

An Approach to Investigate Thermomechanical Effects on Turbine Disks

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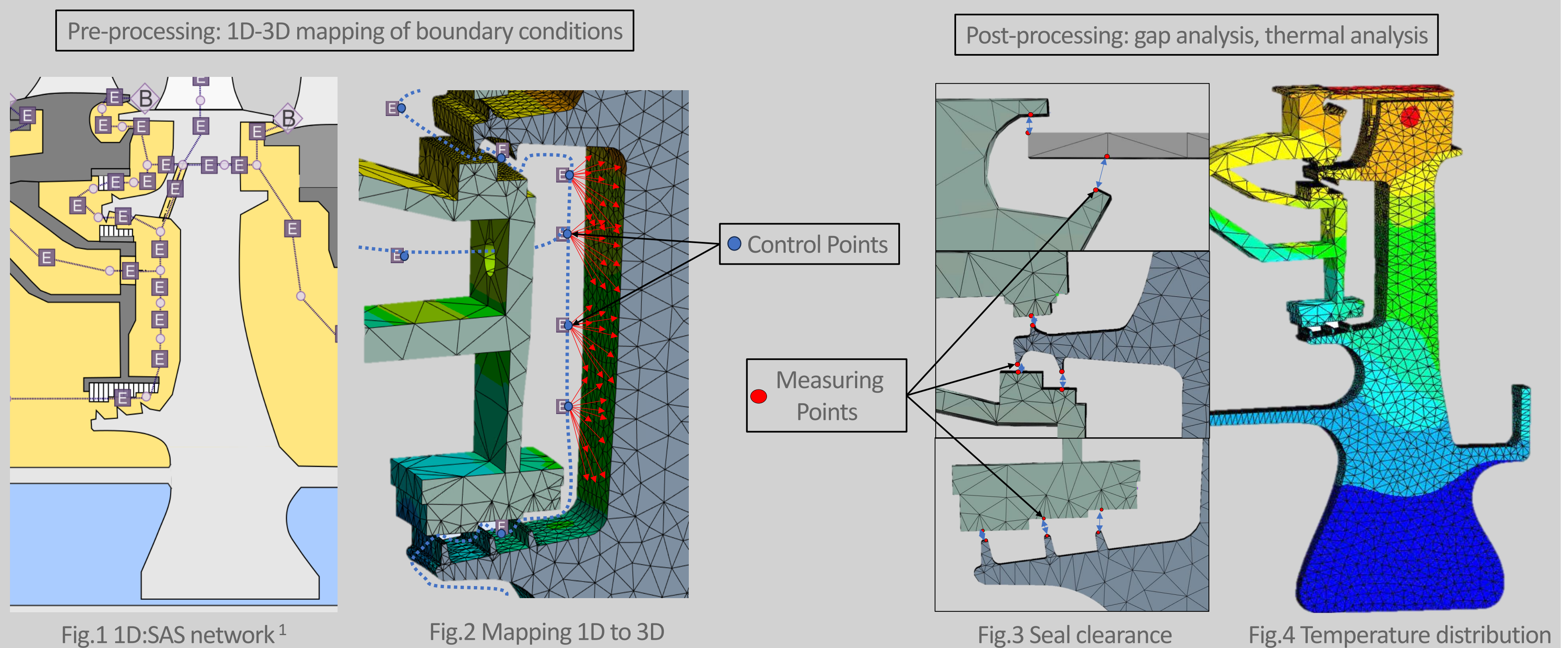
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Motivation

In aero engines, the secondary air system (SAS) necessitates detailed consideration of secondary air components (SAC) throughout all design phases, as well as during engine production and maintenance processes. This approach deals with high fidelity of thermomechanical simulations of SAC with emphasis on complex seal structures of turbine disks. The methodology will provide an iterative simulation process dealing with 1D fluid models (1D:SAS)¹ as shown in Fig.1 and 3D structural model (3D:SAC).

Concept of Fluid-Structure Coupling and Gap Estimation of Seals



The 1D:SAS solver prescribes boundary conditions at each element. Control points are positioned based on these elements in 3D space and scalar values are mapped onto the turbine disk surface (Fig.2). A thermomechanical simulation is performed, incorporating the material thermal properties and fracture mechanics. In the post processing, measuring points are used to record the time-dependent displacements, as illustrated in Fig.3 to assess clearance and thermal expansion is evaluated (Fig.4).

Simulation Workflow for Complex Structure in Transient Conditions

For the transient condition, different systems are coupled as shown in Fig.5. The objective is to estimate seal gap variations at each time step for better prediction of mass flows in the SAS while simultaneously receiving dependent loading conditions from 1D:SAS. The methodology is modular and flexible, allowing application to other components, such as compressor disks. Furthermore, the methodology is part of the work on Multi-X methods at the institute to handle complex simulations, analogous to 3D-CFD² and 1D-3D coupling³. Features of the underlying methods were introduced in Schuff et al⁴.

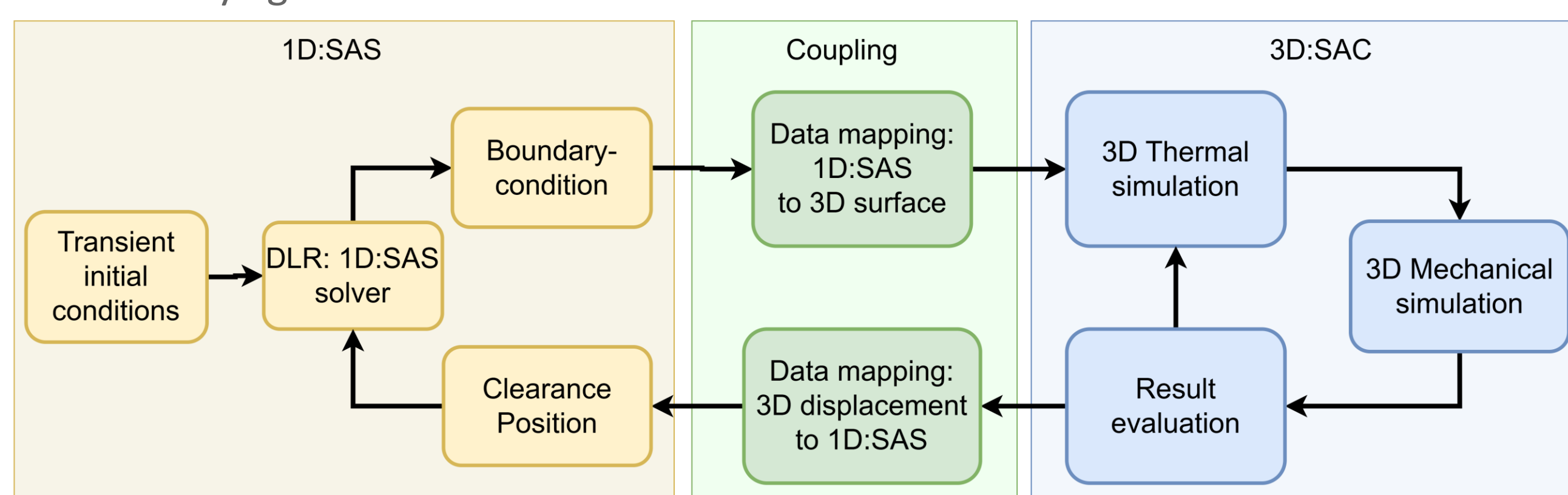


Fig.5 Workflow for iterative process

References:

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