Case study

Keeping wind power flowing...

A new modelling approach is helping a wind turbine manufacturer predict gearbox failures saving them and their customers money through proactive maintenance and by informing more robust gearbox design.

Vestas

The global wind energy market is currently worth more than $160 billion annually (BCC Research 2015) and is expanding rapidly as the demand for renewable energy sources to meet climate change targets globally increases.

The major challenges for the industry are to reduce capital and operational costs whilst increasing the reliability of existing assets. Operations and maintenance costs account for as much as 40% of the life cycle cost of a wind turbine. One of the largest contributors to this cost is gearbox replacement.

However, maintaining gearboxes in harsh and remote environments, for example offshore, is time consuming, very costly and hazardous.

Regular maintenance of gearboxes is vital to avoid failures and being proactive and improving the predictability of gearbox maintenance is crucial to reduce the turbines' overall lifetime costs.

What the IDC did

The challenge for the team was to integrate and interrogate a wide range of existing databases regarding failure modes of gearboxes into a tool that could be used to better inform and schedule proactive maintenance. The approach was initially to model and reverse engineer failure modes of different gearboxes, but the focus quickly shifted to creating repair solutions.

The project sponsored by Vestas applied soft systems methodologies to gather data from across the gearbox design, installation and maintenance lifecycle. Through working with multiple internal and external stakeholders it was possible to capture all of the perspectives of the problem and build a holistic understanding of the issues. The project delivered outputs including repair databases and failure analyses, which have been used to influence design and benchmark repair costs across multiple suppliers.

The Impact

The outputs of the project have moved Vestas from reverse engineering the failure mode to live stream data management:

- The outputs of the damage classification project have been rolled out to 6 service units in Vestas responsible for 11 sub regions in the UK and Europe maintaining over 27,000 turbines.
- The outputs of the project were fed back into the design for serviceability and up-tower repairs of the Vestas' new 3MW turbine variant which has been installed in 34 countries globally.
- The outputs of the project provided clear information to senior management and influenced strategic level decisions regarding when to incur or defer maintenance costs.
- Information from the failure analysis modes was fed back into the Engineering and Development functions of Vestas to inform new gearbox design of the most common risks, how these are divided between different departments and how to avoid them.
- Through working across their production line, Vestas has brought together their Design and Maintenance departments into a new Performance department of over 40 people.
- The Research Engineer was recruited by Vestas to further develop the outputs of the project and move towards developing predictive maintenance tools.
- The project represents pioneering work in the field, as extreme value theory has never been applied in this area, which has led to multiple academic publications.
- The lessons learned in the project are widely applicable to a number of other industries where condition monitoring and data gathering needs to be hardwired from the start to influence design.

The Future

In 2016, Vestas implemented up-tower repair capturing based on the IDC's research on all sites under Vestas service contract. Currently, Vestas has >70GW installed fleet of which >60GW are still under service contract. The wind turbine market is set for significant expansion in the next 5-10 years. The biggest competitive lever that Vestas have is data and being able to supply real time data and use it to move towards predictive maintenance will provide a key competitive advantage in the sector. It is estimated that by undertaking the predictive maintenance enabled by the IDC project that there will be annual cost avoidance/savings of €5-10 million in service costs for Vestas and its customers, ensuring that wind power keeps flowing.

Related publications

Igba, JE, Alemzadeh, K & Durugbo, C, 2016, 'Analysing RMS and peak values of vibration signals for condition monitoring of wind turbine gearboxes'. Renewable Energy, vol 91., pp. 90-106

Igba, J., Alemzadeh, K., Durugbo, C. & Eiriksson, E. T. Through-life engineering services of wind turbines, 2017, CIRP Journal of Manufacturing Science and Technology. 17, 60-70.