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US steelmakers widen range

Myra Pinkham highlights how American steelmakers are embracing new technology to develop an increasing range of grades of innovative finished products

Innovation continues to be a big focus for the US steel industry, which is not surprising given both the challenges and the opportunities that the industry is facing.

"The demand for high-strength automotive steels continues to drive advances in both process and product," Ronald Ashburn, executive director of the Association for Iron & Steel Technology (AIST) says, explaining that with US steelmakers collectively operating at or below 75% of capacity, the pressure is on for them to move product portfolios up the value chain, necessitating investment in research and development.

"We don't have much choice but to invest in technological innovations given external threats, such as imported steel and competing materials, and structural limitations of older, so-called legacy, assets, which weren't designed with the future in mind," says Carlo Travaglini, director of technology for Tampa, Florida-based Gerdau Long Steel North America. "We have to invest to be more productive."

At the same time in this traditionally conservative market, there continues to be some resistance to making changes, he points out. This is both because they tend to be very capital intensive and because it tends to be tricky justifying moves that could increase production capacity at this time when many steelmakers have assets that are underutilised. "Because of this we aren't carpet bombing. We are selecting the projects with the best returns."

AK STEEL

The new hot dip galvanizing line that AK Steel has installed at its Dearborn Works

Technological changes are aimed at finding ways to make steel more efficiently with less energy consumption and doing so at a lower cost in an effort to be more competitive, observes Jody Hall, vice-president, automotive at the Steel Market Development Institute (SMDI) of the American Iron and Steel Institute.

"The beauty of this phase of the evolution of technology is that we can probably access cheaper solutions that are very flexible, even in existing installations," Travaglini says.

To do this, steelmakers are working more closely with their customers to understand what their current and future needs are and how they can help to meet those needs, Meghan Cox, a spokeswoman for Pittsburgh-based United States Steel says: "But the process of doing so has been changing."

She explains that while in the past such requests came from customers, particularly original equipment manufacturers, now steelmakers are looking to lead the way by developing new materials even before customers ask for them. This, she says, comes after collaborating with them to determine what their current and future needs are and how to best service them.

The automotive market

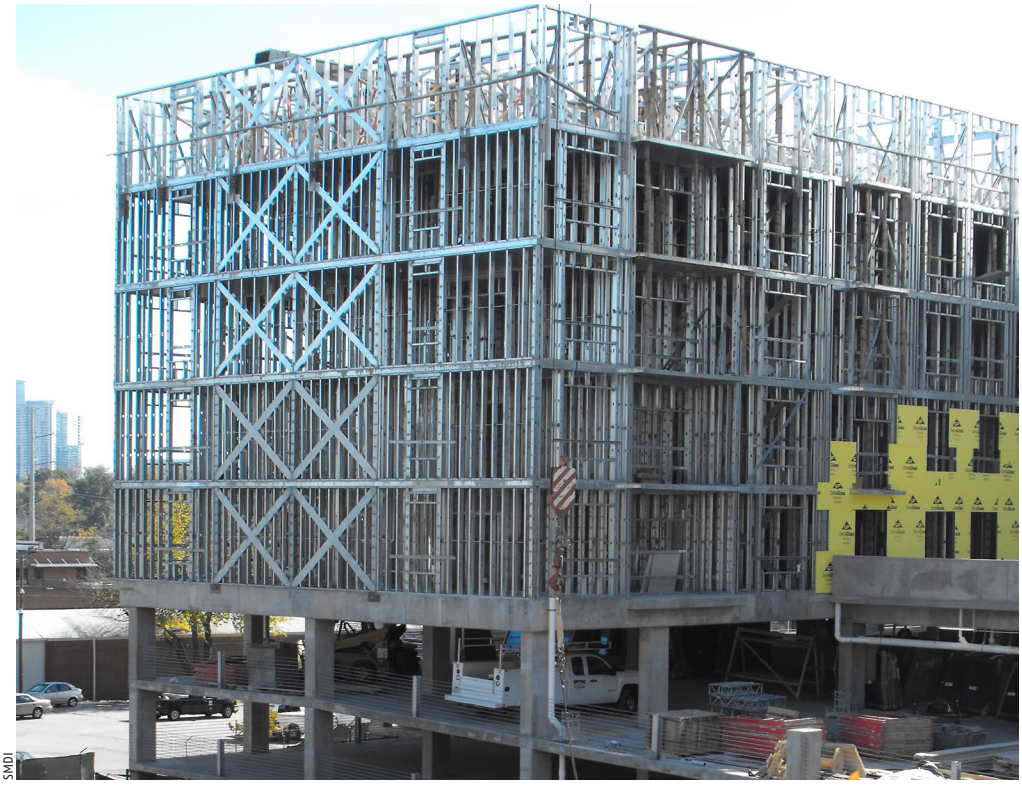
One big push aimed especially at the automotive market has been in the development of high-strength, advanced high-strength steel (AHSS) and ultra-high-strength steels. This, Hall says, includes continued work on third-generation AHSS that are not just

very high-strength, but have more ductility and formability so an OEM could design and stamp parts with complex geometries to enable them to function better in a vehicle. "And when you do that with room temperature stamping, you can do it more cost-effectively than with other manufacturing methods."

Ashburn says that an important development in the evolution of these advanced steels has been the use of sophisticated modelling techniques to predict how parts will behave during manufacturing and subsequent application. "These steels are complex and their microstructures can change with temperature and applied force. Through advanced deformation modelling, we continue to evolve the dynamic properties of steel to identify ideal component geometry for improved manufacturing efficiency," he says, maintaining that because of this the industry has entered into a new frontier for AHSS solutions.

This comes as the SMDI has just completed the four-year, $8 million Integrated Computational Materials Engineering (ICME) for Third-Generation Advanced High-Strength Steel project funded by the US Department of Energy, aimed at developing third-generation AHSS supported by computer-simulated materials modelling. Hall says that the project resulted in the development and predicted mass reduction and crash performance of two grades of third-generation AHSS, one of which has 1,200 MPa tensile strength with 30% elongation and the other a tensile strength of 1,500 MPa with 20% elongation.

One company that had a key role in the ICME project as well as making inroads in its proprietary research is AK Steel Corporation, Middletown, Ohio, which not only has increased the number of its new technology projects four-fold over the last three years, but a bigger percentage of those projects are market-leading versus market-following projects. Eric Petersen, the company's vice-president of research and innovation, notes that this has been supported by its new Middletown, Ohio, research and innovation centre, which was officially opened in April.



SMDI

The Steel Market Development Institute is looking at ways of using high-strength cold-formed steel in construction projects

New innovations include the introduction of several high-elongation, high-strength steels, many of which fall into its NEXMET family of products. This includes its NEXMET 440EX, which Petersen says allows OEMs to increase the strength of exposed automotive panels, therefore enabling them to lighten the weight of those panels, without affecting the distinctness of image, or surface quality, that consumers desire. He says that this steel grade, while not an AHSS, is about 20% higher strength than other steels that are currently used for exposed automotive applications.

AK Steel also delivered the first samples of its NEXMET 1000 and NEXMET 1200, which Petersen says is a next-generation AHSS, to customers in April. He says that even though NEXMET 1200 has 1,200 MPa tensile strength, double the strength of that of dual-phase 600 MPa steels, it still outperforms it when it comes to formability. "It provides an outstanding opportunity for automakers to lightweight components by about 30%."

NanoSteel NXG 1200, which AK Steel developed in partnership with NanoSteel Co., is a third-generation AHSS with 1,200 MPa tensile strength and over 50% elongation, which Petersen says is an unheard of combination of strength and formability. AK Steel delivered its first NanoSteel product to automotive customers last year. "Basically, it gives you the strength of a rail with formability that is even better than something that would go into a quarter panel or a fender," he explains, adding, "Automotive designers never had anything like this in their toolbox before," enabling them to consider new component geometries and shapes.

As the NEXMET steel grades could be incorporated into existing vehicle designs, Petersen says they are likely to find their way into automobiles quickly.

AK Steel is not alone in such advanced steel grade innovation. Ashburn notes that in November ArcelorMittal, which has invested in its Calvert, Alabama, mill to enable it to make third-generation, cold-stamping AHSS products, announced additions to its AHSS portfolio. "Also Nucor is on the

hunt with plans for its speciality cold mill in Arkansas and other recent special bar quality (SBQ) enhancements at its bar mills," he observes.

New product innovations

Other SBQ producers have also had notable new product innovations. For example, TimkenSteel Corporation, Canton, Ohio, commercialised its Ultrapremium SBQ steel, which Ray Fryan, its vice-president of technology and quality, believes to be the cleanest, most consistent air-melt product on the market and a more cost-competitive option for producers of gear systems versus more expensive vacuum-melted grades. Fryan says that one customer is already actively using this new steel while about a dozen others are engaged in active trials.

He attributes the anticipated success of Ultrapremium to not only the company's production process and the control of it, but the ability to verify the results of that process helped by the availability of new, high-end scanning electron microscopes, a mini-version of big data processing and access to analytics that are able to convert that data into a form that is meaningful for component designers.

Luis Colembergue, vice-president of sales and technology, says that Gerdau Special Steel North America has also made "significant strides in sustainable steel cleanliness" through enhanced melt practice developments and strict process controls at its new continuous caster in Monroe, Michigan. This, he says, includes the development of clean steel practices to reduce the size and frequency of inclusions in its bearing quality steel.

In addition, he says that the company is also seeing more interest its Mecamax product, which he says offers customers enhanced machinability, and has completed several trials with positive feedback for its Nanocem high-temperature carburising technology.

Alberto Voltolina, vice-president of sales for Danieli Corporation North America, says another example of a recent bar innovation is the company's Rotoforge technology, which is capable of producing forging-quality heavy SBQ sections using a rolling mill. This, he says, is something that was impossible in the past and which is very advantageous given that it could produce 80 to 100 tph of steel as opposed to 10 to 30 tph for forged products. He says it also allows for faster changing from alloy to alloy versus a forged product, which is very advantageous for SBQ.

"Another thing that a lot of bar producers are doing is adding more vertical capabilities," says David Anderson, SMDI's senior director of automotive long product programmes. "After they roll the billet into a final product, they are taking it further into the processing value chain by doing heat treating, quench and tempering, grinding, straightening or cutting so they could ship it directly to the customer." This, Anderson says, allows them to have more quality control throughout the process while being an opportunity to provide their customers with a value-added product.

AK STEEL

AK Steel will be developing new types of AHSS at it newly opened research and innovation centre in Middletown, Ohio

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Beyond automotive

Other steel end markets than just the automotive industry are also benefiting from technological advances. For example, AK Steel's Petersen says that technologies related to electric steels are focused on increasing the energy efficiency of transformers for the electric grid as well as on moves to develop next-generation motors and the further electrification of hybrid and electric vehicles. AK Steel's Thermax 17 and Thermax 22 steels were developed to handle the higher temperatures and higher levels of corrosiveness in recent smaller engines.

He says AK Steel has recently been awarded a $1.8 million grant to work with the US Department of Energy on a three-year project for its Next Generation Electric Machines programme to develop a new high-alloy, non-oriented electrical steel to provide a greater than 30% boost in the energy efficiency of motors for industrial and automotive applications, including for hybrid and electric vehicles.

"It is too soon to know what the not so quiet revolution in the electrification and autonomous vehicle technologies will mean to steelmakers," Fryan says. "We are watching this with great interest and want to be in a position to participate."

He says TimkenSteel has also been researching high-strength, high-toughness steels that are also highly corrosion resistant to be used for sour service applications in the oil and natural gas sector.

Robert Wills, SMDI's vice-president for construction market development, says that SMDI has been investigating ways to possibly repurpose some high-strength automotive steels or automotive steel production processes, such as stamping, for the construction sector. He says that to date very little cold-formed steel is stamped, but that there is no reason that certain construction products, such as headers, doors and windows could not be stamped.

Also, it could be beneficial to use certain high-strength steels to allow metal roofs to be stronger and even

more hail resistant. It would be unlikely that this would apply to the newest AHSS steels, Wills admits, but rather certain high-strength steels that were developed 10-15 years ago but that have not yet made their way into construction applications.

Wills says SMDI has also continued to make headway in the steel press brake tub girder technology for short-span bridges (under 100 feet in length) as a quicker, more cost-effective alternative to precast concrete bridges. He says that steel press brake tub girder bridges cost about 25% less than a concrete bridge and could be installed in a few days versus a few months. Several demonstration bridges have been erected with more planned later this year.

New mills, new technology

New greenfield steel mills also incorporate the newest technologies. In fact, EAF-based Big River Steel LLC, which is ramping up production in Osceola, Arkansas, has described itself as a technology company that just happens to make steel, as well as being a Flex Mill™.

"Since our inception we have been focused on combining the best of integrated and mini-mills, providing us with the flexibility to make products that before only integrated mills could tackle but with the benefits of a more nimble mini-mill," says Mark Bula, its chief commercial officer, adding that this has been made possible by its technology package, which includes an RH degasser.

He says Big River is also partnering with its equipment supplier, SMS group, to develop a "smart mill" that will learn as it produces steel. "The combination and connectivity of software, data and equipment will allow the mill to identify and correct production issues, so a chemistry out of range in the ladle metallurgical furnace can be brought into range by the mill adjusting through the caster or the rolling mill – all with little manual intervention," Bula explains.

Similarly, there are technological advancements at Commercial Company's (CMC) new rebar micro-mills, including the one it is building in Durant, Oklahoma, including its endless continuous casting technology and its capability to produce spooled rebar.

Coated steel products have benefited from innovation

NUCOR

Danieli's Voltolina says that other companies could recreate some of the benefits of such a micro-mill without building a whole new mill by just adding such equipment as a welding machine and a spooler line, which allows the production of five-tonne compact coils, at their existing mills.

AIST's Ashburn observes that the US steel industry is also continuing to see advanced technologies, including the utilisation of a variety of sensors, robotics and event-prediction analytics within the typical steel plant environment.

"Robots have been – and will continue to be – deployed in all hazardous areas and for repetitive tasks with temperature and chemistry sampling of molten metals being a prime example," Ashburn says, adding that they are good at completing steps in a process. For example, Nucor-Yamato Steel (USA) recently ordered two Danieli Telerobot Labs Q-Robots for its Blytheville, Arkansas, ladle furnaces.

"And now we're seeing an evolution of machines being able to manage an entire process via artificial intelligence making the person-less meltshop almost a reality," Ashburn concludes.

"Looking forward steel innovation will continue to be critical, including collaborative precompetitive innovations," SMDI's Hall says. Gerdau's Colembergue agrees, noting as steel industry requirements get more and more difficult to achieve, there will be the need for new technologies and the development of new grades of steel.