inFOCUS

# Approaching Zero Downtime

*ServiceMax uses the Internet of Things in the field to help companies save money, resources, and improve customer satisfaction.*

*By Kenneth Carter*

*If it ain't broke, don't fix it.*

That cliché can take an ominous turn when it comes to big complex systems like the ones that make up wind-farm turbines.

In that world, when something does finally break down, it has the potential to cause a lot of damage to an unprepared company's bottom line.

But now, with the help of the Internet of Things and the cloud, ServiceMax can give industries such as wind a leg up in detecting problems before they happen.

The Internet of Things and the cloud have come a long way in a short time to connect technology to the world. That connectivity has made it possible for industries to move from a reactive maintenance paradigm to a predictive maintenance one.

Athani Krishnaprasad, co-founder and chief strategy officer with ServiceMax, came to the table with 15 years of experience working with companies to make their service operations more efficient. ServiceMax officially began life in 2007.

"We were doing that using predictive technology, and we were obviously very passionate about it," he said. "It was tough during that time because the cloud was very new, and the mobile devices were still old generation. So we couldn't solve all of their problems, so we started to think how could we change the game."

That game changer was the beginnings of how ServiceMax reimagined better field service software using the cloud.

## REACTIVE VS. PREDICTIVE

By looking at the haphazard methods of reactive maintenance, it's easy to see why ServiceMax searched for a better and more efficient way of approaching maintenance. And that reactive maintenance paradigm had been the traditional service model for all types of industry for decades.

Reactive maintenance would kick in when an asset developed a problem, which would spur the customer to call and report that problem. That phone conversation would start with troubleshooting and more than likely lead to a technician being dispatched to address the problem and repair it, according to Krishnaprasad.

"And that's been the paradigm, and it's totally a reactive paradigm," he said. "So, what we've been advocating is for customers to move into a proactive predictive paradigm. Because now, with the Internet of Things, technology is becoming mainstream, and it's becoming cheaper to connect the products into the internet and start collecting data from them so you can actually, as a manufacturer or a servicer, have a window into what's happening with the machine without needing to do guesswork and essentially predict that something is going wrong."

With predictive maintenance, error messages or other anomalies serve as a prognosticator of possible failure and a heads up to the operators.

The result is sending a repair team out proactively or developing a software patch before a more extensive repair becomes necessary.

"That movement toward predicting failures and preventing failures from happening before they occur is the direction in which the processes and

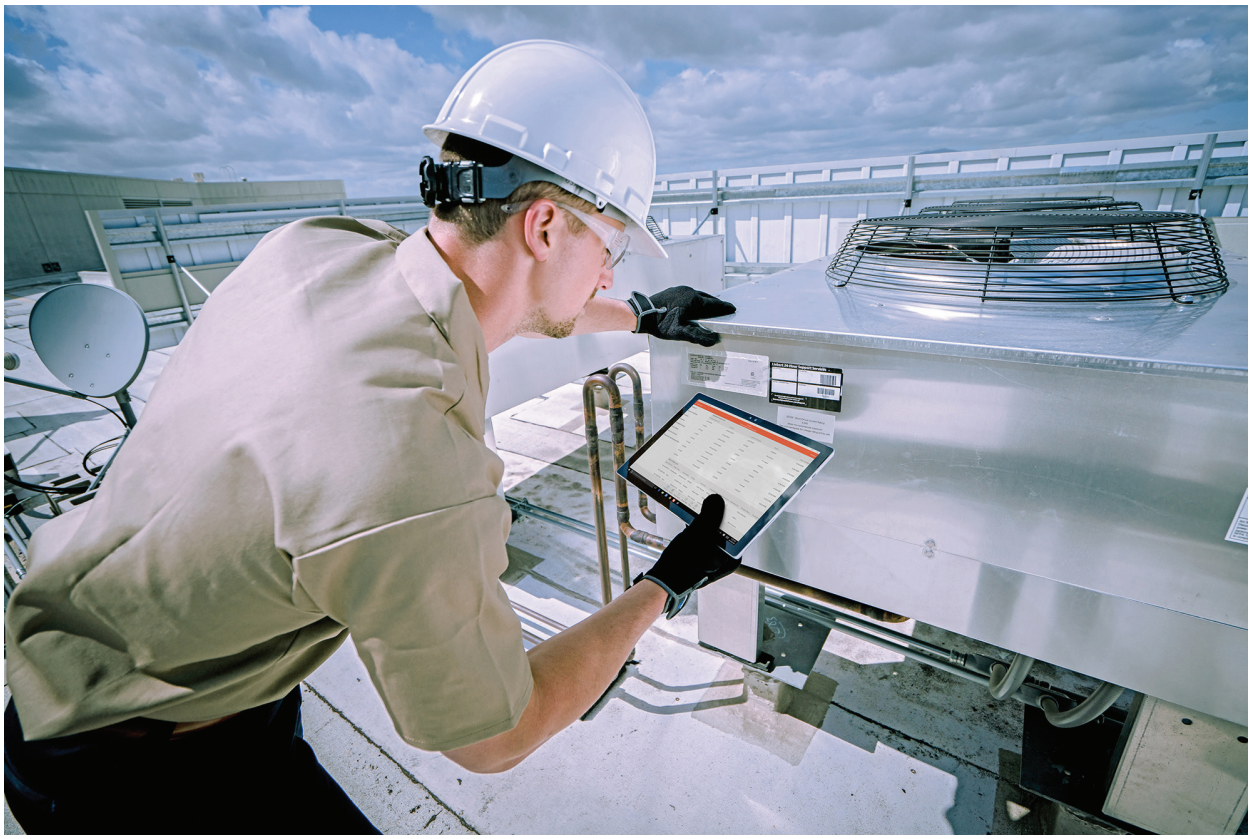

**A field-service worker fulfills a work order and maintains a PREVAC Plus pressurization system using ServiceMax on his portable device. (Courtesy: ServiceMax)**

service thinking can move because it is possible now," Krishnaprasad said.

The predictive service paradigm not only provides benefits in terms of predicting failure and preventing downtime that would affect customers, but it also has benefits for the providers as well, according to Krishnaprasad.

"In a predictive regimen, it's much easier to organize your services more efficiently because you have a visibility into the future, so you can organize yourself much more efficiently in terms of who goes where and how do you organize parts so they're available to the tech when he shows up," he said. "That prevents multiple times the tech might have to visit if he doesn't bring the right part."

## ALSO IN THIS SECTION



ServiceMax is able to capture the data from the technician's repair and feed that back into the system. (Courtesy: ServiceMax)

## WIND ADVANTAGE

Krishnaprasad added that the wind industry is particularly suited for this predictive maintenance.

"Wind is a great example, solar is a fantastic example as well," Krishnaprasad said. "These are the industries that were born in the internet age. So from the get-go, any provider that is managing a wind farm or managing a solar farm connects the panels and these wind turbines into the internet from the beginning. They don't have the legacy of having to design and produce the machines 10, 20, 30 years ago that didn't have the internet connection available at that time."

But he said all industries will have to eventually move to a predictive service model.

"Everyone is going to ultimately, at some point in the future, look and feel like a wind or a solar operator from the perspective that they will have the visibility from the data; they will move toward a proactive maintenance regimen," Krishnaprasad said.

## EXPANDING THE DATA

ServiceMax takes data coming in from wind farms and expands on it, according to Krishnaprasad.

"A lot of these wind operators and solar operators have gotten good at monitoring the assets in the field producing energy," he said. "So they can pick up slow downs in performance, and they can pick up glitches, and they know that there is something wrong that requires intervention."

ServiceMax can take that signal coming from a command center and translate it into an operational flow.

For example, ServiceMax picks up and interprets signals coming from a command center that's monitoring a wind farm, and then automatically kicks out a work order for a technician to go out, according to Krishnaprasad.

The ServiceMax software interfaces with a monitoring system that has data coming in from assets and looks at several parameters: failure patterns, alert patterns, error-message patterns. A root engine in the command center looks at these patterns, and depending on how many times a pattern is perceived within a 24-hour period, the system determines if an asset will require some kind of intervention.

If action is necessary, the work order produced can contain vital information including assigning the right technician, creating a snapshot of the sensor data that led to the failure, and actually bringing a live feed of the failure to a tech in the field, according to Krishnaprasad.

"And that actually provides insights for the tech to be a lot more effective," he said. "It takes the guesswork out of the job. And we make it all available on a mobile device, which works online and offline."

ServiceMax is able to automate the process of sending someone out, and once a technician is dispatched, ServiceMax is able to capture the data from the technician's repair and feed that back into the system, which will serve in better predicting failures and interventions in the future, Krishnaprasad said.

"We help customers close that loop," he said.

## TARGETING RENEWABLES

ServiceMax has been targeting renewables for about half a decade. It started a relationship with GE in 2010. The company recently was acquired by GE Digital for nearly $1 billion.

Before the acquirement, ServiceMax had more than five years' experience working with GE to enable its service deliverable processes in the renewables business. And now ServiceMax includes companies such as Siemens in its wind-division processes.

Krishnaprasad said there are similarities to how it approaches the wind industry as compared to others.

"Wind is sort of ahead of the curve compared to other segments," he said. "They are demanding service processes that can actually slice up data. So they are much further ahead in terms of that curve that everybody else is trying to get onto. That makes it particularly interesting to work with the wind customers."

Another element in wind that comes up more often than with other industries is safety considerations, according to Krishnaprasad.

"Specifically with wind, the assets are hard to access," he said. "So safety concerns bring unique requirements for us in terms of being able to potentially predict issues. For example, if the mobile device the technician is carrying falls, we can detect that through an accelerometer and predict some potential safety issues. The tech has to climb 500 steps on a ladder to get up to the asset, which makes it very hard for them to go back-and-forth from the truck to the top of the wind turbine. That means it's very important for us to enable this tech to know every piece of information he or she needs to be effective up there and make sure we send up all the parts that will be required."

Wind creates unique factors simply due to the settings where wind technicians have to work, according to Krishnaprasad.

"Those are some of the interesting nuances we've learned to address in our product, and we have built features around those because of the interaction with the wind industry," he said.

## "HIDDEN GOLD MINE"

Because of the potential savings that can be a product of predictive maintenance, Krishnaprasad said ServiceMax approaches customers with that economic advantage in mind.

"We talk about service operations management as a hidden gold mine in these companies in terms of the value we can extract from it," he said. "Both from a productivity and efficiency cost savings point of view, but also in terms of moving the needle on the top line growth."

Along with certain metrics that ServiceMax measures, it also produces an annual survey that shows its customers have seen about an 18 percent increase on average in productivity, a 12 percent increase in terms of efficiency, and a 12-15 percent increase in revenue, according to Krishnaprasad.

"These are the same parameters that actually are applicable to the wind industry," he said. "They're looking for efficiencies; they're looking for effectiveness when the tech goes up that ladder as well as overall workforce productivity."

Wind farms employ dozens of techs, so ServiceMax is able to know how to optimally dispatch technicians so they're not wasting time driving from place to place. It can also ensure those techs have the skills needed to solve a particular problem, Krishnaprasad said.

"All of these things matter," he said. "But in addition to that, I think the conversation we have with the wind industry specifically is the safety considerations."

## BROADER PLATFORM

And becoming a part of GE Digital has given ServiceMax a much broader platform to be involved globally about its predictive maintenance platform, according to Krishnaprasad.

"Especially in energy," he said. "All the power generated on the planet Earth, GE technology is used in half of that. That spans across fossil fuels, hydro, and renewables, both solar and wind. So we have both now the ability to ride the GE relationship into these big industries across the globe and bring value and have meaningful conversations."

And with GE Digital also being a pioneer of the industrial Internet of Things, it has been able to gear the platform toward industrial segments that speak to the depth of security, volume, and cloud performance to be able to predict failures fast, Krishnaprasad said.

"We can truly sort of move the needle on what it means to service modern assets through modern technologies like ServiceMax," he said.

# Maintaining the Green-Energy Progress

*Polymeric solutions aid turbine maintenance, keeping renewable energy's future bright.*

Historic milestones in 2016 show a bright future for renewable energy. (Courtesy: Belzona)

*By Thomas Belli*

The renewable energy market is continuing to go from strength to strength, with 2016 marking a series of impressive milestones versus conventional, fossil-fueled energy. Certainly, one of the most remarkable was global investment in new renewable energy infrastructure surpassing that spent on new fossil infrastructure[1]. This statistic reinforces how climate change policies and low-carbon initiatives have improved cost-competitiveness of renewable technologies, making them a much more affordable and accessible form of energy.

Significantly, as funding and support for renewable energy projects begins to outweigh traditional energy sources, it is necessary to ensure a continued return on this investment. This can be achieved through effective maintenance of renewable assets and management of the issues affecting them.

Whether through immersion in corrosive seawater, contact with high geothermal temperatures, or aggressive abrasion imposed by gale-force winds, the methods of harnessing greener energy are not without complications. By its very nature, capturing renewable energy involves exposure to the elements, some of which can wreak havoc on the machinery, equipment, and structures used throughout the industry. This is true for geothermal, solar, tidal, and wind power, all of which suffer from a variety of different damage mechanisms. The expansion of the renewable energy sector is certainly positive for the planet; however, maintaining the existing green assets across the globe is a challenge that confronts many energy companies.

Like the maintenance of any other industrial assets, owners

and operators require cost-effective solutions that can be carried out quickly and easily yet ensure long-term results. Belzona has established itself as a worldwide provider of polymeric solutions for a variety of maintenance issues in most power generation markets, combating corrosion, erosion, and chemical attack. As a result, the transition to repair and protect renewable-energy equipment and facilities has been successful. The most progress has been made in the wind-power industry, where polymeric materials have been able to solve maintenance problems present from the base of the turbine to the tip of the blades.

Polymeric solutions can be applied to a variety of different areas on wind turbines. (Courtesy: Belzona)

## EDGING AHEAD

From the vast investment in new renewable infrastructure, perhaps the biggest beneficiaries were offshore wind farms, which have boomed in the past 12 months. In total, capital spending commitments for this form of green energy reached a record $30 billion in 2016[2].

Further to these pledges, there are offshore wind-farm projects under construction in European waters that equate to 27 GW. This adds significantly to the global wind-power capacity of 433 GW logged in 20157.

Despite being one of the leading forms of renewable energy, the design of wind turbines and the environments where they operate pose a variety of problems from a maintenance perspective.

Corrosion of components and foundation damage are among some of these maintenance issues; however, the single largest problem for the wind-power industry is leading edge damage. Blade tips can revolve at up to 190 mph (300 kph) in widely fluctuating temperatures, humidity levels, and rates of UV exposure. Coupled with the damage from a variety of impact and abrasion factors, including rain, dust, ice, insects, birds, and lightning, this can cause substantial erosion of the substrate.

Evidence suggests damage to the leading edge can lower the annual energy production (AEP) of a wind turbine, with energy losses estimated between 4 percent and 20 percent if the erosion damage is severe[3]. This generates a reduction in aerodynamic efficiency, affecting the energy output as well as exacerbating the damage to other turbine components. Imbalance between the blades can cause wear and damage in the shaft and gearbox, in addition to putting further stresses on the tower and base. Overall, this reduces the tower's operational life expectancy.

Alternative solutions for this problem include fillers, binders, and tapes, yet none of these will provide extensive, long-term repair and protection. In these scenarios, repairing the damaged substrate can be achieved with Belzona's range of reconstructive composites and protective coatings. Following sanding of the damaged area and adequate surface preparation, Belzona 1121 (Super XL-Metal) can rebuild the eroded blade to original specifications, adhering extremely well to FRP substrates. As a protective layer, the molded surface can be overcoated with Belzona's range of erosion and corrosion resistant, epoxy systems. Brush-and spray-applied, they offer a high level of durability and flexibility versus the threats of abrasion and impact.

Rather than simply a reactive option, these solutions can be applied proactively at the OEM stage, protecting the most threatened areas before entering service. A Japanese industry-leading engineering company recently took this approach. It specified Belzona 1341 (Supermetalglide) as a protective coating for the leading edges of turbine blades during manufacture[4]. Over an estimated 10 years since their original installation across sites throughout the U.S., these blades have withstood the effects of erosion beyond their anticipated life expectancy.

It is not just leading-edge damage that can be rectified to improve the output and operation of wind

turbines. Some of the other major issues that befall these structures involve the components in the nacelle. Protecting brake drums, sealing cables, as well as the repair of worn and damaged shafts, can be achieved with Belzona's polymeric solutions.

Meanwhile, the integrity of the nacelle, tower, and platform can all be upheld by using seamless, weatherproof, and waterproof protective coatings, maintaining wind turbines despite the often-adverse weather conditions in their operational environments. In addition, ensuring the stable foundations of these structures is essential. Trends show blades are getting bigger as rotor diameters have steadily increased over the last 20 years in line with higher output capacities. Offshore blades in particular are estimated to reach a staggering 190 meters (623 feet) in diameter by 2030[5], nearly double the size of today's blades, making firm foundations integral to keeping turbines upright. Therefore, the repair and rebuild of concrete around the base can be achieved with Belzona concrete repair systems and the surface protected with Belzona coatings.

Severely damaged turbine blades can result in energy losses of up to 20 percent. (Courtesy: Belzona)

## OTHER RENEWABLES

Although there is an array of maintenance solutions in place for wind turbines, this does not mean that other renewable energies are neglected in terms of their repair and protection. The stresses placed upon the likes of tidal, wave, and geothermal energy are displayed in many of the industrial environments that Belzona operates. Therefore, the solutions adept at resisting corrosion, erosion, and chemical attack will translate well into these new application scenarios.

For example, the characteristics of geothermal fluid can vary significantly, including temperature, chemistry, and non-condensable gas content (NCG), all of which can have an extremely corrosive effect on power-plant components. The negative impact on the efficiency and function of the geothermal power plant can manifest in pipes, turbine casings, heat exchangers, and tanks, all machinery and equipment which Belzona has experience at safeguarding. According to reported statistics on the state of geothermal technology, the use of corrosion resistant materials, such as protective coatings, can reduce generation costs by an estimated 0.25 cents per kWh[6]. When extrapolated to the global electricity generation of geothermal resources in 2015 (71 TWh)[7], savings through corrosion mitigation can exceed well over $100 million, while also helping to improve the efficiency of deteriorated equipment.

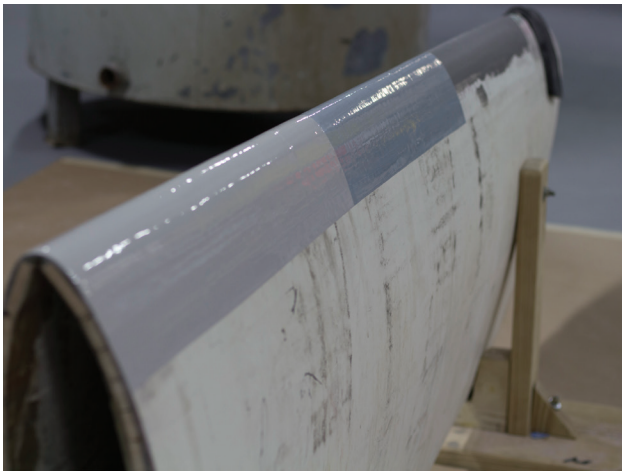
Moreover, the repair and protection of turbine blades is not isolated to wind power, as this type of application has a similar role to play in the tidal-power industry. At sea level, water is 784 times denser than air, so tidal turbine rotors can be much smaller but still generate equivalent amounts of electricity. Cavitation, when there's a pressure difference in a fluid, is prominent in this situation and can threaten the integrity of the blades, much like erosion on wind turbines. By employing a cavitation and erosion resistant solution, the in-service life of tidal turbines can be extended, protecting them against deterioration emanating from turbulent flow.

## GREEN INTENTIONS

With the rapidly growing presence of renewable energies in countries such as Brazil and Kenya, it is clear the world's emerging economies are showing similar interest in the low-carbon transformation of global-energy sourcing. In fact, they are matching many of their better-equipped counterparts. This highlights the wave of support for green energy is truly growing and capturing the world's attention.

As this sector expands, there will continue to be investments of increasing magnitude; however, it is essential these assets are maintained and remain operational, providing an effective return on investment. Polymeric repair and protective solutions already have had proven success in the power industry and have made notable impressions in the renewable energy market to date. Extensive testing and long-term involvement with industry-leading companies certainly demonstrates these systems can effectively manage the frequent issues associated with erosion, corrosion, and abrasion.

Renewable energies represent the future landscape of energy resourcing, something that Belzona aims to maintain through the development of new repair and protection systems for global renewable assets.



**Rebuilding and protecting the leading edge against erosion damage. (Courtesy: Belzona)**

## ACKNOWLEDGMENTS


1. Pettit, D. (2017) 2016: An historic year for renewable energy, [Online] Available at: tumblerridgenews.com/2016-an-historic-year-for-renewable-energy/. [Accessed: 1st February 2017].
2. Thomas, C. (2017) Record $30 billion year for offshore wind but overall investment down. Bloomberg New Energy Finance, [Online]. Available at: about.bnef.com/blog/record-30bn-year-offshore-wind-overall-investment/. [Accessed February 1, 2017].
3. Sareen, A, Sapre, C, & Selig, M. (2014) Effects of leading edge erosion on wind-turbine blade performance. Wind Energy, [Online]. 17;1531-1542. Available at: m-selig.ae.illinois.edu/pubs/SareenSapreSelig-2014-WindEnergy-Erosion.pdf. [Accessed: February 10, 2017].
4. Kawano, M; Hayashi, N; Kuroiwa, T; & Nakamura, N. (2014) Wear control apparatus and wind-turbine blade monitoring system including wind-turbine blade. Mitsubishi Heavy Industries Ltd. [Patent] US 8739612 B2. Available at: bit.ly/2kph3i1 [Accessed: January 4, 2017].
5. Metcalfe, J. (2016) The Future of Wind Turbines is Enormous. City Lab, [Online]. Available at: www.citylab.com/tech/2016/12/how-large-can-wind-turbines-get/509678/. [Accessed: February 15, 2017].
6. Kagel, A. (2008). The State of Geothermal Technology Part II: Surface Technology. Geothermal Energy Association, [Online]. 2, 6. Available at: bit.ly/2kwQiDw [Accessed: January 4, 2017].
7. REN21 (2016). Renewables 2016 Global Status Report, [Online]. Available at: www.ren21.net/wp-content/uploads/2016/10/REN21_GSR2016_FullReport_en_11.pdf. [Accessed: December 11, 2016].



**Thomas Belli** is a marketing assistant with Belzona. He has been with Belzona since September 2015.


The SeaHub system can be installed aboard a vessel, platform, or even on a remote land-based location. (Courtesy: SeaRoc Group)

## Sea-Fire Protects Offshore Communications Hub

SeaRoc Group has launched a monitoring and voice-and-data communication solution that links land-based operations to distant offshore petroleum platforms and wind farms via satellite, fiber, and other data services. An engineered fire detection and suppression system from Sea-Fire Europe was chosen to protect the sensitive and valuable electronics inside these unmanned SeaHubs.

The SeaHub system is mobile, so it can be installed aboard a vessel, platform, or even on a remote land-based location. It allows drill rigs and wind farms to be installed farther offshore than was possible in the past.

Inside are VHF A and M radios, TETRA, AIS, ADS-B, MOB and other high-tech communication equipment. Everything is housed in a temperature-controlled, standard 8-foot or 10-foot DNV-certified shipping container. All systems, including fire detection and suppression, are monitored and remotely managed by SeaRoc's proprietary SeaPlanner™ modular software suite to ensure component protection, service continuity, and worker safety when present.

Sea-Fire Europe engineered a solution that meets IMO and SOLAS requirements. The system includes smoke and heat detectors, an extinguishing release panel, and cylinders containing state-of-the-art 3M Novec 1230 fire suppression fluid.

Novec 1230 is electrically non-conductive and non-corrosive, so electronics aren't damaged during discharge. It's environmentally safe with a global warming potential equal to CO2, so it won't deplete the ozone and has low toxicity for worker safety.

"If personnel are working inside a SeaHub at the time of a fire event, we know that Novec 1230 is not harmful or fatal to human life," said Sarah Simmons, SeaRoc Group marketing manager. "This and safeguarding the equipment were key deciding factors in ensuring the highest fire protection solution, as well as the important environmental consideration."

*Source: SeaRoc Group*

For more information, go to www.searoc.com

## Timken Acquires the Assets of PT Tech

AeroTorque Corp., a U.S. manufacturing and engineering firm for torque damping products and torque monitoring for wind turbines, has joined the Timken team. Timken recently acquired PT Tech, Inc. The acquisition adds PT Tech and AeroTorque brands to Timken's growing portfolio of mechanical power transmission products.

"Acquiring the AeroTorque business expands our offering in existing and comparable end markets," said Hans Landin, vice president — mechanical power transmission for the Timken Company.

"We are pleased to add industrial clutches and brakes to Timken's growing portfolio of mechanical power transmission products," said Richard G. Kyle, Timken president and chief executive officer. "This acquisition allows us to better serve our customers by offering a broader, more diverse package of products and services. The addition of PT Tech will also provide ample growth opportunities, as we leverage our portfolio to drive growth across complementary markets around the world."

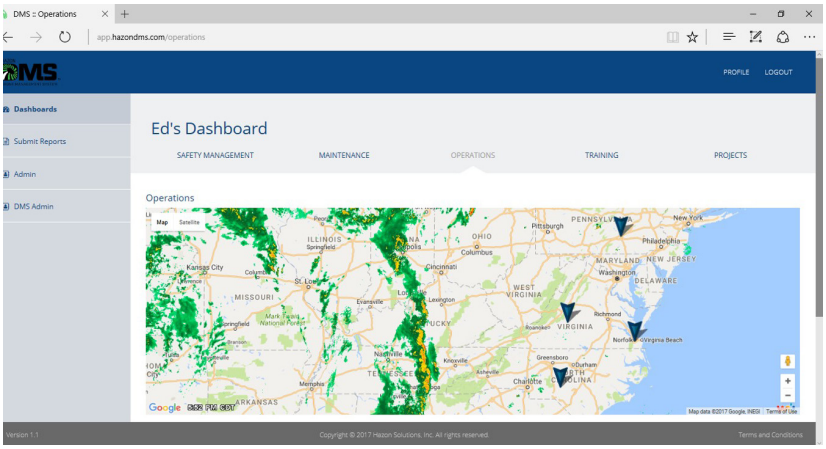
Timken engineers, manufactures, and markets bearings, gear drive systems, chain, belts, couplings, lubrication delivery systems and a variety of related services.

*Source: AeroTorque*

For more information, go to www.aerotorque.com

## Hazon Solutions Announces Cloud-Based Drone Management Software

Hazon Solutions, the national leader in drone-inspection services, recently announced the launch of the Hazon Drone Management System (Hazon DMS). Hazon DMS is a secure, web-based management tool providing all drone operators, whether hobbyists with a single drone or a large corporation with hundreds of drones, a way to safely and efficiently track and manage their drone fleet, pilots, and workflow.




**Hazon DMS is a secure, web-based management tool providing drone operators a way to safely and efficiently track and manage their drone fleet, pilots, and workflow. (Courtesy: Hazon Solutions)**

"Hazon DMS is the first software designed by professional drone pilots, for professional drone pilots," said Ed Hine, Hazon director of drone capability development. "We designed it to be a robust, yet simple to use, management tool that can handle all of our safety, maintenance, operational, and pilot management requirements with one efficient application."

Some of the Hazon DMS features include remote pilot (RP) logbooks, RP qualifications tracking, asset tracking, client management, proactive safety and maintenance tracking and reporting, and workflow management. Hazon DMS is offered as software as a service through the freemium model for individual users.

"At Hazon, we believe it is important to actively promote the safe and responsible use of drones throughout the entire drone industry, so we offer a free subscription to everyone," said Hazon COO and Co-Founder Sean Cushing. "Start-up drone businesses now have the ability to utilize this very powerful tool early in their life cycle. This will allow them to focus on operating drones safely and with professional processes in place from Day 1."

Hazon DMS is a cloud-based service offered at three levels. The "Remote Pilot" level is free to individual users with up to two drones. The "Drone Team" level is for multi-person, multi-drone operations available on a per-user, per-month fee schedule. The "Enterprise Systems" level is designed for larger organizations, municipalities, or universities with organic drone operations that require features such as customized branding, alternative licensing and hosting options, dedicated 24/7 customer support, optional custom analytics, and multi-tiered administrators.

"Even though it is already the most capable management software for the drone industry, we are quickly working to deploy the next set of advanced features,"

Hine said. "One of the things that makes Hazon DMS so unique and powerful is that in order to support our customers' needs and adapt to the rapid changes in our industry, we will update the tool with speed and purpose."

Hazon DMS has recently completed beta testing with a wide range of drone operations including Hazon Solutions, the York County Fire Department, Aerial Works, and Liberty University. It is available at www.HazonDMS.com.

*Source: Hazon Solutions*

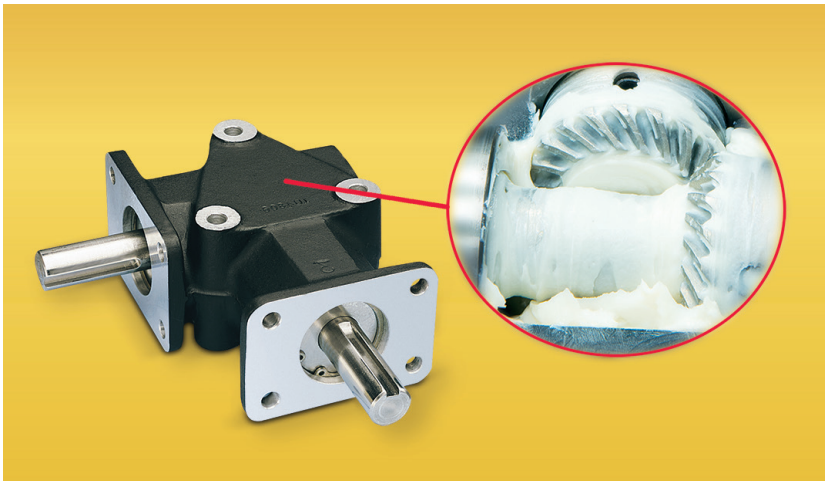
For more information,
go to www.Hazonsolutions.com.

## Lifetime Lubrication Ensures Smooth Operating for Zero-Max Drives

Lifetime lubrication in Zero-Max "Crown" gear drives assures motion system designers of a smooth operating, quiet right-angle gear drive that needs no maintenance. These drives are designed for economical transfer of speed or power.

Lubricated for life with Beacon 325 premium grade grease, Zero-Max Crown drives feature heat-treated AGMA Class 10 spiral bevel gears. This combination of bearing design and lubrication formulation ensures long-term, maintenance-free operation for demanding industrial applications. The drives feature precision hardened and ground ball bearings with non-magnetic steel shafts for handling speeds up to 2,000 rpm in most operating environments. The internal gears are permanently mounted to the shafts with locking pins. This provides a resilient and durable connection for use in heavy load applications while requiring no maintenance.

Sealed-for-life systems using motors, generators, and similar equipment in industrial applications require an equally robust gear drive. Crown drives provide that and more. Lubrication with Beacon 325 grease ensures optimum performance in temperature ranges from minus-50 degrees C to 120 degrees C without evaporation.



**Lifetime lubrication ensures long-term, maintenance-free operation for Zero-Max Right Angle Gear Drives, left. (Courtesy: Zero-Max)**

Zero-Max ensures its drives are predictably smooth operating, and similar model sizes have identical performance characteristics when designed into multiple drive setups. To accomplish this, Zero-Max drives are precision assembled for perfect bearing and gear alignment. The drives are pre-lubricated during assembly, then completely enclosed in a heavy-duty anodized aluminum housing. The housing is designed for maximum strength and heat dissipation. This design ensures internal gears stay permanently aligned, lubricated, and free of contamination from outside debris.

Zero-Max Crown drives are used throughout dozens of industries in hundreds of applications. Available in many sizes and models, Crown drives are ideal for a wide range of horsepower, torque, and shaft speed requirements. Standard two- and three-way models are available with 1:1 and 2:1 speed ratios in shaft diameter combinations of 3/8, 1/2, 5/8, and 3/4 inch.

*Source: Zero-Max*

For more information,
go to www.zero-max.com

> "Zero-Max Crown drives are used throughout dozens of industries in hundreds of applications."

## Abaris and KVE Partner to Train European Customers

Abaris Training Resources Inc. in Reno, Nevada, and KVE Composites Group in Maastricht, The Netherlands, recently announced their exclusive collaboration for composite training for the European market. To better support European customers, Abaris and KVE have joined forces and together will provide the Abaris Training curriculum.

KVE will hold training classes in advanced composite repairs at its facility at Maastricht Aachen Airport. KVE will use Abaris Training course curriculum in both active classroom and workshop environments. Together, the industry-experienced instructors will provide European companies with cutting-edge composite training for their engineers, technicians, and inspectors working with advanced composites.

"This collaboration is a great opportunity for both parties to create more growth and to bring the Abaris Training standard to a worldwide audience," said Abaris CEO Michael Hoke.

The first European class, "Fabrication and Damage Repair — Phase I" was June 12-16 at KVE's Maastricht facility. Future European classes will be posted on the Abaris and KVE websites soon.

An Abaris technician repairs a composite panel. (Courtesy: Abaris Training)

*Source: Abaris Training*

For more information, go to www.abaris.com