Keeping Wind Turbines Turning

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Around the world, communities are increasingly utilizing wind power because it is a clean, sustainable source of renewable energy, is fast to deploy, creates jobs, uses very little water, and is economically competitive. In fact, wind power is the fastest-growing source of energy production, having grown from zero production in the early 1980s to more than 120,000 megawatts worldwide as of 2008. But as wind turbines are increasingly being installed, their power systems are being challenged by a number of issues, especially exposure to harsh operational and environmental conditions, as well as the effects of contamination from the environment.

Elon J. Terrell is an expert in tribology, the science of friction, lubrication, and wear within sliding and contacting interfaces. He uses analytical, numerical, and experimental techniques to analyze the interfacial interactions and the wear between sliding surfaces in either dry sliding or lubricated contact. Since friction and wear are challenges for devices that contain moving components, his research interests include power generation, energy conversion, energy harvesting, microelectromechanical systems (MEMS), and health sciences.

One of Terrell's current projects is focused on the multiphysics analysis of contaminated cyclic rolling-sliding contacts to gain a better physical understanding of the behavior of an interface between two lubricated surfaces. His primary testbed involves particulate contaminants in a lubricated gearbox system, such as those used in wind turbines. A vital aspect of his research is the combined modeling of the various physical interactions that take place within this interface, including lubricant fluid flow, particle motion, particle-surface contact, and the resultant abrasive wear experienced by both surfaces.

To better understand the lubrication of contaminated gear trains, Terrell's group is using mesh-free particle methods, wherein the lubricant flow, the contacting surfaces, and the particles are all represented by virtual particles that interact with one another and move dynamically with time. Although studies have involved the use of these methods for fluid mechanics and solid mechanics, Terrell's group is seeking to be the first to use them to integrally connect fluid mechanics, solid mechanics, and particle dynamics into a single predictive simulation.

His other research interests include the study of crack initiation, propagation, and agglomeration under low-amplitude cyclic loading, work that will help to better explain why the bases of gas turbine blades fail after a given amount of use. Terrell is also exploring the possibility of applying electrokinetics to thin film lubrication, a project that is mostly applicable to devices such as MEMS and magnetic data storage devices.

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