CASE STUDY

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The Challenge

Over the past two decades, there has been a 715% increase in wind energy generation in the UK, with the sector generating a £6b turnover in 2019. As the power capacity and wind turbines rotor diameter increases, larger main-shaft roller bearings are necessary to allow for the same margin of safety. Despite these bearing approaching their maximum size limit, failure rates remain high. This is partly due to machining challenges from distortions and tight tolerances. In addition, historically, rolling bearing life are estimated through data from small-sized bearing which would be invalid for larger-sized bearings as is used in wind turbine drivetrains. To reduce failures, the wind industry is currently facing a paradigm shift from rolling to sliding bearings. However, the industry has no experience of sliding bearing performance in the highly transient conditions of the wind turbine powertrain. Additionally, sliding bearings are traditionally used in high-speed applications such as jet engines and are unproven for slow-speed environments such as on a wind turbine driveshaft. This project intends on rectifying this through developing a suite of measurement techniques to provide the underpinning data.

Innovation
Launchpad
Network+

Innovation

The project pioneered the development of a sensing platform for performance monitoring of wind turbine sliding bearings, addressing a critical gap in understanding their real-world operational behaviour. The work began with a comprehensive literature review of sensing techniques for wind turbine journal bearings to identify technologies capable of capturing key performance parameters under demanding environmental and load conditions. Building on this foundation, the team undertook benchtop validation trials to evaluate the precision, responsiveness, and durability of selected sensors in simulated turbine environments. The innovation lay in the subsequent design and integration of advanced instrumentation methods that enabled sensors to be embedded directly within a rotating shaft — a complex engineering challenge that required careful consideration of space constraints, material compatibility, and signal integrity. This embedded sensing approach allows continuous, high-fidelity monitoring of lubricant film thickness, load, and temperature during turbine operation. Together, these developments represent a major step forward in enabling predictive maintenance and accelerating the transition from rolling to sliding bearings in large-scale renewable powertrains.

Result

From the literature study, the oil film thickness is the most desirable monitoring parameter to inform on friction and wear performance of bearing as well as for theoretical modelling validation. To date, no universal technique exists for oil film thickness measurement in sliding bearings, with eddy current sensors being a favourite for industry despite its limitations and challenges. Benchtop trials conducted showed that ultrasound, despite being an experimental technique, exhibited equal accuracy but better precision (less scatter) for oil film thickness measurement compared to eddy current sensors. Additionally, sensors instrumented within a shaft allows for dynamic circumferential measurement, facilitating comparison across various tilting-pads.

Impact

The project's outcomes are already delivering tangible benefits across the renewable energy and manufacturing sectors. The sensor selection framework and instrumentation guidelines developed through this work have provided industry partners — including Waukesha Bearings and ORE Catapult — with a clear methodology for designing and implementing robust sensing solutions in demanding turbine environments. By enabling the collection of richer, higher-fidelity data from full-scale turbine trials, the platform is supporting more accurate bearing design, validation, and optimisation. This advancement is helping to accelerate the widespread adoption of sliding bearings in wind turbine systems, a key step toward improving drivetrain reliability and reducing maintenance downtime. The embedded sensor suite has also demonstrated potential for real-time, in-situ monitoring within operational turbines, offering early diagnostic insight into lubricant film behaviour and tilting-pad performance. Such predictive maintenance capabilities are expected to enhance turbine uptime and reduce life-cycle costs, contributing directly to the long-term sustainability and competitiveness of offshore wind technology. Beyond its immediate technical impact, the project strengthens collaboration between academia and industry, fostering knowledge transfer that supports the UK's ambition to lead in advanced wind turbine engineering and Net Zero innovation.

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"By embedding advanced multi-sensor systems directly within wind turbine shafts, we can capture high-fidelity, real-time data on lubricant film thickness, load distribution, and dynamic operating conditions. This level of insight provides the fundamental evidence base required to accelerate the transition from conventional rolling bearings to next-generation sliding bearings in large-scale powertrains. The ability to monitor and interpret these parameters in situ not only enhances our understanding of tribological performance but also supports predictive maintenance strategies and the design of more efficient, durable drivetrain systems."

OREC

"We have consistently recognized the need for real-time oil film thickness data and the ability to monitor load distribution within bearings during full-scale wind turbine drivetrain testing at our facility. However, due to the complexity of this task, it has remained on our wish list for some time. This project has provided valuable insight into the range of available sensing technologies, ultimately identifying the most promising technique along with a practical implementation approach. The successful deployment of this advanced measurement solution will significantly enhance our testing capabilities by delivering critical technical insights into actual lubrication conditions—accelerating the adoption of fluid film bearing solutions within the wind energy sector."- Wooyong Song, Head of Drivetrain and Turbine Structure

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