Short Course (**6 CE hours)**
September 2018 Turbomachinery Symposium

BEARINGS FOR OIL-FREE ROTATING MACHINERY

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Gas bearings (GBs) are an efficient alternative for load support of high speed (microturbo) machinery (< 400 kW, +1000°F, +3M DN). Hydrodynamic bearings, often with a compliant surface as foil bearings, use ambient air as the working fluid media. Oil-free systems have lesser part count, footprint and weight and are environmentally friendly and (nearly) maintenance free, thus saving costs and resources. Current commercial applications include air cycle machines, cryogenic turbo expanders, blowers, and micro gas turbines. Other upcoming applications include auxiliary power units, automotive turbochargers, compressors for A/C units, and aircraft gas turbine engines for regional jets.

Successful implementation of GBs in commercial rotating machinery involves a three-tier effort with (a) selecting and designing bearing structural components and solid lubricant coatings to improve the bearing load carrying capacity with reduced friction, (b) having accurate performance engineering prediction models anchored to dependable (non commercial) test data, and (c) integration with secondary flow, operating profile, and the rotor-bearing dynamic system.

The short course provides practicing engineers with a comprehensive review of existing gas bearing technologies including their principle of operation, analysis and experimental verification, comparison amongst other gas bearing types, as well as the integration of gas bearings, foil bearings in particular, into actual rotor-bearing systems (hot and cold). The course also includes an introduction to magnetic bearings and their applications.

Short course offered at TPS in 2014 and 2016 with outstanding success. Attendees reviews complimented the presentations and acknowledged the quality and practicality of the knowledge learned.

2018 CONTENTS

To those attending:

The course is designed around the needs of every job function related to integrating oil-free foil bearings into rotating machinery products. This includes design engineers interested in making their next generation machines or improving current machines with a hybrid oil-lubed and foil bearing system. Additionally, consumers of oil-free machines will benefit from understanding the technology's unique characteristics. The course includes material relevant to oil-free

compressors, industrial and aerospace gas turbines with hot section bearings, air cycle machines, and more. The course gives enough information to rationally select foil bearings by understanding their (current) practical limits and planning for further qualification and standardization. The short course dispels several myths related to GFB performance and stress its unique features.

The reason you are attending to this SC

Foil bearings are an enabling technology that benefits from a novel approach for effective integration into an oil-free rotating machine based on the bearing unique characteristics. The course is taught by engineers with practical, analytical, experimental and commercial experience with oil-free gas turbines and state of the art laboratory modeling and testing.

The course utilizes common rotordynamics, hydrodynamics, and other physics principals already familiar to the community and show how they apply to foil bearing equipped machines from a theoretical and practical point of views. In addition, the instructors' practical experience will prepare the designer for common pitfalls including gauging realistic performance expectations and typical operational failures, streamlining future projects.

THE PRESENTERS

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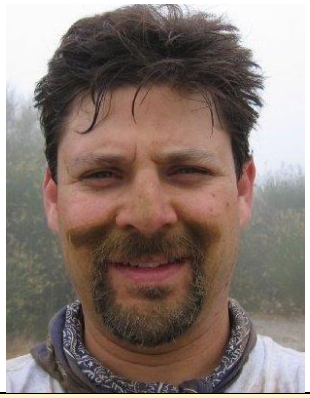
<td>  </td>
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<td>**Luis San Andrés**
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<td>Luis San Andrés is a renowned analyst and experimentalist in the fields of gas and liquid film lubrication and rotordynamics. Since 2000, Dr. San Andrés has performed research on the analysis and experimental verification of gas foil bearing performance for high temperature oil free turbomachinery, squeeze film dampers for aircraft jet engines, and *wet* seals for subsea compression and pumping systems. His computational codes, benchmarked against test data, are standards in the rotating machinery industry. Dr. San Andrés and his students have published over 240 journal and conference papers, several earning best paper awards. Prof. San Andrés is an ASME Fellow and STLE Fellow, a member of the Advisory</td>
<td>Daniel Lubell is a consulting engineer specialized in oil-free and conventional turbomachinery with over 20 years of related experience. Daniel's previous experience includes several years at Calnetix Technologies as the Manager of Rotating Machinery. Additionally, he has over 12 years with Capstone Turbine with diverse roles that included Manager of Turbomachinery Rotating Systems and Principal Engineer of Oil-Free Bearing Technology. His responsibilities included bearing and rotordynamic design integration and testing for all Capstone products as well technical and commercial lead for all outside foil bearing programs. Prior small turbomachinery experience includes APU's and small thrust jets with Sundstrand Aerospace (now</td>
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Committees for the Houston-Turbomachinery Symposium and Pump Symposium, and Asia Turbomachinery & Pump Symposium and the Chinese International Turbomachinery Conference, and a technical Chair for the Global Power and Propulsion Society. Visit his URL site http://rotorlab.tamu.edu for useful information on lubrication, vibrations and rotordynamics.	part of Pratt and Whitney) and air cycle machines with Honeywell Aerospace. Daniel has a Master of Science degree in Mechanical Engineering which he earned at the Texas A&M University Turbo Lab in College Station, Texas. Prior to that, he earned a Bachelor of Engineering Science degree from Trinity University in San Antonio, Texas. Daniel is an ASME member and active participant in conferences and journals and has published papers on squeeze film dampers and foil bearing developments for micro gas turbines.