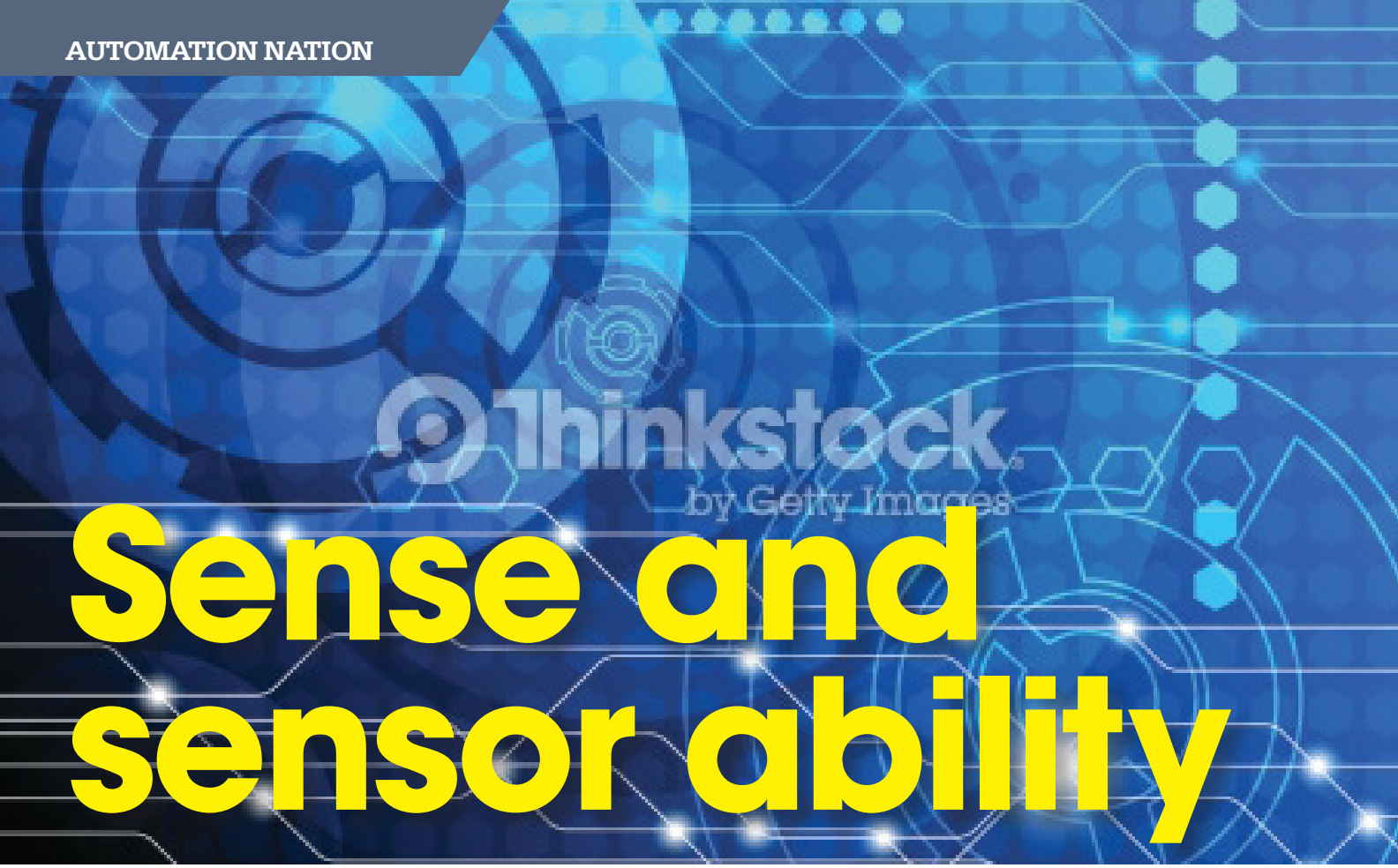


# Sense and sensor ability

**Process automation is becoming more important for the steel industry, as many varieties of inline sensors are starting to allow for real-time information and, in some cases, automatic regulation based upon an individual steelmaker's critical manufacturing parameters.**

Today's steelmakers are becoming increasingly reliant upon sensors not just to produce the highest-quality steel possible, but to do so in the most efficient, cost-effective manner.

"The modern steel mill can't function without the use of sensors to help them monitor its production process," according to Chris Burnett, technical product manager for flat sheet gauging for metals applications, at Thermo Fisher Scientific, Waltham, Mass. He is also chairman of the sensor systems subcommittee of the Association of Iron and Steel Technologies (AIST).

In general, process automation is becoming more important for the steel industry, Rebecca Dettloff, marketing manager for SensoTech GmbH, said. She noted that many inline sensors, including the inline liquid concentration sensors that SensoTech makes, allow for real-time information, and in some cases automatic regulation based upon the steelmaker's critical parameters.

"Simply put, sensors help steel producers achieve the desired quality and performance required by the many applications that steel fills in modern society," Sean Marlow, a plant electrical maintenance engineer for Steel Dynamics Inc.'s (SDI's) flat-roll division in Butler, Ind. Additionally, he is the chairman of AIST's electrical applications technology committee.

He said sensors are used in every stage of the steelmaking process. This spans the iron ore mines and scrapyards that provide steelmaking raw materials to the blast and electric-arc furnaces producing the hot metal, through its casting, rolling and finishing operations and the labeling and packing of the final product.

This, Marlow said, includes a multitude of non-contact sensors that use technology rooted in electromagnetic fields, radiation detection, piezoelectric effects, laser scattering and interference and acoustics, as well as optical sensors utilizing the full spectrum


SensoTech provides key technological innovations to help metals makers control processes.

of light, ranging from ultraviolet to visible to infrared wavelengths.

These sensors are used to collect a wide variety of data, including temperature, mass, pressure dimensions, flow, moisture, line speed, thickness, vibration, chemical composition and more.

"As steelmaking technology has evolved, that has necessitated that sensor technologies evolve with it," Burnett said, explaining that modern steelmaking not only relies on sensors to optimize the production process but also to ensure that companies provide the quality and properties that their customers require. He said this has become more and more challenging with the development of more sophisticated grades of steel, such as the advanced, high-strength steels being increasingly used by the automotive industry.

The data that sensors collect also helps steelmakers keep their costs down. It not only ensures that they aren't wasting raw materials, Dettloff said, but could help them minimize scrap generation. With real-time adjustments during the production process the steel is more likely to be produced within the desired specifications, yielding a good product at the end of the process.

Increases in quality and cost savings often go hand in hand, Amy Woods, a galvanized product metallurgist for SDI's flat-roll division, said. She pointed out that when sensors feed real-time information either directly into the programmable logic controller (PLC), which in an automated fashion causes equipment to make operational changes, or to the equipment operator, that could reduce the amount of steel being produced with a certain defect. These could include being of the wrong thickness or the wrong coating weight, which could necessitate the product to be downgraded and/or scrapped, and to be reproduced.

"We want to make the necessary changes as quickly as possible as it is much better for us to be able to crop out a small portion of coil that isn't within customer specifications than to realize the problem after we have already run a whole coil or several coils," Woods said.

'There are more modern, interactive tools (for) steelmakers' growing needs.'

**Stefan Koch, SensoTech GmbH**

Dettloff said it is a similar situation when monitoring liquid concentrations—such as the acid in the pickling bath or regeneration process, oils used in the cold-rolling process, or the zinc salt, chrome acid and sulfuric acid concentrations during the electro-galvanizing process. If levels either exceed or go below the tolerance ranges set by the steelmaker, the sensor automatically sends a signal to the process control system to make the appropriate adjustments.

The data generated by sensors could also help steelmakers increase customer satisfaction, Stefan Koch, the global metals industry lead for the industry business unit of SAP SE, Walldorf, Germany, said.

"When steelmakers are able to produce their products in a more reliable manner with less deviation and fewer disruptions, they are also able to deliver their products more reliably," he said. He added that sensors and the data that they provide could also help steelmakers to provide more timely feedback to their customers about the production status of the products that they are expecting.

The sensor data could also help the steelmaker with equipment maintenance, SDI's Marlow said. "By seeing what is going on with the equipment in real time, as well as by putting the continuous stream of data that the sensors generate into a database, we can sometimes see that something could possibly be about to fail even before it fails," he noted.

By setting up certain operational levels that would be considered to be optimal, the steelmaker can perform preventative maintenance ahead of time as opposed to running the mill until something breaks, which is what some steelmakers might have done in the past.

Sensors also help to keep the steel mill safer, by monitoring if workers are entering some potentially dangerous production areas and even potentially stopping the line should that occur, Woods said.

"It is amazing how many sensors steelmakers use today," Marlow said. "Practically every piece of equipment is being monitored to one degree or another."

Still, given that the steel industry tends to be very conservative, the development of new sensor technologies aimed at the steel industry has been more of an evolution than a revolution, Manfred Muenzl, global industry manager for metallurgy at Germany's Balluff GmbH, said.

That said, Muenzl agreed that the steel industry has been relying on the use of sensors for the collection of the Big Data that they need to control and improve the steelmaking process for some time, and that their use has been increasing. But that is not always all that easy to do in the harsh environment of the steel mill.


"As the steel industry deploys more sensors in the pursuit of greater automation and data gathering, they have to be careful that they don't create reliability problems while doing so," according to Henry Menke, marketing group manager with Balluff Inc., Florence, Ky. Therefore, steelmakers can't just use a sensor that, for example, was designed for clean application, such as for the food packaging industry, and expect that it would survive very long.

"Also, the proper deployment of sensor technology is very important to ensure that they are not affected by such adverse conditions as corrosion, water, steam, heat, mechanical impact and dirt," Menke said.

It is for this reason that while in general sensors have been getting smaller, that is not necessarily the case with those used for steelmaking, Dettloff noted.

"Given the harsh conditions in a steel mill, it is more important that the sensors are robust than small," she said. "That way they can have a longer lifetime."

There have been inroads in making sensors more robust and more efficient, including the production of sensors that could be used in higher-temperature environments. SAP's Koch said that currently long-term sensor use is largely limited to temperatures below 600 to 700 degrees Celsius (1,112 to 1,292 degrees Fahrenheit), but there is currently some ongoing basic research being conducted to change the physical abilities of the sensors. He said that even some current technology sensors are being used short term in certain hotter applications, such as electric-arc and blast furnaces.

"They might only survive a couple of seconds, but in that time frame they can transmit precise data about such things as temperatures or chemical composition in places where sensors could not otherwise be used," Koch said.

Also, the reliability of sensors has gotten better. Marlow said that in turn has meant increases in mill uptime, which is a big positive for steelmakers. "Even just improving uptime a percent over the course of the year translates to a lot of time and time is money," he added.

Balluff's Menke agreed. "Steelmaking is a continuous process, so steelmakers need to keep running correctly to make profits," he said. "A perfect day is when perfect-quality steel is produced and there weren't any slowdowns or breakdowns of equipment while doing so. That is something that sensors and the data that sensors collect can help them achieve."

Burnett said there has also been some advancements as far as the cameras used for optical sensors, as well as certain changes in materials used, such as increased use of rare earth materials in some accelerometers, but in general technology advancements for the sensors that steelmakers are using have been fairly nominal.

Koch also observed that multipurpose sensors, or the bundling of several different types of sensors, are being increasingly used to collect several different kinds of data—such as temperature, vibration and density—at one point in the production process.

"Any extra data that a sensor could collect and transmit is a big positive to steelmakers," Muenzl said. But the challenge is how to transmit all this data, he added.

Increasingly, operators can remotely connect to the controller, allowing access to a readout of the measurement data from a workplace or laboratory computer, Dettloff said, noting that by using a safe, remote connection, the operators can even connect to certain sensor producers' controllers. "This also enables us to provide immediate support to the customer, including helping them to configure the controller or to give other help with any issues," she said.

Menke said that there are also new technologies, such as Balluff's IO-Link, which remotely provide bi-directional communication between sensors, actuators and other field devices and the company's controller that not only makes transmission of data easier, but can remotely configure or reconfigure universal sensors that have the capability to collect different types of data.

"This is having a huge impact upon equipment maintenance," he said. Instead of a maintenance person having to find the proper sensor and looking up what the procedure for setting up that new sensor is, including what the proper measurement range would be—all of which takes time—such steps could be eliminated.

"But with this new technology you can have automatic parameterization, so you can just install the sensor, make the connection and the parameters are loaded right from the control system into the sensor. It is foolproof," Menke asserted.

But there could also be a downside to such remote technologies and other aspects of what has become known as the Internet of Things, with every device having its own Ethernet or IP address, Burnett maintained.

"If you have the ability to control something remotely through the Internet, that means that someone else could also attempt to maliciously control things, potentially causing some problems," he said. He noted that producers and process engineers are becoming increasingly concerned about the security aspect of sensors.

"As the Internet of Things permeates our world, the security standards of the sensors being used, and action to make sure they aren't corrupted, is becoming more critical," Burnett said. "It could make some steelmakers take a step back and say that no matter how wonderful this wireless technology is, they might consider being hardwired to get direct information point to point for certain critical parameters."

Likewise, there are challenges when it comes to evaluating the data collected by sensors," Woods said, noting that while steelmakers have good systems to save the information that are generated by sensors and to retrieve that data when needed, "you really have to know what you are looking for."

She said that recent advancements in analytical tools help. This is why one thing SDI is looking into as it seeks to upgrade one of its galvanizing lines is not only evaluating the monitoring capabilities of the new equipment it is planning to buy and the ability to capture more data to be put into its database, but also to upgrade its data analysis tools to ensure that the company will be able to better utilize the data that is collected.

Thermo Fisher helps drive modern steel mills.

With advances in computer technology and memory, companies are now able to hand more data and better analyze that data than they had been able to do so in the past, SAP's Koch said.

"There are more modern, interactive tools to help steelmakers to slice and dice their data to fit their growing needs," he said, adding that recent technology has enabled them to more easily and more quickly create simulations of their steelmaking process. He noted that when such simulations are able to be created in real time, it is very helpful to equipment operators as it allows them to be very interactive with the sensor data, even with the high amounts of data being generated. "This is something that wasn't possible in the past."

Looking forward, the use of sensors throughout the steelmaking process will only increase, Menke said. This includes sensors being used in places where vital data can only be collected manually today, enabling a greater amount of data to be collected for process improvements, as well as greater cost control and increased predictive equipment maintenance.

With companies increasingly looking to harmonize and structure both internal and external data, Koch predicts that within the next five to 10 years fully automated steel production could become possible as steel engineers become increasingly able to bring more and more data from the physical world into the virtual world.

"It is the dream of many companies to be able to have black box production, where operators could sit outside and watch the steel lines run on their own without any interference of human beings," Koch said. But while he believes this is possible, he admitted it will take time before it becomes reality.

**MYRA PINKHAM**