbines (HPT) are subject to excessively high temperature and durability is one of the important issues to overcome. Predicting the heat transfer with high fidelity CFD methods such as Large-Eddy Simulation (LES) is especially challenging. There are many elements of complexities that hinder LES from becoming a truly predictive tool; these are high level of inlet turbulence intensity to impact on transition, stator/rotor interaction, surface roughness, effect of film cool and etc.. In this study, heat transfer in a high-pressure turbine rig configuration built at UTRC has been analyzed. A particular challenge here is that turbulence grid generates fairly high levels of inlet turbulence with turbulence intensity (TU) of about 10% just upstream of leading edge; this in turn moves the transition location upstream in a dramatic fashion. As far as the rotor blade is concerned, the flow and heat transfer is also analyzed experimentally for a range of incidence angles assessing the pressure side heat transfer increase at negative incidence angles. Several challenging aspects relevant to flow in the rotor are also considered – the three-dimensionality of pressure side flow separation at negative incidence, the impact of upstream stator wakes, as well as the role of surface roughness. In addition to the HPT configuration, a flat plate boundary layer under high intensity of turbulence was simulated in efforts to validate the transition prediction capability of our LES tool. This analysis revealed the importance of preserving small scale eddies in the free-stream that effectively perturb the laminar boundary layer and initiate the transition process.

Biography:
Jongwook Joo is a Senior Research Scientist at United Technologies Research Center. Prior to joining UTRC, he was a postdoctoral fellow at Iowa State University in the Department of Aerospace Engineering, and he received his Ph.D. and M.S. degrees in the Department of Mechanical Engineering from Stanford University and B.S. degree in Mechanical and Aerospace Engineering from Seoul National University. At UTRC, he has studied various topics regarding turbo-machinery such as turbine and compressor blade simulations as well as centrifugal compressors, and nacelle drag. Previously, he studied the turbulent transition on high-speed boundary layer flow as a post-doctoral researcher. During his Ph.D. study, he researched the heat transfer of turbine blade trailing edge cooling by using eddy resolving simulation.

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