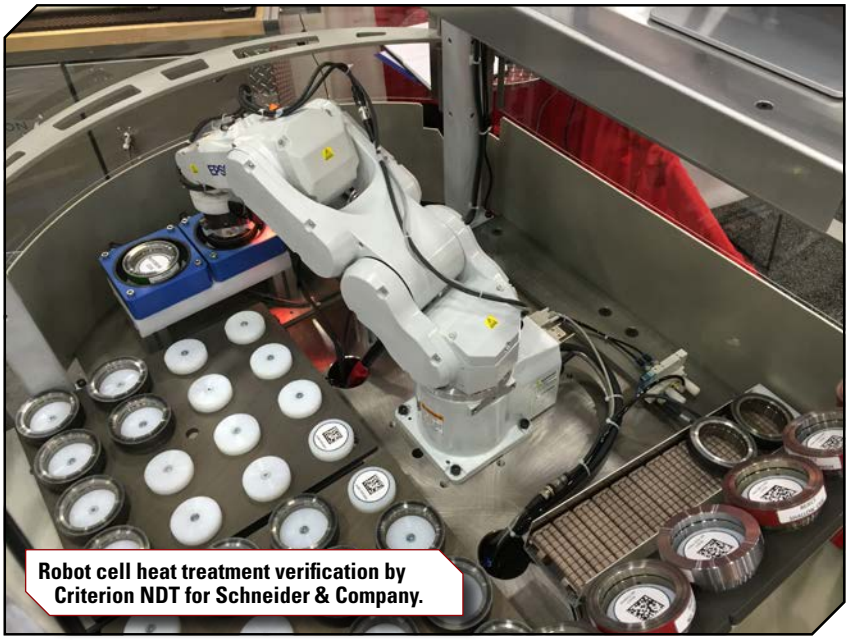
Facing the Future

A Look at Emerging Technologies in Heat Treating

Matthew Jaster, Senior Editor

The following article highlights some of the recent heat treat products, technologies and industry news articles for gear manufacturing. Topics include a technical article on induction heat treat advancements, a developing story on augmented reality on the shop floor and the use of automation and IIoT to liven-up eddy current inspection solutions. Just like general manufacturing, heat treatment is going through a variety of noteworthy changes and developments aimed at making it easier to manufacture and improve gear production. Learn more at *www.geartechnology.com*.



Robot cell heat treatment verification by Criterion NDT for Schneider & Company.

Criterion NDT

LOOKS TO AUTOMATION TO MEET THE CHANGING NEEDS OF GEAR MANUFACTURERS

Criterion NDT specializes in engineered eddy current inspection solutions for the non-destructive testing of critical or essential components. The company serves major automotive OEMs, tier suppliers, industrial products manufacturers, and medical device companies.

Criterion NDT offers single-channel and single-frequency instruments in addition to multi-channel, multi-frequency inspection instruments for more complex inspections. These eddy current instruments and probes have been developed specifically for the component test market, and are simple to incorporate into semi- or fully-automated systems.

Gear Technology recently caught up with Joe Jessop, president at Criterion NDT, Inc., to discuss the role automation plays in the inspection process for heat treating.

Meeting the Challenges of Gear Manufacturing Today

Jessop said there is a lot to consider when designing gears. A mechanical engineer will evaluate a multitude of application aspects, in order to ensure they provide an optimum designed solution. The dimensional calculations must be precise and should be expected when produced on CNC machines. The end goal is that each part manufactured will be physically identical, within some very small tolerance margin.

"Heat treating is one of the final key steps to ensuring a manufactured product will provide its end user the intended function, service life and potential safety requirements," Jessop said. "Automation of heat treating processes provides manufacturers and design engineers with the confidence that each of the manufactured products will result in a correct and consistent uniformity of every manufactured part, which meet the needs of the application as the engineer intended."

This is where Criterion NDT comes into play. Advanced eddy current (electromagnetic test) instrumentation is a key component of an automated heat treatment inspection system. The instruments provide intuitive user interfaces and essential industrial I/O to support automated testing of manufactured materials.

"Modern instrumentation features provide automated adjustments of product inspection limits, minimizing operator interfacing and human subjectivity in order to provide consistent, repeatable and impartial evaluation of each manufactured part. Proper implementation of this automated inspection technology can non-destructively test every part for correct heat treatment results, thereby reducing the number of parts that are destroyed in the lab," Jessop said.

This saves gear manufactures money by minimizing employee time gathering and cutting parts, reducing scrap and consumable materials expense, while ensuring improperly heat treat parts are quarantined before exiting the factory.

Improving Technologies

Jessop believes that leveraging advancements in robotics and the ever increasing power of computer processing, provides gear manufacturers with a range of faster and more precise automation system components. Continued improvements to ancillary devices also help to reduce the time and expense to manufacture a given part. Coupling the key system devices

with advanced subordinate controls contribute to automation stations production speed improvements, while reducing manual operations previously required for system setup/training and production.

"For example, an automotive transmission gear can be evaluated for heat treatment in less than 200ms after eddy current sensor engagement. The use of robotics for system setup (loading and unloading of gear components) removes operator interaction, thereby increasing setup time with real world operational conditions," Jessop added.

The end goal is ensuring that the eddy current instrumentation Criterion NDT develops provides thoughtful and flexible communication methods and protocol solutions. Working closely with regional machine builders ensures gear/component manufacturers have a responsive local source for any systems support needed. Jessop said that accessibility, application customization and responsiveness provide Criterion's customers with a unique and welcomed systems solutions partnership.

Bridging the Skills Gap

The skills gap is still a hot topic across every facet of manufacturing and automation is no exception. So how are manufacturers filling the void left by employees that have been running these shops for 25 to 35 years?

"What I've witness during my system installations & training at manufacturing companies is that younger engineers are assigned to one or more of production lines, consisting of one or more high-end automation systems. While this new generation demonstrates the ability to easily comprehend new concepts and complex systems, the rate of employee turnover has appeared to increase due to workload burnout," Jessop said.

Recognizing this new normal of high turnover, Criterion NDT has made a decision to take an often misunderstood technology with overly complicated instruments and make them more intuitive. "This makes the training and operation much easier for the newer individuals as well as their occasional interaction with the instruments during regular production," he added.

The company is also looking into IIoT solutions that can provide additional benefits when it comes to productivity and training. "This is an area that is providing some exciting opportunities for manufacturers, which we are anxious to explore," Jessop said. "We will remain open and adaptable to our customer's needs as they arise."

Competition continuously drives innovation, Jessop said. "Evolution specifics are hard to pin down, but I think it's a safe bet saying that there will always be incremental changes providing the end users with something a little faster, more reliable and cheaper to operate."

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Gears and test coils that were part of an automated water pump assembly station. Eddy current test instrumentation and coils then confirmed heat treatment in advance of pressing the gears onto the water pump shaft.

Experience Pays Off

Criterion NDT's team of applications engineers has the know-how to develop solutions to meet inspection requirements. One example was a transmission gear supplier that was shipping gears that were too soft, resulting in transmission failures. The gear supplier was forced to pay the automobile manufacturer for the entire cost of the failed transmission.

The solution was for the gear supplier to install an InSite HT eddy current test instrument and encircling coil downstream from their induction hardening system. The InSite HT simultaneously tests components at eight unique frequencies, helping it to capture multiple failure modes.

The InSite HT is very easy to set up. Known good components are used to develop the heat treat testing standards. The data captured from the good components automatically creates acceptance thresholds for all eight frequencies. The components under test are compared to these acceptance thresholds. Testing times of less than 1 second per part are achievable, making it easy to install in a production line.

The InSite HT has full industrial I/O capabilities, enabling it to interface with material handling systems. The system can be set up to send alarms on consecutive rejects, indicating that there is a process issue on the production line. These could include power failures or bent/damaged induction heating coils. Plugged cooling nozzles can also cause an improper quench which, depending on the severity of the reduced flow, could result in improperly heat treated parts.

Another example was a powder metal fuel pump manufacturer required an in-line hardness test to provide results comparable with those from Rockwell hardness testers. The system had to inspect 100% of the parts and run two lines simultaneously. Parts to be tested included 15 star sizes, 10 ring sizes and three lobe geometries for each size. The test had to be easy to

configure with minimal set-up changes. The goal was to reduce production scrap and warranty costs.

The manufacturer installed a multi-frequency eddy current test system downstream of the heat-treat furnace. The system included a multi-channel, multi-frequency eddy current instrument, two eddy current hardness testing coils (one for stars and one for rings), and two sorting stations (one per lane). This provided 100% component testing up to 60 parts per minute, with the ability to physically reject out-of-tolerance components.

While eddy current testing is typically used as a go/no-go test, we were able to develop a close correlation between a measured Rockwell hardness (HrB) and the eddy current results. In an initial sample test, the eddy current test results and actual Rockwell hardness readings are compared.

From this initial test the correlation between Rockwell hardness and eddy current was very good, showing only about 1~3 HrB points variation. Eddy current readings (solid blue line) tended to show a more consistent value when compared to the Rockwell readings. During a subsequent production test, the Rockwell hardness readings were accurate to ±1.0 HrB while the eddy current test provided more consistent results.

For these and other case studies visit *criterionndt.com*

Inductoheat's Dr. Valery Rudnev received two awards at the ASM International Thermal Processing in Motion conference.

Dr. Valery Rudnev

RECEIVES TWO PRESTIGIOUS HEAT TREATING AWARDS

Dr. Valery Rudnev was recognized during the opening ceremony of the American Society for Materials (ASM International) *Thermal Processing in Motion* conference. Dr. Rudnev, director of science and technology at Inductoheat Inc., an Inductotherm Group Company, received two prestigious awards for his contributions in the field of induction heating and heat-treating.

Dr. Rudnev was elected as a Fellow to The International Federation for Heat Treatment and Surface Engineering (IFHTSE), "*For his preeminence in induction heat treating and modeling of the induction heat treating process*" (IFTSE, 2018). IFHTSE is a nonprofit group of scientific/technological societies and associations, groups and companies and individuals whose primary interest is heat treatment and surface engineering. Dr. Valery Rudnev is also Fellow of ASM International and considered by many to be one of the leading global figures in the induction heating and heat-treating industry. He has more than 30 years of experience and is known among induction heating professionals as "*Professor Induction*." His credits include a great deal of "*know-how*", more than *50 patents and inventions* (U.S. and International) and more than 250 engineering/scientific publications.

Dr. Rudnev was also presented with the ASM International "Best-Paper in Heat Treating" award for co-authoring an article entitled "*Revolution — Not Evolution — Necessary to Advance Induction Heat Treating.*" The article was published in the September 2017 issue of *Advanced Materials & Processes Magazine* (HTPro quarterly newsletter), and co-authored by Gary Doyon, Collin Russell, and John Maher. The ASM International Heat Treating Society, Research and Development Committee, established this award to recognize the best papers in the heat treat industry each year. To be considered, papers must appear in either the HTPro quarterly newsletter or be published in ASM's Heat Treat conference proceedings. Papers are judged on several criteria including production readiness and breadth of potential applications.

Over the years, Dr. Rudnev has contributed a number of publications for ***Gear Technology*** magazine.

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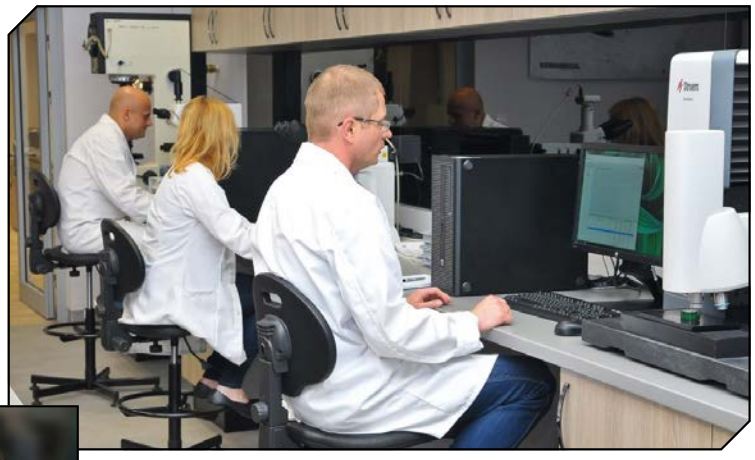
Seco/Warwick

DEVELOPS AUGMENTED REALITY TECHNOLOGIES FOR HEAT TREATING

Augmented reality (AR) and virtual reality (VR) are two technologies that are often mentioned simultaneously and often confused. VR and AR are approaches of different but similar formats. What is the difference between them? Virtual reality (VR) replaces the real one, cutting off the user from the environment. AR is a technology that enriches its experience, supporting the real world with artificial images, sounds or other stimuli, and Seco/Lens is based on this technology.



Seco/Lens is an application that, based on Microsoft holographic computer — HoloLens, introduces heavy industry into the world of augmented reality. Slawomir Wachowski, director of the automation department at Seco/Warwick created the solution as a way to blend digital components—sensors, displays and data processors—to real manufacturing environments.

Slawomir Wachowski created the Seco/Lens technology at Seco/Warwick.

Seco/Lens can superimpose previously developed 3D models of the device for heat treatment of metals enabling its monitoring, diagnostics, maintenance of the production process, remote repair and planning the most optimal layout of the production line on the hall.

Seco/Lens will allow for a very accurate visualization of Seco/Warwick solutions, as well as for conducting training on the operation of the device without the need for expensive and time-consuming travel. With this technology, a service engineer can check and verify equipment from his desk across the globe. Seco/Lens presents an efficient and accurate means to conduct remote repairs and equipment monitoring.

This is just one of many R&D projects that Seco/Warwick is investing on a national and global level to promote new heat treat technologies.

In 2016, the company launched Seco/Lab, a state-of-the-art metallographic laboratory to conduct its own, unique research and carry out full metallographic tests and develop the acquired or purchased technology, as well as expansively invest in new production undertakings around the world.

The metallographic laboratory at Seco/Warwick is divided into two areas. The first one conducts preliminary work, i.e. prepares material for studies. The research area, on the other hand, conducts analyses of the prepared samples. The Seco/Warwick R&D department is not just about technological trials or the metallography laboratory; it also provides design support using specialized computer software. The new office space serves to carry out computer simulations using the *ANSYS* application, which is based on the finite element method (FEM).

Using the *ANSYS* software the company is able to model the distribution of temperatures, flow speeds, pressures, as well as distribution of stress, deformation, etc. Numerical analyses contribute to significant reduction in design times, as well as costs. They are an excellent tool which enables to develop and optimize the construction of their equipment, without the need to build expensive and complex physical models. The use of CFX and Mechanical modules significantly extends the range of research capabilities of the Seco/Warwick R&D department.

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