In the steel plant of the future, the complexity of hot and cold rolling becomes more easily manageable. Smart sensors, a new generation of digital process models, and better cooling technologies all contribute to a higher and more consistent end-product quality.
In 2010, a brand new idea for a novel type of cooling model triggered a wealth of activities geared toward an implementation in the years to follow. In its current form, the model is designed to use a comprehensive thermo-dynamic approach, starting at the roughing mill and calculating strip temperature, phase content, and microstructure in real time from the roughing stand to the coiler.

The process model not only controls cooling units but also allows for the control of the booster pumps for Power Cooling and the water-management pumps. The fact that the cooling model always knows in advance how much water is going to be needed has two major benefits: Large amounts of water can be controlled with unequalled dynamics, and efficient control of pumps and water can lower production costs.

Another highlight is the comprehensive temperature control for the transfer bar, final strip, and coiler. Based on measurements of pre-strip temperature after the roughing mill, the cooling model predicts subsequent rolling temperatures and controls the speed of the finishing mill with an optimized speed diagram. Since the future rolling speed is thus a known factor, it can improve the accuracy of the values for the final rolling and coiler temperatures—above all for thick strip, where dead times are especially long.

Together with the mechanical equipment from Primetals Technologies—cooling aggregates are fitted with continuous-control valves and pumps with vector control—the new cooling model forms a cyber-physical system. It lowers production costs by reducing the need for alloying elements and energy, increases throughput as well as quality, and opens up new possibilities for the production of advanced steel grades.

The main challenges facing today’s basic and process automation systems for hot-strip mills are the reduction of strip-width deviations and the avoidance of below-minimum widths after the finishing mill, which is why Primetals Technologies has developed model-based strip-width control. Recognizing that tension can be used to manipulate the strip width in the finishing mill, model-based width control compensates for width deviations.

Width deviations are measured in front of and after the finishing mill. Entry-width deviation and width deviation due to inhomogeneous temperature distribution along the strip are reduced by a feed-forward width control (FFWC). The residual exit width deviation is reduced by a feedback-width control (FBWC). Moreover, the model-based feed-forward width control takes account of the effects of width spread in the roll bite as well as creep deformation between the stands. Effective width-deviation compensation using tension control is limited to low-frequency width deviations.

By default, the strip width in a hot-strip mill is determined by edging and rolling the strip in the roughing mill. The width deviation after the finishing mill arises from the width deviation in front of the finishing mill and from width-spread anomaly occurring inside the finishing mill. The behavior of width spread in a finishing mill depends on effects in roll bite and on the creep deformation between the stands, whereby the width spread in roll bite is influenced, for example, by thickness reduction, front and back tension, and the change-of-strip-crown ratio. The creep deformation between the stands depends on factors such as yield stress, strip temperature, specific tension, distance between stands, and strip speed.

Essential measuring instruments for FFWC and FBWC are standard width measurements located respectively after the roughing mill and finishing mill. In the case of a large product mix with different entry-strip temperatures to the finishing mill, a temperature measurement in front of the finishing mill improves the performance of the FFWC. The signal processing of the exit width of the roughing mill is an important component of the FFWC. It tracks the actual filtered exit width and the reference exit width of the roughing mill at the entry of the finishing mill for the FFWC.

The model-based approach ensures better strip quality and therefore improved productivity due to the decrease of overwidth. There is less off-gauge, with decreased areas close to minimum width through the reduction of reference tensions in the finishing mill, and the overall result is increased product tonnage.
Rolled strip is ideally both straight (i.e. without camber) and left-right-symmetrical with respect to thickness (i.e. without wedge). Unfortunately, if wedge within a slab is removed through swiveling of the roll stack without further countermeasures, the result is camber, which—from a quality point of view—is even worse than wedge. The wedge and camber control solution from Primetals Technologies combines a number of technologies to tackle the problem: it uses cameras to obtain reliable readings of the strip’s position, measures thickness across the width of the strip, uses precise process modeling for both the roughing mill and the finishing mill, and utilizes the edger as a straightening machine. As a result, wedge is reduced to a minimum, and camber formation is avoided altogether—as are cobbles while threading and tailing out.

In order to control both wedge and camber, several components of the solution are ingeniously interlinked. First, the model-aided slab-to-slab swiveling in the roughing train reduces wedge at a point where there is still enough lateral material flow. Any camber that might result from this is straightened by the edger on the reversing pass. Second, a camber-measuring device placed after the roughing mill not only delivers data on camber, but also on the possible formation of hooks on the head or tail. Third, cameras monitoring lateral strip position in the finishing train support two functions of the “steering expert” from Primetals Technologies: threading control to compensate for camber effects on steering in the first stands, and strip-guidance control to react to steering issues and settle the strip’s run.

The full functionality of the solution was installed and tested at thyssenkrupp Steel Europe with very positive results. But even in cases where only a selection of the complete functionality is implemented, wedge formation and strip guidance are still notably improved.

The Electrics & Automation experts at Primetals Technologies, together with thyssenkrupp Steel Europe, have devised a new vision-based strip-steering control system for hot-strip mills. From the start of the development phase, the solution was intended to further improve strip quality by enabling even tighter tolerance levels for the strip profile and for strip flatness. Also, the buildup of camber was to be counteracted. The finalized solution met all expectations. During the pilot phase, nearly 18,000 coils were produced to statistically validate the effectiveness of the strip-steering control system. Results showed that with the steering control system turned on, the lateral displacement of the strip was dramatically reduced, whereas with the system switched off, the displacement strongly correlated with the evolved thickness wedge after the finishing mill (see comparison below for a visualization of the effect). Improvements were achieved for all products rolled in the testing mill, and for all material grades usually targeted.

While the complete strip-steering control system is complex and involves sophisticated control mechanisms, it could not function without a reliable sensor. Since operating conditions in a hot-strip mill are demanding (significant amounts of dust and splashes of cooling water), the sensor had to be able to withstand the challenges of its environment. The technology experts chose a custom-made optical sensor called the “ShapeMon” sensor—a combined camber and centerline measurement device with the ability to also measure the width of the strip. thyssenkrupp decided to keep the vision-based strip-steering system in regular use at its Duisburg plant, based on the excellent results delivered by the solution.

A package of intertwined technologies rises to the challenge of reducing wedge formation in rolling without causing camber.

Lateral displacement of the strip in successive stands, and thickness wedge of the rolled product without strip-steering control

Lateral displacement of the strip in successive stands, and thickness wedge of the rolled product with active strip-steering control
SMARTER PLANTS
THROUGH ARTIFICIAL INTELLIGENCE

Günther Winter has been with Primetals Technologies for 38 years and currently holds the position of Technology Officer and Head of Innovation Electrics & Automation. Winter has led and participated in the creation of numerous innovative automation solutions. He views process automation from a holistic standpoint and strives to see the big picture of how steel producers can optimally set up their operations for maximum efficiency and profitability.

What do you consider to be the core challenge in the push toward digitalization?

Günther Winter: First and foremost, digitalization is going to increase the creation of added value along the full metals-production chain. This can be done, for instance, to increase productivity, flexibility of operations and product quality. However, a core challenge that steel producers are facing is the transfer of application knowledge from their seasoned operators to the next generation of employees. In many cases, new employees arrive with far less experience than their predecessors. This will increasingly become a widespread problem over the coming years. Digital assistants and the digitalization of know-how will be supporting our customers in their agenda. Our Through-Process Optimization and Maintenance and Asset Technology are examples of superposed systems for intelligent production capable of implementing existing operational and maintenance know-how and providing a high-quality database for the training of software systems based on artificial intelligence—such as digital assistants. Last but not least, cyber-physical systems, i.e. our implementation of the next generation of process automation, will optimally collaborate with our digital assistants and our superposed systems for intelligent production. They will make process control even more autonomous and robust.

Digitalization aims to connect all process steps within a plant in order to control and optimize overall efficiency. This is a big undertaking, so how far along are we?

Winter: Compared to other industries, the steel business in general—and Primetals Technologies in particular—has been ahead in terms of the level of process automation for a long time. This is a fact. But it is also true that most automation systems have been limited to specific parts of the production chain, and are based on heterogeneous systems that are difficult to connect with one another, which would be an essential prerequisite for a technology to participate in the Internet of Things. Many steel producers still have to upgrade their equipment in order to properly mirror and interconnect their processes through software. This will take place in successive steps, for instance, within the scope of modernization projects, and Primetals Technologies will provide its customers with scalable modernization packages.

Is there any one country that you think is moving toward digitalized steel production more forcefully than others?

Winter: The Chinese government has issued the so-called “Made in China 2025” program, which is without parallel in its ambition. However, we are also seeing impressive progress in our customer projects in the EU, USA, Japan, and other countries.

Will artificial intelligence play a role in the steel plant of tomorrow?

Winter: Yes. I am glad to state that Primetals Technologies is a pioneer in the field of artificial intelligence. We introduced machine learning and neural networks to the steel industry in the mid of the 90s. Since then, we have accumulated many references for the enhancement of process models with artificial intelligence. Let me give you some concrete examples: our Acoustic Expert, a technology that relies on smart analysis of recorded sounds, is an excellent tool for condition monitoring. Also, the interlinked data history of our Through-Process Optimization system is an excellent basis for data analytics and for the creation of expert systems, which enables comprehensive fine-tuning of the full steel-production chain. Recently, machine-learning technology has made further vast advancements, especially in the area of imaging, autonomous systems, and digital assistants. I think that machine learning in metals will continue to play an important role, especially in complementing our advanced cyber-physical systems with digital assistants. Overall, Primetals Technologies is continuously enhancing its portfolio of solutions that incorporate artificial intelligence in all the fields that I just mentioned, and many more!
AIR-BEARING SHAPEMETER

The Air-Bearing ShapeMeter of Primetals Technologies accurately measures the shape of rolled metal sheet and foil material (Aluminum and other metals). It provides continuous, high-accuracy readings with fast signal-response rates even at low rolling speeds. Thanks to its modular construction, the Air-Bearing ShapeMeter can be adapted to almost any application without compromising its full operating capability. The core of the instrument is a roll comprised of hardened, precision-ground rotors, which are supported by an air film on a stationary, stainless-steel arbor. Each rotor is supplied with air by an array of jets that are connected to a common plenum chamber in the arbor’s center. This design results in low-inertia rotating elements that exhibit the minimal frictional resistance typical of air bearings. The need for helper drives is eliminated.

The operating principle of the Air-Bearing ShapeMeter is straightforward: the pressure differential between the top and bottom of the inside of each bearing is proportional to the load applied to the rotor. It is therefore possible to calculate the tension at each rotor position across the width of the rolled metal sheet. As a result, the Air-Bearing ShapeMeter can accumulate enough data to determine a profile of the stress distribution—a "shape"—of the sheet. Every differential-pressure output is measured by a high-integrity pneumatic transducer, which is located remotely in the transducer housing attached to the end of the arbor through an armored signal cord. With more than 600 installations worldwide, the Air-Bearing ShapeMeter has a track record of excellence going back 40 years. Its high accuracy, robust construction, modular design, low maintenance needs, and strikingly positive impact on end-product quality have convinced many customers of Primetals Technologies to trust its readings for optimal rolling operation.

TRANSFORMATION MONITOR

The Transformation Monitor directly measures the transformation of iron from austenite to ferrite through a real-time, online measurement of the ferrite concentration within the steel as it cools. It uses EMspec technology under license from The University of Manchester, U.K.

The Transformation Monitor breaks with the traditional approach of measuring the surface temperature of the steel on the runout table, a method which is open to error as the temperature reading can be affected—for instance, scale or water on the steel surface will produce a lower reading. In this case, however, the sensor head is constantly washed with water to prevent false signals caused by material on the surface. One or more sensor heads are located under the passline on the runout table. Each water-cooled head is in close proximity to the hot steel and generates a primary magnetic field which interacts with the hot steel, producing a secondary magnetic field that is detected by the sensor head. Austenite has a low magnetic permeability while ferrite has a high magnetic permeability, so the Transformation Monitor exploits this difference to measure the percentage of transformation that has occurred.

The Transformation Monitor measures transformation directly, making it superior to the common approach where modeling is still used to determine the microstructure of the final product by controlling rolling and cooling. This model often relies on parameters that are not exclusively related to microstructure. Given that certain steel grades do not fully transform to ferrite, a more useful measurement is the Transformation Index, a material-dependent measure of the ratio of austenite to ferrite in the final product. The Transformation Monitor can be installed into new and existing mills.

Peter Hunt, Development Manager at Primetals Technologies, demonstrates the capabilities of the Transformation Monitor.

The Air Bearing ShapeMeter is precision technology, assembled in the U.K. by experienced Christchurch technicians.
Rolling mills are prone to many different vibration phenomena, especially when rolling high-strength steels in combination with thin product gauges and high rolling speeds. These vibrations can have a significant impact on quality and productivity in cold-rolling mills. The most destructive form of mill vibration, termed “third-octave chatter,” occurs in a frequency range between 90 and 150 Hz. It is a self-excited vibration, meaning that once it starts, it can grow quickly and result in unstable and uncontrollable rolling conditions.

The ChatterBlock solution is a unique anti-chatter system that fully eliminates third-octave gauge chatter in cold-rolling mills. It is based on an in-depth root-cause analysis of the chatter phenomenon. During this analysis, the Primetals Technologies specialists found that mill chatter represents a process parameter-excited instability generated in the roll gap. The solution thus required a stabilizing system that would bring the rolling mill back into a stable and controllable state. The core function needed was the exertion of a damping effect on the powerful roll-force cylinders that would not hamper the mill’s automatic gauge-control system. Primetals Technologies therefore developed customized controller algorithms, completely new and highly dynamic servo-valves, and hydraulic design solutions to control vibration frequencies between 90 and 150 Hz.

Results show that a 10% increase in maximum mill speed is possible, which translates into an impressive increase in plant productivity. ChatterBlock Control is available as an autonomous technology package that can be modified to meet the individual vibration-solution requirements of both new and existing mills. Through the suppression of unwanted mill vibration, producers also benefit from prolonged equipment lifetime, improved product quality and higher profit margins.
UCM Flat optimizes strip-flatness quality with the Universal Crown Control Mill of Primetals Technologies.

**UCM FLAT—THE NEW FLATNESS CONTROL FOR 6-HIGH UNIVERSAL CROWN CONTROL MILLS**

Mechatronics know-how from Japan, combined with German expertise in Electrics & Automation: the international team of Primetals Technologies has developed an advanced flatness-control system for the production of cold-rolled strip. The system has been designed to complement the 6-high Universal Crown Control Mill (UCM) technology and enables earlier prevention of nonconformities at optimal actuator use. It is based on commonly used flatness-control approaches but adds significant improvements:

- Model-based actuator-efficiency calculation
- Model-based flatness-error optimizer
- Model-based control principle

The UCM Flat encompasses a newly structured control software that makes operation extremely straightforward. The UCM Flat software’s general advantage is its high degree of reliability stemming from the decades-long experience of Primetals Technologies in strip-flatness control. Primetals Technologies has developed an application called “ChartConverter,” which automatically transfers the UCM Flat software to different types of automation platforms and will ensure optimal implementation of UCM Flat far beyond its current reach.

When used stand-alone in conjunction with a measurement system, the flatness control is an ideal upgrade for existing automation systems. Alternatively, it can be integrated into the larger automation system of Primetals Technologies.

The new control system was successfully tested on a 6-high UCM in the Hiroshima testing facilities of Primetals Technologies. During the pilot phase, the control system and the mechatronics were optimized and further aligned. Early rolling tests showed significant improvements with fewer nonconformities and a reduction of off-gauge material at the head and the tail of the strip.

**MAIN BENEFITS OF UCM FLAT**

- Higher strip-flatness quality
- Shorter start-up time with mill revamps
- Reliable production planning
- Lower risk for producers’ customers
NON-STOP FLYING ROLL CHANGE
TO ACHIEVE HIGHER MILL PRODUCTIVITY

Stopping a continuous rolling mill will result in strip defects as well as production losses. Strip-surface marks and thickness deviations may exceed quality control limits and the strip section may have to be cut out.

Depending on strip-surface quality targets (e.g., when producing in high-end stainless-steel mills), roll changes may be called for after two or three strips. In today’s plants, this means the line has to be stopped and restarted.

With the patented Flying Roll Change (FRC) from Primetals Technologies, work rolls can be changed on the fly without stopping the mill. The technology works as follows: one stand, e.g., a hypothetical inactive stand No. 4, is prepared with new rolls during the line run with the roll gap being open at that time. At the stand with the worn rolls, e.g., an active stand No. 3, the roll gap will be set to open when the weld seam passes so that rolls can be changed. As long as stand No. 3 is not operating, the thickness reduction it usually performs will be automatically taken over by the stand that is already equipped with new rolls—stand No. 4 in our example. Production can therefore continue without interruption.

Introducing the FRC to a rolling mill can increase its production by of up to 8% per year depending on production speed, frequency of roll changes, and type of material. As an example: at a production capacity of 1 million tons per year and $60 of added value for stainless steel, this could mean an additional $4.8 million in profit per year.

If a mill works with materials that require all stands to be permanently active for maximum strip thickness reduction, the solution may be to add an additional stand to the setup. The investment typically pays for itself within one or two years of production.

MAIN BENEFITS
• Higher production stability
• Higher output due to longer production time
• Higher output due to shorter off-gauge length
• Hot (active) spare parts in case of failure
When cold strip is wound onto a mandrel, the coil is never perfectly round but slightly eccentric. These eccentricities have a number of different causes:

- A bump resulting from the strip head being wrapped on the coiler mandrel by a belt wrapper, which is propagated with each revolution
- A bump caused by the strip head coming out of the gripper slot (being used instead of a belt wrapper)
- In reversing mills, a difference in thickness emerging after a few passes between the head and tail on the one hand, and the strip body on the other
- An imbalance in the coiler mandrel mechanism

This coiler eccentricity causes tension oscillations in the strip, which in turn can lead to strip-thickness errors and strip-surface defects.

Since tension disturbances are repeated with each revolution of the coiler, their frequency depends on the rotational speed. At high rolling speeds, these periodic changes are much too fast to be compensated by the closed-loop tension controller. Moreover, the behavior of the system to be controlled changes dramatically with speed, coil diameter, strip geometry, and pass reduction.

As a solution to this problem, Primetals Technologies has introduced Coil Eccentricity Compensation (CECO), which can be used for all strip types and coil diameters. It is a model-based control that makes use of the fact that the shape of the eccentricity remains relatively constant during coiling. CECO can therefore create a model of the eccentricity over several revolutions. Using an inverted plant model, the eccentricity is translated into a compensation torque for the coiler drive (pre-control).

As a result, strip quality improves: stable strip tension leads to better strip-thickness tolerances and higher strip-surface quality.
OFF-GAUGE OPTIMIZER

Head- and tail-end off-gauge length is defined as the length of strip from the weld to the point from which the final thickness deviation reliably stays within a tolerance band of approximately ±3%. Reprocessing costs of downgraded, off-gauge material can have a considerable impact on the final cost figure in rolling.

Moreover, high off-gauge lengths decrease the annual yield in quality product. To unlock this “hidden potential” of rolling-mill equipment, Primetals Technologies has developed a very cost-effective technology package called the Off-Gauge Optimizer (OGO).

Based on the perfect combination of technology, process control, and instrumentation, the OGO features a smart implementation of the control algorithms of a tandem cold mill based on the mass-flow principle.

The architecture of OGO is modular and consists of three parts: First, Advanced Mass Flow (AMFnew) controls the mass flow from the mill entry to the mill exit and ensures stable rolling conditions to keep thickness errors at a minimum. Second, Soft-Sensor for Strip Thickness (SST), a soft-sensor-based roll-gap-thickness estimator, perfects the performance of OGO during weld-seam-transition rolling. Interstand rollgap thicknesses are modeled based on strip speed data and one initial strip-thickness measurement. Third, Feed-Forward Control (FFCn-1) minimizes thickness errors that occur for reasons such as tension disturbances during weld-seam rolling on the next-to-last stand.

In the end, OGO significantly reduces the average off-gauge lengths—to approximately 8 m, as verified at several reference plants.
Minimum Quantity Lubrication (MQL) is Primetals Technologies’ next generation roll-gap lubrication system for cold-rolling mills, applying neat rolling oil atomized with air directly onto the surfaces of the work rolls. This is especially relevant in light of recent trends toward increasing production of advanced high-strength steel grades (AHSS) for the automotive industries or silicon steels for electrical appliances.

MQL allows for intelligent control of the oil-film thickness depending on the rolling process. Based on actual process and product parameters, the digital solution can determine and control the optimum amount of oil to maximize rolling efficiency and secure rolling stability (intelligent forward-slip control). MQL not only ensures optimum product-specific lubrication, but the effortless and rapid change of lubrication settings offers a much higher degree of flexibility than has been previously possible with classical emulsion systems. Comprehensive tests at three different European steel producers proved the industry strength, and also showed conclusively that MQL permits the application of considerably lower rolling forces and motor torques, as it maximizes the level of oil concentration in the roll bite. These savings can be converted into more reduction or a wider strip. Another major advantage of the system is better strip-surface cleanliness, which is achieved via improved lubrication leading to less strip wear and hence less iron fines on the strip surface after cold rolling.

MQL is a pre-tested technology package now available to customers and consists of spray bars with quick-change nozzles (as illustrated above), an oil-supply unit, and a process unit with a defined interface to the mill automation system. The system can be easily installed on existing mills either as an additional lubrication system, or to replace an existing emulsion recirculation or direct application system.

After several successful prototype tests, MQL was installed permanently in the batch tandem cold mill of a major European steel producer. It has been in operation for more than a year, delivering outstanding results.
The advantages of a high-speed bar mill are lost if bottlenecks develop during production. One of the final post-production steps prior to delivery is bar bundling and counting. An engineer from the Primetals Technologies operation in Worcester, Massachusetts, U.S.A., has invented a static non-contact bar-counting system to provide the precision expected by end customers.

"Before now, the number of bars per bundle was often estimated, based on weight and the known lengths of the bars," says Ruth Kirkwood-Azmat, a senior engineer in the Electrical & Automation group in Worcester. "The old system generated some considerable errors. This was particularly problematic as bundles can range in size up to 500 bars."

In the new, low-cost, highly accurate solution, Kirkwood-Azmat incorporated an intelligent camera to take an image of the end of a bundle for high-speed optical analysis. The system provides visible evidence of the count—a vast improvement over the previously necessary, labor-intensive manual checks. Kirkwood-Azmat’s innovation is part of the broader, patented, Industry 4.0 bar-counting systems that have been installed at several customer sites.
The Long-Rolling Process Expert excels at quality management. Online quality monitoring allows for the results of product inspections to be accessed at any time, while interface modules to manufacturing execution and plant-automation systems ensure secure communication. There are also analysis and reporting modules, a report editor, and a label editor, with archiving capabilities so that all data can be archived and production history accessed, even years down the line. Comprehensive and accurate reporting on the mill, production efficiency, equipment utilization, downtimes, energy and media consumption, tool stand times, and much more can be used as the basis for increasing the competitiveness and ultimately the profitability of a plant.

The Long-Rolling Process Expert also helps to increase customer satisfaction, making it easier to respond quickly and flexibly to inquiries from new customers or to demand for new products. Checking production availability, calculating the time needed for product changes, tracking the route from raw material to finished product, creating customer labels, or producing quality reports are all challenges that can be met with the Long-Rolling Process Expert.

**EXTENDABLE FUNCTIONALITY**

The Long-Rolling Process Expert provides a modular range of basic functions for managing orders, assets, and qualities, enabling plant operators to pick and choose between functions. For instance, the yard-inventory modules for incoming and outgoing materials provide a real-time status of stock materials; the production-sequence module provides up-to-date information about production schedules, line status, and material position, and increases flexibility in the fulfillment of production orders; the tracking module records data on all material flows from the yard to the charging grid to the outgoing yard—including processing, compacting, weighing, and tagging.

**ROLL AND GUIDE MANAGEMENT**

Roll and guide management helps monitor and manage the rolling mill. Tools such as rolls, calibers, and guides are located in the roll shop stock, and plant, tonnage, and rolling time are tracked. Then, based on production requirements, tool-change lists are created to shorten product change time while also maximizing tool-utilization time.

The Long-Rolling Process Expert is part of the comprehensive Electrics & Automation solution portfolio of Primetals Technologies for the long-rolling industry. It can either be supplied as a stand-alone installation or seamlessly integrated into other long-rolling automation concepts.
The Long-Rolling Roll Master is a powerful and easy-to-use tool geared toward increasing plant flexibility and performance by providing advanced pass scheduling for continuous and reversing mills, and for both monoblocks and flat blocks. With plant operators under increasing pressure to boost productivity in response to aggressive competition on the steel market, the Long-Rolling Roll Master is the ideal solution for precise management of the rolling mill.

The Long-Rolling Roll Master allows for the easy creation of pass schedules for grooves and guides as well as setup data for smooth mill start and restart based on material database, specific mill design, mill-load conditions, and available rolls. For switching to new steel grades or dimensions, the Long-Rolling Roll Master features a database of more than 200 steel grades and special alloys. Another database for rolls, grooves, guides, and other components contains a plant's own mill-specific data. The system constantly tracks current tool and mill conditions during operation and takes them into account when providing pass schedules, thereby making the most of plant availability and supporting maintenance routines.

Plant operators are faced with multiple challenges that can be addressed with the use of the Long-Rolling Roll Master. When changing dimensions or steel grades, high productivity can only be maintained with a fast and secure production restart. In order to reduce the cobble rate, mill settings need to be accurate right from the start. And because of groove wear, it can also be challenging to repeat rolling schedules. In general, it is difficult to make precise calculations for the implementation of new dimensions and steel grades. Tests are time-consuming and require in-depth knowledge of the rolling process. Grooveless flat rolling offers high flexibility, but pass-schedule creation and the calculation of mill setup data are difficult to calculate and confirm.

Because the challenges are so complex and wide-ranging, Primetals Technologies is committed to carrying out a thorough analysis of mill layout, design limits, and drive systems. Primetals Technologies also handles integration of all available tools (rolls, grooves, and guides) into the database as well as adaptation of the Long-Rolling Roll Master to specific mill design and production targets. Calculations and models are tailored to a plant's own processes and interfaces engineered accordingly.

The advantages of the Long-Rolling Roll Master are that it offers greater flexibility and optimized production thanks to computer-based pass scheduling, while smooth scheduling is guaranteed by the material database of steel grades.

The Long-Rolling Roll Master can be seamlessly integrated into long-rolling automation concepts, but is also available as a stand-alone product, making it ideal for retrofits and upgrades. Due to its modular design, it can easily be adapted to meet the specific requirements of any plant. The Long-Rolling Roll Master is a proven solution and has so far been installed at over 25 mills worldwide.
What in your view are the main targets for digitalization in the steel industry?

Hans-Jürgen Zeiher: For me, digitalization has some very clear objectives: it will make the steel-production process more flexible, raise end-product quality, and increase overall plant efficiency. At the same time, it will help to minimize raw-material costs and energy consumption. Also, a fully digitalized production facility requires a far lower operations and maintenance effort.

How many years will it take for digitalization to fully “arrive” in the steel industry?

Zeiher: There is no one answer to this question. Some of our customers already own highly advanced plants, and many of the processes taking place in their facilities are led and captured by sophisticated software. Other customers still rely on Excel sheets to plan their production. How long it will take for these customers to have their plants fully upgraded varies greatly. What is true for almost every steel producer is that the pressure to modernize has increased. Europeans and East Asians probably feel the urgency the most.

At Metals Magazine, we have found that there is still substantial insecurity about the impact of digitalization—even among seasoned technologists. Have you discovered any popular misconceptions about what digitalization will change?

Zeiher: I think that Industry 4.0 as a concept was never properly fleshed out by those who created it, and therefore has remained somewhat vague. Our interpretation of it is this: In a typical steel-production plant, many processes are already highly automated, but largely they are still operating on their own. The challenge is to end this isolation and integrate everything into one comprehensive network by a holistic approach towards digitalization. On the basis of such a system, steel producers can serve their end customers in completely new ways, with higher degrees of customization regarding product specifications and lot sizes. Recent developments in hardware, software, and especially data analysis have made all of this possible.

Is it true that when it comes to advanced automation, the steel industry has been ahead of discrete manufacturing and other areas for a long time?

Zeiher: Definitely. I think that our industry is about 25 years ahead of almost everyone else.

Is the linking of existing technologies for an increasingly digitalized production the main challenge?

Zeiher: Yes, this will be the key to a successful digitalization strategy in our field. Steel-production equipment is simply so expensive that no company will be willing to replace everything they have been using successfully up to now. Our job then is to determine which upgrade packages a customer needs to sufficiently improve the existing plant in order to reach compatibility with today’s technologies and market requirements. We often have to enable old equipment to communicate with newer solutions, so that all plant activity can be monitored and controlled in a unified manner. At Primetals Technologies, we have built a unique competence profile that is widely recognized within the industry: we combine classic automation skills with deep knowledge about the metallurgical process. We are using these capabilities to support our customers in developing the right digitalization strategies based on
their current equipment. And we are regularly approached about entering new partnerships to create completely new automation solutions.

Artificial intelligence is a much-discussed if somewhat vague subject matter these days. Will artificial intelligence be a cornerstone of the steel plant of the future, and if so how?

Zeiher: For me, the key question is to what degree self-learning algorithms might at some point replace our traditional physics-based approach. Theoretically, we could see some major technological shifts or disruptions in the future. Therefore, we are actively conducting company-wide research to stay ahead of everyone else. Of course, I don’t believe that our tried-and-tested methods will become obsolete any time soon. But there might be disruptive changes from big-data analytics that could speed up certain parts of our work in the future.

Should steel producers be worried about falling behind? What should they focus on?

Zeiher: I think that those steel producers who are currently leading the industry will have to work even harder on pushing the envelope in order to maintain their position. Companies from the Far East are beginning to catch up technologically, and faster than many expected. It is very important to be realistic about this development—but it is also essential not to overreact and throw in the towel. Many high-end producers are addressing this issue sensibly, for instance, by approaching us about partnerships to create new solutions that will further improve their plants’ efficiency and end-product quality.

What are the top three measures that steel producers should take in order to meet the trend toward more computer-controlled processes?

Zeiher: Our holistic take on steel production—and in particular on the future of steel production—implies that software systems which can integrate all production-related processes are arguably the most crucial factor. We are talking about a “Digital Unity” of three systems: a computer-backed maintenance system that is based on expert knowledge but can be used by regular workers, a quality-management system such as our Through-Process Optimization, and a state-of-the-art production-management system. Importantly, these three systems need to harmoniously interact with one another.

Which solution of the “Industry 4.0” portfolio that Primetals Technologies has established do you consider particularly remarkable, and why?

Zeiher: We have just recently seen remarkable success with big-data analytics from our technology experts. For a Chinese customer, we were able to isolate the source of hardness deviations that occurred at the rolling stage. Initially, the reasons were completely unknown. The Primetals Technologies team was able to pinpoint the origin of the problem by use of our Through-Process Quality Control software in combination with advanced data analytics. In other words, we combined our deep process know-how with the power of big data to narrow down the relevant process parameters. Our customer is now able to reliably reproduce the improved end-product quality levels. I consider that an impressive achievement, and I am intrigued by the technology that made it possible.