JANUARY 2010

WIND SYSTEMS

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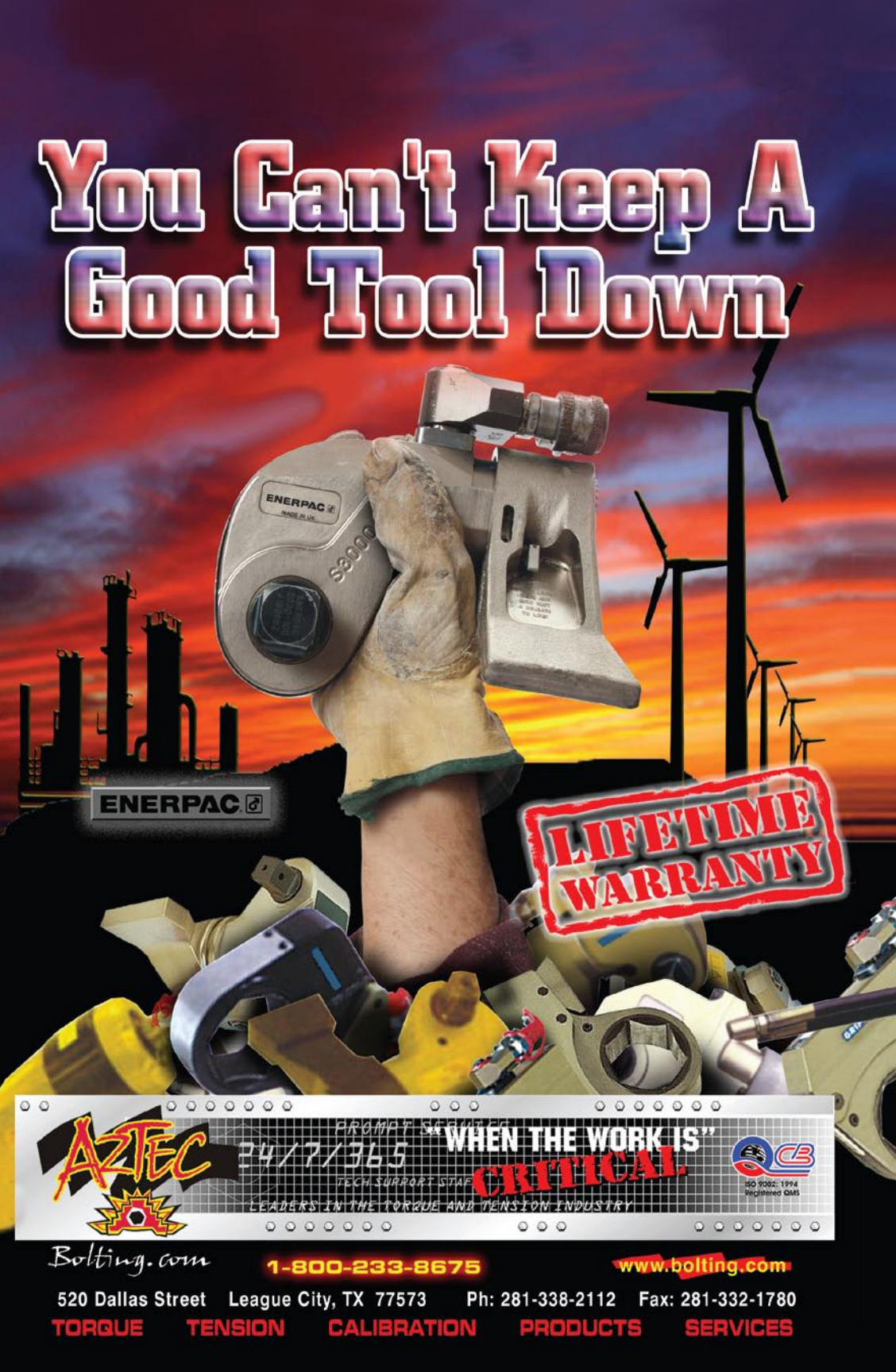
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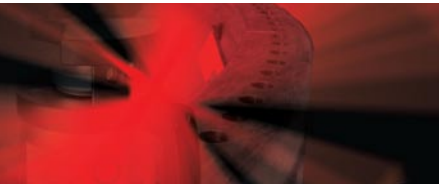

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DEPARTMENTS

VOLUME 2 NO. 5

RESOURCES

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Cover Photo Courtesy Snap-on Industrial

EDLETTER

This issue marks the beginning of monthly production for *Wind Systems* magazine. The response we've received over the past year has been so overwhelmingly positive that we wanted to expand our coverage of this fascinating and ever-evolving industry. We appreciate your support, respect your expertise, and encourage you to consider contributing to our editorial lineup in the coming year.

Speaking of which, you'll find quite an assortment of informed and well-written articles in this issue, beginning with a case study of pouring concrete at The Majestic Wind Farm by Kelly Hayes of Putzmeister America, Inc. Frederick Brookhouse and Dave Dalpaos of Snap-on Industrial have written "Torque Certification Marks Maintenance Advance" about the company's torque training program, and Sebastian Shaw of Windera Power Systems has contributed "Thinking Outside the Gearbox," in which he discusses their cutting-edge design work. In "Laser Measurement for Tower Flanges," by Tony Talley and Bill Seiffert of Seiffert Industrial, Inc., you'll read about laser instrumentation for measuring wind-tower flanges, and Dipankar Ghosh, Ph.D., of Phoenix Integration has penned "Optimizing Design to Maximize Profitability." Closing out our technical articles you'll find "The Mobile Age of Service Technology" by Merritt N. Brown of Rev1 Power Services, Inc., in which he describes technology that will help maximize the return on your investment.

As for our columns, we're pleased to introduce a new one devoted to logistics, and also to welcome Hüseyin Kizilagac of BDP Project Logistics to our pages. In his first installment he shares helpful insights into the shipping side of wind-farm construction. Kathleen O'Dell of NREL's National Wind Technology Center describes their work with industry partners to create next-generation of wind energy systems in our technology column, and James D. Hussin of Hayward Baker, Inc., provides pointers on dynamic compaction in his construction column. Kevin S. George. national account manager of the wind energy business at SKF USA, Inc., provides excellent pointers for extending turbine life in this issue's maintenance column. Tower-manufacturer DMI Industries, Inc., is our company profile—many thanks to Belinda Forknell for sharing the company's history and capabilities with us—and Jeff Gribble, operations manager of UVLM, Inc., is our Q&A subject. Our thanks go out to everyone involved in helping us produce such a wide-ranging collection of interesting topics.

In addition to monthly production of the magazine, other plans for the new year include optimizing our Web site to feature a searchable article database and many other useful tools, and we will also begin the BPA Worldwide auditing process in 2010. We have a lot of plans in the works, as you can see, and we look forward to working with you on upcoming issues of *Wind Systems* magazine!

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PUBLISHED BY MEDIA SOLUTIONS, INC.
P. O. BOX 1987 • PELHAM, AL 35124
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CUTTING TOOLS FOR WIND TURBINES FROM EMUGE

Emuge Corp. has introduced an extensive line up of tools optimized specifically for the production of wind turbine components. Continuous technology advancements in components and materials demand high quality tooling for the most efficient and cost-effective machining of parts used in today's wind turbines. Emuge's new Wind Power program offers a complete solution for precise, affordable machining of wind turbine parts.

For the production of top quality internal and external threads, Emuge's new program provides taps up to 114 mm (4 ½"), roll form taps up to 51 mm (2"), and thread mills up to 102 mm (4"). These tools are designed for all thread sizes—with a special focus on large and deep threading—and every material used in the manufacture of wind turbines. Also included in the new line are the highest quality tap and workpiece holders, available from stock or custom engineered for wind turbine applications. Gaging tools are also available for quick and reliable process control.

The new Wind Power program also offers a wide range of both solid carbide and high-speed steel milling cutters, milling tools with indexable inserts, and other milling accessories. The program includes end mills, slot drills, die-sinking cutters, shell end mills, and gear cutters, in addition to the most complex profile milling tools.

"The wind power industry is currently undergoing a period of rapid growth," says Peter Matysiak, president. "Constant improvements in component and material technology makes it challenging for suppliers to keep up. Emuge is committed to meet this challenge and to providing tools that are precision-manufactured for optimum performance, durability, and tool life for manufacturers in this growing market."

Emuge Corp. is a subsidiary of the 1,000-plus employee German company Emuge-Werk Richard Glimpel KG that has been the product technology and performance leader in their field for more than 90 years. The company manufactures an extensive line of taps, end mills, thread mills, holders, and attachments, with 100,000 items sold through distributors worldwide. Emuge also offers end-user technical support through a network of field engineers with extensive tooling experience.

More than 10,000 types of cutting tools and accessories are stocked in the company's new North American headquarters. The 21,000 square foot state of the art facility, custom-designed and built in 2005, also serves as a technology center, offered to the industry as a resource for machining process development. Milling, thread cutting, and workholding seminars will also be conducted at the technology center. For more seminar information visit www.emuge.com.

ESAB INTRODUCES NEW CADDY TIG PORTABLE WELDERS

ESAB Welding & Cutting Products introduces the new Caddy™ Tig 1500i and 2200i single-phase DC/CC portable welding machines. The new machines have been designed to deliver quality gas tungsten arc (TIG) and shielded metal arc (Stick) welds in a variety of materials for the demanding professional. This fifth generation of Caddy machines features advanced inverter technology to

Companies wishing to submit materials for inclusion in this section should contact Russ Willcutt at russ@windsystemsmag.com. Releases accompanied by color images will be given first consideration.

outdoor use, even in the rain. They are also equipped with a power factor correction (PFC) circuit that allows the machine to perform a full range of functions on a 16A fuse, protects against fluctuating mains voltage, and makes the machine safer to use with a generator. A Caddy Tig 2200i AC/DC version is also available.

With more than 100 years of experience, ESAB Welding & Cutting Products is one of the world's largest and most knowledgeable manufacturers of welding and cutting equipment and welding filler metals. To ensure customer satisfaction, many ESAB products carry a 100-percent satisfaction guarantee. Recognized as the technological leader in the industry, ESAB is committed to providing deliver unparalleled welding quality and performance and offers a compact design with an impact-resistant polymer and aluminium casing that is light and easy to carry, yet stands up even in demanding environments.

The Caddy Tig 1500i and 2200i feature new control panels that present all welding parameters in an easy-to-understand layout. ESAB's two-program function allows pre-programming and program changes during welding. Caddy Tig offers a pulse TIG feature for greater control of heat input and the weld pool, and a "micro pulse" feature that minimizes the heat-affected area, particularly with thin metals. Other features include "hot start" and "arc force" settings.

The new Caddy family is equipped with large cable connectors for high durability. Large heat sinks and an innovative design create a cooler running machine with a longer life expectancy when used in harsh working environments. This ensures that the small size of the machine does not compromise the cooling of vital internal components. The design also helps to keep all sensitive parts inside the machine clean and dust free.

Caddy machines are built in accordance with IP23 for

customized solutions for its customers. For more information call (800) ESAB-123 or visit www.esabna.com.

DENVER FACILITY CERTIFIED AS WIND SERVICE CENTER

TRICO TCWIND, an IPS company, has certified the IPS Denver Regional Service Center for wind service. Denver joins four other TRICO TCWIND certified locations—Litchfield, Minnesota; Portland, Oregon; Shreveport, Louisiana; and Washington, Pennsylvania—in providing coast-to-coast maintenance service for the wind power industry.

IPS, the national leader in the service and repair of electric motors, generators, and mechanical power transmission components, acquired TRICO TCWIND in September 2008 to lead its wind power services. The family-owned independent power services company had played a key role in the industry for years, developing in-shop and up-tower service and repair standards for wind turbine generators while working closely with OEMs, operation and maintenance companies, and wind turbine owners.

"We've found that our counterparts at other IPS service centers have ready-made skill sets," says Jason McDonald, IPS senior VP of wind power. "They look at wind power the way they look at every technology that involves rotating assets—their job is to make it more reliable and meet delivery commitments. Certifying the IPS Denver regional service center was the right thing to do in support of our customers and the growing wind power industry in the Rocky Mountain region."

"Adding TRICO TCWIND to the IPS portfolio gave us instant recognition and an entrepreneurial approach to wind power services," says Brian Brehmer, president and CEO of IPS. "Our plan is to continue on this path, certifying additional IPS regional service centers to expand our wind service capabilities. As one company with 16 regional service centers, we believe we have the best local, regional, and national footprint for wind power services in the United States."

To learn more contact John Covington, IPS senior vice president of marketing, at (864) 451-5634 or jfcovington@integratedps.com. Go online to www.integratedps.com or www.tricotcwind.com.

NORDEX TO BUILD PLANT IN ARKANSAS

Nordex USA, Inc., a leading manufacturer of wind turbines, has begun construction of its first U.S. manufacturing plant in Jonesboro, Arkansas. The announcement comes after a decision by the supervisory board of the parent company, Nordex AG. "After much careful planning, we are eager to break ground and make the plant a reality," says Ralf Sigrist, president and CEO. "The plant is critical to our goal of generating 20 percent of global revenue in the U.S., and I must say I am extremely pleased that construction will begin on schedule."

The United States is on track to be the world's single largest wind market in 2010, with 8,500 megawatts of new capacity projected. Globally, that represents 23 percent of expected new capacity. The Arkansas plant will position Nordex to be a key competitor in the U.S., building on its growth of over 50 percent for four consecutive years. "The U.S. is hungry for wind power," says Sigrist, "and Jonesboro will supply it with the highest-quality turbines in the world."

Construction will take place in two phases, beginning with the nacelle assembly plant and followed by a rotor blade manufacturing facility at the same location. Nacelle assembly will begin ramping up in the second half of 2010, operating at full scale by 2012 with an annual production capacity of 300 turbines, or 750 megawatts. The entire facility, including rotor blade production, will be fully operational by 2014. The nacelle plant will be built on 187 acres in the Craighead Technology Park and will have 115,000 square feet of production space, 10,000 square feet for a training academy, and 35,000 square feet of office space. The plant represents a total investment of $100 million, with about $40 million allocated to the nacelle plant and the remainder to the rotor blade facility. It will directly employ up to 700 skilled workers and other staff by 2014.

The Jonesboro operation will be an original equipment manufacturer (OEM) producing one of the largest classes of wind turbines in the world, the 2.5 megawatt N90 and N100. In the U.S., each of these utility-scale turbines is capable of generating enough renewable energy to power about 700 homes. Nordex was the first manufacturer to build a turbine this large in 2000 and has the longest track record for reliability in the class. To learn more go to www.nordex-online.com.

NEW CORE PRODUCT CATALOG FROM LAPP GROUP

In addition to Lapp's full-line catalog, it has introduced a core product catalog for industrial and factory automation. At a time when other companies are implementing higher minimum order quantities and longer lead times, Lapp Group is committed to servicing product demand from stock on all core products. This

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The wind power business is growing rapidly leading to new metal cutting challenges. As a Sandvik Coromant partner, you can always rely on a specialist nearby, focused on your success. Smart solutions for every component; from the base of the tower to the blade.

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48-page catalog features a mixture of cables, connectors, and cable glands. Product cross references are included to make it easier to find the right SKINTOP® and EPIC® connector for each cable.

The Lapp Group offers a complete one-stop automation solution for cable and connector needs. Lapp has the broadest range of products, including OLFLEX® power and control cables, UNITRONIC® data cables, EPIC rectangular, circular, and pin and sleeve connectors, SKINTOP strain relief cable glands, cable management accessories, remote access ports, and custom harness assemblies. From its manufacturing facilities in Florham Park, New Jersey, Lapp manufactures custom cables for unique applications. For more information call (888) 456-3539 or visit www.lappusa.com.

NEXT-GENERATION HARNESS FROM CAPITAL SAFETY

Capital Safety announces the launch of the world's next generation harness, the ExoFit

NEX™. With first of its kind features and benefits, the harness provides the highest level of safety and the utmost comfort with technologically advanced hardware, soft yet extremely durable anti-absorbent webbing, strategically placed padding, and protective elements that prolong the service life of the harness.

"The original ExoFit, the industry's first premium comfort harness, changed workers' attitudes about fall protection. With the ExoFit NEX, we're taking that to the next level," says Nate Bohmbach, product manager for soft goods. "We're turning the harness into a piece of equipment that workers will want to wear and that's long-lasting. So we're catering not only to the end user, but to the safety director and purchasing department as well."

The technologically advanced hardware allows for a one-time adjustment that stays in place throughout the day and improves safety by ensuring a snug fit. The Duo-Lok™ quick-connect buckles now include a revolutionary locking mechanism to eliminate slippage and constant readjustment. Workers will no longer need to adjust their harnesses throughout the workday; the straps won't budge, even with movement and the weight of tool belts that have traditionally caused adjustments to loosen. The Revolver™ ratcheting torso adjustor features a winding adjustment that spools the webbing as the user adjusts the harness for a proper fit. The adjustor locks into place and holds the adjustment, preventing slippage due to movement and added weight. It also eliminates excess webbing that can be hazardous near moving parts. Additional hardware includes breakaway molded lanyard keepers that allow easy connection of any size snap hook and breaks away to help prevent snagging and tripping. To learn more call (800) 328-6146 or go to www.capitalsafety.com.

NRG SYSTEMS ANNOUNCES RESEARCH PARTNERSHIP

NRG Systems has partnered with the Massachusetts Institute of Technology Wind Energy Group on a multi-phase project to advance the use of renewable energy at MIT's campus and further the science of remote sensing with laser-based technologies. The MIT Wind Energy Group, an on-campus organization that addresses global wind energy challenges through fact-based research, analysis and education, initiated the partnership after meeting with NRG Systems' employees last year at an energy career fair.

"NRG Systems is a name synonymous with wind resource assessment here in the U.S.," says Katherine Dykes, vice president of the MIT Energy Club and founder of the group. "Their reputation, in addition to their role in developing new technology such as lidar, makes them an ideal partner for MIT."

Along with Kathy Araujo, current group president, Dykes has been leading the project that should culminate in the installation of small-scale wind turbines on MIT's campus. Last month NRG Systems' employees Larry Jacobs and Emeric Rochford installed measurement equipment on an existing light tower at the MIT athletic fields to begin

collecting wind resource data. This will be followed by deployment of a WINDCUBE™ lidar remote sensor, a laser-based sensor that provides 200-meter vertical wind profiles, and a 34-meter meteorological tower. Installations will support student research in the fields of wind measurement and renewable energy. "We're thrilled to be partnering with the MIT Wind Group on this initiative," says Jacobs, NRG Systems' marketing manager. "Not only does it deepen scientific understanding of lidar, it also supports ongoing innovation and technological advancement in the field of wind resource assessment."

NRG Systems is an independently owned company that has served the global wind energy industry for 27 years. Its wind measurement systems and turbine control sensors can be found on every continent in more than 130 countries. The Wind Group of the MIT Energy Club was founded in the summer of 2008 with the mission of bringing together people within MIT and the broader community who are interested in all aspects of wind energy. For more information go to www.nrgsystems.com or www.mit.edu.

CARBONE OF AMERICA INTRODUCES RE-ENGINEERED BRUSH HOLDER

Carbone of America, a leader in power and signal transfer solutions, has redesigned the phase and ground brush holders for Hitachi generators installed in the GE fleet of 1.5 MW wind turbines. The new brush rigging assembly is a totally reengineered system, designed to reduce wear, maintenance and downtime in the long term. The brush holders are plug-and-play, so that uptower installation is fast, simple, and requires no modifications to the generator. The mass produced holders, die-cast from bronze alloy, are sturdy and built to withstand rigorous field use and turbine maintenance without sustaining damage. The radial-mounted brush holders were engineered to eradicate the previous reaction and trailing configuration and improve load sharing and equal wear rates between brushes. The brush dimensions were changed to provide equal surface area for the same energy transmission. The ratios of brush coverage to slip-ring diameter, width, and helical groove, have been optimized for peak performance.

The constant-force style brush pressure systems—200g/cm2 applied to the well-known carbon brush grade CG626—provide extremely low wear rates and minimal ring wear over long-term operation. They exert consistent force to keep all brushes in constant contact with the high-speed rotating slip rings for the best possible distribution of current between the four-phase (power) brushes. Upgraded brush terminals carry continuous high loadings; bolted connections ensure continuous, even current distribution between brushes in a phase group. Carbone of America's brush rigging also incorporates a reliable indication system to alert when brushes become worn. The micro switch system, already widely used in the field, has proven to be dependable. For more information contact Roy Douglas, technical manager, at (973) 299-4518 or roy.douglas@carbonelorraine.com. Visit online at www.carbonebrush.com.

SCHMIDT 5D COUPLINGS FROM ZERO-MAX

New Schmidt 5D couplings from Zero-Max are the ideal choice for applications requiring large axial, angular, and parallel shaft misalignments. This "all in one" coupling design will handle all shaft displacements, providing low backlash for precision high torque applications such as roll forming and similar heavy duty fabricating equipment.

Designed to fill an important need in the Zero-Max family of torque-rigid couplings, 5D couplings allow for easy adjustment to any possible misaligned shaft position without imposing heavy side loads on shafts, bearings, or other machine equipment. The coupling can accommodate up to 5 degrees of angular misalignment and as high as 1.5" parallel misalignment while maintaining undisturbed power transmission at constant angular velocity. Acting forces within the coupling can be precisely calculated, assuring reliable, trouble-free system operation; especially important in heavy-duty applications. This unique design will tolerate high shock and reversing loads with minimal or no maintenance required.

Additional features include space-saving design and easy installation—couplings can be mounted to shaft hubs or directly to existing machine flanges (no need to reposition either shaft being coupled)—and they are available in standard and inverted hub configurations in bore sizes from 1.500 inch to 6.375 inches or 38mm to 160mm. Custom designs can take this coupling design beyond the catalog specifications. The 10 different model sizes handle speeds up to 1000 RPM and torque from 2800 to 500,000 in-lbs. Special design modifications are available.

"The 5D coupling has very robust design features for use in applications such as roll drive systems used in converting machinery," says Robert Mainz, sales manager. "The unique and highly flexible design allows for a wide range of movement to improve the quality of the end product. They do a very good job of handling shaft misalignments and

protecting drive train components in these high performance systems."

To learn more call (800) 533-1731, e-mail zero-max@zero-max.com, or go online to www.zero-max.com.

NEW GLEASON TITAN GRINDING MACHINES FOR LARGER CYLINDRICAL GEARS

Gleason has introduced a new line of Titan® grinding machines designed to reduce finish grinding times by as much as 50 percent on cylindrical gears up to 1,500 mm in diameter. Titan machines are unique in their ability to offer users, on a single platform, both pure profile grinding for the greatest flexibility when producing single parts, and threaded wheel grinding and profile grinding working together for much faster fully-automated large-scale production. This new process, called Power Grind, enables users to reduce grinding production times by as much as 50 percent, by first using threaded wheel grinding to "rough" gears much faster and then profile grinding to achieve optimal gear quality, surface finish and complex gear modifications in the finishing operation.

The Power Grind process can optionally include an external setup table to allow the workpiece and workholding package to be set up in parallel with primary production, rather than sequentially. Workpieces then can be loaded automatically through use of an optional workpiece changer. These features, plus an innovative new high-speed tool changer that automates the exchange of threaded wheel for profile grinding wheel, greatly reduce non-productive time.

Titan 1200G and 1500G machines—for workpiece diameters of 1200 mm and 1500 mm respectively—are also equipped with a patent pending universal dresser. This enables the user to dress both threaded grinding wheels and profile grinding wheels right on the machine using a single dressing tool, thus eliminating the changeover time and expense of multiple dressing tools. These machines also greatly reduce the time required for the production of individual parts through pure profile grinding. A unique, patented dual-flank twist-free grinding option is available that can create highly desirable asymmetrical tooth trace modifications in half the time normally required when conventional single flank grinding is used. The machines come equipped with the latest Siemens 840D CNC and Gleason Windows-based Intelligent Dialogue software to greatly simplify setup and operation. For example, a grinding technology database recommends and optimizes the production methodology for the Power Grind process before machining starts, enabling even less experienced operators to produce high quality parts more productively.

Titan machines are just the latest in a complete line of Gleason gear grinding machines that include profile grinders for workpiece diameters up to 6 meters. For more information visit www.gleason.com.

SECOND WIND EARNS THIRD YEAR RANKING ON THE 2009 INC. 5000

For the third consecutive year, Second Wind has made the Inc. 5000 list of fastest-growing private companies in the United States. "Second Wind is dedicated to making wind energy profitable through the use of innovative technology," COO Larry Letteney says. "Our third year on this prestigious list speaks to the hard work of our dedicated employees and the continued growth of the renewable energy sector."

Letteney credited the growing acceptance of Second Wind's newest product, the Triton sonic wind profiler, as adding significantly to the company's overall growth. The Triton is designed to give wind farm developers more accurate information about siting wind farms and turbines, thus streamlining wind

farm development and increasing financial certainty. The Triton assesses wind speed and direction by sending sound pulses into the sky and measuring the returning echoes. Triton sales are increasing each quarter, with over 80 units currently operating in the field including sites in the United States, Canada, Europe, and Australia.

"With this accomplishment, Second Wind, Inc., joins the rarified company of enterprises that have appeared on the list multiple times," says Inc. 5000 Editor Jane Berentson. "Since debuting in 1991, the list has served as evidence of the significant accomplishments of entrepreneurial companies."

Founded in 1980, Second Wind advances the use of wind data to make wind energy more profitable for owners, painless for operators, and practical for consumers. More information is available at www.secondwind.com.

DR. SHRINK LAUNCHES NEW WEB SITE

Featuring more helpful tips and installation advice than before, Dr. Shrink's new Web site is a single source for all necessary shrink-wrap knowledge, allowing visitors to browse the company's complete line of shrink wrap and accessories.

Serving seasoned business owners to novice do-it-yourselfers, a convenient "How-To/Training" tab offers free, step-by-step directions on how to shrink wrap a wide variety of objects. A helpful chart enables users to find the right size shrink wrap for their asset. Visitors can sign up for the company's e-newsletter to learn more details about upcoming shows, new products, tips, and other special offers. The site offers a full-color photo gallery, providing ideas on all the different types of objects that can be shrink wrapped.

Based in Manistee, Michigan, Dr. Shrink is an international premium shrink-wrap supplier. With a reputation for great customer service, the company provides prompt service, competitive pricing, and experienced application advice. Call (800) 968-5147, e-mail drshrink@dr-shrink.com, or go to www.dr-shrink.com.

RBC BEARINGS RECEIVES GL LETTER OF CONFORMANCE

RBC Bearings is pleased to announce that it has received a letter of conformance from Germanischer Lloyd (GL) for pitch and yaw bearings for the ACCIONA Windpower wind turbine generator. ACCIONA Windpower North America is owned by the ACCIONA group, a Spain-based global leader in the renewable energies field. The company has installed 252 wind farms in 14 countries and manufactures wind turbine generators with proprietary technology.

The GL type certification was issued to RBC Bearings in April, 2009, for RBC slewing ring bearings being built for 1.5 MW ACCIONA wind turbines. The bearings are being manufactured in RBC's new custom-built 80,000 square-foot facility in Houston, which became operational in late summer of 2009. This is another important milestone for RBC in the company's initiative to supply pitch and yaw bearings to the wind turbine generator industry.

"We are pleased with the progress our team is making to serve this industry. Our state-of-the-art manufacturing facility is now ready. Our advanced engineering team, equipped with the most up-to-date analytical design tools, now provides custom-engineered solutions to some of the largest producers of wind turbine generators in the world," says Dr. Michael J. Hartnett, RBC president and CEO. "This certification is another significant step for RBC Bearings. We are at the beginning of what I am sure will be a very successful new business segment for us as we provide critical components necessary to the growth of the U.S. wind turbine generator industry."

RBC Bearings is a leading manufacturer of precision bearings for industrial, aerospace,

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Hüseyin Kizilagac
BDP Project Logistics

How do you keep wind power logistics costs from blowing you away? Overcoming the hurdles of moving wind turbines from factory to project site will help.

ALTHOUGH WIND POWER is the fastest-growing energy source, in many instances the skills required to move components to the project site have not kept pace. Wind power components are not your typical shipments, after all. If you are responsible for the construction of a wind farm, you want delivery of all components to be made on time and on budget, as well as eliminating downtime due to equipment shortages. And as the manufacturer you want your product to arrive quickly, intact, and fully functional, with the shortest effective hold times on inventory in order to improve your cash flow.

Transportation now accounts for at least 25 percent of the wind power supply chain. At the same time logistics is becoming more challenging as the size of the equipment grows, especially the blades, thereby increasing project expenses. Then there are supply chain constraints caused by general equipment availability and transport capacity, especially in the United States. In 2010 equipment shortage is expected to be one of the most critical challenges for the wind power industry. There will not be sufficient equipment dedicated to wind power to erect all the planned windmills—and not only in the United States, but worldwide.

Project moves vary both in terms of complexity as well as the challenges they present. The last leg, resulting in delivery to the job site, is often the most critical. When shipments enter congested ports they are exposed to double handling, poorly coordinated transportation to the job site, and infrastructure issues such as roads that are not completed, or even paved. This means that every step, from the manufacturing point to final delivery, can be a major logistical issue. That also means that the challenges facing logistics managers can be daunting. So what do you do?

Wind farm developers have had three options when sourcing the movement and erection of their wind farm equipment: work with the manufacturer, which may charge more for the move; outsource to an EPC contractor that generally sources from different places; or go to a number of resources and handle it piecemeal. When BDP Project Logistics analyzed the wind power market, we often observed a lack of coordination within the supply chain, especially concerning transportation. Frequently, there was not a single point for coordination or monitoring.

Looking at the wide range of specialized services required to move components and equipment, and the rising costs of project logistics, a practical option for many developers is to work with an outside, non-manufacturer resource. The benefits of working with a project logistics management company can be many. They include having a resource that can get the equipment you need when you need it; minimize shipping and inventory costs; and monitor performance to ensure that project milestones, budget, construction quality, and specific performance parameters are met. Ideally this company provides consultation, coordination, project and cost planning, and end-to-end accountability—one that focuses on solutions, in other words.

This resource should handle all interfaces involved in moving an entire wind farm from production plant to jobsite within a fixed schedule, managing the sea, air, and inland stages, avoiding detentions and double handling at ports and, if necessary, moving the shipments to an intermediate storage location. An independent, non asset-based resource is not interested in drawing out the process or providing equipment that is not needed, and the more global the project logistics company, the wider the capabilities and sourcing options. In-country staff or partners can neutralize local language barriers, take the guesswork out of meeting customs and other governmental regulations, and also cut any red tape that may be encountered. As some projects are in remote areas, unique technical skills are often required. In addition, the latest technology is required on some projects, as well as equipment that is tailor-made for a particular project.

While still somewhat unique, a limited number of project management companies have civil engineering experience. Such a resource can offer road surveys and consult on infrastructure issues, providing preliminary road infrastructure and building bridges, roads, and foundations if necessary. As the wind industry continues to expand, logistics professionals are evolving to match that growth.

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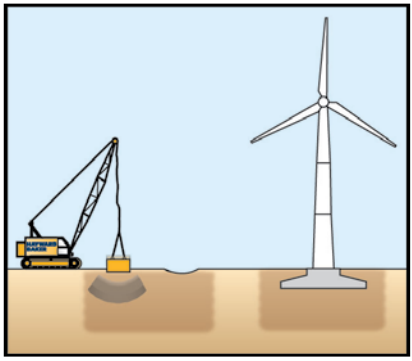
James D. Hussin
Hayward Baker, Inc.

Densification of loose material prior to tower construction is often required at wind-farm sites. One method, dynamic compaction, is discussed in this installment.

PLANNED SITES FOR WIND TURBINE towers are sometimes underlain by loose, granular soils such as sands, gravels, or mine spoils, which can produce static, dynamic, and seismic foundation challenges. These challenges include excessive settlement, low bearing capacity, and liquefaction or lateral spreading. Densification of loose, granular material prior to tower construction is often the most cost-effective solution to address these issues. Densification methods include vibro-densification, vibro-displacement, compaction grouting, and dynamic compaction, described in this installment.

Dynamic compaction (DC)—also referred to as dynamic deep compaction and impact densification—is likely the oldest soil improvement process, with documented examples of DC used during Roman times. Thousands of sites have been treated with DC worldwide, including wind farms. The process consists of repeatedly dropping a heavy weight on the ground surface to impart stress waves to compact soils at depth. Typically, a standard crane is used to drop 5- to 30-ton weights from heights of 20 to 100 feet. Weights typically consist of hardened steel plated or box-steel and concrete. The impact points are distributed on 5- to 20-foot centers in a regular pattern determined by the subsurface conditions and the foundation loading and geometry beneath the foundation footprint and a perimeter area. Depending on the subsurface conditions and energy imparted to the soil, densification can be achieved to depths of 30 feet or more. Although the process appears simple, experience is required to understand the capabilities, limitations, and risk factors associated with the DC technique.



The soils that are most improved by DC are those with high permeability and low plasticity, including sand, gravel, some non-plastic silt, and granular mine spoil. The technique is also effective at densifying collapsible soils, which are soils found in the western U.S. that undergo large volume reductions when they become wet. Clayey soil, which deforms slowly with loading, is not a good candidate. In addition, thin clay layers within a granular profile can absorb the DC energy, preventing the energy transfer to underlying loose soils. A thorough geotechnical investigation is critical in determining the design parameters.

The depth of densification depends on the soil type and the energy applied. Repeated drops only increase the degree of densification within the treatment zone, not the depth of influence. To increase the treatment depth, the energy level must be increased by increasing the drop weight and/or drop height.

Dynamic compaction densifies loose deposits of windblown sand at a planned wind power farm. Prior to selecting DC for ground improvement, existing nearby structures must be evaluated for vibration sensitivity. The ground vibrations associated with this technique can result in foundation settlement, slope instability, and adverse affects on vibration sensitive equipment and structures. For this reason DC is generally restricted to remote sites, a common feature of wind farm sites. As with every ground improvement project, a quality control program is essential to confirm that the required improvement has been achieved. During the DC process the height, location, and number of drops are recorded, and crater depth, adjacent ground surface heave, and pore pressure are observed. After DC the degree of densification can be measured with standard penetration testing (SPT), cone penetration testing (CPT), pressuremeter testing (PMT), dilatometer testing (DMT), or other in-situ testing methods. The densification is permanent and the foundation design on DC improved soil is the same as if the soil were naturally dense.

Determining the required weight, drop height, impact grid dimension, and number of passes is often the responsibility of specialty contractors, who rely on years of experience to determine the most efficient configuration. In addition, there are many safety issues associated with this technique, which are also addressed by the use of an experienced specialty contractor.

The large number of DC projects completed has resulted in its capabilities and limitations being well defined. A mat foundation bearing on soil densified by a properly designed and performed DC program is an efficient and economical alternative to full soil replacement or deep foundation systems.

James D. Hussin is a director with Hayward Baker, Inc., the leading specialty foundation and ground improvement contractor. He can be reached at jdhussin@haywardbaker.com. Go online to www.haywardbaker.com.

SITE IMPROVEMENT FOR NEW FOUNDATIONS AND FOUNDATION REHABILITATION

Photos, *top to bottom*:
Biglow Canyon Wind Farm, *Oregon*
Hayward Baker performed Dynamic Compaction for seismic and liquefaction mitigation for new wind turbine pad footings.

Wind Farm, *Wyoming*
Hayward Baker performed Dynamic Compaction for ground improvement and installed Driven Piles *(shown)* and Micropiles for construction of new foundations.

Trent Mesa, *West Texas*
Micropiles, installed in rock and designed for high cycle fatigue loading, stabilized 30 existing wind tower foundations.

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Kevin S. George
SKF USA, Inc.

The best way to avoid turbine downtime is to follow quality maintenance procedures throughout its performance life. SKF shares the following pointers.

WITH THE GROWTH OF WIND FARMS, users are turning to condition monitoring and automatic lubrication systems for increased reliability. The following questions, and answers, may provide helpful insights:

What are some of the fundamental challenges associated with wind turbine maintenance? Given the operating conditions a wind turbine experiences throughout a 20-year service life, maintenance problems are not a question of "if," but "when." Nevertheless, for many wind farms the number of maintenance technicians trying to delay the inevitable is limited and their deployment for service may be sporadic. When maintenance problems ultimately occur, farms face the downside of exorbitant crane mobilization costs, lost energy production, escalating costs per kilowatt-hour, and limited supplies of spare parts due to intense industry demand for components.

What types of proactive maintenance activities can be applied to wind turbines for improved reliability? An integrated online condition monitoring system can serve as an effective tool for managing day-to-day maintenance routines for a wind turbine and consolidating risky, costly maintenance activities. By tracking component performance with condition monitoring technology, maintenance activities can be coordinated across the wind farm, service calls can be better planned and combined, and operators can take advantage of planned shutdowns to service several turbines at the same time, since machinery conditions are known from the monitoring.

What types of operating faults can be detected with condition monitoring? By regularly measuring physical parameters and their variances, a variety of operating conditions can be targeted for early detection, diagnosis, and remedial action. When implemented properly, condition monitoring can forecast trouble inside or outside the nacelle, including unbalanced turbine blades, misalignment, shaft deflections, mechanical looseness, foundation weakness, gear damage, blade or tower vibrations, inadequate lubrication, and others.

In general, how does a wind turbine condition monitoring system work? A system specially developed and dedicated for wind turbines allows for continuous monitoring of key turbine components by regularly measuring physical parameters such as vibration, temperature and lubrication particles. Mounted sensors and enabling software pinpoint the problems. Systems have become quite sophisticated and some can handle any number of turbines and multiple data points for analysis. They can provide a maintenance-forecasting service by continuously recalculating fault frequencies and delivering accurate values based on reliable trends. This ability can facilitate the assigning of alarms at various speeds and loads, including low main shaft speeds, and form the basis for trend-based root cause failure analysis. Wireless capabilities expand system potential by offering the capability to review data from any location with a computer or handheld device with Internet access. This can shorten lead-time from alarm to solution. One system installed in hundreds of wind farms worldwide can fit every turbine's nacelle and includes an intelligent monitoring unit featuring 16 different channels that connects multiple measurement points. The typical wind turbine configuration incorporates the main bearing (one channel), gearbox (four channels), generator (two channels) and tachometer (one channel). In addition, other monitoring points may be added, including tower/structure vibration, blade vibration, oil temperature, oil pressure, oil quality and generator temperature.

What other technologies can help wind farms improve turbine reliability and reduce maintenance costs? Centralized automatic grease lubrication systems can aid sustained reliability. Systems engineered for bearings, pitch and yaw gears, and other locations in a wind turbine can efficiently and precisely deliver exact, clean quantities of the appropriate lubricant. The associated maintenance benefits from timely and effective lubrication include reduced wear, minimized lubricant consumption, maximized efficiency and less unscheduled downtime. The automatic delivery of lubrication can be credited with lifting a heavy burden from the shoulders of the maintenance staff.

Kevin S. George is national account manager-wind energy business at SKF USA Inc., Call (770) 591-8747, or go to www.skf.com. Courtesy of *Pumps & Systems* magazine.

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Kathleen O'Dell
National Renewable Energy Laboratory

NREL's National Wind Technology Center is working with industry partners to create the next generation of wind energy systems.

THE TWO LARGEST WIND TURBINES ever erected at the National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC) towered into the sky this fall. A 1.5-MW turbine manufactured by General Electric was dedicated for research in November, and a 2.3-MW turbine manufactured by Siemens Power Generation was dedicated for research in October.

The U.S. Department of Energy (DOE) purchased the GE 1.5SLE turbine (referred to as the DOE 1.5) for long-term wind energy research and development activities. The DOE 1.5 allows NWTC and industry partners to conduct research to improve performance and reliability. The turbine, which is 119-m tall and has a 77-m rotor diameter, will be extensively instrumented to collect detailed data that will help researchers study the microclimate in which the turbine operates, the aerodynamics of its design, the effects of turbulence on its loads and performance, and how the combination of these factors may affect wind plant performance. The turbine will also be used to educate budding wind engineers and researchers from universities, laboratories, and companies nationwide.

The Siemens 2.3-MW turbine is part of a cooperative research and development agreement (CRADA) with Siemens Power Generation to conduct research and testing. At 131-m tall with a rotor diameter of 101-m, this turbine is among the largest land-based turbines deployed in the United States. Critical tests include structural, performance, modal, acoustics, power quality, and aerodynamics.

In addition to conducting research on the turbines, NREL is working with wind project developer RES Americas under a CRADA to study the non-turbine components of wind energy systems. Work to be conducted during the next three years includes study of the design and performance of turbine foundations and thermal performance of underground electrical cables to increase their reliability and reduce installation and maintenance costs. Because the turbines are so large, their custom-designed foundations contain between 400 and 800 tons of steel rebar and concrete. Data collected on the foundations of these turbines will result in some of the first-ever measurements of structural loads inside and under an operating wind turbine. In addition to its research on foundation and cables, RES will also install multiple brands of sensors, data loggers, and wireless communication systems at the NWTC for a "side-by-side" comparison of their performance.

Beyond these results, the commissioned turbines will generate clean electricity to meet the laboratory's aggressive sustainability goals, including the reduction of greenhouse gas emissions, for its expanding research campus and support facilities. The new turbines are expected to generate twice as much energy as the NWTC consumes. Work toward an agreement to allow the export of surplus power to the local utility grid is underway.

NREL's wind center, nestled at the base of the Rocky Mountains, is located just south of Boulder, Colorado. It is DOE's premier wind energy research and development facility. At the NWTC, NREL researchers work side by side with industry partners to create the next generation of wind energy systems.

Turbine Specifications

DOE 1.5-MW Turbine

Model	GE 1.5SLE
Production (NWTC site)	1,600 MWh/y
Production (typical site)	4,600 MWh/y
Homes Powered (typical site)	410
Tower Height	80 m/262.5 ft
Rotor Diameter	77 m/252.6 ft
Swept Area	4.6k m2/50.1k ft2
Total Height	119 m/388.8 ft
Met Tower Height	134.1 m/440 ft

Siemens 2.3-MW Turbine

Model	Siemens 2.3-101
Production (NWTC site)	2,800 MWh/y
Production (typical site)	7,050 MWh/y
Homes Powered (typical site)	630
Tower Height	80 m/262.5 ft
Rotor Diameter	101 m/331.4 ft
Swept Area	8k m2/86.2 ft2
Total Height	131 m/428.1 ft
Met Tower Height	134.1 m/440 ft

Kathleen O'Dell is a communications specialist with NREL. Call (303) 384-6957, e-mail kathleen.odell@nrel.gov, or go to www.nrel.gov.

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DMI INDUSTRIES, INC.

By Russ Willcutt

With customers including the world's major turbine OEMs, this company has built a reputation as a premium tower manufacturer.

IT HAS BEEN SAID THAT WHEN ONE DOOR CLOSES, another one opens. For DMI Industries that door opened wide in 1999, when it was seeking to grow beyond its agricultural roots into new markets. "We had an opportunity to quote on fabricating and welding some large steel frames that were about the size of an automobile," according to Belinda Forknell, who is in charge of marketing and public relations for the company. "We later discovered that these objects were the bed frames that are mounted on top of utility-scale wind towers. While we didn't land the order, that experience set us on the path toward manufacturing towers for the wind industry, and I guess you could say that the rest is history."

Founded as the Dakota Machine Tool Company in 1978, focusing on machine tools and reconditioned equipment for resale, it shifted to custom manufacturing in 1986, the next year beginning to produce sugar-beet pilers and then sugar diffusers. Although it had capitalized on the sugar-beet boom of the late eighties and nineties, once that market began to shrink it started searching for a new direction, resulting in its serendipitous entry into the wind-energy market. Over the past decade DMI has worked hard to earn its reputation as one of the most trusted wind-tower manufacturers in North America. "We have fabricated towers for nearly every major wind turbine OEM in the world, in fact," Forknell says. "And that's a lot of towers."

They are constructed at three DMI facilities—West Fargo, North Dakota; Tulsa, Oklahoma; and Fort Erie, Ontario—representing 770,000 square feet of manufacturing space and employing approximately 500 individuals in total. Strategically located, these facilities are found within 500 miles of 75 percent of the nation's wind farms, and the company's acquisition by the Otter Tail Corporation in 1990 bolstered its entry into the wind-energy market at a time when it was building momentum throughout the United States and Canada.

As part of its due diligence company officials asked pertinent questions such as who are the potential customers, and where are they currently obtaining their towers? With most being built in Texas and the Southeastern U.S., they quickly realized that their location was much closer to where most farms were actually being built. Its experience in manufacturing large metal parts was also an asset, and after meeting with an OEM that required 14 towers for a project in Wisconsin on a tight schedule, DMI landed its first wind-tower order.

Since that time the company has continued researching the wind industry, staying abreast of developing requirements, technologies, and opportunities to help its customers reach their professional goals. "We are constantly working to gain insights and develop new processes that make it possible for us to deliver towers of the highest quality to our clients," Forknell says, "and our annual production capacity currently supports about 3,000MW of wind-derived energy being delivered into the power grid."

In securing its reputation as an industry leader, the company utilizes its manufacturing team in developing exclusive DMI-engineered technologies while following a rigorous system of quality controls to manufacture high-tech towers equal to the incredibly demanding specifications required by the wind industry. DMI relies on the highest-quality, cleanest steel plate for secure and dependable welds, form-fit flanges for the highest performance in the field, advanced coatings to withstand the toughest environments while providing smooth contours, and rigorous checks and balances to ensure that the highest standards are being met by all of its material suppliers. In addition, it provides logistical support so that deliveries are made on schedule, thereby contributing to a project's overall efficiency and cost effectiveness.

Just as its home within the Otter Tail Corporation family has strengthened its activities in the wind industry, DMI provides reciprocal benefits to its parent company as well, sharing valuable insights with its sister entity—the Otter Tail Power Company—that will help it realize its goal of acquiring 18 percent of its total energy portfolio from wind in 2010. As is the case with any successful manufacturer, however, its focus remains on its customers.

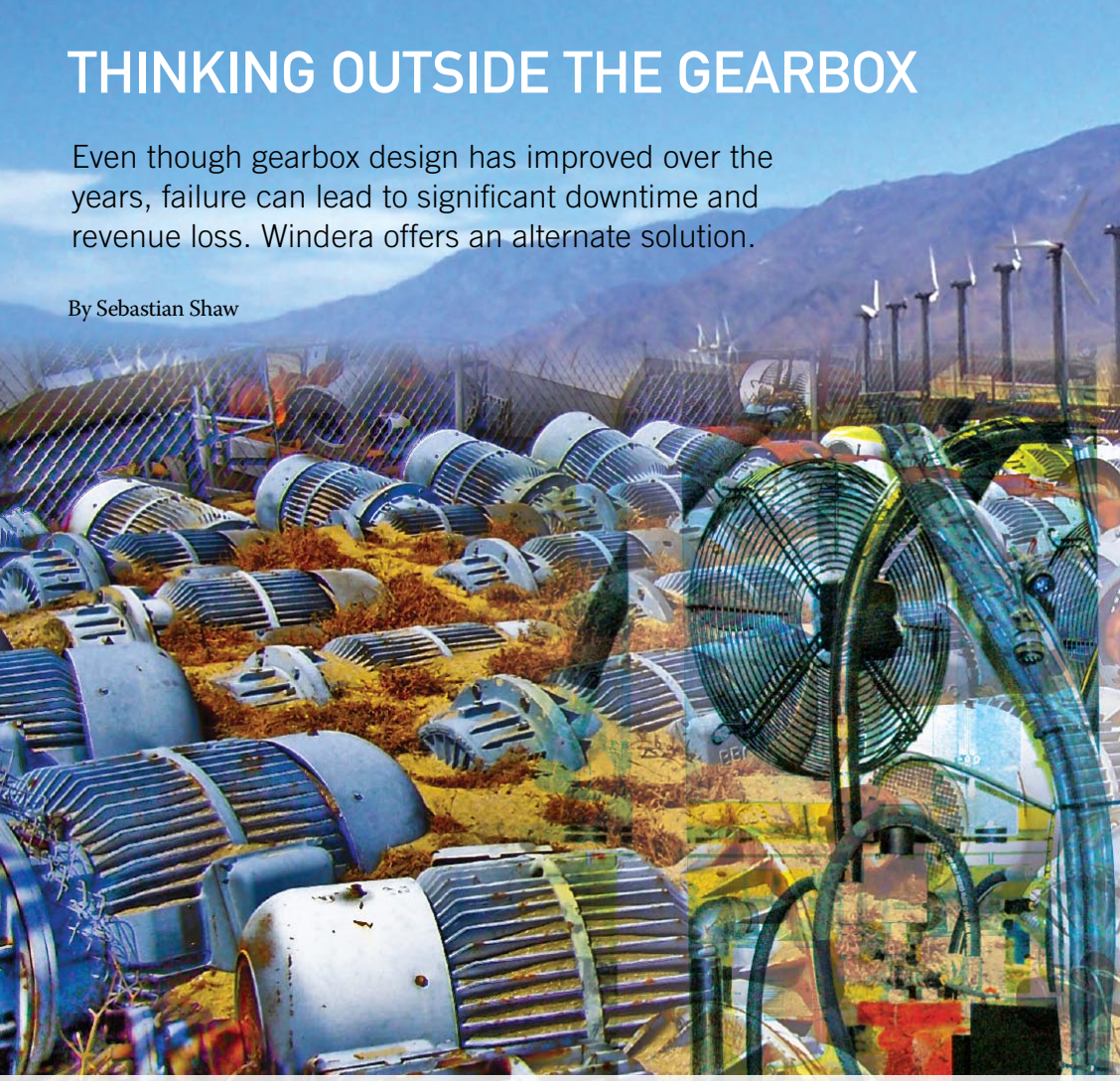
"Our goal is to help them lower manufacturing costs, to provide them with stronger, more-reliable towers, and to eliminate extra work during assembly at the project site. We believe that by manufacturing and delivering quality towers that hold up over time and in demanding environments, we're actually decreasing the long-term costs of wind-farm ownership," Forknell says. "And that's something that we take very seriously."

Call (800) 669-0988 or go to www.dmiindustries.com.

THINKING OUTSIDE THE GEARBOX

Even though gearbox design has improved over the years, failure can lead to significant downtime and revenue loss. Windera offers an alternate solution.

By Sebastian Shaw



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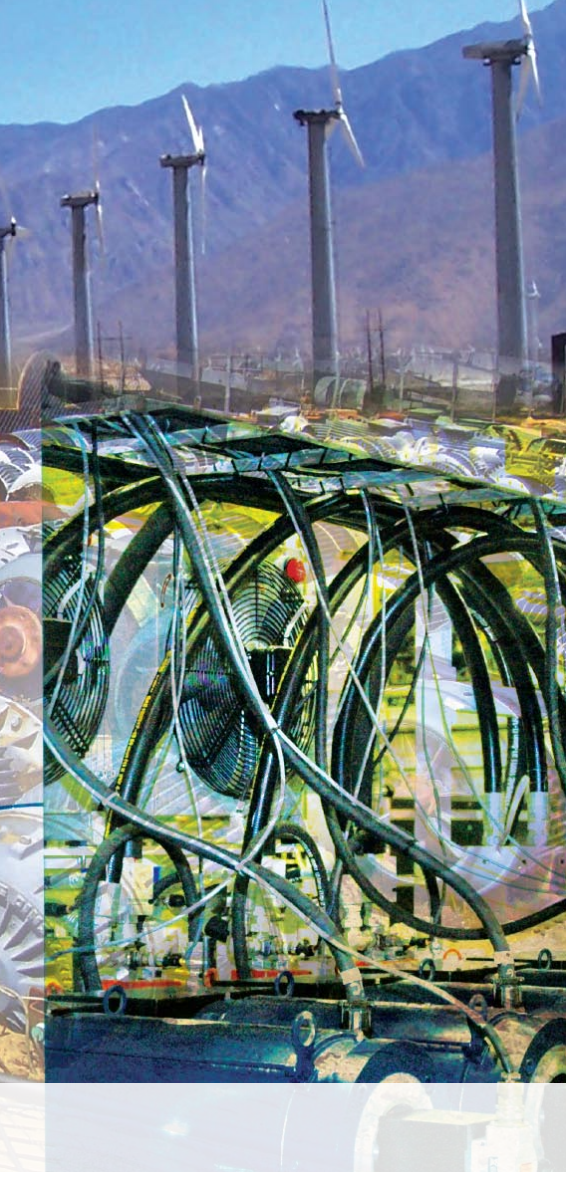
THE WIND INDUSTRY IS CURRENTLY MOVING at an incredible pace, despite restrictions mainly having to do with legislative issues. As with anything else, however, that rate of growth will ultimately be governed by technology. Those present at WINDPOWER 2009 in Chicago, hosted by the American Wind Energy Association, saw an incredible show featuring juggernauts such as GE all the way to individuals with new inventions or innovative ideas. Those with problems, and others with solutions, were in the same building, and therefore able to discuss their shared concerns. Among those attending for the first time was Windera Power Systems, Inc., which has developed innovative technologies of interest to the wind industry.

If you travel to Palm Springs, California, and take a drive through the Coachella Valley, you will notice thousands of wind turbines. Something else you may notice is that many of them are not operational. This is because the turbines are broken down, and the brakes are on in order to keep the blades from spinning out of control. If you were to ask the wind farm owners what the problem is, the answer would most likely involve gearboxes. That's the reason they have extracted problematic gearboxes and set them on the ground in what resembles an automotive graveyard (see fig. 1).

In fact, this is a problem with wind turbines worldwide. When we ponder wind turbines, we think of cutting-edge technology or future en-



ergy. Amazingly, what's holding this technology back is a component based on technology that's hundreds of years old: the mechanical gearbox. In other words, the technology of today that is responsible for powering tomorrow is being thwarted by a mechanism that was used by Leonardo Da Vinci. While current gearbox technology is much more sophisticated than those used in Da Vinci's first machines in the 1400s, of course, it relies on the same fundamental principles of mechanics. Even more astounding is the fact that the problems that he encountered are the same ones we're dealing with in the wind turbines being built today. There is simply no getting around the fact that a mechanical gearbox creates friction and, as a consequence, heat. In short, it wears down until it eventually fails. The more moving parts to a machine, the more problems one will encounter. These principles, while straightforward, are still the primary culprit that impedes the advancement of wind turbine technology.

Let's get back to all those turbines standing erect and motionless, not generating any power, and simply wasting away. While wind farm owners can opt to repair the gearboxes and get those turbines up and running for another five or so years, it doesn't make financial sense. They will have to continue this process, and they will lose money in the long run. That's where Windera comes in.

Richard Burt, the company's CEO, developed the technology to solve these problems while working in the solar industry. He saw these turbines in question and discovered the California re-power market. With so many turbines being repaired or overhauled, and countless others wasting away, there is immense potential in implementing this technology to get the wind farm owners back to producing power, and even more efficiently than before. After much work, Burt developed a drivetrain that makes sense for many reasons, one being that there is no gearbox. With this drivetrain design he developed Windera Power Systems, and he continues working to change the wind-energy landscape.

The Windera technology is based on a dynamically controlled, air-cooled, direct-drive, variable-speed hydraulic drive train. This enables the system to deliver ultra-stable AC frequency, voltage, and conditioned power at high efficiencies over a wide range of wind and grid conditions without the use of complex and expensive power inverters. The turbine's rotor is connected directly to the hydraulic pump in a "direct drive" configuration, which eliminates the need for a gearbox (see fig. 2).

The design also features a remote monitoring system. Throughout the entire assembly there are various controls and detection devices that monitor temperatures, pressures, and speeds. This information is processed by a CPU and can be remotely sent to headquarters. Windera can monitor this information and contact the owner with any issues that may come up. This means that developing problems are detected immediately, with preventative maintenance information sent to the owner long before costly damage can occur. Another important feature of this particular system is that the unit can be installed down-tower in an enclosure (see fig. 3).

In other words, Windera can actually link the blades and rotor shaft to the hydraulic pump and, using hydraulic lines running through the

Fig. 1: Two views of a "gearbox graveyard" in California.

tower, link the system with the generator and controls systems on the ground. It's easy to imagine the cost and time savings this system generates with no more elevators, cranes, or technicians scaling towers to service a single turbine.

The number of kilowatt-hours a wind turbine generates is primarily determined by the average daily wind speed of where the wind turbine is located. An interesting fact about wind energy is that, for up to a third of the year, turbines produce very little usable electricity because the wind speed is near or below their start-up, or "cut-in" speeds, and considerably lower than the rated speed

Fig. 3: A modular unit.

at which they operate most efficiently. As an example, many of the older classes of wind turbines don't start producing usable electricity until wind speeds reach 10 mph. In many areas wind speeds remain below this level for as much as a third of the year, which means these turbines will only produce usable electricity for two thirds of that time period. In contrast, the Windera system will begin producing usable electricity as soon as the wind is capable of rotating the wind turbine blades, which is approximately three mph. Windera's advanced design enables power generation at a greater range of wind speeds as compared to conventional wind turbine generators, and as a result can increase power production and wind farm revenues by up to 25 percent or more.

From the first day a turbine is operational there is stress on the assembly from wind. The stress put on the gearbox, driveshaft, and bearings has an obvious negative impact on the lifespan of the turbine. This stress is magnified when the turbine is not operating under "optimum conditions." Gearboxes are constantly under duress due to their mechanical nature and the fact that they are not variable-speed. As wind speeds change, stress is put on the gearboxes in the form of friction. As any mechanic knows, friction is the primary nemesis of mechanical machines, from car engines to wind turbines. The stress can also overload the generator and destroy the turbine over time. This is why most turbines last for about five years and usually have a one- or two-year warranty. However, with the Windera drivetrain, all of the excess forces generated by the turbine are converted into heat, although not through mechanical friction. The heat, which is in the hydraulic oil, is cooled with heat exchangers. This heat can be dissipated through the rear of the turbine via fans, or if someone has a use for the heat, it can be harnessed and re-used. Such is the case when the heat is utilized in refractive chillers to heat a building, or in any number of other applications. The fact that the excess heat can be dissipated allows for the amount of power going to the generators to be precisely controlled. This is conducive to the length of the life of the generator and to precise power output control, which not only enables the smooth startup of power delivery to the external electric system, but also allows the control system to prevent spurious power delivery in the case of shutdown due to blade failure, for example. Finally, the system allows

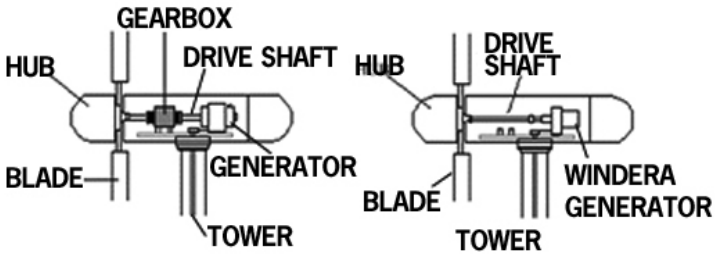


Fig. 2: "Conventional" vs. "Direct Drive" wind turbine drive train application.

for field upgrade opportunities. A machine may be built with the capability of producing more power, but limited to meet certain regulations (e.g. limits on net metering). If those regulations change to allow more power, the software can enable more output power. The drivetrain can be retrofitted into existing turbines such as those found in California, or it can be utilized in new ones. A wind farm owner can now have a turbine that's more efficient, has lower maintenance costs, and provides a lifespan of 15 to 20 years.

While there are a number of direct-drive designs in the industry, Windera strives to offer the most efficient and logical choice. The company is in the business of eliminating technological barriers that impede progress in the wind energy industry, and to push the boundaries of efficiency and innovation in creating clean energy. Since less than one percent of the electricity consumed in the United States is currently produced by wind, there is a tremendous opportunity for growth, which will require constant innovation. For every challenge that arises in the field of renewable energy, Windera will continue seeking solutions that make both financial and technological sense.

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TORQUE CERTIFICATION MARKS MAINTENANCE ADVANCES

As the U.S. wind industry gains momentum, torque training is shifting from the jobsite to the classroom, thanks to an innovative program developed by Snap-on Industrial.

By Frederick Brookhouse and Dave Dalpaos

Frederick Brookhouse is business development manager, education, and Dave Dalpaos is industrial/international product manager for Snap-on Industrial. For more information contact Dale Alberts at (262) 656-6559 or dale.l.alberts@snapon.com. Visit online at www.snapon.com.

WHEN PEOPLE THINK ABOUT WINDPOWER generation, the first thought usually extends to the blade cutting through the breeze, the aerodynamic turbine capsule, or the 300-foot tower. Torque and its precise measure of fastener tension is the last thing on anyone's list. But when it comes to ensuring that those giant blades keep turning and the ubiquitous towers remain standing, torque really is the most important component in the mix.

And that's why Snap-on Industrial, in conjunction with education and industry partners, has spearheaded a torque certification training program as part of a technical school or junior college curriculum. As a result of conversations about training requirements with representatives from industry segments that range from auto repair to renewable energy, Snap-on Industrial representatives actively engaged wind-industry experts about specific skill requirements for the next generation of workers. And in many of those conversations, safety and torque were at the forefront of training issues marked as critical—whether that's preparing young workers new to the workforce, or retraining workers from industries hard hit by the economy for jobs in windpower maintenance.

Defining Torque

Torque is the twisting motion used to tighten or secure a fastener. The amount of force used in a particular task is measured in Newton meters or foot pounds. The Snap-on Industrial torque certification program explores both torque theory and proper

use and application of equipment. Testing for the certification focuses on equipment use.

The understanding and proper application of torque is a mission-critical element of a viable and sustainable windpower industry in the United States. Industry leaders know that strong training programs are necessary to meet the burgeoning demand for manpower. Government and industry estimates put the manpower requirement for professional windpower technicians at more than 180,000 by 2030, when windpower is expected to provide 20 percent of the United States' electric power (statistics from the U.S. Department of Energy study, 20% Wind Energy by 2030, May 2008). Currently, there are about 30,000 windpower technicians working in the U.S.

Fig. 1: Worker operating ratchet device.

The curriculum is straightforward and understood by all those who work in industrial settings or industries such as wind. It's a step-by-step program outlining what a bolt is, how threads impact the strength of the attachment, which materials work together, and which ones don't.

The examples are simple: When you take a grade-eight bolt and put a grade-five nut on it, you can no longer torque the bolt to the same torque levels as when you use a grade-eight nut. There is a difference in heat treatment, and a difference in strength between the fastener grades. Training explains the differences between various fasteners and shows participants how to determine fastener grades.

And there are different kinds of torque equipment, as well, including mechanical torque, electronic torque, and what's referenced as high torque; a pump that uses hydraulic fluid and air to accomplish the torque value required. For one-inch bolts and larger fasteners, that's 5,000 psi and up.

The aim of the training program is to ensure that the worker knows that when he's putting a flange together there's a sequence for the bolts, there's recognition about the type of bolt used, and there's a specific torque value for that bolt. These workers need to know the proper torque sequence and how to apply the same amount of pressure on each fastener so that a strong attachment of the flange is achieved. Using the correct procedure for flange attachment, the piece is torqued two or three times before it gets to maximum torque. It's not like a car, where the technician may torque a bolt on a wheel to maximum value only once. In an industrial setting or in the wind industry, tolerances are such that a given piece may require torquing up to five times for a single bolt. Workers need to know that if you don't follow this process, you could create a gap on one side of the flange or another that allows a leak or oxidation.

Torque certification is built around certifying that workers understand the technique of torque and the consequences of improper torque application. For example, they need to know when and when not to put oil on bolts or to use of a seizing material when working on a gasket. In applications that require a gasket, it may be necessary to pre-torque the bolt be-

Fig. 2: Snap-on tools complement jobsite operations.

fore a liquid additive is applied and final torque application is made.

Many times auto technicians diagnose component problems; they may have to remove the part and replace it. It's critical to apply manufacturers torque specifications to help ensure that the vehicle doesn't return with the same problem because of an incorrect torque value. Professionals in the windpower industry, and other industrial segments, learn on the job and may not have been taught properly from the start. It's the job of technical education professionals working with industry leaders to show them the right way to torque a fastener.

Taking Shape

Working with partner schools that already have training programs for automotive technicians, Snap-on representatives talked about torque certification courses tied to the expressed needs of other industries, particularly the wind industry. This group of colleges provided technical instruction expertise and facilities, while Snap-on Industrial and its partners brought comprehensive theory, real-world application knowledge, technical experts, and equipment to the table. The result is a melding of academic culture, field knowledge, and world-class technologies focused on best-practices for fastener use.

The group even looked outside the U.S. for guidance. In the province of Alberta, Canada, Lethbridge College is working with European partners to expand upon its popular and growing wind technician training program. Instructors there have stated that there are three core maintenance requirements in the turbine and on the tower that they preach: lubrication, cleaning, and torque. That's it.

Finally, there are monetary interests in all of this training. States have both a social and an economic incentive to support these training programs, which will retrain displaced workers and attract new investment to the state. To ensure that a healthy environment for re-

Fig. 3: TAH cordless wrench.

training and reinvestment exists, the technical education system needs to be in place so that when companies come forward, the infrastructure is ready. Windpower is clearly a growth industry since the U.S. has reached only 5 percent of its goal objective for energy derived from wind to date.

The Program

The 16-hour torque certification course is designed as a component of an existing windpower technician training course, but the program is flexible enough to be applied as a standalone course. The curriculum includes modules on theory, technique, mechanical torque wrenches, electronic torque wrenches, hydraulic torque wrenches, torque multipliers, and safety. The program covers every aspect of torque, from the basics through master-level skills. Current standard windpower technician curriculum incorporates study of electrical and electronic components, electrical safety, working in confined spaces, and working at height.

The Snap-on torque certification program is integrated into windpower technician courses currently available at Lakeshore Technical College in Cleveland, Wisconsin; Gateway Technical College in Kenosha, Wisconsin; and the multi-campus Frances Tuttle Technology Center in Oklahoma.

Completion of this course gives participants an advantage over others who do not opt for torque certification. These workers can go anywhere, into any industry, and immediately show that they have the skill set necessary to perform certain kinds of jobs. It's like having a college degree and being considered for a job along with someone who has no college training. There's no comparison.

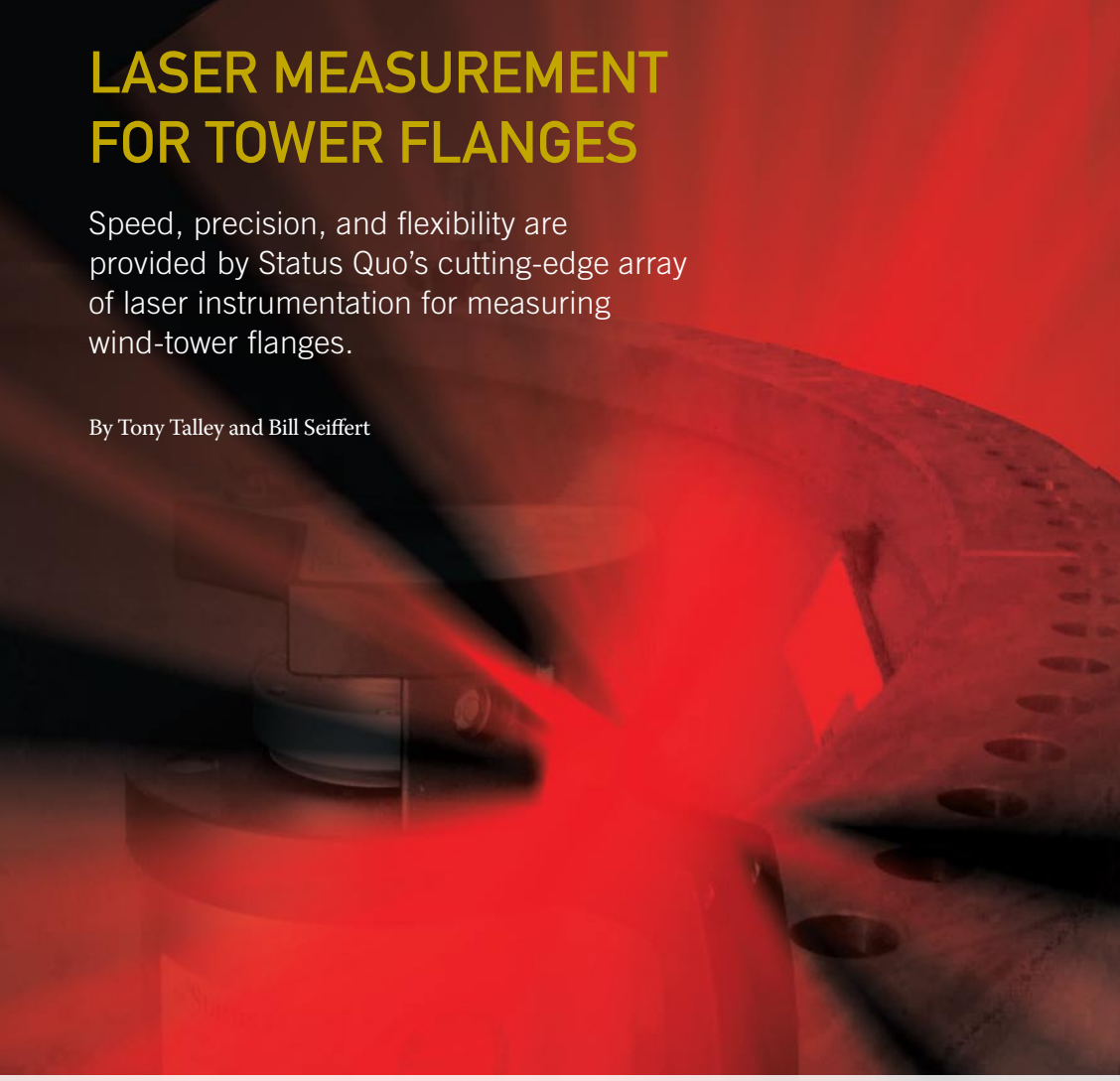
Summary

Torque training in the windpower industry is part of an ongoing, sustained American effort to tap renewable energy sources in the years ahead. Site selection and building the mechanisms to harvest wind and solar energy is important. But it does not supersede—and in some ways is subordinate to—the requirements for ongoing maintenance and support. Maintaining necessary structures over a long period of time falls to the knowledge and skill of trained professionals, technical personnel who know how to use tools to prevent small issues before they become production stoppers. Torque certification plays an important role in developing those skilled technical professionals.

LASER MEASUREMENT FOR TOWER FLANGES

Speed, precision, and flexibility are provided by Status Quo's cutting-edge array of laser instrumentation for measuring wind-tower flanges.

By Tony Talley and Bill Seiffert



Bill Seiffert is president and Tony Talley is national sales manager at Seiffert Industrial, Inc., the exclusive U.S. distributor for Status Pro of Germany. To learn more call (972) 671-9465 or go to www.seiffertindustrial.com.

AS ANY WIND PROFESSIONAL KNOWS, the towers supporting massive turbines are far more complicated than they might appear from the ground, requiring incredibly precise manufacturing techniques and practices. Made of rolled steel segments attached by flanges, these increasingly tall tubular structures demand flanges that meet very tight flatness and parallelism tolerances.

Manufacturing the flanges is difficult enough, but many have also found difficulty in accurately measuring the flatness or quality of the flange. Achieving geometrical correctness is made difficult by the manufacturing methods used. During the welding of the flange segments and storage of the sections, tension and/or stress can be induced. This stress can change the dimensional characteristics of the flange/segment, making it out-of-spec and therefore rejected. This condition then requires additional labor and machining to correct the problem, driving up costs and delaying the schedules. The ability to detect and ultimately correct these geometric features ensures a faster production schedule, better quality, and a trouble-free assembly as it was designed, along with happy customers. Up to now 19th century tools were used to measure flatness on these flanges, utilizing a straight edge or tight-wire and feeler gauge. This is no longer acceptable, and proper instrumentation is required. Thus began the search for new

Fig. 1: The T330 laser transmitter, R310 receiver, and DU310 handheld display.

measuring methods and techniques to be able to combat these problems.

Based in Germany, Status Pro® has developed a new and unique laser system enabling geometrical measurement as required by the wind energy industry. The ultimate goal was to develop an easy-to-use yet highly precise measuring system, enabling the user to obtain the information needed quickly, accurately, and with excellent documentation. The result is a universal system capable of measuring a wide variety of geometrical features on many different components.

The System

The T330 laser transmitter essentially consists of a rotating laser-prism unit integrated into a sturdy housing. The laser produces a 360-degree "plane of light" instead of a dot. The functions of the rotating laser unit can be remotely controlled via infrared communication that is built into both the laser and the R310 receiver. In other words, the setup of the laser plane is achieved automatically.

With its 80mm range, the R310 receiver is the largest sensor in the industry. The measured readings will display the height of the laser plane using an onboard LED display, and it will also send the results to the DU310 handheld display unit via Bluetooth. Measurements are recorded as fast as you can move the receiver and push the button. As already mentioned, the flow of information is completely wireless, making cables a thing of the past and reducing the resulting downtime by providing real-time results on the handheld PC.

All the system components (fig. 1) use either disposable batteries, rechargeable batteries, or AC power. There are various accessories that can be added to the system allowing the measurement of almost any geometric application required: precision leveling, flatness, straightness, parallelism, bores, and so on.

Laser Flange Measurement

Flanges are essentially joints, so they must be machined properly in order to avoid tension during or after coupling, and also to ensure water tightness of the coupling faces. Achieving geometrical correctness is made difficult due to the manufacturing method. During the welding of the flange segments together or during storing of the sections, tension and/or stress can be induced. The ability to detect and ultimately react to these dangers ensures a trouble-free service life. Many people have had to rely on straight edges and feeler gauges to accurately measure flatness on their flanges. This method is fine as long as the objects are smaller than the straight edge, but with segmented, chained, or overlapping measurements the problem of

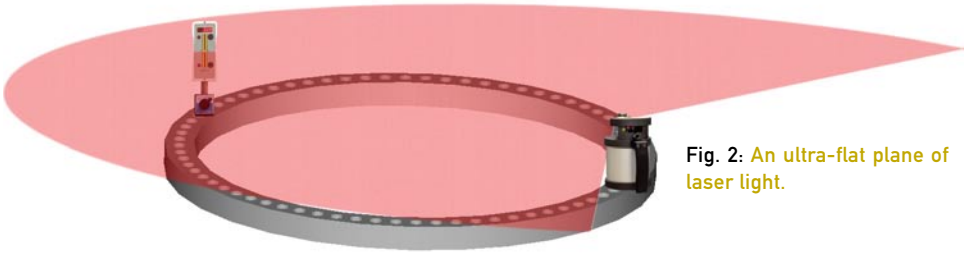


Fig. 2: An ultra-flat plane of laser light.

surface waviness arises. This created the need for modern measurement tools, methods, and techniques to be able to combat these problems in a fast and easy way. Using a rotating laser, it became possible to measure the entire flange against a constant reference; an ultra-flat plane of laser light (fig. 2).

First, mount the laser directly on the flange or beside it using a tripod, allowing the laser beam rotation to effectively produce a laser plane. With a R310 receiver you are able to measure the distance between the flange surface and the laser plane very accurately.

Traditionally, the laser plane has been manually adjusted to parallel at three points on the flange, and those points become "zero." This method is very time consuming and relies on the skill of the two people during the setup process. Manual calculations are also involved to achieve parallelism.

A preferred method is to simply allow the laser to rotate 360 degrees, thus producing an ultra-flat plane of laser light. This method is much quicker with the use of a PC and the appropriate flange flatness software. With modern systems this can be achieved onsite very

quickly and in real time. Older systems measure first, then you have to transfer the data to a separate PC for evaluation, and then a report has to be generated.

Measurement Layout/Results

Status Pro's goal is to make the measuring equipment simple to handle yet as precise as possible, and to ensure speedy measurements (fig. 3). Simply set up the laser as described,

Fig. 3: Status Pro's laser device provides measurements quickly, easily, and accurately.

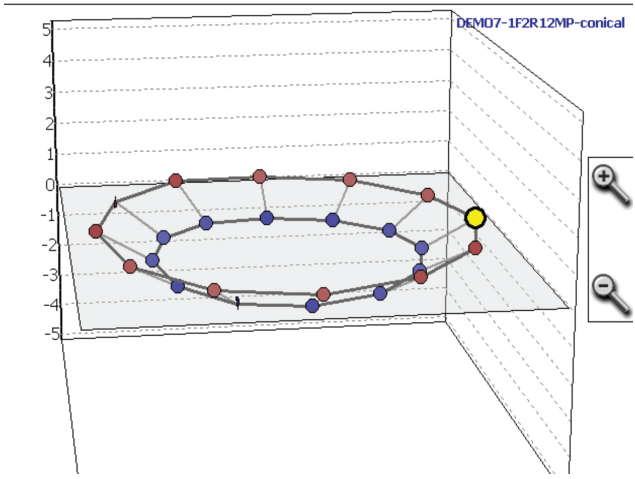


Fig. 4: 3D measurement, normalized.

scan all the points to be measured in any order, and record the results. The measurement of a flange with 104 holes takes around 25 minutes to complete, which includes the time it takes to set up the system. In the case of a measurement error, a single point can be remeasured at any time without having to repeat all of the previous readings. The results are directly displayed in 3D (fig. 4), 2D (fig. 5), or as a chart format.

Another feature of the program is a well-arranged measurement report in PDF format,

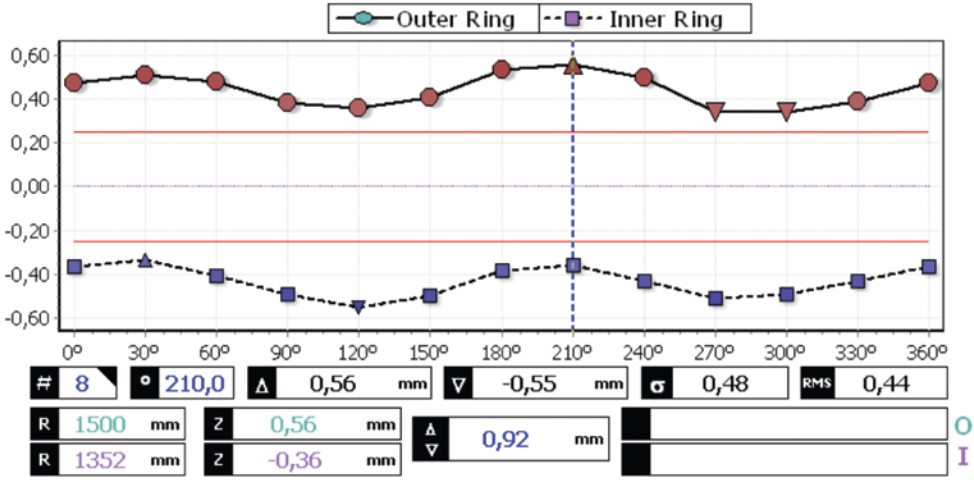


Fig. 5: 2D measurement view.

WIND SYSTEMS

Just as its name implies, *Wind Systems* magazine will address all aspects of this booming industry, providing information pertinent to landowners and managers, site developers, maintenance workers, economic development professionals, construction companies, tower and component-parts designers and manufacturers—in short, everyone involved in the systems central to and surrounding wind power generation. Brought to you by Media Solutions, Inc., publishers of *Gear Solutions* magazine.

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Fig. 6: The system can be used to measure the parallelism of two flanges.

and the data can be transferred as a CSV file into other types of software for further analysis if desired. Consequently, evaluation of the raw data is possible with most programs and applications.

An additional highlight of this system is "expandability." In other words, with the aid of a second sensor, the system can be used to measure the parallelism of two flanges (fig. 6). Hence, the flanges at both ends can be measured for evenness and parallelism with the appropriate documentation.

In addition to measuring flanges, the system is also able to level surfaces such as foundations and base plates. Utilizing the integrated "self-levelling" feature, you are able to measure objects in much the same way as you do a flange. Just push a button and the T330 laser levels itself within 0.025mm/meter. Then use the R310 receiver to scan and record the points to be measured. Using the LED display on the receiver makes a PC unnecessary. Measurements with spirit levels, cumbersome straight-edges, and tight wire and feeler gauges are a thing of the past. Propeller hub and the blade flanges can be measured in the same way, enabling detection of prob-

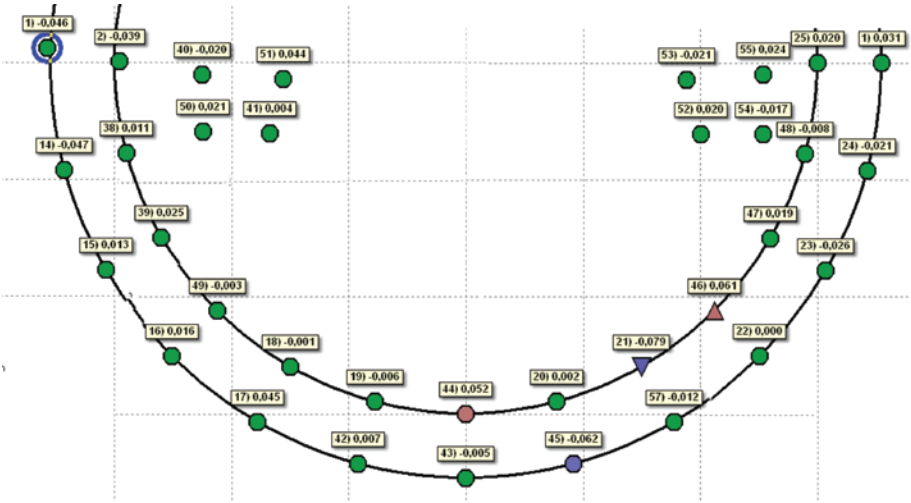


Fig. 7: Measurement of a tower head assembly.

lems that could arise during the machining or assembly process.

Even quite complex arrangements of more than one object can be measured and documented thanks to the innovative software. Figure 7 shows the measurement of the tower head assembly.

The base frame is a vital part of the tower, and it is also subject to twisting during the welding process. Locating and supporting surfaces (gearbox-to-generator) can be measured and documented very quickly. If twist or tension is identified in time, actions can be taken to prevent damage or problems during assembly, ultimately prolonging service life.

CONCRETE PROOF: THE MAJESTIC WIND FARM

By using the Putzmeister Telebelt conveyor to transport concrete, contractors were able to meet their deadlines efficiently and certain of a job well done.

By Kelly Hayes

Kelly Hayes is marketing services manager at Putzmeister America, Inc. For more information call (262) 884-6387, e-mail hayesk@putzam.com, or go to www.putzmeister.com.

AS OF JANUARY 2009 TEXAS IS THE NATION'S number-one producer in megawatts of installed utility-scaled wind power, with a total of 7,116 megawatts. As a result of the growth in Texas wind farm development, Mortenson Construction and Brundage-Bone Concrete Pumping have seen an unbelievable boost in wind farm projects.

Mortenson and Brundage recently worked together on the Majestic Wind Farm project in Panhandle, Texas, where Brundage's Putzmeister Telebelt® TB 110 telescopic belt conveyor delivered 18,000 cubic yards (13,762m^3) of concrete for 53 wind turbine foundations and pedestals.

Farm Forecast

The United States is the world leader in wind electricity generation. As of September 2008, wind provides 20,152 megawatts of its electrical capacity, which is enough electricity to serve 5.3 million U.S. homes. This is the electricity-generating equivalent of 28.7 million tons of coal, or 90 million barrels of oil.

According to the American Wind Energy Association (AWEA) the U.S. wind energy industry installed 5,429 megawatts of new wind capacity in 2007, crushing all of its previous records. In 2006 a record 2,454 megawatts of new capacity was installed, according to the U.S. Department of Energy in their Annual Report on U.S. Wind Power, Installation, Cost, and Performance

Fig. 1: Each wind turbine at the Majestic Wind Farm is comprised of a concrete pedestal connected to a pentagon-shaped concrete foundation with embedded rebar.

Trends: 2006. This expanded America's total wind power generating capacity by 45 percent in 12 months. This record also brought an investment of more than $9 billion into the economy.

Even though Germany has more generating capacity installed (about 23,000 megawatts), the United States is producing more electricity from wind because of its much stronger air currents. AWEA announced on its Web site in January 2009 that a record 8,358 megawatts of new wind capacity was added in 2008 in the United States, again crushing all of its previous records. 2008's installation of new wind capacity expanded America's wind energy fleet by 50 percent, bringing total U.S. capacity to about 25,170 megawatts. Texas takes the number-two spot next to first place North Dakota for wind energy potential.

A study by the U.S. Department of Energy showed that wind could provide 20 percent of U.S. electricity by 2030. This would in turn support 500,000 jobs and reduce greenhouse gas emissions equal to removing 140 million vehicles from the road.

Natural Growth

According to Mortenson, the general contractor for the project, the development of the 79.5-megawatt Majestic Wind Farm is part of an initiative by Xcel Energy to supplement its traditional power for the Amarillo, Texas, area with renewable energies.

Xcel is a leading combination electricity and natural gas energy company that offers a comprehensive portfolio of energy-related products and services to 3.3 million electricity customers and 1.8 million natural gas customers. Mortenson had six other wind turbine projects going at the same time as the Majestic Wind Farm.

"At Brundage we've had a steady amount of wind turbine projects in the Texas area," according to Ross Finnestad, branch manager of

Fig. 2: Concrete being placed for a wind turbine foundation and pedestal on the Majestic Wind Farm job site.

the company's Oklahoma City and West Texas branches, a subcontractor on the project, "and we don't see it slowing down anytime soon."

Project Pressures

The aggressive schedule was perhaps the most challenging part of this project, especially when Mortenson was coordinating with several different landowners, municipalities, and utility contractors at one time. The Oklahoma City-based Brundage team arrived on site in late July 2008 and was hired by Mortenson to convey 18,000 cubic yards (13,762m^3) of concrete for 53 wind turbine foundations and pedestals by early fall 2008. Mortenson's experience with both the Brundage team's expertise and their line of Putzmeister Telebelts is what led them to working together again on the Majestic Wind Farm.

"A typical week on the job included early morning pours for the foundations and pedestals that started at two a.m., Monday through Saturday," Finnestad says. "Usually it would be a 10-hour day. We conveyed concrete for two foundations and two pedestals six days a week, and the Telebelts made what could have been a grueling job more efficient. The purpose of the foundation for a wind turbine is to give the tower stability below the pedestal, which connects it to the tower. The tower rises skyward to support the turbine where the wind will turn its blades, generating as much electricity as possible."

Larger turbines weigh more, requiring larger towers that demand larger foundations and pedestals for support. "There were about 300 cubic yards (229m^3) of concrete conveyed by our TB 110 for each wind turbine foundation and pedestal combined," he says, "with 270 cubic yards (206m^3) of concrete conveyed for each foundation and 30 cubic yards (23m^3) for each pedestal.

"The TB 110 proved to be an invaluable asset on this job. Given the tight time constraints for this project as well as the budget, we needed a machine that could be easily operated by one individual to reduce the amount of workers we needed onsite. Production from the TB 110 was outstanding," Finnestad says, "and it met every need we had for the project."

Concrete placement for the Majestic Wind Farm occurred during the hot Texas summer, which made the use of the TB 110 even more beneficial. According to Mortenson, using the TB 110 to place the concrete eliminated the possible hose, pipe, or slickline problems that could have been encountered if they had used an alternative method to place the concrete. Be-

Fig. 3: The concrete mix for both the foundation and the pedestals was a basic 5,000-psi (345 bar) mix.

cause of the heat, the chances of clogs occurring in a boom pump end hose, for example, is much more likely. This not only causes a decrease in production, but also invites the potential of having cold joints occur in the foundation of the concrete. Mortenson's use of Brundage's TB 110 prevented these issues.

The TB 110 features a 106' 1" (32.34m) horizontal reach. Finnestad also notes that the TB 110 conveyed the concrete smoothly, rising easily up the feed conveyor to the main belt from which it was delivered precisely where needed. "We had to move the Telebelt from one foundation and pedestal to the other for all 53 wind turbines so the quick, easy setup and teardown of our TB 110 made for a seamless process in moving to the next foundation," Finnestad says. "We were able to set up the Telebelt in one location for each foundation and pedestal placement, and we were able to reach every spot where the concrete needed to be conveyed with the quick, telescoping action of the four-section boom."

The standard folding hopper also contributes to making setup a breeze on any site, including the Majestic Wind Farm. "The side panels of the folding hopper fold into the feed conveyor and the end panels connect with linchpins," he adds. "The belt can easily be fed by a ready mix truck from three different sides of the hopper, if necessary. The fast placement of the concrete at more than 100 cubic yards per hour (76m^3/hr) and the minimal cleanup were added advantages that kept the project moving ahead."

Fig. 4: The telescoping action of the Telebelt's four-section boom allows concrete to be conveyed exactly where it's needed.

The Oklahoma City branch of Brundage has five TB 110s, one of which was used on the Majestic Wind Farm. Brundage has a total of 64 branches throughout the United States, with the corporate offices located in Denver, Colorado.

Maximum Mix

According to Craig Snell of Amarillo-based Golden Spread Redi-Mix, Inc., the concrete mix for both the foundation and the pedestals was a basic 5,000-psi (345 bar) mix. The only difference between the two mixes was the pedestal concrete mix included 4.5 percent air entrainment whereas the foundation mix did not. "The pedestal concrete mix included the air entrainment because the pedestals are exposed to freeze/thaw cycles, whereas the foundation is not," he says. "The air entrainment creates tiny air pockets which allow

Fig. 5: For the Majestic Wind Farm project Brundage's Putzmeister TB 110 used a standard folding hopper.

Job Specifications

Owner/Developer: Babcock & Brown, Austin, Texas

General Contractor: Mortenson Construction, Panhandle, Texas. Corporate Offices, Minneapolis, Minnesota

Subcontractor: Brundage Bone Concrete Pumping, Oklahoma City Branch. Brundage Bone Concrete Pumping Corporate Offices, Denver, Colorado

Concrete Ready Mix Company: Golden Spread Redi-Mix, Inc., Amarillo, Texas

Equipment: One Putzmeister Telebelt® TB 110 telescopic belt conveyor

Completion: Late 2008

Fig. 6: Brundage's TB 110 placed 18,000 cubic yards (13,762m3) of concrete.

for the expansion and contraction of moisture during cold periods, when water may have migrated into the concrete mass."

A division of one of the world's most well-recognized and respected heavy equipment manufacturers, Putzmeister Concrete Pumps GmbH and Putzmeister America, Inc., manufactures a complete line of truck-mounted concrete boom pumps, separate placing booms, truck-mounted telescopic belt conveyors, and trailer-mounted concrete pumps as well as mortar, grout, shotcrete, plaster and fireproofing pumps and mixers, industrial pumps, and tunneling machinery. Some of the industry's best-known brands—such as Allentown Shotcrete Technology, Thom-Katt®, Powercreter®, and Telebelt®—are part of the Putzmeister America family. The company's workforce is dedicated to hands-on customer support and advancing the industry in design and technical innovation.

OPTIMIZING DESIGN TO MAXIMIZE PROFITABILITY

Multidisciplinary Design and Optimization links every aspect of wind farm and turbine design to explore all available alternatives and work toward increased profitability.

By Dipankar Ghosh, Ph.D.

Dipankar Ghosh, Ph.D., is director of product management at Phoenix Integration. To learn more call (800) 500-1936, send e-mail to dghosh@phoenix-int.com, or go online to www.phoenix-int.com.

WIND ENERGY HAS THE POTENTIAL TO MAKE a major contribution toward solving the world's energy problems, but it faces significant obstacles in improving its efficiency to the point that it can compete with fossil fuels. More mature industries, including the fossil fuel based electric power generation industry, have spent many decades evaluating different design alternatives and relentlessly focusing on those that provide the best economic performance. Being a relatively new industry, wind energy has not had the time to climb this far up the learning curve. Barring a major technological breakthrough, a key challenge is that the people in charge of the major aspects of wind turbine design—site, tower, blade, and generator design, etc.—move toward their own goals, but don't usually have the information or tools to consider the impact of their choices on other important objectives.

This article will describe a new approach called Multidisciplinary Design and Optimization (MDAO), which links together the tools used in every aspect of wind farm and wind turbine design to explore all of the various interrelated alternatives and iterate toward a design that optimizes profitability. MDAO can be used to develop a high level view of the complete wind farm design by considering each of the major systems as a black box. It can also be used to address detailed design issues by incorporating high fidelity computer aided design (CAD) of the entire wind farm and turbine, or whatever parts that it makes sense to model. This approach can help the wind energy industry quickly make up for

its relatively recent start by rapidly evaluating huge numbers of possible design alternatives to make rapid improvements in profitability.

Catching Up

The first wind turbine—developed in 1888 by Charles F. Brush in Cleveland, Ohio—had a full load capacity of 12 kW, and it was used to charge batteries. The technology was slow to gain serious commercial attention, however. In the United States there were limited applications for powering rural homesteads that were not connected to the electrical grid. These mostly ended with the growth of government sponsored rural electrification in the 1930s. During the 1950s there was research in Denmark leading to the three-bladed wind turbine,

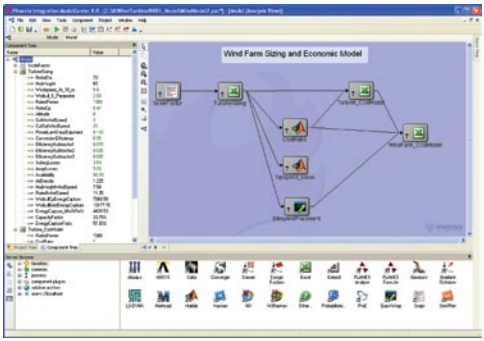


Figure 1: Wind Farm Sizing/Economic analysis showing various interdisciplinary components that are integrated into a system model. The problem definition is to minimize the investment cost to the utility (COE) for a given load requirement (100,000 MWh/yr), wind speed profile (5.8 m/sec at 10 m, Weibul k=2.0), site area constraint (6.0E6 square meters), and noise constraint (tip speed < 65 m/sec). The primary design variables are ScaleFactor (size of machine compared to a baseline Diameter of 70 m & HubHeight of 65 m) and RatedPower. TurbineSizing, Turbine_CostModel, and WindFarm_CostModel were adapted from NREL spreadsheets found on http://www.nrel.gov/wind/coe.html.

which is the predecessor to the modern Danish turbine. The modern wind turbine industry finally got off the ground in the 1970s as a result of the 1973 oil crisis, leading to a search for alternative means of energy. But the development of wind energy moved slowly for decades, with worldwide installed capacity reaching 10,000 Megawatts in 2005.

More recently the growth rate of the wind energy industry has increased substantially, reaching an installed capacity of nearly 30,000 Megawatts in 2008. The recent rapid growth of the wind turbine industry has not provided enough time for designs to be optimized by traditional engineering methods. What is needed is a new approach that will enable wind farm and turbine designers to rapidly consider huge numbers of possible alternatives to compress the period of time required for wind energy to quickly compete economically with carbon-based power generation.

Points to Ponder

The ideal wind farm design is dictated by a combination of technology and economics. The goals are usually to maximize energy production, minimize capital and operating costs, and comply with the constraints imposed by the site. There are many different, and often conflicting, disciplines involved in the site design process. The wind farm is typically laid out by considering various site sizes, site layouts, turbine types, and hub heights. Spacing of wind turbines on the site must be considered carefully to avoid unacceptably high wake losses. Of course, the optimum layout for the site is affected by the design of the tur-

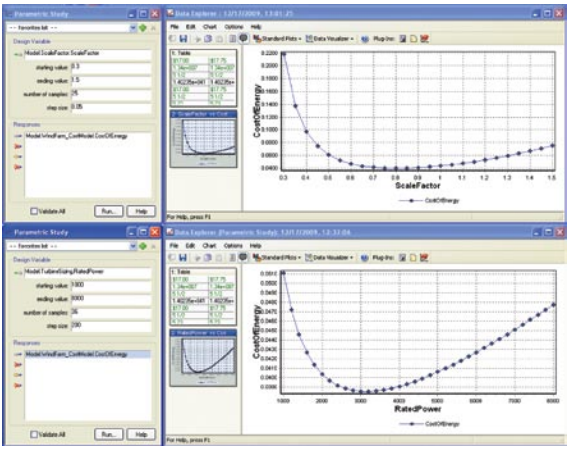


Figure 2: Once a model is integrated, a number of trade study tools can be invoked to explore the design space. Shown here are two parametric studies to explore the effect of scale factor and rated power on the cost of energy.

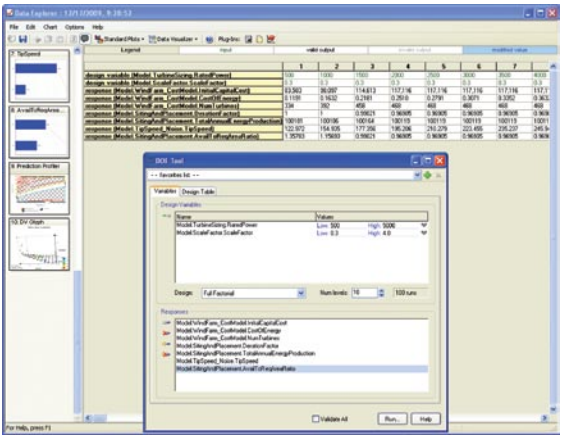
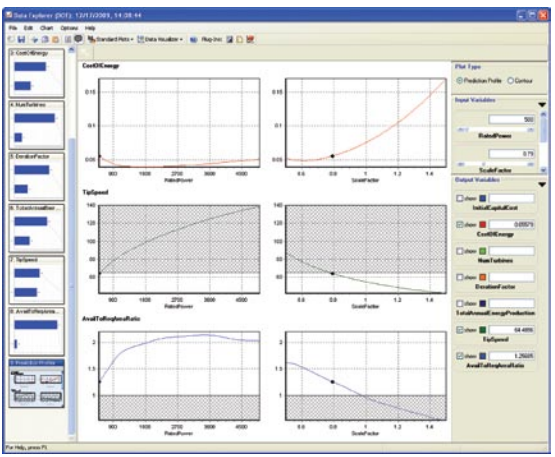


Figure 3: A design of experiments is used to study both the rated power and scale factor at the same time. The results are shown in a table and can be easily graphed.



bines used on the site, and the optimum turbine design is also affected by the site layout.

Likewise, wind turbine designers have the goal of delivering electricity at the lowest possible cost per kilowatt hour (kWh) of energy. Wind turbine blades have many similarities to helicopter rotorcraft blades and share many of their design characteristics. Taller towers increase wind turbine energy production but cost more to build, so this tradeoff must be optimized during the design process. The determination of the airfoil shape and number of blades involves questions of aerodynamic efficiency, component costs, system reliability, and aesthetics that in turn impact the site design. A small generator requires less force to turn, which makes it more efficient at low wind speeds, but it also is less efficient at high wind speeds.

One of the greatest challenges of wind turbine design is that these design decisions and many others interact in very complex ways on the overall profitability of the wind farm. Each of these decisions is typically in the hands of specialists that use a variety of rules of thumb and engineering software. Often, design variables overlap into multiple disciplines. In this case, each discipline typically provides a recommendation that is optimized based on its own analysis methods. The usually conflicting recommendations of different disciplines must be traded off against each other. There is usually no way to simultaneously evaluate the impact of the different design variables on the overall profitability of the wind farm, nor is there a practical method to search the entire design space for combinations of design variables that might provide better overall results.

Optimizing Tradeoffs

The new MDAO tools address this challenge by linking analysis tools used by all disciplines involved in wind turbine and wind farm design in automated processes that are suitable for analyzing large numbers of design alternatives. Once the model

Figure 4: The Prediction Profiler allows you to change design variables, RatedPower and Scale Factor in this case, and see instantly the effect on output. The lowest cost of energy (COE) can be found which meets noise (tip speed) and site area constraints. Areas of constraint violation are shaded and the black diamond is the chosen design point.

is created it can be automatically executed and data transferred from one application to the next, freeing engineers from the time-consuming and error-prone tasks of manual data conversion and data transfer. MDAO tools provide optimization routines that greatly reduce the number of analysis runs required to explore a design space and identify the best design alternative. Multidisciplinary optimization can simultaneously evaluate a large number of designs against a wide range of objectives such as revenues under various wind conditions, initial capital investment, and life-cycle costs. This makes it possible to provide an objective answer to the question of which design is best.

MDAO can easily be applied to the wind farm site design process. (go to www.windsystemsmag.com for supporting graphics) The inputs to the model are the wind profile of the site, the price received for power generated by the farm, the geometry of the available site, and the design of the tower, blade, and generator. In this case the tower, blade, and generators are represented by relatively simple black box models that yield their performance as a function of their cost. The question that we are trying to resolve is what number, siting, and type of wind turbines on the site will optimize the long-term profitability of the site while meeting noise and environmental constraints.

The software initially shows a graphic depiction of the model of the wind farm and lists the various design inputs. The MDAO tool can then be configured to optimize the design. The model is parameterized so that the design variables can be automatically controlled by the MDAO tool. Trade study tools can be used to run the integrated analysis models repeatedly by manipulating these design variables to generate vast data for alternative designs. The design space can then be explored using visualization tools to understand important design trends such as trade-offs between the capital costs and operating costs to produce a specified energy output. When promising designs are found, sensitivity analysis can be performed to identify potential risks and opportunities for improvement.

Fidelity in Design

In the MDAO approach, the major subsystems of the wind turbine were considered as black boxes. This type of analysis would typically be performed as part of the site feasibility study. Later, the fidelity

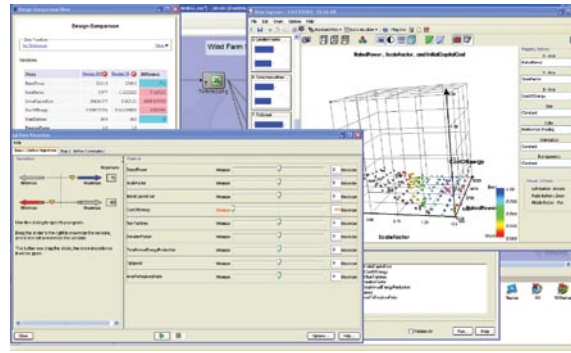


Figure 5: The best alternative can also be found with the Data Visualizer. Slider controls can be changed to adjust objective function and constraints. A built-in genetic algorithm can then continue searching for designs. Alternatives are graphed in multiple-dimensions and color-coded based on how well they meet the objectives. Promising designs can be compared side-by-side in a separate table.

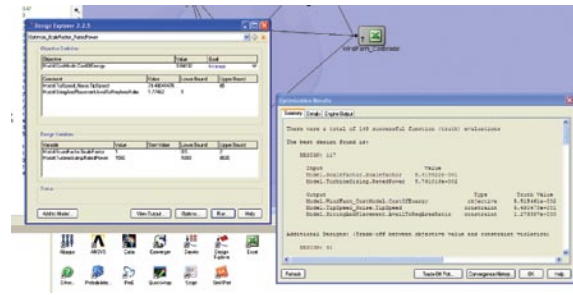


Figure 6: Optimization can be used to further refine the design automatically. In this case, a scale factor of 0.842 and a turbine rated power of 579 kW result. To match the load requirements, this yields a wind farm consisting of 45 turbines on a site area 6 km2. The resulting cost of energy is 0.055 $/kWh. The tip speed constraint for noise (< 65 m/s) is the main reason the turbines have the small power rating. With no noise constraint, the result is a turbine rating of 3000 kW and scale factor of 0.98.

of the optimization process could be increased to optimize the wind turbine design at a more detailed level. MDAO makes it possible to move fidelity forward in the design process, enabling site planners and wind turbine designers to make better choices between alternative design concepts at a point in the process when many critical and irreversible design decisions are made. Moving fidelity forward also reduces product development time and expense by enabling the concept design and detailed design phases to largely be conducted simultaneously.

MDAO can advance wind power systems technology by encompassing every aspect of wind farm and turbine design to integrate any or all of the applications used in the design process. MDAO can improve the profitability of wind farms by enabling trade studies that can be used at every stage of the design and engineering process to make better tradeoffs between the many conflicting objectives that are involved in wind farm and wind turbine design.

THE MOBILE AGE OF SERVICE TECHNOLOGY

Like it or not the mobile age is here, and wind turbine project owners and operators who leverage the available technology will maximize the return on their investment.

By Merritt N. Brown

Merritt N. Brown is director of business development for Rev1 Power Services, Inc. To learn more call (866) REV1NOW, e-mail wind@rev1ps.com, or go online to www.rev1wind.com.

AN ATTENTIVE CAR OWNER KNOWS HIS vehicle so intimately that he can easily sense when something isn't quite right. Whether it's a small noise under the hood, a drip beneath the engine, or a new squeak coming from the front passenger side door, the relationship with the car is a personal one.

The same can be said of a wind turbine technician. Experienced technicians can tell you with a great deal of accuracy which component is making noise and will soon require replacement simply by listening from the ground level. Just like the car owner, this sort of experience is gained through a close relationship with the equipment they visit every day.

In this environment of rapid growth, how does a wind project owner or operator leverage the available experience and extract the greatest potential from their workforce? Rev1 Wind answers this with a solution that has been an integral part of the utility industry for years: digital information capture. Using subcompact computers, handheld devices, and built-in features such as cameras and video recording, service work results that were once recorded only on paper can now be captured electronically and reused by future technicians.

With open-source, Internet-based software, Rev1 has introduced the Tracker DB application to several utility and wind project owners with rapid and enthusiastic acceptance. Using today's technology and incorporating continuous feed-

back from service technicians, Rev1 has built a knowledge management system designed to enable fast, accurate decisions by project management thereby maximizing revenue, minimizing downtime, and maintaining continuity of service work on wind assets. Other service companies have methods for recording service work, but the Rev1 Tracker offers something more to owners and operators. Its designers have implemented proven electronic methods to gather, query, and report inspection and service work all for wind project owners and operators to gain a significant competitive advantage.

Innovation and the Internet

Based on their experience in serving the architect/engineer and regulated utility industry, Rev1 quickly understood the need for the wind industry to evolve to utility standards for digital information capture and management. Originally developed in 2005 for utility American Electric Power to manage such things as turnover packages, drawings, punch lists, , and maintenance tracking, the Rev1 Tracker application has evolved into a much more comprehensive system. Those familiar with typical service documents—either having to complete them as a technician up tower or who may receive it in the project office—know all too well in what condition these can often arrive. "Grease-covered," "torn," and "illegible" are all descriptive of a service report, and it stands to reason since the work being accomplished is performed at a height of 50-80 meters and in a cramped working environment. By the time this information is placed in the hands of decision makers, its value has been reduced to markings on a piece of paper, ineligible for cross-reference to other sources of data, rapid fleet-level review, or a quick spare parts search to assure high availability of operating equipment. Handling such information becomes redundant now that several people must extract their relevant information from the same document. The Rev1 solution enables anyone who needs this service information to access it immediately online, to filter and query it according to the type of information required, and to maintain a running database of asset information available for every subsequent technician to review prior to conducting service or inspection work (see fig. 1).

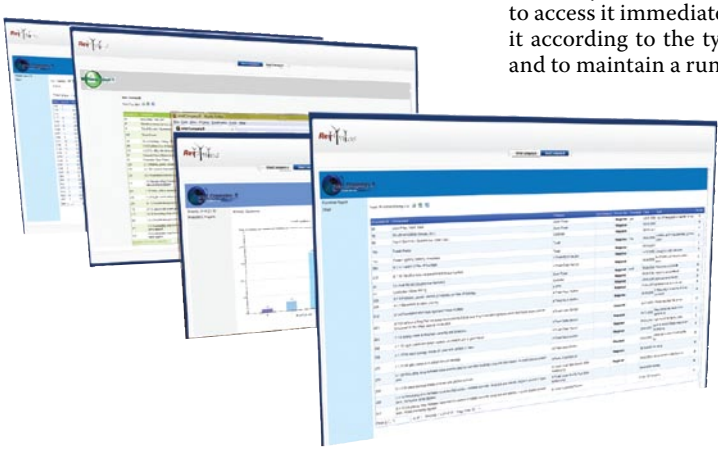


Fig.1: The Rev1 solution provides immediate online access to project participants requiring information.

21st Century Technologies

Handheld devices such as the personal digital assistant, smart phones, and tablet or notebook PCs are no longer on the cutting edge of innovation. They are now commonplace tools of business and daily life. The use of handheld devices in business yields benefits by converting downtime to productive time and their increased application drives business success by allowing simplification of processes as well as standardization of data. With its newly implemented Tracker application, Rev1 is able to improve the quality and consistency of a service business process by documenting and automating the exact way the process should be completed in every instance. In a mobile software application on a handheld device, Rev1 ensures the appropriate processes are done in the appropriate order. This is accomplished through a variety of means including:

- Requiring specific information to be captured before moving to the next data field or page;
- Requiring a digital photo of the work performed (before and after);
- Automatically capturing time and date stamps for work;
- Automatically checking inventory levels before replacing a part (Inventory Module);
- Routing the technician to a different set of questions, based upon answers (e.g. if equipment is not operating automatically ask question number 4, or if equipment has been repaired, automatically proceed to question number 10);
- If inspection is completed, close inspection file. If steps are incomplete answer question number 120 about hydro station fluid level.

The Rev1 Tracker application can substantially improve the efficiency gain of reporting service work results. One of the most innovative and practical deployments of the Rev1 technology is the near real-time notification of a wind turbine project's quality inspection. Because Rev1 deploys crews to service wind projects in compressed schedules, they often complete the inspection of an entire project in a matter of weeks as opposed to months. The inspection results are captured, prioritized, uploaded, queried, and reported as soon as the technicians have completed each inspection. Looking for common issues among the results might take an owner several hours of reading each paper report, documenting similar inspection results, and reviewing photos from each turbine. Instead, Tracker's Internet-based system is immediately available once the inspection results are uploaded. Run a query of priority-one findings and a report is generated showing issues that require immediate attention due to a critical safety concern. Design a custom query to report all findings related to yaw brakes, gearbox borescope results, or tip cable conditions and the information is compiled, accessible, and has immediate enterprise value (see fig. 2).

Intelligent Information

Co-designers Andrew Rachel and David Jones, who are long-time veterans of parent company Rev1 Power Services, Inc., have custom-built Tracker to offer full flexibility with a wide range of tools and reporting features. The designers reflected on the mounds of data collected on paper in years past and stored in a file drawer somewhere "for future reference." Except in rare cases, the data was never reviewed and no "intelligence" or "predictive data" on turbine operation is ever developed. A huge opportunity in equipment betterment has been lost because the technology was not available to create information of value from collected data. Already deployed at multiple utility locations, the Tracker designers developed additional features to allow its use in the wind sector and continue to improve its functionality through feedback from the field. Now used for a variety of wind turbine inspection and service work scopes, the value of digital information available from the Tracker application has increased to a level unparalleled in the paper world.

Tracker is more than a computerized maintenance management system (CMMS) or an enterprise asset management (EAM) tool, although both of these functions are incorporated in the program. This application serves to track the asset from its construction and commissioning phase through the entire life cycle. Information captured during a mechanical completion inspection is available to any technician or business leader who seeks to learn the full history of a component, including problems that may have existed during commissioning. Because of its Web-based versatility, Tracker will provide a real-time view of an entire fleet of equipment, allowing purchasing managers to coordinate local parts inventories, performance managers to better understand fault and serial issues, and business leaders to appreciate the total cost of ownership for a growing turbine fleet. Rev1 has deployed a tool businesses need to drive asset performance and ensure the delivery of projected financial results.

Explaining the functional aspects of Tracker is quite similar to describing how one pays bills online. As an example, a technician who is assigned to conduct an End of Warranty inspection is equipped with a Netbook PC preloaded with the turbine manufacturer's inspection check sheet. The inspection alone may cover as many as 600 inspection points at various locations on the turbine as well as requiring digital photos, pressure readings, and lubrication levels. Necessary information such as site location, turbine number, date and time is entered upfront. The technician then

ascends the tower with the Netbook. At each location the technician will select a checklist sectionto enter task completion notes, data or values from the inspection, and to determine if a digital photo is required. All comments and attached photos become part of the final report. In addition, the technician will select a priority code from one to four indicating a safety concern, immediate attention required, reduced reliability, or operational restrictions. These priority codes are later used to create punch list reports for the customer to address findings from the inspection.

The Rev1 Tracker application is a modular design, meaning only features that are required or requested will be active to the user. The current wind turbine inspection and service database contains thousands of inspection points, yet because a technician might only wish to inspect a Gamesa G52 turbine, for example, only those inspection points will be displayed for his walkthrough. The same holds true from a report review perspective. If a fleet owner had multiple turbine technologies being serviced, they may only wish to query for the Gamesa G52 turbine model, looking for common serial issues that might have arisen from the quality inspections performed by Rev1 technicians.

Moreover, Tracker is designed for the entire lifecycle of an asset, not just construction, commissioning, post-warranty inspection, and service work. Turnover dates, burn-down curve generation/graphs (turnover time v. estimate), project staffing, test equipment calibration dates, model and serial numbers, commissioning test and status, component test forms, and safety checklists can all be integrated into the construction module. Following this construction stage, ongoing maintenance functionality is added to the project application and includes such activities as inventory monitoring, purchasing data, special work orders, tool and material requirements, average time to complete, mean time between replacement, and maintenance and safety procedures. The true value of this information is in the continuity and consistency of the component tracking, from the first time power was applied through all the times a service technician visited the turbine to perform an inspection.

Besides the data storage aspects of Tracker, customers are offered the ability to perform enhanced troubleshooting and monitoring of serial issues in a more technically savvy way. The custom query function allows an owner to drill down into subcategories and even component descriptions and part numbers. Knowing that you've prematurely replaced

Fig.2: Rev1 technologies allow project technicians to compile and arrange information in useful configurations, available via mobile networks.

failed hydraulic system o-rings is a good example of a knowledge system that adds predictive value. Failure analysis tools enable the user to filter by model or component number, registered faults, cost of parts, or even by a particular site location.

Ease of Deployment

The Tracker scalability enables a rapid deployment to sites with identical equipment and maintenance requirements, making it even more useful for wind turbine projects. MS Access Runtime environment does not require unique software for offsite use and information can be accessed remotely as long as Internet service is available. If continued maintenance modules are preferred, Tracker is able to upload purchasing data directly to a client system or to integrate purchase order formats into each site's inventory management module. Additionally, the functionality of Tracker makes it well-suited for failure analysis through a fleet-level interface, adding significant value to efforts in mitigating warranty costs and improving product reliability.

Mobile Service Tracking

Although there are an infinite number of ways a service or inspection process can be automated, Tracker was developed to ensure fieldwork would be completed in a systematic, quality manner. In effect, Rev1 endeavored to build best practices into its mobile application by continuously improving upon the database structure, input devices, wireless capability, and query features provided for the customer. For example, changes to the application design itself can literally be made to each mobile device over the Internet. With a long-term vision, Rev1 is adding features that will enable the application to serve as a training tool for its service technicians. Considering that much of the work completed in the wind field is done remotely, Rev1 sees additional value in having automated processes and instructions such as pop-up messages and training tips built into the mobile application.

As a final example, consider the following scenario: A new wind technician inspects a Vestas V90 wind turbine and identifies damage to the gearbox cooler radiator return hose. He correctly inputs this information into the Tracker application on his Netbook computer. Based on the identified damage to the hose, the inspection application brings up an additional set of questions:

- Location of damage on the hose;
- Type of damage (tear, scrape, puncture, etc.);
- Severity of damage;
- Type of hose (metal sheath, rubber, etc.);
- Serial markings on hose.

For each of these questions a button is available to select for more detailed instructions. This is a powerful inspection-training tool and will help to standardize all answers to ensure the most accurate service inspections possible.

Mobility is an inevitable technology solution for wind project owners. The rise in mobile and wireless technology capability is the catalyst that the wind industry needs in order to keep pace with owners' eager demands for real-time turbine status, particularly when multi-MW turbines are at risk. Managing project and service data on a utility grade platform such as Tracker will allow wind farm operators to maximize the use of historical information to optimize reliability and equipment longevity, minimize downtime, and improve the analysis of more comprehensive information. Rev1 Wind has created a solid solution that serves to maximize project profitability.

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and defense applications. The company has 22 manufacturing facilities throughout North America and Europe and is supported by a global network of sales engineers, authorized distributors, and agents. For additional information call (800) 390-3300 or go to www.rbcbearings.com.

UPDATE ON IOWA CITY'S WIND ENERGY SUPPLY CHAIN CAMPUS

The City of Iowa City, Iowa, continues its work to develop what is believed to be the first Wind Energy Supply Chain Campus in the United States. Since November 2008 the city has taken steps to acquire, annex, and zone 173 acres of land located on the city's east side and begin infrastructure work. Sewer service projects and road improvements are underway or scheduled for development. To date over three-dozen companies have visited or requested information about the campus.

"We are able to meet power and transportation needs because this campus is being developed from the ground up," says Joe Raso, Iowa City Area Development (ICAD) Group president. "Unlike other industrial sites which may have to be retrofitted, this campus is being designed specifically to the needs of the wind energy sector."

This development puts OEM suppliers in close proximity to Acciona North America's operations in West Branch and Clipper's North American nacelle manufacturing plant in Cedar Rapids. The campus is rail served and will allow companies easy access via Interstate 80 to their customers and the growing number of wind projects not only in Iowa, but in the upper Midwest. Additionally, it will soon be certified as one of only three "shovel-ready sites" in the region.

In response to continuous inquiries, ICAD Group has launched a special Web site featuring a snapshot overview of the campus and important facts about the benefits of doing business in Iowa City. Users can link to laborshed reports, detailed property information about the campus, and obtain a free transportation quote to estimate costs of shipping products to and from our area. "At this stage companies are planning for projects in 2010 and 2011 and need data to determine which locations make sense for their needs," Raso says. "Our supply chain campus Web site will help national and international companies with their research and make it easy for them to contact us with specific questions or to arrange site tours."

To learn more contact Raso at (319) 354-3939 or jraso@iowacityarea.com. Also visit www.iowacitywind.com.

HYOSUNG, ROMAX PARTNERSHIP CONTINUES

Hyosung has again selected Romax Technology as a leading partner in their wind energy activities. Following the success of their first collaborations on 750kW and 2MW wind turbine gearboxes, Hyosung and Romax will cooperate on future wind turbine projects.

Romax and Hyosung first worked together when the UK based consultancy supported Hyosung in the design and optimization of a 750kW and 2MW gearbox. Romax assisted in the collation of commercial and engineering market research and the concept design, detailed design, and manufacturing drawings. In addition, Romax has provided continuous testing and certification support. Both projects proved successful with the 750kW and 2MW gearboxes recently achieving type certification through DEWI-OCC (Offshore and Certification Centre GmbH) following successful field trials.

The success of these previous ventures and the standard of the technical and commercial support they received led Hyosung to select Romax as a key partner in their new venture. "Romax's expertise in wind turbine engineering is an important factor in our success," according to K.H. (Kevin) Ho, senior vice president of industrial machinery PU from Hyosung. "We have no doubt that this will continue well into our future collaborations, and we had no hesitation in choosing to work with Romax again."

"We are delighted that Hyosung have asked us to partner with them again and we are confident that the partnership will yield more success for both Romax and Hyosung," says Andy Poon, director of renewable energy at Romax. For more information go to www.romaxtech.com.

MAG AND DOWDING WORK TO REDUCE HUB PRODUCTION TIMES

A new collaboration between MAG Industrial Automation Systems and Dowding Machining LLC is poised to revolutionize manufacturing of wind turbine components with specially-designed CNC modules for the production of hubs and new automated technology for composite wind blade production. The Michigan-based venture—dubbed Astraeus from the Greek mythological "father of the four winds"—will use a unique new machine design to dramatically reduce the production times of turbine hubs, the large castings to which the blades are attached, to about four hours—a process that now typically takes 20 to 24 hours on the best production lines. In what will be the first implementation of MAG's Rapid Material Placement System (RMPS), the new

company will bring integrated manufacturing with automation and repeatable process control to wind blade fabrication—a process that has historically been manual, making blades prone to imperfections and weight variations, and exposing wind turbine manufacturers to warranty and replacement costs.

The new business unites MAG, a world leader in machine tools and aerospace composites, and Dowding Machining, a large-component precision machining operation, in an effort to make wind energy more cost-competitive as an alternative energy solution. "We've already seen significant interest in our capabilities from Asian and European companies," says Jeff Metts, president of Dowding Machining. Plans for Astraeus include opening global facilities to supply worldwide demand.

The management and organization of Astraeus will be announced by the end of the year, with production expected to ramp up very quickly. "We plan on producing some of the components by the middle of next year," according to Roger Cope, president of the Strategic Business Development Group of MAG.

MAG is a leading machine tool and systems company serving the durable-goods industry worldwide with complete manufacturing solutions. The company offers a comprehensive line of equipment and technologies including process development, automated assembly, turning, milling, automotive powertrain production, composites processing, maintenance, automation and controls, and core components. Key industrial markets served by these technologies include aerospace, automotive and truck, heavy equipment, oil and gas, rail, solar energy, wind turbine production and general machining. More information is available at www.mag-ias.com.

Dowding Machining LLC is a precision machine solutions provider for large components and is an affiliate of Dowding Industries, Inc., a woman-owned manufacturer of progressive die stampings, metal fabrications, and welded assemblies. Learn more by visiting www.dowdingindustries.com.

VAISALA WIND OBSERVING SYSTEM TO BE INSTALLED IN U.S.

The world leader in environmental measurement Vaisala, together with electricity and natural gas energy company Xcel Energy and the National Center for Atmospheric Research (NCAR), have joined forces on a pioneering pilot project in the United States that will take observing and forecasting for wind energy production to the next level.

The goal of the pilot is to explore the use of a new wind observing and forecasting system in Xcel Energy's wind power generation. The system will provide critical decision-making support for balancing wind power with traditional fossil fuel generation while minimizing costs and improving reliability. A primary focus of the effort is to develop technologies that will better anticipate changes in wind energy output from wind farms. "This is a great opportunity for Vaisala to again demonstrate how we can provide observation systems for weather critical applications," says Richard Pyle, head of the company's wind energy market segment.

"We are extremely pleased to enter this pilot project with Vaisala and NCAR, who both are leading players in their fields and can significantly contribute to the development of wind forecasting in energy production," says Mary Fisher, vice president of strategic technology for Xcel Energy. "Once completed the pilot, if successful, will inform wind farms operators on the means to increase reliability and minimize integration cost."

Vaisala is providing Xcel Energy with surface weather stations, radar wind profiling capability, and National Lightning Detection Network® data, as well as installation and operating services for a 12-month pilot program. The wind observation network will be located around wind farms in Colorado that total 400 megawatts of installed capacity. The network became operational in November 2009.

NCAR has been contracted to refine a wind forecasting system that focuses on wind ramp detection for the project. Vaisala's observation data will be integrated with the forecast information in a decision support tool developed by Vaisala in close cooperation with the three parties. To learn more contact Richard Pyle at (303) 589 8772 or richard.pyle@vaisala.com. Visit online at www.vaisala.com.

LINCOLN ELECTRIC HOSTS STATE INVESTMENT ANNOUNCEMENT

Ohio Gov. Ted Strickland recently announced that 25 state solar and wind projects will receive more than $13 million in grants funded through the American Recovery and Reinvestment Act's State Energy Program. The announcement was made last November at Lincoln Electric's Automation Center of Excellence in Cleveland, highlighting the company's welding solutions for wind tower fabricators.

Among those projects was $1 million awarded to Lincoln Electric to help install a wind turbine at its Cleveland manufacturing facilities. The plans call for a 2.5-megawatt turbine that will generate approximately 10 percent of the electrical needs for Lincoln's Cleveland manufacturing operations.

"We are excited to have this opportunity under Ohio's energy program to demonstrate the value of wind energy by investing in our own installation," says John Stropki, chairman and CEO. "This project is a continuation of other Lincoln environmental, health, and safety (EHS) programs and green initiatives currently under way in our manufacturing operations to improve our costs and protect our environment. Not only will the wind project provide long-term benefits by reducing our energy costs, it will also showcase the unique benefits that Lincoln products and welding solutions provide to wind tower manufacturers to improve their quality and lower their costs." Learn more at www.lincolnelectric.com.

SHAFT GROUNDING RING FROM ELECTRO STATIC TECHNOLOGY

By safely channeling harmful shaft currents away from bearings to ground, Electro Static Technology's

new AEGIS WTG™ wind turbine grounding ring prevents bearing damage that could otherwise cause generator failure, unplanned downtime, costly repairs, and lost revenues. Maintenance-free, effective at any RPM, and available for any size wind turbine generator, the ring is designed for OEM installation or easy uptower retrofit.

High-frequency currents induced on the shafts of wind turbine generators can reach levels of 60 amps and 1200 volts or greater. If not diverted these currents will discharge through the generator's bearings, causing severe electrical damage that results in bearing failure and catastrophic turbine failure, sometimes in as little as six months or less. The AEGIS WTG's patented conductive microfiber technology effectively steers these currents away from the bearings and safely to ground.

The WTG is engineered to safely divert up to 120 amps of continuous shaft current at frequencies as high as 13.5 MHz and discharge up to 3000 volts (peak). Ideal for use as part of a preventive maintenance program to protect against premature bearing failures, it can be installed whenever bearings are replaced. For more information contact Adam Willwerth at (866) 738-1857 or (207) 998-5140. Send e-mail to sales@est-aegis.com, or go online to www.est-aegis.com.

MISSOURI WIND PROJECT TO FEATURE GE TECHNOLOGY

In an effort to meet Missouri's ongoing renewable energy goals, Wind Capital Group is developing the state's largest wind project, Lost Creek, with the support of GE's 1.5-megawatt wind turbine technology. The Lost Creek project supports Missouri's Clean Air Initiative, which calls for 15 percent of the state's power to be generated from renewable resources by the year 2021. When it enters commercial service in the spring of 2010, the project will have the capacity to generate 150 megawatts of electricity, enough to power more than 50,000 homes.

GE is supplying and servicing 100 of its 1.5-MW units for the Lost Creek Wind Project, which is located in DeKalb County. The wind turbines will be delivered in 2009 and 2010. GE will provide operation and maintenance services for the project for five years. "Even in these difficult economic times, it is possible to find people who are committed to the development of clean, wind-generated wind power," says Wind Capital Group President Tom Carnahan. "We're pleased that GE Energy, the leading U.S. supplier of wind turbines, is joining us in this milestone project for the state of Missouri. With its technology expertise and substantial experience in the wind industry, GE will help ensure the success of this important effort."

Power generated at Lost Creek will be sold under a 20-year power purchase agreement to Associated Electric Cooperative. "This marks our first project with Wind Capital Group, an innovative company that shares our commitment to help the United States develop its vast wind energy potential," says Victor Abate, vice president of renewables for GE Power & Water. "We're very excited to support projects like Lost Creek, which are helping the country move closer to energy independence."

As the most widely deployed wind turbine in the world, GE's 1.5-MW machine has demonstrated the flexibility to meet a wide range of wind project requirements. GE's 12,000+ installed wind turbine base coupled with the technology's record of proven performance also is a major asset for project developers as they seek financing for their new projects.

GE is a diversified global infrastructure, finance and media company that's built to meet essential world needs. From energy, water, transportation, and health to access to money and information, GE serves customers in more than 100 countries and employs more than 300,000 people worldwide. To learn more go to www.ge.com.

ADINDEX

Jeff Gribble
Operations Manager, UVLM, Inc.

GIVE US A SENSE OF HOW UVLM CAME INTO BEING.

My grandfather, Lowell Gribble, started an industrial maintenance service company called Ultrasonic Predictable Maintenance, Inc., or UPM, in 1968. My father, Doug, and my uncle Stuart joined the company soon after, and they spent the next two decades using infrared and ultrasound devices to inspect the bearing conditions in manufacturing equipment. In 1989 my father gave me a call—I was in the military at the time, living in Germany—and told me that he had an idea. He said that he'd come to realize over the years that the vast majority of the bearing problems he encountered involved lubrication, and that you could detect underlubricated bearings by the sound they made. It was a gritty, sandy noise instead of the smooth, continuous sound that you want to hear in bearings that are properly lubricated. He wanted to develop a device that would allow a lubrication technician to actually listen to the internal workings of a machine, and after years of testing, development, and working to have a patent awarded we launched UVLM in 1991 and sold our first Ultra-Lube in 1994. My grandfather passed away a number of years ago, so I'm a partner in the company along with my dad and my uncle.

WHAT ARE THE DEVICE'S ATTRIBUTES?

The first is that my father made a conscious decision to utilize the sonic rather than the ultrasonic frequency range, mostly because he wanted it to be very easy to use with little or no training involved, as is the case with the ultrasonic instrumentation that's already out there. Luckily dad's best friend is a retired ear, nose, and throat (ENT) specialist, and his expertise was invaluable in the development of the Ultra-Lube. It was his opinion that to base your lubrication reading on ultrasonic frequencies alone was dangerous at best, because so much depends on the type of crystal in the transducer and what it's been tuned to detect. You're going to pick up different sounds if an ultrasonic device is set at 35 kilohertz or at 40, after all. I sat on a panel once debating the attributes of the two detection methods, and when the representative of ultrasonic instruments said that everyone hears things differently, I agreed. But I also pointed out that if the two of us went to hear a piano concerto we're both going to hear the same instrument, not a tuba and a saxophone, even if the tones we hear don't match up perfectly. That's how it is with the sonic frequency we utilize, while an ultrasonic reading can lead you to believe you're hearing something else altogether. Another benefit of the Ultra-Lube is that it allows users to tailor their lubrication schedules to the exact piece of equipment they're monitoring. Most industrial machinery is lubricated according to a time/amount schedule, where every two weeks, or two months, a certain amount of oil or grease is applied. That can be a waste of time if it's not necessary. Our customers have told us that once they've started using the Ultra-Lube, the vast majority of the time they're able to adjust their lubrication schedule downward. This device can also be used as an early warning diagnostic tool, because you can detect the noises that could indicate impending bearing failure. We always stress that in these instances the Ultra-Lube should only be used as a screening tool, with follow-up tests including vibration analysis, data collection, oil analysis, and thermography should anything seem amiss.

IS SEEMS LIKE AN INSTRUMENT OF THIS NATURE WOULD HAVE A WIDE VARIETY OF APPLICATIONS.

It really does. I've even used it to detect a malfunction in my wife's car. But we have managed to place our product in a long list of industries, including power generation, wood products, petrochemicals, OEM and parts manufacturing, mining, agriculture, hospitals, pharmaceuticals, and maintenance service companies, just to name a few. And I think a big part of its acceptance has to do with how easy it is to use. There are some things that just can't be reduced to an automatic process, where it's better for the sensory input and judgment of an actual human being to be involved, and that's where the Ultra-Lube comes in. It's like putting a stethoscope in the hands of a doctor.

Call (360) 736-2333, e-mail info@uvlm.com, or go online to www.uvlm.com.

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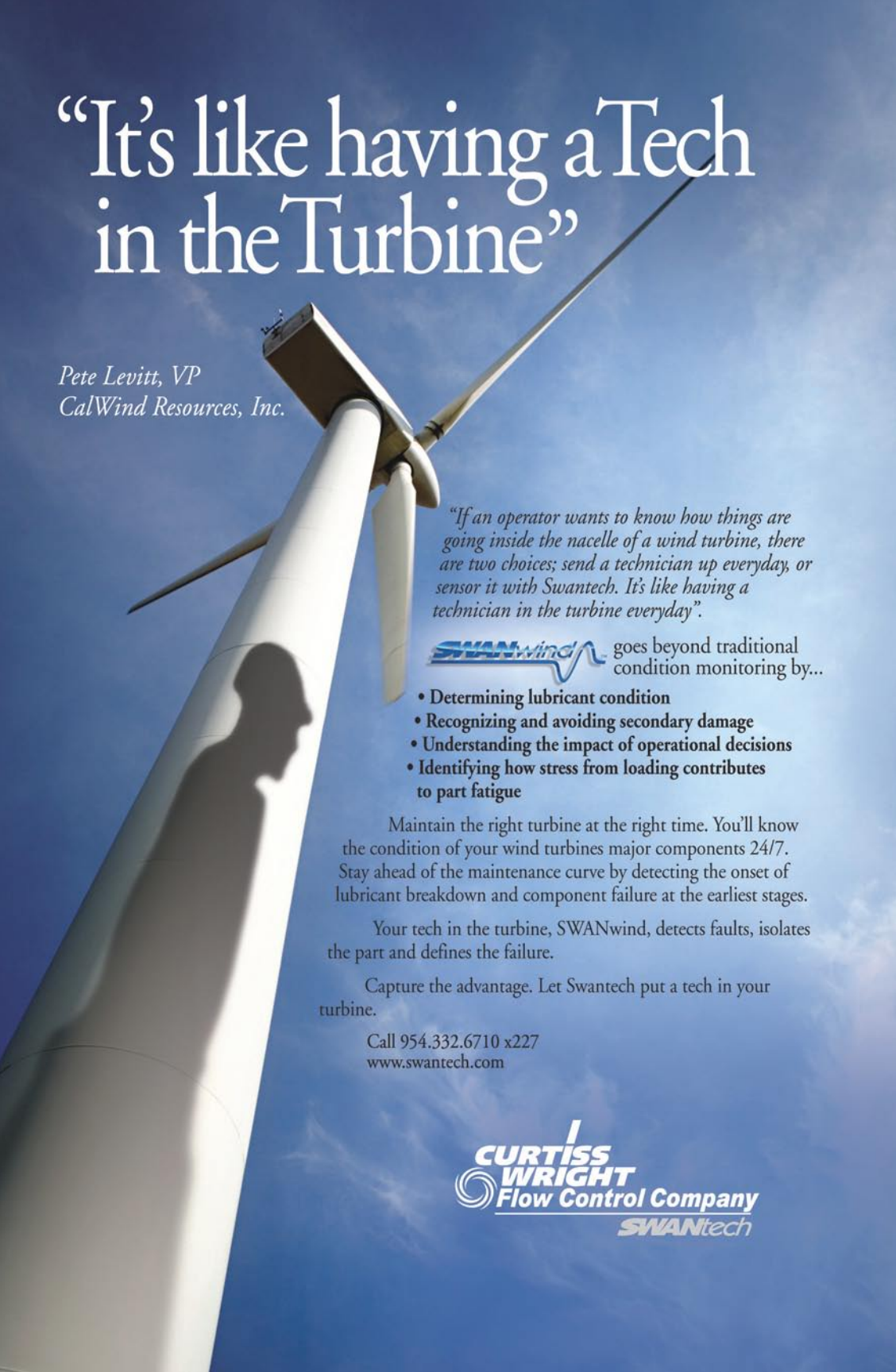
Pete Levitt, VP
CalWind Resources, Inc.



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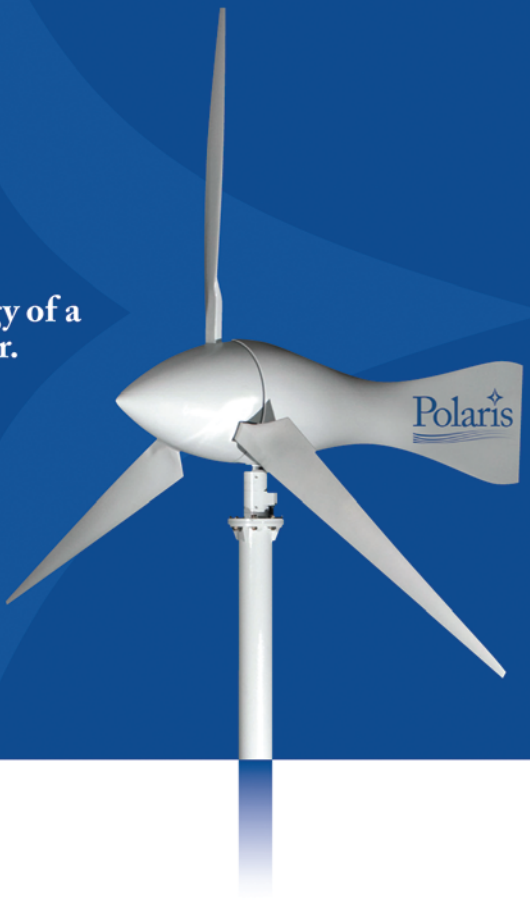

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