

OS12 – Rotordynamics and Multidisciplinary Challenges: Tribology, Design Optimization, Digital Twins, and Systems Engineering in Turbomachines

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This organized session addresses rotordynamics and multidisciplinary challenges in turbomachines, spanning tribology, design optimization, digital twins, and systems engineering. We invite contributions on seals and clearance flows (including thrust-balancing devices), bearings with thermal/tribological effects, and rotordynamic fluid forces that can drive instability and vibration in high-speed rotating machinery. Studies on rotor vibration and axial vibration—covering stability, resonance crossing, and coupled rotor–bearing–support dynamics—are especially welcome.

A key focus of this session is the integration of physics-based analysis and system-level simulation. Topics include reduced-order models, model-based design (MBD) workflows, and 1D-CAE / 1D thermo-fluid approaches that enable efficient design-space exploration and control-oriented analysis. We also encourage work on controls, diagnostics, and condition monitoring for reliability improvement, anomaly detection, and prognostics. This includes methods such as data mining, data assimilation, and machine learning, which are increasingly important for high-reliability operation, automation, labor saving (reduced operational workload), and advanced maintenance planning.

Non-exhaustive list of suggested topics

- Seals and clearance flows (incl. balancing pistons / thrust-balancing devices)
 - Bearings, tribology, and thermal issues in high-speed rotating systems
 - Rotordynamic fluid forces and destabilizing forces (cross-coupled forces)
 - Rotor vibration, axial vibration, and stability (including resonance crossing)
 - Structural mechanics and rotor–structure coupling (FSI, support dynamics)
 - Blade dynamics, fatigue, and flow-excitation / unsteady pressure effects
 - Design optimization and robust design (DOE/Taguchi, sensitivity analysis, multi-objective optimization)
 - Modeling & simulation: reduced-order, MBD, and integrated rotor–system modeling
 - 1D-CAE / 1D thermo-fluid and high fidelity simulation
 - Controls and control-oriented modeling for rotating machinery
 - Diagnostics, condition monitoring, data assimilation/mining, and AI/ML for health management
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Organizers



Tsuyoshi Inoue is a Full Professor with the Department of Mechanical Science and Engineering, Nagoya University. His research interests include nonlinear dynamics, rotor dynamics, vibration analysis and fault diagnostics, vibration control, and dynamics of fluid-structure interaction. In recent years, his work has focused on developing high-speed, high-accuracy nonlinear analysis methods for rotor dynamics, developing health-assessment techniques for rotating machinery based on digital twins and mathematical models, and designing new types of damper mechanisms.

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Kazuhiko Adachi is a professor in the Department of Mechanical Engineering at Chubu University, Japan. His research interests lie in two distinct fields: vibration engineering and clinical biomechanics. In the field of vibration engineering, he focuses on the vibration analysis of spindles in high-speed machines and rotor dynamics analysis of turbomachinery.

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Masaharu Uchiumi is a Professor at Muroran Institute of Technology (MuIT), Japan. His research integrates rocket propulsion turbomachinery with rotordynamics and system-level design, addressing cavitation-driven rotordynamic fluid forces, rotor/axial vibration, and mitigation technologies relevant to bearings and seals. He develops multi-fidelity modeling workflows up to 1D-CAE and 1D thermo-fluid engine-cycle simulation, and applies these tools to reusable launch-vehicle and spaceport-related studies.

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