

ISSUE 01 | MAY 2019

METALS MAGAZINE

INNOVATION AND TECHNOLOGY FOR THE METALS INDUSTRY

PIONEERS AT HEART: EXPLORING WHAT'S NEXT

DISCOVER THE ERLANGEN COMPANY
LOCATION OF PRIMETALS TECHNOLOGIES

KNOWLEDGE MANAGEMENT
IN STEEL PRODUCTION AND BEYOND



“ Exploration is a great metaphor for life in general, where the most defining and rewarding things usually don’t come about easily.”



EDITOR'S COLUMN

DEAR READER,

Have you ever heard the names Robert Falcon Scott or Roald Amundsen? They were both explorers who loved the extremes, and they both wanted to be the first to reach the South Pole. As true adventurers, they were willing to risk their lives if that's what it took to push the limits—to go where no human had gone before. The weather at the South Pole was gruesome. In September 1911, temperatures became so extreme that Amundsen, in spite of his extensive preparations, was forced to abandon his trek. On October 19, he and his team took four sledges and 52 dogs, and set out again. Just 12 days later, Scott followed, using motorized sledges as well as horses and dogs. Scott desperately wanted his British team to beat Norway, represented by Amundsen. Scott's plan was to slim down his initially large caravan, so that only four men would ultimately make it to the pole. But Amundsen had the better equipment. For clothing, he relied on furred skins, as worn by the Inuit, the natives of the earth's coolest regions. After 57 days in the bitter cold, many arduous climbs, and endless trudging through an inhospitable desert of ice, Amundsen reached his destination on December 14.

While I couldn't imagine ever walking in Amundsen's or Scott's shoes (and I mean this quite literally), I do find their stories immensely inspiring. It is not just the bravery that intrigues me. I also feel that the kind of exploration they were committed to is a great metaphor for life in general, where the most defining and rewarding things usually don't come about easily. And the metaphor clearly extends to the work we do at Primetals Technologies: We like to pioneer new solutions that will change the way metals are produced. We want to push the limits of what's possible. We strive to continually provide the future-oriented technologies our customers have come to expect from us. And in order to do just that, we're on a mission—to explore what's next.

Yours sincerely,



Dr. Tom Widter
Editor-in-Chief of Metals Magazine
metalsmagazine@primetals.com



DR. TOM WIDTER
EDITOR-IN-CHIEF, METALS MAGAZINE



18 EXPLORING WHAT'S NEXT

03 **Editor's Column**

04 **Table of Contents**

06 **Message from the CEO**

08 **Recent Project and Company News**

FEATURED STORIES

18 **Exploring What's Next**

At Primetals Technologies, we explore what's next. We pioneer solutions that will define the future of metals.

30 **Overcoming Bottlenecks for Greater Productivity**

Logistics analysis can help steel producers achieve higher productivity by uncovering hidden bottlenecks.

36 **m.space—The Web Portal for the Metals Industry**

The innovative web platform m.space unites a wide range of e-services from Primetals Technologies.

40 **Discovering How Much You Already Know**

Knowledge management is essential in both general business operations and steel production in particular.

44 **Weltmeisters in Digitalization**

A visit to the Erlangen company location of Primetals Technologies, which specializes in "all things digital."

TECHNOLOGY

54 **The Secret is in the Mix**

Standardized sample taking is key to running sinter plants at full potential. The fully automated sinter raw-mix analyzer takes productivity to a new level.

60 **DRI Plants, Tailored to Your Needs**

Two Midrex direct-reduction hot-briquetted iron plants, recently commissioned in the U.S.A. and Russia, demonstrate the operational flexibility of the Midrex direct-reduction process for all climatic conditions.

66 **The Next-Generation Copper Stave**

Primetals Technologies has developed a new copper-stave design that ensures more effective and reliable cooling of today's blast furnaces.

72 **A New Strategy for Secondary Cooling**

DynaJet Flex, the new secondary-cooling system from Primetals Technologies for continuous casting machines, can be dynamically adjusted to the strand's width and remedies issues associated with corner defects of slabs.

80 **Coil Logistics, Made Simple**

The Modular Coil Shuttle system from Primetals Technologies is the solution of choice for coil logistics in hot-rolling, Arvedi ESP, and cold-rolling plants. It is cost-effective and highly adaptable.



"Pioneers at Heart," the new company slogan of Primetals Technologies, underlines the company's commitment to innovating for the steel industry—and to exploring what's next.

INSPIRATION

90 Great Pioneers that Inspire Us

Who are the exceptional pioneers that inspire Primetals Technologies employees? This time, we turn our attention to aviatrix Amelia Earhart.

94 Straight from the Labs of Primetals Technologies

This series presents new, remarkable solutions pioneered by the engineers of Primetals Technologies. In this issue, we peek into the secret lab of data scientist Manfred Kügel.

96 What if ...?

We ask business developer Stefan Lechner for his personal opinion on a large variety of subjects—in the form of a number of "what if" questions.

100 The Pioneer's Guide to Boosting Creativity

How can multitasking add to your creativity? With the right techniques, you can boost your creative output.

105 Subscribe to Our Newsletter

106 Primetals Technologies on Social Media

METALS MAGAZINE IS ALSO AVAILABLE FOR TABLET COMPUTERS

The "Primetals" app is available for iPads and Android tablets and can be downloaded for free in the respective App Store. The app features a collection of articles from the current and past issues of *Metals Magazine*, as well as interactive presentations of select technologies.

PRIMETALS TECHNOLOGIES APP

Search for "Primetals" in the App Store of your choice to download the app.



MESSAGE FROM THE CEO

DEAR CUSTOMER,

What does Primetals Technologies stand for? Those of you who know us well will already have an answer to this question. But it is equally important to me that new customers, potential customers, and the wider public also have a clear idea of who we are. That is why we have started a new branding initiative, accompanied by a comprehensive marketing campaign, to convey the unique identity of Primetals Technologies.

At the center of our branding activities is our new company slogan, “Pioneers at Heart.” It was designed to encapsulate the two facets of Primetals Technologies that define us. First, we continually strive to be at the forefront of innovation. We pioneer new solutions to facilitate progress in metals production. We push the limits of what’s possible in fields such as digitalization and environmental technologies. We do not take the path of least resistance; we do the things we do because we are driven to move the world of steel production forward. As pioneers, we are undaunted by even the toughest of technological challenges.

Second, we are pioneers “at heart.” This choice of words—which could be rephrased as “to the core”—doesn’t simply reaffirm our pioneering spirit; “heart” also underlines an absolute commitment to our customers. It illustrates that we care, that we listen closely to our customers’ needs, and that we can be counted on to deliver everything we promise. Our predecessor companies built a reputation for being one hundred percent reliable partners to metals producers all over the world, and I see it as my personal responsibility to ensure that this legacy is continued.

Now, if you haven’t had the chance to familiarize yourself with Primetals Technologies, what’s the best way to get to know us? I understand that different people favor different means of getting in touch, and it is important to me that we as a company make use of

all possible communication channels. Let’s start with this magazine: it is a representation of who we are and what we do, and it contains several email addresses (the main one being contact@primetals.com) that you can use to drop us a line or send us an inquiry. Another important medium is our company website. Not only does it contain detailed information about most of our products and our services portfolio, it also includes a contact form as well as links to our Social Media channels so that you can reach us quickly and easily.

If you’d like to meet us personally, there are many great opportunities to do so. We’d love to learn about your goals and the kinds of solutions you are looking for, and this is why we attend several trade fairs and conferences every year. One of this year’s most significant events is the Metec trade fair, which will take place in Düsseldorf, Germany, from June 25 to 29. Primetals Technologies will be attending with an interactive booth, hands-on labs, and, of course, a large team of technology specialists who will go out of their way to make your visit worthwhile. One of our main focus areas at Metec will be digitalization, which advances your production methods and makes your business operations smarter.

Our dedicated sales team is another great source of inspiration to our worldwide customer base, as well as to new customers and entrepreneurs who want to break into the steel business. Many of our sales staff will be joining our technologists at the Metec conference—with their multi-faceted expertise, their passion for metals production, and their thorough knowledge of precisely the market-specific conditions that you’re experiencing. With so many communication channels available, the entire team of Primetals Technologies and myself look forward to being in touch with you, so that we can all pioneer the future of metals production together. ●



SATORU IIJIMA
CEO of Primetals
Technologies

**“ We do not take the path of least resistance;
we do the things we do because we are driven
to move the world of steel production forward.”**

Satoru Iijima
CEO of Primetals Technologies and Chairman of the Board

PROJECT AND COMPANY NEWS HIGHLIGHTS

Primetals Technologies supports steel producers all around the world in meeting their targets and achieving long-term success—with advanced solutions and services designed to address the challenges of tomorrow.



1. Vinton, Texas, U.S.A.
2. Benton Harbor, Michigan, U.S.A.
3. Talcahuano, Chile
4. London, United Kingdom
5. Lonato del Garda, Italy
6. Ranshofen, Austria
7. Tornio, Finland
8. Nizhniy Tagil, Russia
9. Cherepovets, Russia
10. Port Qasim, Pakistan
11. Toranagallu, India
12. Dujiayan, China
13. Caofeidian, China
14. Maanshan, China
15. Rizhao, China (see pg. 9)

Geographic locations
of the project news topics
discussed in this section



Arvedi ESP
lines produce
hot-rolled strip
directly from
liquid steel.

A WORLD RECORD: HOT-ROLLED STRIP MADE WITH ARVEDI ESP NOW 0.6 MILLIMETERS THIN

CHINA: In October 2018, hot-rolled strip as thin as 0.6 millimeters was produced for the first time ever—at Rizhao Steel Group Co., Ltd. in China. The Arvedi Endless Strip Production (ESP) line, which had been supplied by Primetals Technologies, had previously delivered 0.8-millimeter thin strip. The new achievement is a testament to the advantages inherent in the Arvedi ESP process: thanks to the extremely high process stability, constant speeds, and steady temperatures, ESP lines produce hot-rolled strip directly from liquid steel in a continuous, uninterrupted process via linked casting and rolling. ESP lines are guaranteed to manufacture strip with a thickness of 0.8 millimeters without the involvement of any additional cold rolling—which is particularly striking considering the fact that around 50% of all cold-rolled strip traded worldwide is of equal or greater thicknesses. Now that ESP has become capable of manufacturing 0.6-millimeter thin strip, the thicknesses it can realize cover over 80% of those made through cold rolling. The next target for Rizhao is to increase the percentage of ultra-thin strip manufactured using its Arvedi ESP lines.

This is one of the first coils of hot-rolled, ultra-thin strip ever produced.

The upgrade will enable Vinton to reduce delays, increase productivity, and improve bundle quality. It will allow the mill to handle bar as long as 24.4 meters.



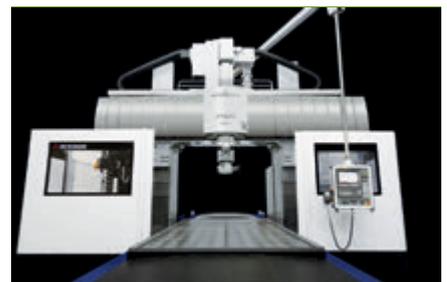
Vinton Steel LLC will be substantially upgrading its bar mill with equipment from Primetals Technologies.

PRIMETALS TECHNOLOGIES TO UPGRADE BAR MILL AT VINTON STEEL IN TEXAS

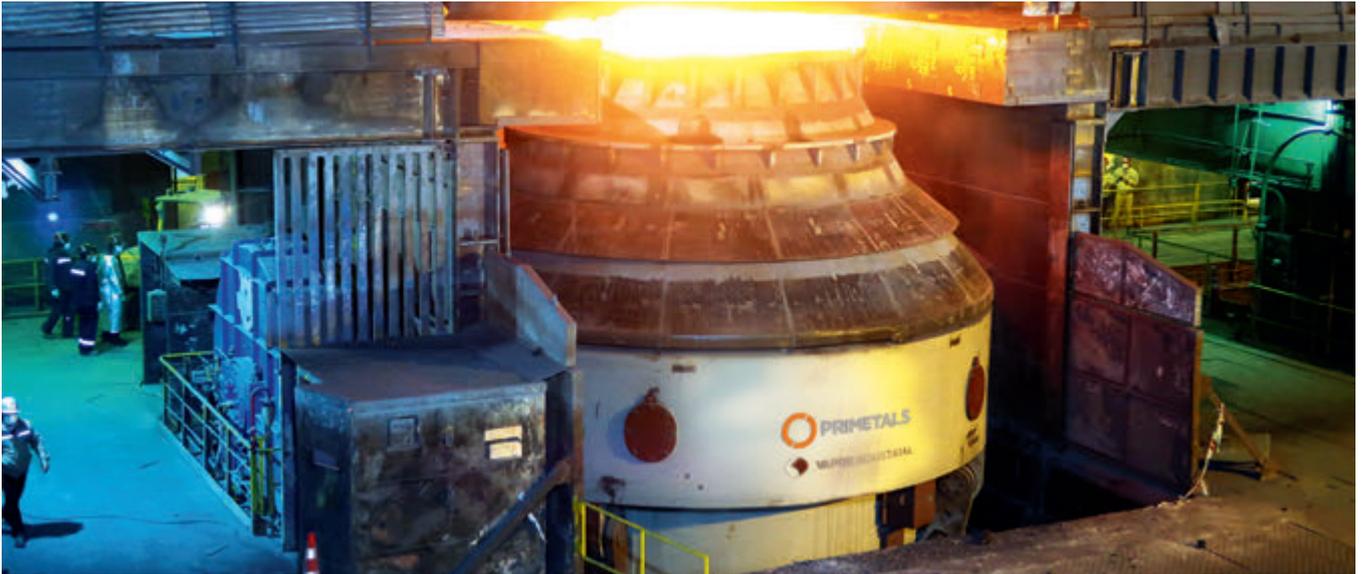
1. U.S.A.: Vinton Steel LLC of Vinton, Texas, U.S.A., a rebar producer with an annual capacity of 300,000 tons, has signed a contract with Primetals Technologies for an upgrade of its bar mill. The upgrade will enable Vinton to reduce delays, increase productivity, and improve bundle quality. It will allow the mill to handle bar as long as 80 feet (24.4 meters). The project consists of a complete bar-handling arrangement from cold shear to product unloading, which includes a 660-ton cold shear, cold-shear run-out table, gauge beam, short-bar handling system, bar-counting equipment, bundle-forming equipment, bundle tying, and bundle storage. Primetals Technologies will also supply Vinton with an optical bar counter with positional layer separation, electrical equipment, automation systems, and installation engineering. Startup is expected in early 2020.

STRATEGIC UPGRADES FOR BENTON HARBOR COMPANY LOCATION

2. U.S.A.: Primetals Technologies has realized planned investments in its Benton Harbor, Michigan, U.S.A., location to augment available services and meet increased demand for continuous caster mold or zone refurbishment and advanced copper-plating technology. The company has purchased an advanced Mitsubishi Vertical Precision Milling Machine to increase its capability and efficiency for servicing a wider range of mold sizes and to ensure versatility, accuracy, and reproducibility when meeting complex customer requirements. One of the upgrades to the facility's plating line will enable Primetals Technologies' proprietary hot-drain electroplating technology to be used for narrow-face copper-plating requirements. This cost-effective and innovative process optimizes the application of nickel plating while reducing energy consumption and minimizing the environmental impact.



Primetals Technologies recently upgraded its facilities in Benton Harbor, Michigan.



After the successful revamp of CAP ACERO's LD (BOF) converter No. 2, the company placed a follow-up order with Primetals Technologies.

CHILE-BASED CAP ACERO COMMISSIONS SECOND LD CONVERTER REVAMP

3. CHILE: In October 2018, Primetals Technologies received an order from Compania Siderurgica Huachipato S.A. (CAP ACERO) to replace LD (BOF) converter No. 1 in the Talcahuano, Chile, works. This repeat order follows the successful startup of converter No. 2 in May 2018, which was also revamped by Primetals Technologies. In addition, CAP ACERO ordered the installation of Primetals Technologies' Vaicon Stopper slag-retention system on converter No. 2, marking the 150th implementation of this system worldwide. Vaicon Stopper ensures that any carry-over of slag to the ladle during converter tapping is kept at a minimum, resulting in a significant reduction in operating costs on account of a lower consumption of slag-formation agents and de-oxidizing materials and, ultimately, positively impacting steel quality. The modernized converter No. 1 is scheduled be operational in March 2020.

For the first time ever, a process-optimization system for continuous casters has been sold via a subscription model.

PRIMETALS TECHNOLOGIES STARTS OFFERING SUBSCRIPTION MODELS

4. UNITED KINGDOM: Primetals Technologies has pioneered the provision of process-optimization systems to operators of continuous casting machines via annual subscriptions. The company's first customer to obtain a license was a U.S.-based steel producer; it was the first time ever for a system of this kind to be sold in this innovative way. The license-based model has several advantages: New releases, upgrades, updates, and fixes are implemented on a regular basis. The application is always up-to-date, enabling caster operators to benefit from continuous developments, improvements, and innovations. The modularity of the system allows customers to subscribe to individual functions and models depending on requirements. Newly developed features and functions can be implemented upon request as they become available. A comprehensive support package encompassing expert assistance as well as any fine-tuning of the system is also included with the license. Thanks to the new subscription model, the annual cost is highly predictable from year to year and can be accounted for as an operational expenditure (OPEX), requiring less capital to be allocated to obtain the technology.

The revamp will introduce standardized solutions to increase plant availability, simplify maintenance, and to further improve safety standards at the plant.

FERALPI INCREASES PRODUCTION CAPACITY WITH CASTER REVAMP

5. ITALY: A six-strand billet caster revamped by Primetals Technologies was recently started up at the Lonato del Garda works of Feralpi Siderurgica S.p.A., part of the Italian Feralpi Group. The aim of the project was to improve plant availability, increase billet production capacity by approximately 10%, produce billets with a larger square-cross section of 150x150 millimeters, and prepare the plant for 160x160-millimeter square-cross sections. Prior to the revamp, the caster had an installed annual capacity of 1.1 million tons of billets with a square-cross section of 140x140 millimeters. Feralpi produces medium carbon, carbon, and low-alloyed steels for the construction industry. As part of the revamping project, the casting machine was equipped with new DiaMold high-speed casting molds, which feature tapered mold tubes and open bottom-mold corners to reduce strand friction, and also with a Dyna-Flex hydraulic oscillator for improved strand-surface quality. Primetals Technologies also supplied new secondary cooling and a dummy bar head.



Feralpi had its six-strand billet caster revamped to increase capacity.



Austrian aluminum producer AMAG has placed an order with Primetals Technologies for the modernization of a continuous heat-treatment line.

PRIMETALS TECHNOLOGIES TO MODERNIZE HEAT-TREATMENT LINE FOR AMAG

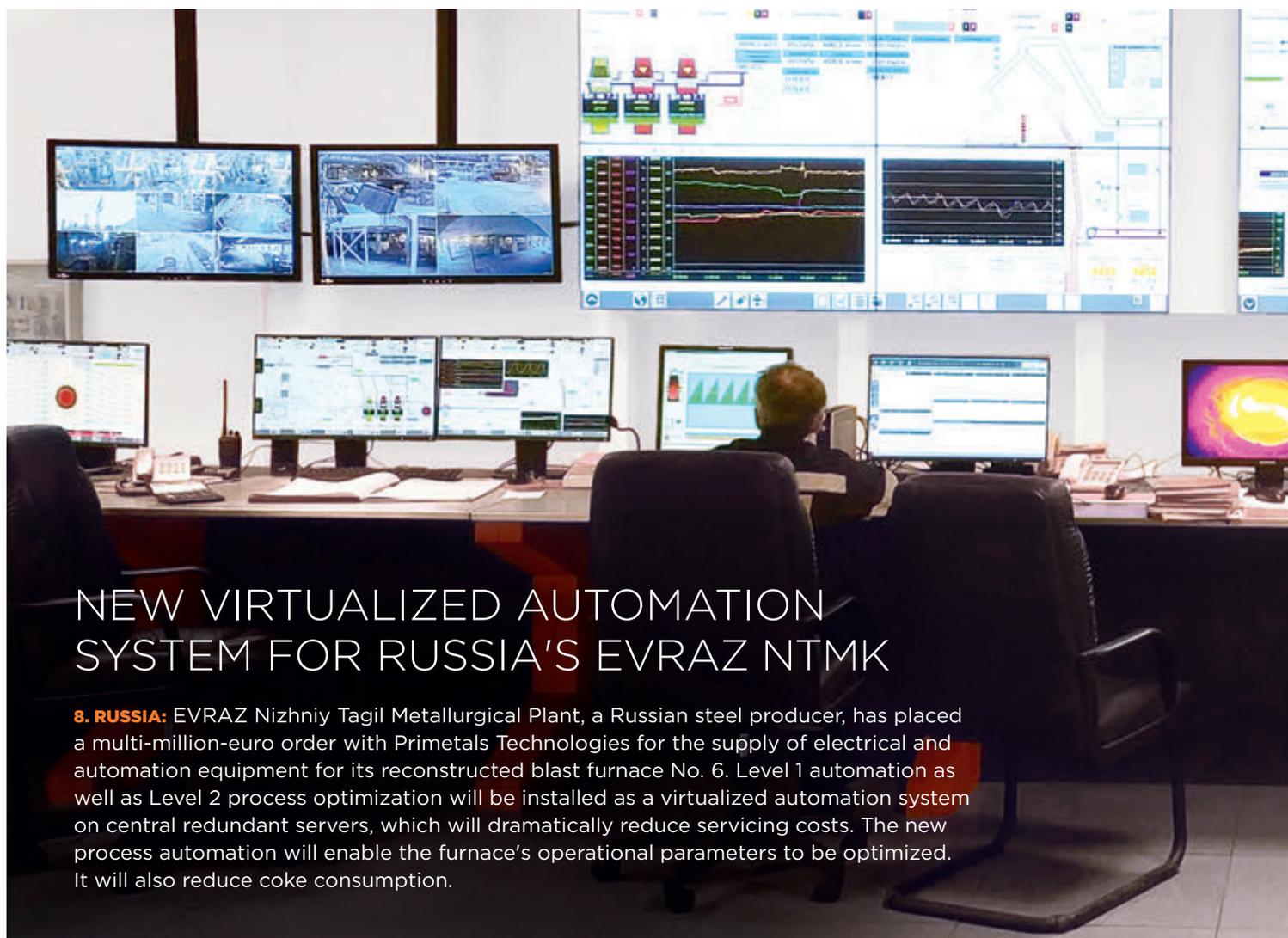
6. AUSTRIA: Aluminum producer AMAG rolling GmbH placed an order with Primetals Technologies for the modernization of its continuous heat-treatment line No. 2 at its plant in Ranshofen, Austria. The project involves the renovation of the electrical and automation equipment as well as the replacement and addition of instruments and other control components. The safety equipment will also be modernized to make it state-of-the-art. The aims of the project are to use standardized solutions to increase plant availability and simplify maintenance. New safety equipment will be installed in accordance with machine-safety regulations. In previous years, Primetals Technologies successfully implemented a number of similar modernization projects in Ranshofen. The revamp of the heat-treatment line is scheduled for completion in the fourth quarter of 2019.



Outokumpu's new No. 1 AOD converter was successfully started up at the producer's Tornio site. Primetals Technologies fitted the converter with a new tilting drive, trunnion ring, and other associated equipment including electrics and automation.

AOD CONVERTER MODERNIZED BY PRIMETALS TECHNOLOGIES STARTED UP AT OUTOKUMPU'S TORNIO SITE

7. FINLAND: In December 2018, the No. 1 AOD converter modernized by Primetals Technologies was started up at the Tornio works of Outokumpu Stainless Oy, a Finnish stainless-steel producer. The project involved fitting the converter with a new tilting drive, trunnion ring, and other associated equipment including electrics and automation. The Vaicon Drive Damper system developed by Primetals Technologies was also installed on the tilting drive. It reduces the vibrations caused by the blowing processes and therefore lowers the mechanical load acting on the entire system—from the converter down to the foundations. The patented system minimizes wear and maintenance costs while also extending the service life of the plant, and can be installed in new plants or retrofitted to existing converters. Primetals Technologies was responsible for the planning, manufacturing, and supply of the new converter equipment. This comprised the trunnion ring, tilting drive, damping system, rotary joint, and pipework. The scope of supply included the hardware and software for the Level 1 system of the tilting drive and damping system.



NEW VIRTUALIZED AUTOMATION SYSTEM FOR RUSSIA'S EVRAZ NTMK

8. RUSSIA: EVRAZ Nizhniy Tagil Metallurgical Plant, a Russian steel producer, has placed a multi-million-euro order with Primetals Technologies for the supply of electrical and automation equipment for its reconstructed blast furnace No. 6. Level 1 automation as well as Level 2 process optimization will be installed as a virtualized automation system on central redundant servers, which will dramatically reduce servicing costs. The new process automation will enable the furnace's operational parameters to be optimized. It will also reduce coke consumption.

SEVERSTAL ISSUES FAC FOR LADLE FURNACE SUPPLIED TO ITS CONVERTER STEELWORKS IN CHEREPOVETS

9. RUSSIA: Russian steel producer PAO Severstal has issued the Final Acceptance Certificate (FAC) for a new twin ladle furnace supplied by Primetals Technologies to the converter steelworks in Cherepovets. Primetals Technologies did the engineering work for the twin-ladle furnace, the alloying system, the dedusting system, and other key components including electrical and automation equipment. The new ladle furnace is able to process 375-ton charges of liquid steel with a treatment time of 45 minutes or less and has an annual capacity of 4.8 million tons. This increases the site's annual converter-based steel production from 9.5 million to almost 10.3 million tons. The additional ladle furnace also enables Severstal to realize all steel treatment in one single section of the plant, saving the company an estimated 10 million euros per year in operating costs.

The additional ladle furnace will help Severstal to save 10 million euros per year in operating costs.



NEW CONTINUOUS BILLET CASTER AND BAR-ROLLING MILL FOR NAVEENA'S PORT QASIM PLANT

10. PAKISTAN: Primetals Technologies has received an order from Naveena Steel Mills Ltd. to supply a continuous billet-casting machine and a bar-rolling mill for a new minimill in Port Qasim, Karachi. The billet caster will be supplied by Concast Ltd., an Indian-based Primetals Technologies group company. The new mill will enable Naveena Steel to enter the growing market for regional infrastructure projects. The minimill will produce around 270,000 tons of reinforcing steel—rebars—per annum, with diameters ranging from 8 to 40 millimeters. Diameters of up to 12 millimeters will be rolled in multi-slit mode to improve productivity. A particular feature of the new plant is that billets will be charged to the rolling mill directly and in hot condition, which will provide significant energy savings. Commissioning is scheduled to commence in the second quarter of 2019.



Billets will be charged to the rolling mill in hot condition for significant energy savings.



JSW STEEL TO EXPAND CAPACITY WITH NEW WIRE-ROD MILL

11. INDIA: To keep up with growing market demand, JSW Steel Ltd. has contracted Primetals Technologies to supply and install a new 2-strand wire-rod mill. The new mill will be built in Toranagallu, India. It will be the third mill to be bought by the company from Primetals Technologies, following JSW Steel's previous purchase of a single-strand wire-rod mill and a bar mill. Designed for a guaranteed maximum speed of 115 meters per second, the mill will run at 220 tons per hour for an annual capacity of 1.2 million tons of wire rod per year. The contract also includes site supervision and spare parts. Startup of the new mill is expected at the end of 2019.

CHENGDU CHANGFENG PLACES ORDER FOR EAF QUANTUM AND LADLE FURNACE FOR DUJIAYAN

12. CHINA: Chinese steel producer Chengdu Changfeng Steel Group Co., Ltd. has placed an order with Primetals Technologies to supply an EAF Quantum electric arc furnace and a ladle furnace for its plant in Dujiayan, Sichuan Province. This marks the 9th EAF Quantum sold to Chinese producers. The EAF Quantum is designed to handle scrap steel of varied composition and quality. The electrical energy requirement of the electric arc furnace is extremely low because the scrap is preheated. This reduces both the operating costs and CO₂ emissions.



SHOUGANG JINGTANG ORDERS PICKLING LINE FOR UHSS

13. CHINA: Shougang Jingtang United Iron & Steel Co., Ltd. has entrusted Primetals Technologies with an order for a continuous pickling line for its new production plant in Caofeidian, Hebei Province, which is currently in the second phase of construction. The pickling line is designed to treat hot-rolled strip with thicknesses ranging from 0.8 to 6.0 millimeters, handle coils weighing up to 33.6 tons, and process approximately 1.5 million tons of hot-rolled strip per year. It is designed to process ultra-high-strength steel grades for high-added-value products to be used in automotive, bus, and truck production, as well as for applications in heavy industry. The pickling line is scheduled for startup in late 2019.



Masteel had its cold mill upgraded to a Hyper Universal Crown Control Mill by Primetals Technologies. The modernization will enable Masteel to produce electrical steels, which are in increasing demand by the automotive industry, among others.

FIRST EVER REVERSING COLD MILL UPGRADED TO HYPER UC-MILL BY PRIMETALS TECHNOLOGIES

14. CHINA: In August 2018, Chinese steel producer Magang Group Holding Co (Masteel) produced its very first coil on a reversing cold mill modernized by Primetals Technologies. The mill represents the first upgrade to a Hyper Universal Crown Control Mill (Hyper UC-Mill) worldwide and was officially inaugurated later that month. Hyper UC-Mills employ smaller-diameter work rolls, thus reducing rolling loads. This allows for the production of harder and thinner products of generally higher quality. The mill concept also helps to save both investment and maintenance costs. The upgrade enables Masteel to meet the growing demand for electrical steels stimulated by increasing requirements for end uses, for instance, in vehicle electrification. The modernized mill can now process silicon steel grades with product thicknesses between 0.3 and 0.65 millimeters. Primetals Technologies supplied the project block, mill rolls, roll chocks, drive spindle, and drive gear box, and supervised the erection and commissioning.

EXPLORING WHAT'S NEXT



At Primetals Technologies, it is our mission to pioneer innovative solutions that will change the way steel is produced. We listen closely to the needs of our customers in the metals industry to help them stay ahead of the curve. We develop technologies that point the way to the fully automated plant of the future—a plant that is far more energy efficient, more flexible in terms of lot sizes and raw-materials, and capable of orchestrating all production-related activities using advanced digital tools.

DISCOVER THESE TOPICS:

- 19 **“Pioneers at Heart” Corporate Identity video**
- 20 **Unique Solutions from Primetals Technologies**
- 22 **Six of Primetals Technologies’ pioneers**
- 28 **What’s Next in the World of Metals**



CORPORATE IDENTITY VIDEO

We have created a new corporate identity video to convey our passion for innovation to our customers and industry partners.

meta.is/explore

PIONEERING UNIQUE SOLUTIONS



IRONMAKING

In the field of ironmaking, we make a point of innovating for nature. Our **MEROS** dry-type multi-component gas-cleaning solution is the best technology on the market for environmentally compatible sintering. **Sinter Waste-Gas Recovery** reduces the overall sinter waste-gas flow and increases energy efficiency. New, more reliable, and more durable **stave solutions** for blast furnaces are another unique contribution to more effective and eco-friendly ironmaking.



STEELMAKING

In the steelmaking area, we could not be more proud of our **LiquiRob**—a highly versatile robot that takes care of the jobs too dangerous for human operators. **Lomas** uses sensor technology to continually monitor the off-gas stemming from the steelmaking process; this information is then passed on to the **Dynacon** system for dynamic blow-end detection. The **EAF Quantum** is unique by virtue of its capability to pre-heat scrap for increased energy efficiency.

**SOLUTIONS
ONLY AVAILABLE
FROM PRIMETALS
TECHNOLOGIES**

As pioneers at heart, we are driven to push the limits of what's possible for metals producers worldwide. Our determination to create new, powerful solutions has led to numerous innovations that are still unique in the industry. While we could not list all of them here, we'll mention some of those that have been attracting particular interest. Learn more about the technologies discussed below by visiting our website primetals.com.



CASTING & ENDLESS STRIP PRODUCTION

Primetals Technologies is world-renowned for its caster technology, with innovations such as the process models **DynaPhase**, **Dynacs 3D**, and **DynaGap**. The legacy is continued with the **Single-Roll DynaGap Segment**, **DynaJet Flex** secondary-cooling system, and **Mold Expert** mold-monitoring and sticker-prevention solution. **Arvedi Endless Strip Production** combines endless thin-slab casting and rolling, and can produce hot-rolled strip as thin as 0.6 millimeters.



HOT AND COLD ROLLING

When it comes to hot and cold rolling, Primetals Technologies has many innovative solutions in its portfolio that can't be found anywhere else—such as the **Hyper Universal Crown Control Mill**. The **Wedge and Camber Control** technology is unique in its sophistication. **Power Cooling** is synonymous with unparalleled cooling performance, particularly for high-end steel grades. And the **iBox** is the descaling solution of choice that requires no circulation heating or jet nozzles.



DIGITALIZATION

Primetals Technologies has developed the concept of the **Metals Orchestra** to illustrate its vision for the digitalization of steel production. The core idea is that a steel plant is much like an orchestra, with individual, highly versatile “players” (aggregates) and a digital “conductor.” This conductor is represented by a **unity of sophisticated digital solutions** that cover everything from **production management** and **quality optimization** to **maintenance scheduling**.

THE DIGITAL EYE

INSIDE THE MOLD

Have you ever wondered what the inside of the caster mold looks like? There are plenty of good reasons why you might be curious: the inner workings of the caster determine to a large extent the quality of the cast slabs, blooms, or billets. It is also essential that the caster operates smoothly and any stickers are detected early, as stickers can lead to breakouts and to costly standstill times. Mold Expert was designed to let you do exactly that—to see what goes on inside the mold. With 250 installations to date, Mold Expert is the best-selling mold-monitoring solution worldwide. The newest version, Mold Expert Fiber, adds a new level of detail to the system by increasing the number of measuring points from 120 to over 3,000.

Nicole Oberschmidleitner, together with her team, has made huge steps forward with Mold Expert. It was under her guidance that Mold Expert Fiber was developed, which uses fiber Bragg gratings to increase mold-specific data by a factor of 10–20. This gain in information led to a significant refinement of the algorithms used to monitor and analyze the casting process—and allowed Oberschmidleitner to keep an even more attentive “digital eye” on aspects such as mold levels and subminiscus speed inside the mold. Oberschmidleitner also pioneered new support packages for Mold Expert customers: “I realized we had more to offer steel producers in terms of providing them with specialist support after implementation. Over the years, we have forged many lasting relationships, ensuring that our customers can realize Mold Expert’s full potential.”

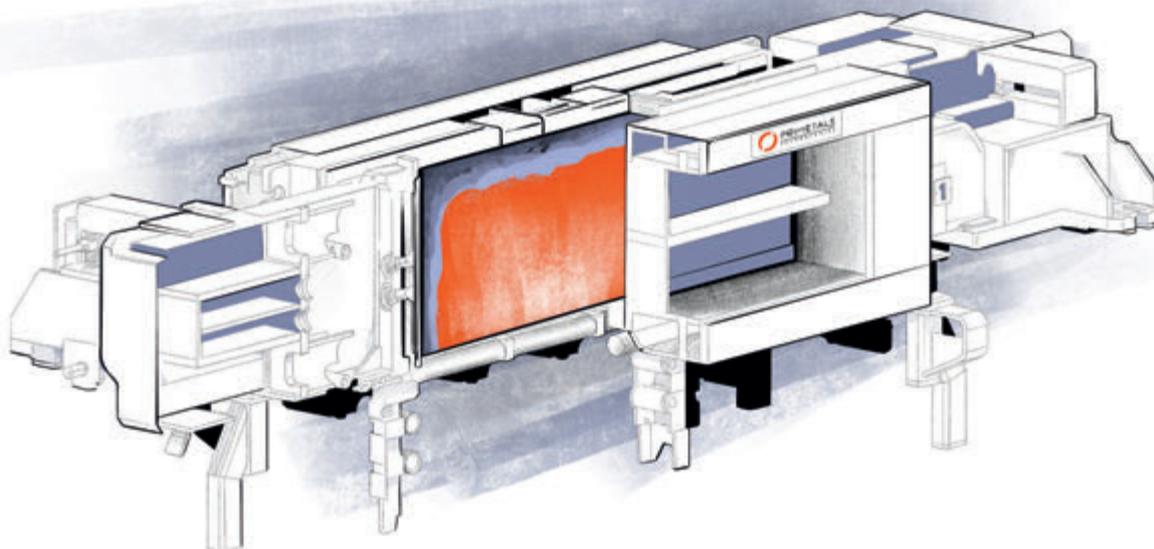


NICOLE OBERSCHMIDLEITNER ...

... is Head of Mechatronic Products at Primetals Technologies and is committed to addressing steel producers' challenges with innovative solutions and services.

MOLD EXPERT FIBER ...

... is the most recent version of Mold Expert and uses fiber Bragg gratings to monitor the condition in the caster mold.



GOING ALL IN ON ROBOTICS

The cooling process in long rolling naturally produces wire rod coils with head and tail-end metallurgical inconsistencies. Trimming those ends has proven to be a production challenge, however, and Head of Technology Matt Palfreman and his R&D team in Worcester, Massachusetts, U.S.A., wanted to find a better approach. High-speed shear accuracy was difficult to maintain at speeds of 120 meters per second. Manually counting rings to clip off and remove was tedious and dangerous. So the team considered adapting existing technology with a novel application—vision-enabled robots programmed to trim coils exactly where needed.

"We wanted a completely different alternative to competitor products," says Palfreman. "Robotics seemed the right solution." The team soon discovered it "started with the most difficult of possible applications," he says, "but we went all in." Testing numerous iterations of rapid prototypes created with 3D printers involved "a massive effort and long hours" before the team was ready to share its results with the first customer. The new robot has proven to be simpler, safer, easier, and faster than existing approaches. Workers previously tasked with a repetitive, potentially hazardous operation can now be retrained with new skills in robot system maintenance. Steel producers benefit from the greater consistency of coil and higher overall metallic yield. And soon the vision-assisted capabilities of robots will improve other stages of the long rolling process.

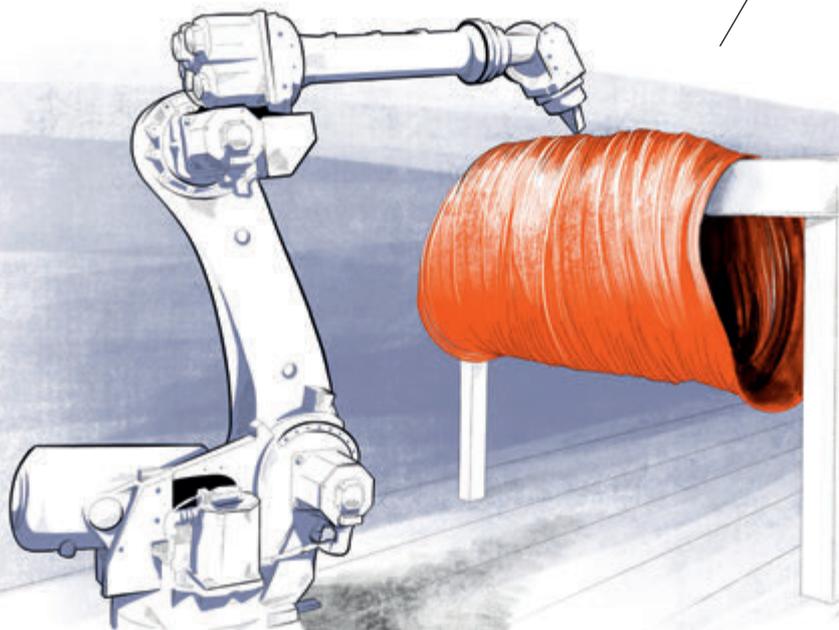


MATT PALFREMAN ...

... has pioneered vision-enabled robotics by prototyping new designs using 3D printing technology.

VISION-ENABLED ROBOTS ...

... for long-rolling applications can be programmed to trim coils exactly where needed.



THE PERFECT WELD

EVERY SINGLE TIME

The laser-welder solutions of Primetals Technologies are unique within the steel industry. They are highly effective and reliable, and can be used to both cut and weld a large variety of steel grades: dual-phase, transformation-induced plasticity, twinning-induced plasticity, boron, silicon, stainless, and specialty steels can all be processed by laser-welder-based production lines, reaching tensile strengths of up to 2,000 MPa. The laser welders from Primetals Technologies are designed to prevent any deformation of the strip during treatment. Compared to other welders, they deliver much higher performance, with a 20 to 50% boost for welding and a 20 to 100% increase for cutting, depending on strip thicknesses.

Primetals Technologies has over 20 years of experience with laser-welder solutions, and Thomas Vallee has pioneered many of the most recent advancements. Vallee worked on adapting the laser-welder technology, which had originally been crafted for medium-size applications, to heavy ones. "To make a good weld, you need a perfect cut," he says. "Steel producers want a solution that reliably achieves both, without any deformation of the strip." Vallee likes to push the limits of what's technologically possible: "I enjoy developing solutions that surpass others performance-wise. But they also have to be dependable and easy to operate." To underline this conviction, Vallee refers to a Thomas Edison quote: "The value of an idea lies in the using of it."

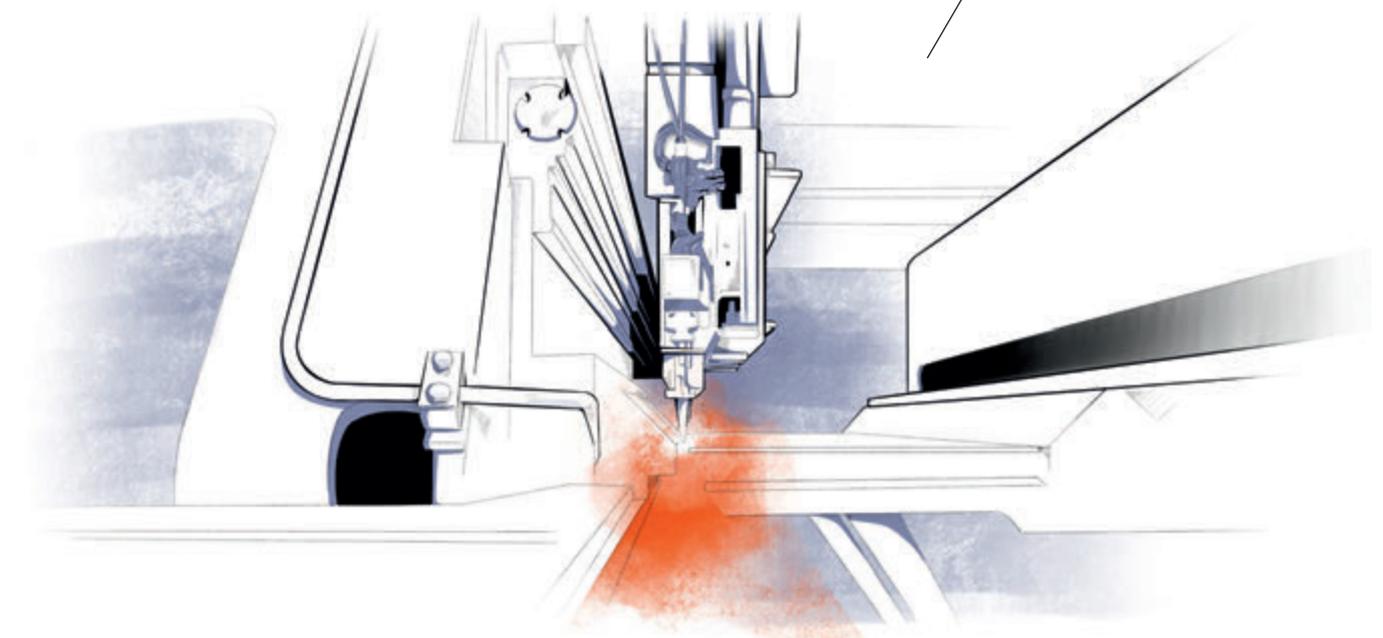


THOMAS VALLEE ...

... is the Lead Product Manager for Primetals Technologies' laser welders, which he wants to be both innovative and practical.

LASER WELDERS ...

... from Primetals Technologies are reliable and easy to maintain, and require up to 50% less energy than other laser welders.



HUMAN EXPERTISE PAIRED WITH AI

An innovative solution only available from Primetals Technologies, Through-Process Optimization (TPO) helps steel producers make the most of their equipment. It indicates in great detail what parts of the production chain could be further improved to facilitate a transition to higher-quality steel grades—for instance, steels for the automotive industry. TPO relies on two things: a powerful software system that incorporates many thousands of data points stretching right across the production chain, and the experience and insights into the steel-production process that the specialists at Primetals Technologies have gained over decades.

"Creating TPO was hard because it was based on such a novel approach," says Dr. Thomas Pfatschbacher of the early days of his brainchild. "We were a small but dedicated team, and I remember constantly facing completely new challenges, coming up with new ideas for how to resolve them in my car, on business trips, and late at night." At the core, the goal of TPO was to pioneer a new solution for the digitalization of all production-related processes in a steel plant. The combination of expert advice and information technology was unique, as other companies only provided traditional consulting without the ability to enable knowledge-based quality control. TPO emerged as a driver for customer-oriented innovation at Primetals Technologies: "The better we understand a steel producer's situation, the more effectively we can support them," says Pfatschbacher.

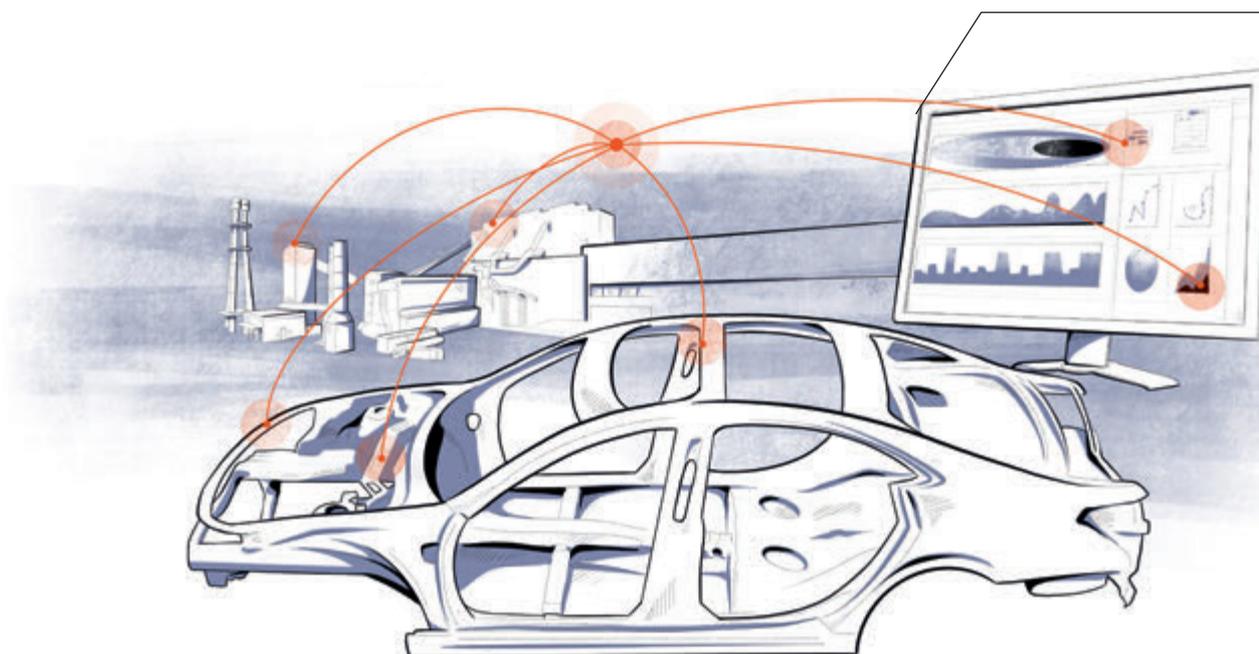


DR. THOMAS PFATSCHBACHER ...

... wanted to channel decades of operational experience into one intelligent IT system, which could assist steel producers in upgrading their product portfolio.

THROUGH-PROCESS OPTIMIZATION ...

... uses human expertise and artificial intelligence to support steel producers in holistically optimizing their products, their processes, and their operations.



NEW METHODS

BEARING THE LOAD

In 1932, the Morgan oil-film bearing, branded MORG-OIL, offered rolling mills a radical alternative design—a thin film of oil with immense load capacity. The new MORG-OIL bearings reduced friction, increased speeds, and lowered power demands, all while achieving better product tolerances with increased reliability. To date, the tapered-neck MORG-OIL bearing has seen three generations of hydrodynamic technology. The latest innovation, the MORG-OIL KLX, has maintained the position as the industry standard, while offering more than 25% increased capacity in the same space.

Thomas Wojtkowski, a former aerospace engineer, led the team behind the MORG-OIL KLX. "The challenge was to redesign the bearing technology without overloading other components that mate with the bearing," he says. For the first time ever, the new technology was tested on a custom-built half-scale device that runs at realistic speeds and loads. "We measured what was actually happening inside, rather than relying on theoretical work," he says. That knowledge allowed the MORG-OIL R&D team to refine the design with a thinner bearing still robust enough for real-world applications. "The proportions looked so different that many people were skeptical," says Wojtkowski. But 100-plus mills later, the technology has more than proven its value. "It's great to see how widely KLX has been adapted to so many types of mills worldwide. Our team is very proud of the success of the product."

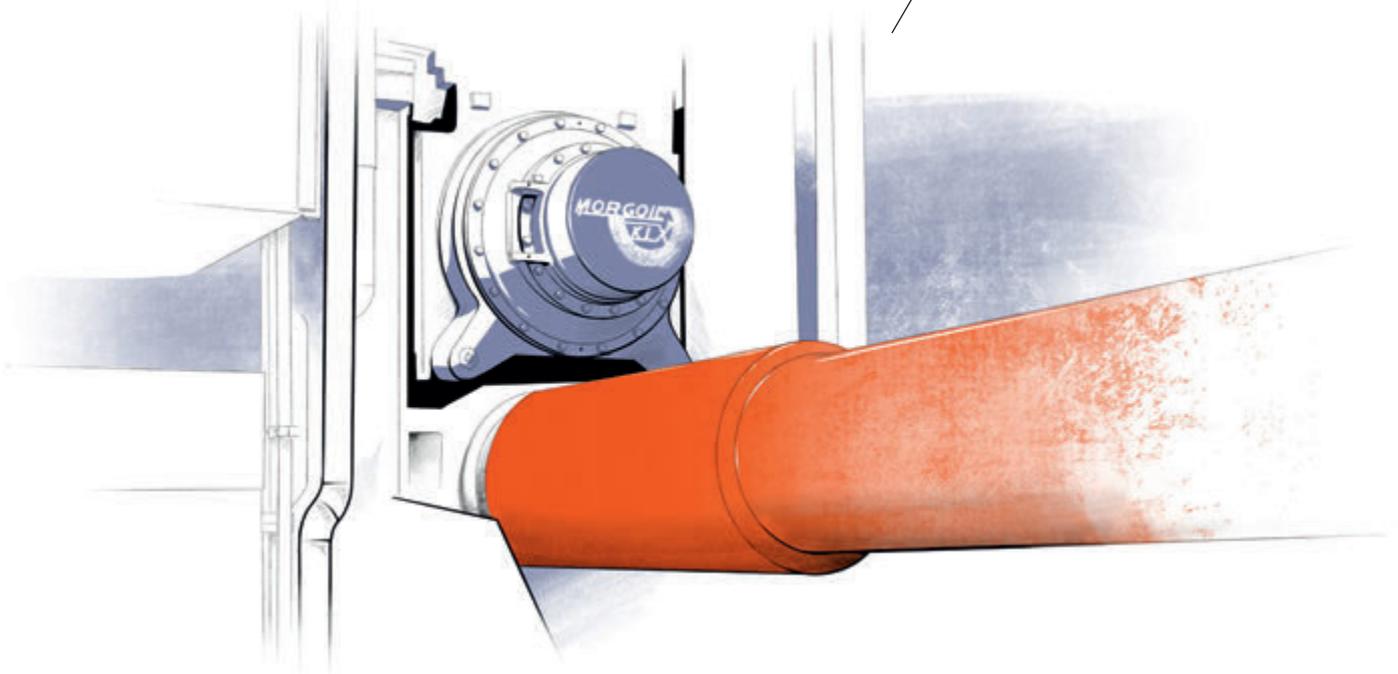


THOMAS WOJTKOWSKI ...

... took an innovative approach to advancing the MORG-OIL bearing and created a half-scale testing device that allowed his team to gain invaluable real-world insights.

MORG-OIL KLX ...

... is the latest MORG-OIL product, offering 25% higher capacity at the same space requirements.



HARDENING RAILS

THE SMARTER WAY

idRHa+ is the inline injector dual-phase rail-hardening system from Primetals Technologies, capable of applying the desired temperature profile and microstructure distribution of the rails during manufacturing in real time. Optimized for the requirements of today's rail producers, idRHa+ is fully Industry 4.0 compatible and offers advanced thermo-metallurgical process control, state-of-the-art production management, and strictest quality assurance. The system was designed from the ground up to be future proof and provides pioneering, highly advanced functionality. It can predict the rails' material properties in terms of hardness gradient, microstructure transformation, deformation behavior, and more. The high energy efficiency of idRHa+ rounds off a solution that is without equal in the metals industry.

Alberto Lainati was involved with the development of idRHa+ from the beginning. He started by studying in detail what market conditions the new technology would be facing and got in contact with rail producers, end users, and standardization organizations around the world. "With rails, you have zero room for mistakes," says Lainati. "Rails are among the very few steel products that go into operation as rolled, so their performance, consistency, and reliability are absolute." For idRHa+, an innovative pass-through rail-production method had to be crafted, with selective and flexible quenching protocols using water, air, and mist. "Ahead of the first production run, I was up all night, hoping it would go as planned." It did.

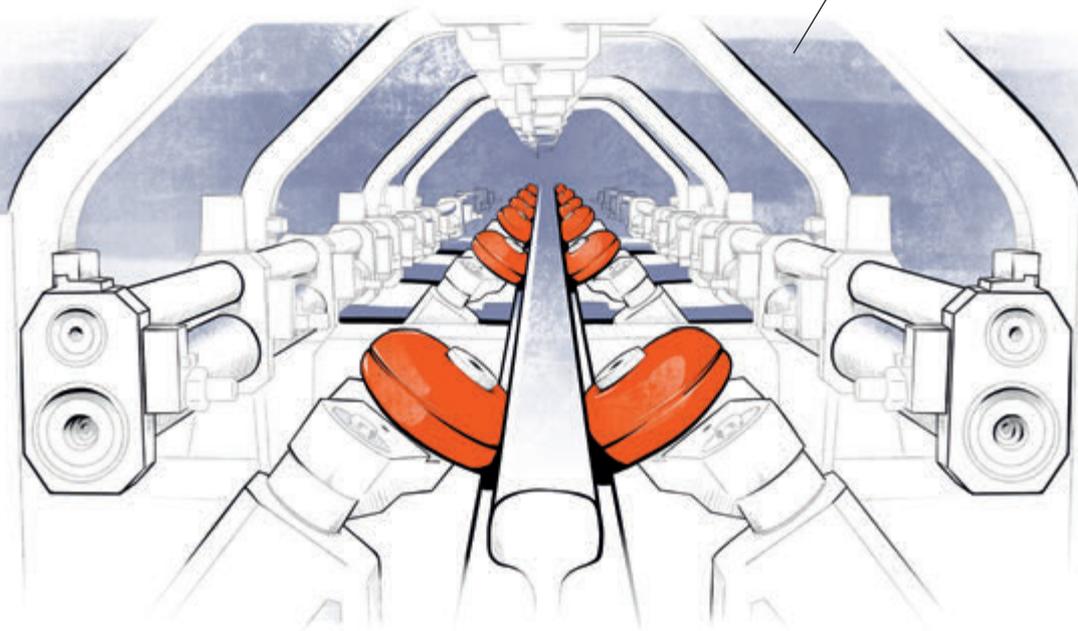


ALBERTO LAINATI ...

... has been with Primetals Technologies (and predecessor companies) since 1989 and led the efforts behind idRHa+.

IDRHA+ ...

... integrates with advanced sensors and electronics, thus implementing Industry 4.0 principles to harden rails.



WHAT'S NEXT IN THE WORLD OF METALS

**UTILIZE
NEW DIGITAL
SOLUTIONS**

**MAXIMIZE
PRODUC-
TIVITY**

**INCREASE
OPERATIONAL
FLEXIBILITY**

**ENHANCE
PRODUCT
QUALITY**

**LOWER
OPERATIONAL
COSTS**



What are the "hot topics" for steel producers who want to anticipate the future and ensure their long-term success? The experts of Primetals Technologies have studied the current trends, and have carried out extensive research to prepare for future developments. Based on their findings, they are pioneering innovations designed to meet the challenges ahead. But even with the technologies in place to meet these demands, every steel producer still has to find the ideal implementation strategy. Primetals Technologies is ready to support its customers individually.



**IMPROVE
ASSET
UTILIZATION**

**LOWER
MAINTENANCE
COSTS**

**INCREASE
SAFETY
OF STAFF**

**MINIMIZE
ENERGY CON-
SUMPTION**

**LOWER
EMISSIONS**

OVERCOMING BOTTLENECKS FOR GREATER PRODUCTIVITY

THE LOGISTICS OF ALMOST ANY STEEL PLANT CAN BE FURTHER OPTIMIZED—WITH LOGISTICS SOLUTIONS FROM PRIMETALS TECHNOLOGIES.





Ladles are among the most common sources of production bottlenecks.

Sometimes, even a small change to a plant's logistics can have a major impact on overall productivity. And when a larger change is required, detailed analyses of its effects are essential for reliable business planning. Primetals Technologies has the logistics software and experience required to bring transparency to both major and minor plant-optimization efforts.

Identifying bottlenecks in steel production is no small feat: The overall complexity of a plant's operations can be daunting, as all production steps are interdependent and impossible to isolate. Also, the intricacies of internal staff structures and the assignment of responsibilities make it even more difficult to achieve complete transparency. And yet, many steel producers believe that their plant could deliver even higher performance once all of these factors have been visualized and analyzed using the right tools.

Primetals Technologies is aware of the enormity of this challenge and supports steel producers in addressing it with its advanced plant and logistics optimization software and process-specific application knowledge. To be able to analyze and visualize all of the processes that take place within a steel plant, Primetals Technologies first embarks on a fact-finding mission in collaboration with the customer's production team. Aspects such as the plant's current layout, production capacity, material flow, and final-product mix are all taken into consideration. More detailed questions regarding maximum sequence length, the number of hot ladles in circulation, crane utilization, and other factors, are also considered until the full scope of operations can be precisely mirrored and simulated in software. Based on this simulation, Primetals Technologies' specialists are able to pinpoint bottlenecks and make proposals about which improvements or changes to equipment and logistics could be made for an increase in productivity.

DE-BOTTLENECKING TYASA

The immense capabilities of this solution are best showcased by one of Primetals Technologies' most recent logistics-optimization projects. The company teamed up with Mexican steel producer Tyasa in a project that was designed to take operations to the next level.

Tyasa was the first customer of Primetals Technologies to buy an EAF Quantum—an advanced electric arc

furnace capable of preheating scrap. In a more recent development, Tyasa again decided to pioneer the use of a new solution—namely, the thin-strip casting technology Castrip. Having traditionally manufactured long products, Tyasa took its first steps toward moving into the growing market of flat products, which is why a ramp-up of its Castrip-based production became necessary.

However, increasing Castrip production had a detrimental effect on overall plant output. The Castrip process has a casting time of about 65 minutes in its faster setups, while the EAF Quantum's tap-to-tap time is significantly shorter. Since the Castrip is unable to harness the full production capacity of the EAF, the plant's overall output drops as Castrip production increases.

IN-DEPTH ANALYSIS

To address this issue, Primetals Technologies conducted an in-depth analysis of the process routes used at the time—starting with the EAF Quantum, progressing to the secondary-metallurgy processing units, and ending with the billet caster and Castrip. The goal of the analysis was to identify setups that would allow simultaneous operation of both casters for maximum EAF Quantum utilization and production capacity.

The single-bay layout and the special heat-treatment process required for Castrip-based production involves one ladle-furnace treatment before and one after vacuum treatment. This is why ladle transport in conjunction with Castrip can be quite a challenge and, in Tyasa's case, it was also the reason why an advanced ladle-logistics simulation proved necessary.

The analysis was conducted using Primetals Technologies' carefully designed logistics-simulation model, which is detailed and sophisticated enough to take into account aspects such as the actual scheduling of the casting machines, all other processing units, and the EAF Quantum.

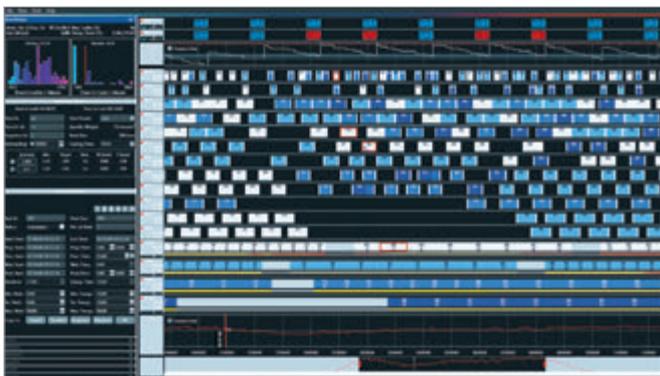


FIG. 1: The first step in logistics simulation involves the creation of a realistic production schedule of the respective plant.

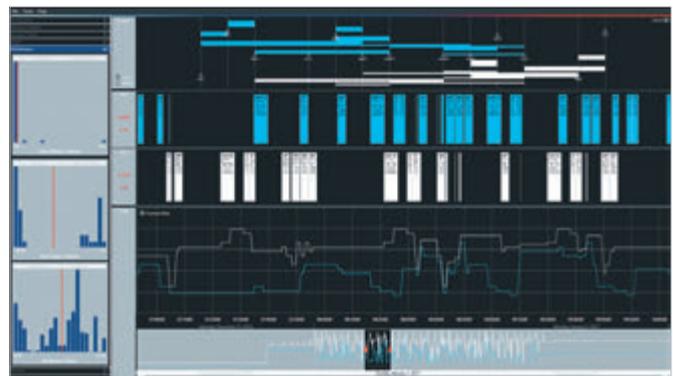
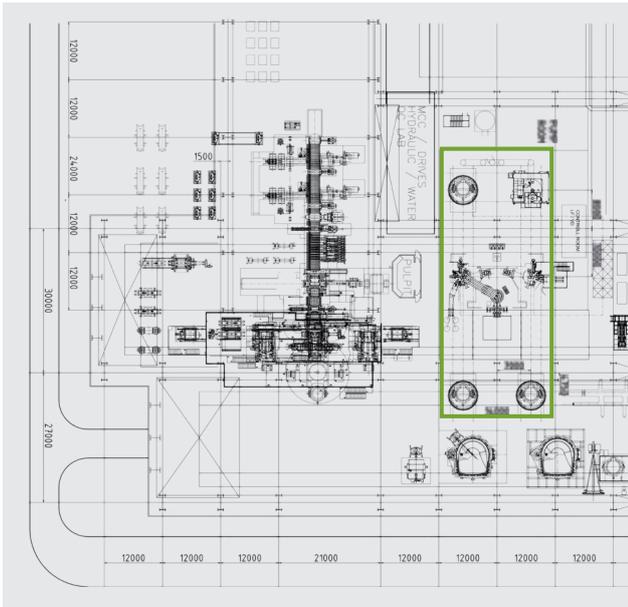


FIG. 2: As a second step, all production-relevant crane and ladle movement is calculated to match the production schedule.



SMARTER LADLE HANDLING

The twin-ladle-furnace vacuum-degasser (Twin-LF-VD) design is capable of performing heating and vacuum operations for two separate ladles at the same time. While one ladle is kept in heating position, the other is put under vacuum, and vice versa. This practice matches the specific ladle furnace-vacuum-ladle furnace (LF-VD-LF) process route required for Castrip production. Since the ladles with their alternating pattern are moved not by crane but directly by ladle car, the crane remains free for other important activities that are carried out in the same bay—such as ladle-maintenance-related tasks.

It emerged that the available twin ladle furnace as well as the teeming crane constituted major bottlenecks for longer Castrip sequences of four heats or more. One of the main reasons was that Castrip heats are executed at temperatures that are more than 100° C higher compared to those used at the billet caster. Castrip heats also require additional time at the twin ladle furnace after vacuum treatment. It is this second treatment that raises major challenges in terms of crane and ladle-furnace scheduling, since the ladle furnace is—at the same time—also used for billet heats.

IDENTIFYING THE BOTTLENECK

Based on the simulation of a variety of suitable caster setups and sequence lengths, Primetals Technologies found a way to eliminate the bottleneck, which involved placing an additional ladle furnace adjacent to the Cas-

trip machine. When Primetals Technologies explained that simultaneous production would require only moderate crane involvement and that crane operators would not have to exceed any limits, Tyasa responded very positively.

However, the investigation threw up yet another issue. Thus far, the main focus of the investigation had been on the production of billet grades that did not require any vacuum treatment with Castrip products. In order to ensure maximum production flexibility with respect to future requirements, Tyasa wanted Primetals Technologies to also take into account vacuum grades on the billet caster as well as on the Castrip machine. It quickly became apparent that the installed twin vacuum degasser with a vacuum-treatment time of about 45 to 50 minutes for Castrip heats would eventually »»

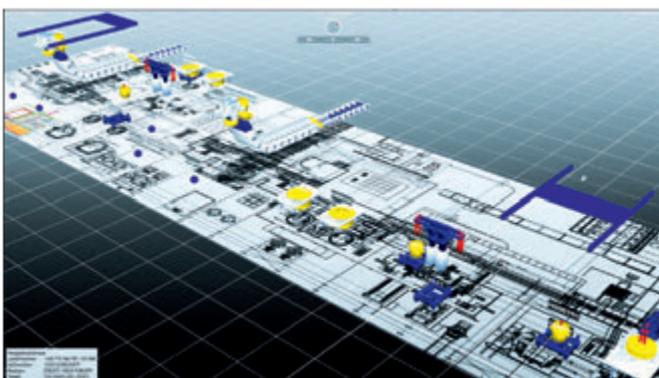


FIG. 3: In a third step, all transport activities are visualized by a three-dimensional, computer-generated model.



FIG. 4: The results of the analysis as well as potential improvement measures are then presented in a comprehensive report.



PIONEERING THE SOLUTIONS OF PRIMETALS TECHNOLOGIES

Oscar Chahin Trueba is Tyasa's CEO and has been a valued customer of Primetals Technologies since the early 1990s.

How have recent changes in market demands impacted your operations?

Oscar Chahin Trueba: Being able to react quickly to market demands by adjusting our production is the key to our success with long and flat products. As is quality. Competitive prices and high raw-material availability are essential for efficient production, and we have to stay flexible to maintain a healthy cost basis.

How has Primetals Technologies helped Tyasa to meet these demands?

Trueba: The deep analysis of our logistics helped us to isolate our bottlenecks. It confirmed that the investments we had planned for were correct and would benefit our operations. Everything we needed could be provided by a single supplier: from the logistics simulation to the installation of the online heat scheduler. Primetals Technologies helped us to anticipate future trends and stay ahead of the curve.

What have you found particularly rewarding in working with Primetals Technologies?

Trueba: We were very impressed by the professionalism of Primetals Technologies and by the support we received in configuring a customized solution. The combination of plant technology, advanced logistics simulations, and tremendous experience was extremely beneficial for us. Also, everything was done in a timely manner. Our relationship with Primetals Technologies is strong and very productive.

represent another serious bottleneck in spite of the additional ladle furnace.

Hence, in order to ensure maximum production flexibility and production capacity, a second comprehensive logistics investigation was conducted. Instead of only one additional ladle furnace, Primetals Technologies adapted a particular Twin-LF-VD design that included a twin ladle furnace and a twin vacuum degasser. The relatively small footprint of this custom design allowed for it to be perfectly placed in between the billet caster and the Castrip machine. Once implementation was complete, the new equipment was able to handle all Castrip-related alloying, heating, and vacuum treatment, thus leaving the existing twin ladle furnace and twin vacuum degasser free for special bar quality (SBQ) production. In addition, the simulation showed that the choice of location for installation of the equipment would result in a reduction in load for the two teeming cranes and would make production scheduling more straightforward.

A POWERFUL AND VERSATILE SOLUTION

The fact that the logistics solution from Primetals Technologies was able to include non-standard equipment and address the associated challenges is a good indicator of the solution's immense potential and serves as a proof of concept. Most remarkable is that all simulations and analysis tasks have been conducted without having to change or adapt a single line of code!

Primetals Technologies also calculated the resulting crane movements for the new production schedule and studied the impact of relocating slag pots and ladle-tilting stations in terms of crane utilization and production output. It was also possible to indicate the times at which the teeming crane could be freely moved, which is essential for daily maintenance operations in the EAF Quantum area during the two-hour EAF Quantum shutdown periods. This calculation was based on the exact scheduling of all crane operations taking place on a regular production day.

The logistics simulation even took non-standard equipment into account.

The logistics solution from Primetals Technologies can support any steel producer who wants to uncover hidden bottlenecks.

Ultimately, Primetals Technologies was able to demonstrate that the design and placement of the new equipment would meet all of Tyasa's requirements.

FUTURE-PROOFING THE PLANT

There was an additional benefit of the logistics simulation: the newly devised production schedules clearly demonstrated that it would make sense for Tyasa to pay close attention to heat scheduling when simultaneously operating two lines with a single EAF Quantum. Primetals Technologies has submitted a corresponding offer to Tyasa for a specially designed Twin-LF-VD in combination with a sophisticated Online-Heat Scheduler (OHS), which is part of Primetals Technologies' Production-Management System—a true Industry 4.0 solution. The OHS would support shift managers in real-time heat scheduling and in the coordination of both casting machines. It can take into account delays and actual treatment times (with the respective data being provided by shop-floor L2 systems) and is able to automatically re-schedule production in a way that avoids sequence breaks and ensures maximum EAF Quantum utilization.

Overall, Primetals Technologies' logistics-simulation solution can greatly enhance operations—not just in the case of Tyasa but for any steel producer determined to uncover hidden bottlenecks, to optimize production output, and to ensure future profitability. To contact the logistics-optimization team, send an email to contact@primetals.com. ●

Dr. Gerhard Kurka, Senior Consultant, Logistics Simulations
Peter Örtelt, Vice President, Integrated Plants
 (Both with Primetals Technologies Austria)



IMPROVING LOGISTICS WITH AN ANALYTICAL MIND

Dr. Gerhard Kurka has worked in the steel industry for more than a decade and is an expert in Plant-Logistics Simulations.

How and when did you first become involved with logistics simulation?

Dr. Gerhard Kurka: I started dealing with logistics simulations over ten years ago when I ran my own consulting and software business. The first project I did was for voestalpine in 2006; it dealt with scrap-yard optimization. My second assignment was a large-scale conceptual engineering study by Siemens VAI, conducted for Novolipetsk Steel (NLMK). Three years later, I joined Siemens VAI to do more extensive work in this field.

What are the challenges involved in logistics projects?

Kurka: You never know upfront what the outcome will be. Also, you have to deal with a variety of intricate influences like process times, transport systems, human influences, and other boundary conditions, all of which make these kinds of investigations so exciting for me.

Are there a lot of ongoing projects?

Kurka: At the moment, we are working on a large logistics investigation for Metalloinvest OEMK as part of a comprehensive paid study. After that, my next job will be to conduct a crane-logistics analysis for Zaporizhstal as part of a basic-engineering project we are doing for the company. In addition, we continually support our sales people throughout their pre-sales activities to provide well-integrated and finely balanced solutions.

M.SPACE

THE WEB PORTAL FOR THE METALS INDUSTRY



m.space is the innovative online platform created by Primetals Technologies to bring together a wide range of e-services in one place. Under the m.space umbrella, steel producers can order spare parts online, make the most of the latest e-learning opportunities, and centralize document management—and the m.space platform is growing all the time.

Primetals Technologies is renowned for its customer-centric approach, and in an effort to further streamline the plant-management workflow, and as part of its ongoing strategy to embrace digitalization, a groundbreaking web platform has been introduced purely with the steel producer in mind: m.space conveniently delivers a growing number of features and services as a software as-a-service package in one place, enabling steel producers to operate more efficiently and stay ahead of the curve. It is designed first and foremost to be a user-friendly environment, at the heart of which is the steel producer of today.

Digitalization has impacted the steel industry on multiple levels while also creating unparalleled opportuni-

ties for improving plant operation and maintenance. The m.space platform is firmly built on the premise to tap into the potential of Industry 4.0 and make the lives of steel producers easier. One of its many facets is the product catalog m.buy, which includes a web shop where customers can browse a large selection of spare parts. The m.academy training platform was created to encourage staff at all levels to keep their knowledge up-to-date through a range of e-learning and real-world training opportunities. Another feature of m.space is the secure document-management system m.doc, which centralizes the document management process. It doesn't end there, though, because m.space is a portal into a much wider world of e-services that can be configured by the customer in just a few clicks.



M.BUY

WEBSTORE FOR STEEL PRODUCERS



m.buy is a comprehensive online catalog of spare parts for Primetals Technologies equip-

ment, including related product drawings and blueprints. Users simply log in for a personalized user experience, which then enables them to browse through the catalog, request quotations, read through the available engineering-related information, and start the inquiry process quickly and easily. These inquiries as well as other customer questions will be quickly answered by the experienced m.buy team.

meta.is/mbuy



M.ACADEMY

ONLINE TRAINING PLATFORM



m.academy is an e-learning space that offers both online courses as well as on-site

training opportunities for steel-plant operators. It provides worldwide classroom training, practical training, process training, e-learning, and individual training. Courses can be tailored to individual requirements for maximum personal benefit. m.academy is the perfect knowledge-sharing platform and is designed to help staff sharpen their skills and keep their career development on track.

meta.is/academy



M.DOC

DOCUMENT-MANAGEMENT SYSTEM



m.doc is a document-management service for storing the technical documentation of a steel

plant. The m.doc documentation system provides reliable, fingertip access to critical information, and because the data is centrally organized and ready for use, the time, cost, and energy saved in being able to quickly navigate through a wealth of information could make all the difference in terms of keeping ahead of the competition.

meta.is/mdoc

m.space delivers a growing number of features and services in one place, enabling steel producers to operate more efficiently and stay ahead of the curve.



M.CRANE

AUTOMATED ENGINEERING SERVICE



m.crane is an automated web-based engineering software that allows a customized hoisting

drum to be designed in a matter of minutes by entering parameters such as lifting weight, height, speed, and rope drive. Every aspect of the design process is covered, and once the parameters have been entered m.crane is capable of calculating and designing the drum in less than fifteen minutes. m.crane is designed to save time and money when replacing hoisting drums.

meta.is/mcrane



M.FLEETGUARD

CMS AND GPS TRACKING



m.fleetguard is a software-as-a-service solution that monitors technical parameters of

all your vehicles in real time and gathers information such as whether a truck is currently operational, its location, tire pressures and lifecycles, fuel and oil levels, payloads, and even the road conditions. m.fleetguard sends alerts whenever a scheduled route is changed, or if a technical problem is detected, so that preventive action can be taken before damage occurs.

meta.is/mfleetguard



M.CONNECT

PROCESS-ANALYSIS SOLUTION



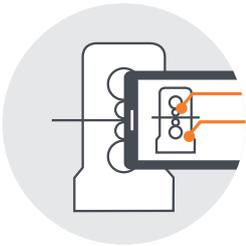
m.connect is designed to make sense of even the most complex plant data, gathering

unorganized data, analyzing it, and transforming it into structured information. m.connect turns raw data into an asset that a steel plant can put to good use. For example, seemingly random measurement signals can be put together with production figures to paint a bigger picture that indicates quite clearly where improvements can be made.

meta.is/mconnect

BENEFITS OF M.SPACE

- Software-as-a-service solution; no local installation necessary, regular updates
- Easy access to full spectrum of e-services all in one place
- Practical, user-friendly e-shop for spare parts
- Instant access to user-specific training
- Fast and secure document management, including augmented reality support
- One user account and single-sign-in for all m.space features, services, and webstore
- Online payment feature (currently in development)



M.ARIO

AUGMENTED REALITY FOR THE MILL



m.ario is an augmented reality enhanced document-management software designed

to collect, organize, and visualize operational information in a uniquely structured way for unparalleled usability. Using augmented reality, m.ario visualizes data such as voltages, for example, precisely where it is needed on a mobile device such as a tablet. The m.ario data management system is designed to streamline and increase the efficiency of maintenance and operations.

meta.is/mario



M.PREDICT

PREDICTIVE-MAINTENANCE SYSTEM



m.predict uses sophisticated vibration-signature analysis for the early detection of devel-

oping equipment faults, enabling steel producers to act quickly and avoid unscheduled downtime or worse. m.predict is the culmination of decades of experience in vibration-based condition monitoring and analysis. To identify potential problems, it combines the analysis of mechanical vibration signatures with deep knowledge about equipment design and function.

meta.is/mpredict



M.SIMTOP

HOLISTIC PLANT MODELLING



m.simtop is designed to replicate the business environment of a steel plant by turn-

ing the plant's production processes into a digital model. This allows steel plants to use simulations to cost-effectively analyze multiple scenarios and make improvements to strategic planning processes and optimize plant operations. An extensive metallurgical model library is the basis for sophisticated holistic plant modeling, delivering results at the push of a button.

meta.is/msimtop



FIG. 1: Digitalizing human expertise is tricky and requires the correct tools.

DISCOVERING **HOW MUCH YOU ALREADY KNOW**

Knowledge management is a critical factor in any enterprise: A lot of hard work goes into developing new solutions, establishing processes, and ensuring sustainable business operations—added to which are all the efforts that go into managing customer relationships. All of these activities generate knowledge—but how can this knowledge be shared and preserved?

DIGITIZATION VERSUS DIGITALIZATION

In English, there is a distinction between "digitization" and "digitalization" that is not reflected in some other languages. What makes things even trickier is that certain attempts to define the two terms have failed to produce clarity; rather, they have promoted ambiguity. However, with the Fourth Industrial Revolution gathering pace, the Metals Magazine team believes it is important to differentiate between these terms; this is how we have decided to use them. Digitization needs to be discussed first, as it technically and logically precedes digitalization. According to Gartner, "digitization is the process of changing from analog to digital form." One example would be scanning a book with character recognition—essentially transforming analog information into digital data. Digitalization, however, involves making entire procedures take place in the digital realm. You therefore could not "digitize" a factory with everything that goes on in it; you can only "digitalize" it. And if, for instance, a steel producer were to introduce robots to handle tasks that were previously executed by highly skilled operators, this would be a question of digitalization.

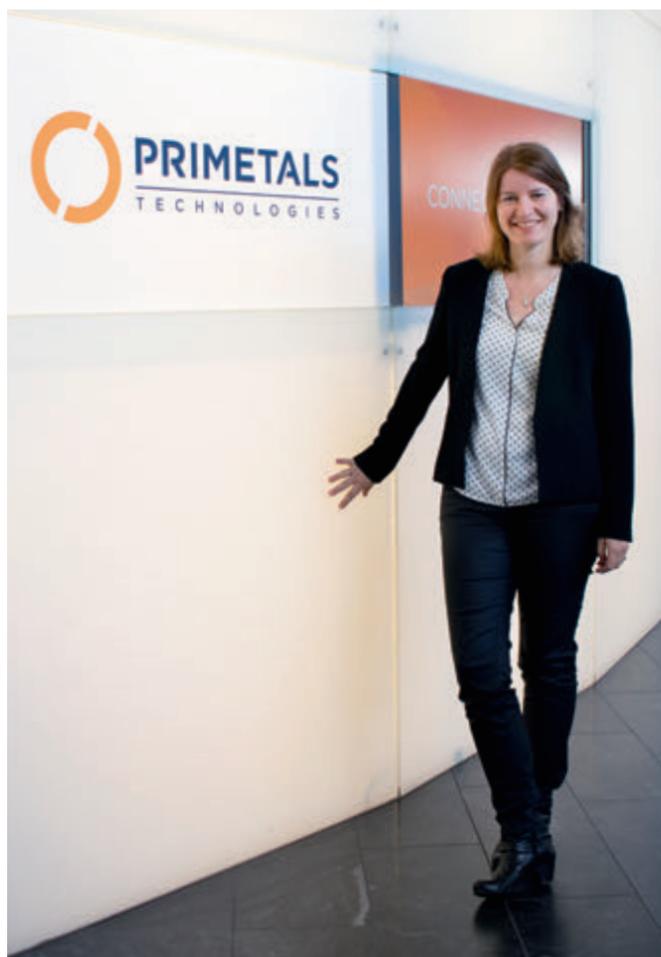


FIG. 2: Erika Hofstätter is pioneering highly effective knowledge-management techniques at Primetals Technologies.

Companies, particularly those driven by research and development, are usually aware that the expertise of their staff is one of their most precious resources. They know that innovations are not only based on inspiration but also on the experience and knowledge of their employees. And while inspiration can't be captured, experience and knowledge can. Or can they really? Clearly, it is not easy to locate, standardize, structure, digitize, and distribute knowledge—at least until such time as scanning peoples' brains has become an option. For now, effective communication is crucial; as is the willingness of staff to discuss and share what they know and what they've learned.

SO WHAT DO YOU KNOW?

"The single greatest challenge in knowledge management is finding out what the company already knows," says Erika Hofstätter, who implements techniques designed to accumulate, sort, and distribute operations-relevant data at Primetals Technologies. "People have

to know where they can check for information, and this information has to be easily accessible and up-to-date. Otherwise you'll run the risk of everyone starting from scratch all the time, because they find it too frustrating to search for what their colleagues discovered."

INSIGHT ENGINES

Because much of the company's information is only available in scattered and unstructured form, Hofstätter uses "insight engines" to process, group, and structure the data. Once this is done, she makes the accumulated knowledge available to those who can profit from it. The information can be searched using dashboards and 360-degree views, but also with keywords. So are the algorithms used in insight engines similar to those of Google? "Not quite," says Hofstätter, "they are far more capable than what we're familiar with from today's internet search engines. They can be customized to use our own terminology. They also let us search sources such as our 'lessons learned' database for »



FIG. 3: Günther Winter is Technology Officer for Electrics and Automation at Primetals Technologies and develops data-science solutions.

clues for how to optimize project management under specific circumstances. This ensures continual progress.”

But avoiding past mistakes and typical pitfalls is not the only reason to use Hofstätter’s insight engines. Well-implemented knowledge management can help companies to better deal with retiring staff or unexpected departures. It also eases the process of arriving at far-reaching strategic decisions—for three reasons: First, decision makers have more current and reliable information at their disposal when considering their options. “They have a more complete picture of the situation and are better informed,” says Hofstätter. Second, with all the required information already available, management can concentrate on the decision-making process itself, rather than having to gather all the data they need and wasting a lot of time in the process. Third, the time required to finalize quality decisions is significantly shorter, which increases the company’s overall efficiency.

MANAGING METALLURGICAL EXPERTISE

However, at Primetals Technologies, knowledge management is not only relevant in the context of Hofstätter’s efforts. Steel production, the center of Primetals Technologies’ activities, is extremely complex, and

enormous skill and experience are required to know how to engineer and operate a steel plant. Günther Winter is intimately familiar with the challenges and opportunities associated with knowledge management in steel production. Asked whether he works with “unstructured data”—a term that is undeniably trendy in 2019—, Winter smiles. “The world we live in is essentially chaotic at its core,” he says. “Reality is inherently unstructured, and this is a truth that certainly extends to the world of metals.” Winter explains that, in steel production, no two facilities are ever the same, and as a result, the production data they generate is usually not comparable. “Every producer records different things in different ways, and even if this information is collected in a consistent manner, we often have to bring order to the ‘chaos’ and provide solutions that can put it to use. We are continually extending the capabilities of our technologies in terms of handling unstructured data.”

One of Winter’s goals for the next few years is to develop a digital assistant with his team; an assistant that makes the everyday lives of plant operators simpler, by providing expert advice that even non-experts can understand and follow. There are many contexts in which such an assistant could prove useful. “Let me give you one example,” Winter says. “If you work in maintenance,

“ Different ways of thinking are like pieces of a puzzle: you will only see the big picture if you bring them all together.”

Erika Hofstätter,
Knowledge-Management Specialist at Primetals Technologies

you are confronted with a large number of error messages and alarms every day, but they are not sorted by relevance. So which ones refer to issues that could actually develop into something dangerous? And what needs to be done to remedy the situation?” Questions like these, Winter says, could be answered by a digital assistant. But first, vast amounts of data have to be examined: the alarms themselves, the underlying data, and the actions that were taken to get the plant back into its proper state. Much of this data is available only in unstructured form. “If you’ve ever compared maintenance reports, even from the same plant, you’ll know just how unstructured data can get,” Winter says. “And yet, there is so much experience—so much expert knowledge—in these reports, just waiting to be put to use.”

PIECES OF A PUZZLE

What Hofstätter and Winter have in common is their passion for knowledge, and for making this knowledge available in new and innovative forms to those who need it. Knowledge management is often interdisciplinary and involves techniques or technologies that were previously used in other contexts. “Different ways of thinking are like pieces of a puzzle: you will only see the big picture if you bring them all together. Then they have their largest impact,” says Hofstätter. ●



THROUGH-PROCESS OPTIMIZATION

Through-Process Optimization (TPO) was developed to comprehensively digitalize the knowledge of plant operators—and to augment it with the expertise of Primetals Technologies’ own specialists. TPO effectively serves as a holistic knowledge-management solution, taking the expertise of a steel plant’s current operators and transforming it into a “rule-based system” that safeguards production. Many steel producers are facing the challenge of experienced operators nearing their pension age—and of the knowledge drain caused by their departure. TPO takes care of this problem by combining plant data with various kinds of application knowledge, for instance, with operational, metallurgical, quality-assurance, and production-process related know-how. In doing so, TPO increases plant efficiency and optimizes end-product quality.

WELTMEISTERS IN **DIGITALIZATION**



ERLANGEN IS THE FEATURED COMPANY LOCATION IN THIS ISSUE OF METALS MAGAZINE



In German, "Weltmeister" means "world champion," and Germany has indeed accumulated many such titles over the years—be it in football or thanks to its strong, export-oriented economy ("Exportweltmeister"). The technology specialists at the Erlangen location of Primetals Technologies are equally world-class: they excel at developing new, Industry 4.0 compatible electrics and automation solutions for steel producers around the world. Metals Magazine's Dr. Tom Widter visited the location.

As I approach the main entrance of Primetals Technologies Erlangen's new office building, the front door swings open automatically, inviting me to step inside. It is not a sliding door, which you'd expect to be motorized, but an utterly massive construction made out of glass and steel, and equipped with enormous handles on both sides. With impeccable timing it opens up toward me, subtly hinting at the fact that this is a place where everything is automated to perfection.

I am welcomed by Katharina Landes, in charge of communications at the location. "If you're impressed by our doors, you'll be thrilled with our conference rooms," she says. Indeed, next to every conference room, there's a cutting-edge touch panel that allows you to directly book meetings, and every action is synchronized with everyone's Outlook calendar and the central facility-management system. All the light switches are digital, and the lights themselves are of the new-style LED type that I have not yet seen before.

But of course, these are just gimmicks compared to the sophistication it takes to automate steel plants. The technologists in Erlangen specialize in electrics and automation for the downstream area—everything related to rolling and processing—, and they collaborate with other company locations to deliver endless casting and rolling solutions such as Arvedi ESP. While they certainly have the expertise to plan and execute the implementa-

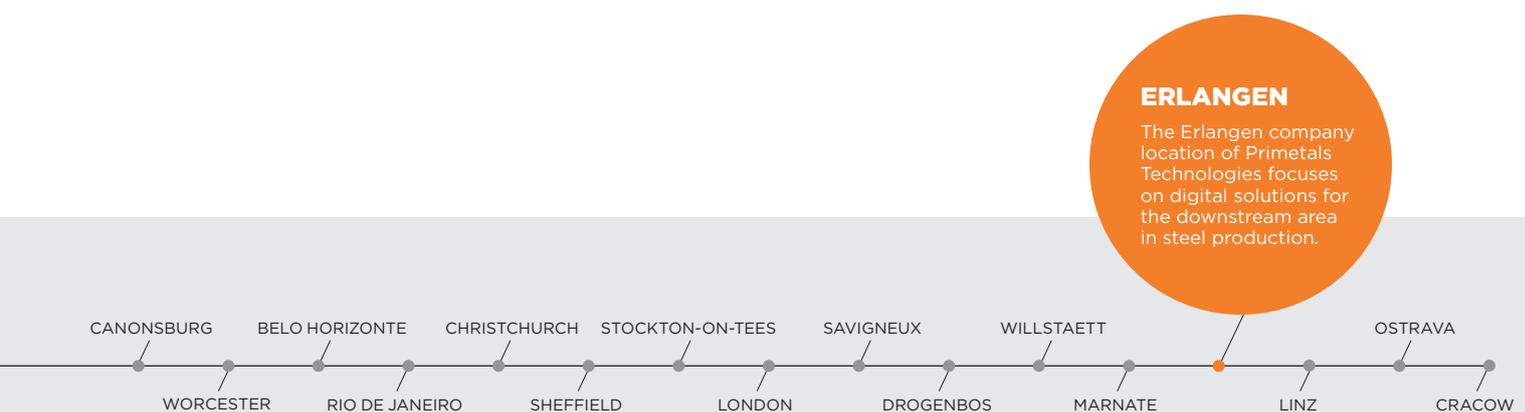
tion of advanced automation systems for any greenfield plant, their main focus is on upgrade packages and modernization concepts for existing production facilities.

A CITY OF STUDENTS AND SIEMENS

The Erlangen location has its roots in Siemens, and while the staff have forged their own identity in the four years since Primetals Technologies was founded, the presence of Siemens can still be felt. Many Primetals Technologies employees have spent years, if not decades, working here, and with a workforce of more than 20,000 in Erlangen alone, the company's presence in the city is inescapable. "Erlangen is essentially made up of Siemens people and the student community," Landes tells me.

It shows. Many of the office buildings feature the Siemens logo, and with such a high student population there is a tendency for the inter-city commute to be made by bike—bicycles being the cheap and environmentally friendly means of transport that even the poorest of students can afford. You'll find cyclists everywhere you look, even in winter.

The Erlangeners' passion for biking, however, does not prevent them from loving their cars. On the contrary: sometimes it almost seems that, in Germany, patriotism is demonstrated only through an affection for German-made cars—and football. And with the »



Germans' fondness for cars, you could argue, comes a natural affinity with one of the automobile industry's most important base materials: steel.

EXPERTS IN STEEL PRODUCTION

It is steel that the staff at Primetals Technologies Erlangen live and breathe, especially from the perspective of the “digital orchestration” of a plant's production equipment. After all, it was the German government that coined the term “Industrie 4.0,” and over the last few years, digital production technologies have advanced significantly—not least thanks to the efforts being made in Erlangen. Much progress has been made of late, and the steel producers of today have developed a sense of urgency that digitalization is something they need to embrace right now in order to stay ahead of the curve.

“We have seen many steel producers refine their digitalization strategy,” says Hans-Jürgen Zeiher, Global Head of Electrics and Automation [illustration pg. 44, right]. “Everyone is busy determining what steps to take next, but the truth is that comprehensive digitalization takes time.” Not all producers are equally forthcoming about their strategic goals, he says: “European producers tend

to keep their thoughts on digitalization more to themselves, whereas their Chinese counterparts tend to be more open.”

Asked what aspects of the Fourth Industrial Revolution he believes to be most relevant for the steel industry, Zeiher says that producers should be focusing on implementing just-in-time production as soon as possible. “If you are capable of combining ‘lot size 1’-style production with holistic, product-oriented quality control, you're in a superb position even in a competitive market.” Are there any hidden challenges to digitalization, I ask Zeiher. “It is easy to forget that steel producers need to properly train their staff to make the transition,” he says. It is a notion I have heard before. In some cases, steel producers undergo a process that is nothing short of a cultural shift in order to harmonize their operations with the new technological possibilities.

PIONEERING DIGITALIZATION

It turns out that the technologists at Primetals Technologies Erlangen have discovered a fair number of hidden challenges involved in implementing digital solutions for steel producers around the world. “It's a process of constant discovery,” says Günther Winter,

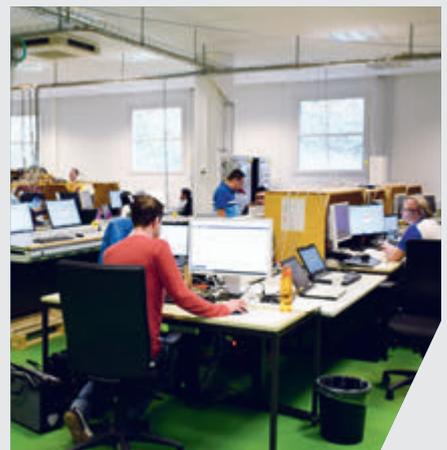
THE TEST CENTER IN FÜRTH



Günther Besenreuther, site manager at the test center in Fürth, shows us some of his server racks. These computers are used to host automation software.



The role of the site is to test new automation equipment before it is installed in steel plants. These are control panels for the roll change in finishing mills.



Programmers from all around the world have found their way to Fürth—to ensure that the Level 1 and Level 2 automation systems are performing as expected.

Head of Innovation for Electrics and Automation. “Digitalization means something different to every single steel producer. Everyone is in a unique situation and has their own targets.” Winter has a clear idea of the role Primetals Technologies has to play in terms of supporting producers on their journey: “There is no ‘official guideline’ for how digitalization should best be applied to steel production. It is therefore our job to come up with strong concepts, develop the solutions required, and steer our customers into the future.”

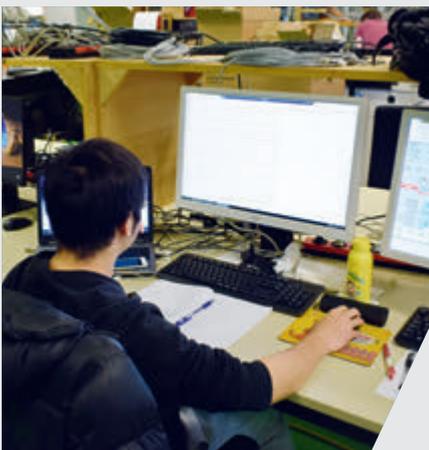
Is there any one technology currently in development that Winter expects to make a particularly great impact upon its release? “We are working on a next-generation condition-monitoring system,” he says. “Earlier systems already incorporated a lot of expert knowledge, but our ambition is to create something that is both even more comprehensive and very user-friendly—an expert system for people who don’t have to be experts themselves to use it.” Knowledge transfer, he goes on, is a big issue for many producers: it has become increasingly difficult to replace experienced staff who leave the company—for instance, through retirement. Solutions such as Winter’s next-gen condition-monitoring system and Through-Process Optimi-

zation [TPO, further information on pg. 25] alleviate this problem by capturing the operators’ knowledge and adding to it. At their core, they are designed to ensure optimal knowledge management.

NEURAL NETWORKS, THEN AND NOW

This kind of expert knowledge is evident throughout the entire company location, and whenever you talk to any of the technologists. Dr. Klaus Weinzierl has been working with advanced algorithms for several decades, which makes him the perfect candidate to introduce a historical perspective and explain to me the difference between the “neural networks” of the 90s and “artificial intelligence,” which is so often talked about today. “There definitely has been a technological evolution,” he says, “but it’s not so much that the architecture of the algorithms we use today have changed, rather the algorithms themselves have become more complex.” It is necessary to understand the concept of “depth” in deep learning, he says. It is about layers, and the number of layers a system can handle.

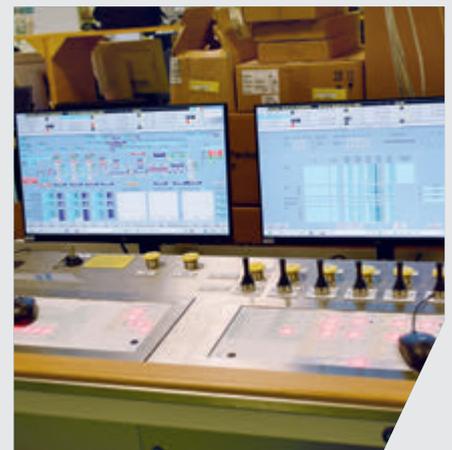
While the neural networks have increased in complexity, it is often the hands-on experience of applying them to steel production that makes the difference in terms »



A Chinese programmer is working on SQL database queries. He is part of the Level 2 team for a new Arvedi Endless Strip Production line destined for ... that’s right, China.



Everything is assembled according to detailed plans to reflect the production setup in the plant. As a result, both development and testing are highly accurate.



These control panels are particularly impressive. When the work in Fürth is completed, they will be sent to the plant, where they’ll be part of the control pulpit.

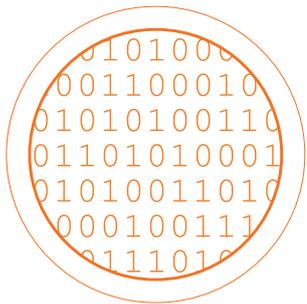
of their effectiveness. “In theory, you have to program neural networks to cover all of the aspects that could possibly influence the processes they are meant to control. But in practice, this is often impossible. What you’ll then want to do is introduce random values at distinct points, so that the neural net can be trained not to be disrupted by unexpected events.” As a writer, I am naturally bad with numbers and algorithms, but this is fascinating.

Weinzierl tells me that it’s important to know the process you’re trying to automate in great detail. He once implemented a neural net-based automation system for a Russian customer, but when it was fired up, something wasn’t working correctly. The situation must have been tense; was his algorithm flawed? As can be expected from a cooling-line expert, Weinzierl kept a cool head. It occurred to him that maybe there was still air in the hydraulic system, and indeed there was. Once the air was released, everything worked as planned. His algorithm was fine.

EVER-SMARTER ALGORITHMS

I try to quantify the degree to which “smart” systems have become more intelligent. Dr. Rüdiger Döll, who has worked in rolling mill automation for 22 years, makes a comparison to illustrate the development: “When we started to digitally monitor the crown of the strip, we had one static track and one scanning track, which gave us three to six values over strip length. Today, it is not uncommon for up to 500 tracks to provide us with up to one hundred values over strip length.” Listening to Döll, it seems that the exponential increase in computing power evident in our everyday lives also extends to the steel industry. “Sure,” he says, “with the much-improved sensor technology we have available today has come the ability to store much more data.” This development, he says, is the core enabler for what we now call machine learning.

With machine learning on the rise, it seems logical to think that older algorithms might become outdated or



HOW IS DIGITALIZATION CHANGING GERMANY?

Employees of Primetals Technologies share many passions, such as pioneering new solutions for their customers. But every location also has its own unique qualities. In this section, we catch a glimpse of what makes Germany so special.



“Germany’s strength is a unique combination of ingenuity, precision, and comprehensive higher education. Digitalization is changing all three of these factors.”

Dr. Alexander Thekale
Head of Electrics & Automation Digital Solutions,
Technology Downstream



“Digitalization is impacting our lives on many levels. Soon, I won’t even have to order shampoo anymore when the bottle is empty—my digital assistant will take care of that.”

Karola Gurrath
Development Engineer; Models, Concepts and Solutions

outclassed. The steel industry has long relied on physics-based and mathematical models, which in themselves have grown and matured—and since they are often the product of decades of expertise, they are still being relied upon. Will artificial intelligence one day replace these tried-and-tested models? “No,” says Döll. “Both approaches are still valid and will continue to coexist. In fact, they complement each other.”

In effect, their applications vary, he says. “To give you an example, in hot rolling, we are still calculating the roll gap using physics-based models,” Döll says, “and very successfully so. But the flow stress of the strip is something we predict via a data-driven approach, with neural networks.” Some things, Döll says, can’t be calculated from first principles, especially not in real time—and even if this were to become possible, the models would still be unable to account for what Döll calls “the day’s form” of the mill. These “unknowns” can only be handled with statistical methods—and with data analysis.

CODING WITH PRECISION

Talking to the technologists in Erlangen is so intriguing that I almost wish I were a programmer myself. But it also makes me wonder how all these algorithms, all this expertise in plant automation, is applied to actual physical equipment—to what in the world of computers and software we would call “hardware.” Katharina Landes kindly suspends her communications work for a few hours and takes me to the company location’s “test center” in nearby Fürth.

After a short drive, appropriately with a BMW, we arrive at the site and are welcomed by Günther Besenreuther, the test center’s manager. You can tell he loves what he does as he ushers us around, passionately opening up control panels and server racks to show us the inner workings of the technology that is being tested and developed at the center. Katharina had shown me some photos of the site prior to my visit, and it turns out that the center is much larger than I expected. »



“Not enough. Wireless broadband availability is quite fragmented, with good coverage in major cities but a subpar infrastructure in the more rural areas.”

Dr. Rainer Schulze
Press Officer, Corporate Communications



“Germany will become even more competitive. I recently read that several companies are bringing back manufacturing thanks to the advanced automation systems we’re embracing here.”

Andreas Maierhofer
Innovation Manager, Electrics & Automation



“Our public transport system has seen a major transformation. You can plan your journey using smartphone apps, and in Nuremberg they recently introduced a driverless U-Bahn [the German subway train].”

Volkmar Stach
Service Manager, Process Automation



DIGITAL SOLUTIONS FOR DOWNSTREAM APPLICATIONS

Hubert Koebach joined a predecessor company of Primetals Technologies in 1987 and is Head of Technology for the E&A downstream area.

Of all the technological achievements made in Erlangen, which are you most proud of?

Hubert Koebach: There are many achievements we can be proud of. To name just a few, we were the first in our industry to use neural nets to supplement our analytical process models. At that time, our approach was ridiculed by some, but things changed. Today, the view is that we did exceptional pioneering work, and everyone is talking about artificial intelligence and digital assistants. We were also early with pioneering “remote commissioning,” which allowed us to scale down the number of engineers on site and to better utilize our key experts supporting multiple sites via remote data connection. Nowadays, commissioning without a remote connection is unthinkable.

Is there an R&D project you are working on that you’re particularly excited about?

Koebach: We are working on programs to make our digitalized know-how in our solutions platform independent, and we are developing robust, self-optimizing, non-interacting multivariable controls to reduce tuning and commissioning time. We focus on R&D projects with fast ROI for our customers such as a second-generation condition-monitoring system including digitalized know-how modules helping our customer towards higher productivity through improved equipment availability and up-time.

Dozens of programmers from various corners of the world are busy writing code—at the time of my visit, many of them are Mexican and Chinese. The workforce changes, Besenreuther says, according to the projects that are in the works. One project is an automation solution for a new Arvedi Endless Strip Production line, soon to be implemented on location in China. Besenreuther takes us to see the Level 1 development team in action. Monitors depict the whole production line, with all production steps nicely laid out and a vast number of control elements. “Precision is extremely important here,” I am told. “At the rolling stage, especially at the last roll stands, two milliseconds can make a tremendous difference.”

The activities of the Level 2 team are a bit more obscure to me—someone whose coding skills never went beyond basic hypertext markup language. I can, however, determine that a young Chinese coder is working on queries to an SQL database, and that much of the work is done in C++. Again, it’s fascinating, and also a little intimidating. Besenreuther comes to the rescue and shows us some control desks that will be installed at the same plant as the software. The desks feature big, colored, sturdy knobs that will probably outlive me, and rugged switches that would probably survive a nuclear explosion. I am certainly confident that the equipment will work reliably for decades to come.

BRING ON THE FLYING CARS

As we drive back to Erlangen, I ask Landes about what it is that Germans love so much about their cars. She smiles. “Me, I just want my car to be practical and convenient,” she says. She does, however, enjoy driving the occasional 200 kilometers per hour—if not more—on Germany’s autobahns. “With a good BMW, you don’t feel the speed,” she says.

Before I leave Erlangen, I sit down with Rolf Riedle, CEO of Primetals Technologies Germany (see pg. 53 for the interview). We discuss recent developments in the steel industry and the solutions the company location is setting out to pioneer. “We are ahead of our time,” he says, “even if development cycles have become noticeably shorter.” Riedle adds that, in Erlangen, they have been focusing on region-specific innovations for a long time, a strategy that has and will continue to serve them well.

As our conversation comes to an end, I ask Riedle one of the “fun” questions that I like to have handy during interviews—questions that can add levity to the conversation or help me conclude a meeting with a little humor. “If you could, which would you choose,” I ask him, “delivery drones, high-speed tunnels, or flying cars?” Without hesitation and in good German tradition, Riedle opts for the flying cars. “They’re just the most fun,” he says.

A DAY IN THE LIFE OF TANJA NEUNER

As part of the series "Visiting the Company Locations of Primetals Technologies," the editorial team of Metals Magazine sits down with one employee of the respective location—with the aim of illustrating what a regular work day is like for them.



TANJA NEUNER
How does the Head of Controlling for E&A spend her day?



EXPERIENCING THE COMPANY LOCATION AND THE CITY OF ERLANGEN



GERMAN CARS

In Germany, people are rightfully proud of the car manufacturers, who use high-quality steels as the basis for car-body parts and other components. At Primetals Technologies Erlangen, all five of the company-owned cars are German-made.

GUMMI BEARS AND PUZZLES

The staff of the Erlangen location strive to find new solutions for their customers—or for their colleagues, since the trio photographed here works in Human Resources. They like to solve puzzles and eat Haribo gummi bears during their lunch break.



CRYSTAL BALLS FOR ALL EVENTUALITIES

"The best way to predict the future is to create it," Abraham Lincoln said. The second-best solution is to use trusty crystal balls. At Primetals Technologies Erlangen, both methods are used, and there are crystal balls for "warranties", "deadlines," and "prices."

BICYCLES WHEREVER YOU LOOK

Erlangen feels a lot like Copenhagen or Amsterdam: there are cyclists everywhere. This is thanks in part to the large student population, which relies on bikes as the main mode of transport to keep living costs low. It's also a healthy way to commute.



ERLANGEN PALACE

Erlangen palace was built in 1700–1704 by George William, Margrave of Brandenburg-Bayreuth. It was the first baroque building to be constructed from scratch in Franconia. The picture shows the orangery, which at the time of our visit was perfectly sunlit.

THINK GLOBAL ACT LOCAL

Rolf Riedle has been with Primetals Technologies and its predecessor companies for 28 years. He started his career in Saudi Arabia and spent six years in Malaysia working for Siemens. Later assignments took him to Australia and New Zealand. Together with his family, he then settled in Bavaria, a region in the south of Germany. Riedle is now CEO of Primetals Technologies Germany, which makes him responsible for three company locations, namely Erlangen, Willstätt-Legelshurst, and Saarbrücken.



What is it that makes the Erlangen location unique within Primetals Technologies?

Rolf Riedle: In Erlangen, the focus is on electrics and automation for the downstream. The contribution of the Erlangen location to the larger portfolio of Primetals Technologies is essential in my opinion.

How has the location developed over time?

Riedle: We have extended our business activities and our technological competence. New portfolio elements have been added, and we've further strengthened our efforts to provide steel producers with cutting-edge digital solutions to move closer toward "Industry 4.0."

Are you serving steel producers worldwide or only in specific regions?

Riedle: We are operating globally, but we are structured to serve individual regions according to their particular needs. I believe that it is crucial to have a local presence to really understand and support any one part of the world. Much of our success is a result of us having built strong and market-specific local representations. We are incredibly close to our customers.

Is there any one aspect to steel production where you feel digital technologies should be adopted more comprehensively?

Riedle: The amount of production-related data is always increasing, and with the right technologies, their analysis can yield fantastic results. Today's steel producers are under immense pressure to manufacture steel grades of higher and higher quality. Data-analysis tools can help them meet these challenges. Another thing that should be adopted more widely is robotics, because it makes plants a much safer workplace.

How will digitalization change our societies?

Riedle: That is the great debate: will robots soon replace human workers? Many jobs will clearly change, and it would be wrong to assume that it's only the economy that will be affected by the transformation. Our education system will have to change to meet the new demands, and new ways of teaching and learning must be implemented to prepare us for the future.

Do you think the steel industry is in a relatively healthy state in 2019?

Riedle: No, I don't. Viewed globally, we are still seeing significant overcapacity. Also, over the course of the last three years, we have noticed just how politics can impact the steel industry. The Chinese government, for instance, brought about a change in direction in the country, in terms of steel-production methods. Other major developments affect the U.S.A. and Mexico.

Is the outlook positive in your opinion?

Riedle: I think it is positive for the next two to three years. I would expect a slight downturn after that, with some consolidation in the industry. We live in a time of permanent change. The steel industry is still cyclical in nature, but the cycles have become shorter.

Two more quick questions: what invention do you feel should be made—but probably never will?

Riedle: The work that's being done for the prevention and cure of illnesses is never enough.

Do you view artificial intelligence (AI) as a threat or as an opportunity?

Riedle: To me, the glass is always half full, so I take a positive view and see AI as a catalyst for progress. ●

THE SECRET IS IN THE MIX

STANDARDIZED SAMPLE TAKING IS KEY TO RUNNING SINTER PLANTS AT FULL POTENTIAL. THE FULLY AUTOMATED SINTER RAW-MIX ANALYZER TAKES PRODUCTIVITY TO A NEW LEVEL.

AUTOMATED SAMPLING

FIG. 1: A robot system allows for continuous monitoring of raw-mix properties.





The robot periodically draws raw-mix samples, takes measurements, and feeds data into the process optimization system.

Continuous optimization and constant supervision of the sintering process are key to meeting productivity goals and other business objectives in today's competitive environment in ironmaking. When it comes to the precise control of the properties of the sinter raw mix in particular, there is still much room for improvement in today's plants. Identifying and reacting to changes and fluctuations in these parameters as quickly as possible can yield enormous benefits in terms of sinter-plant productivity.

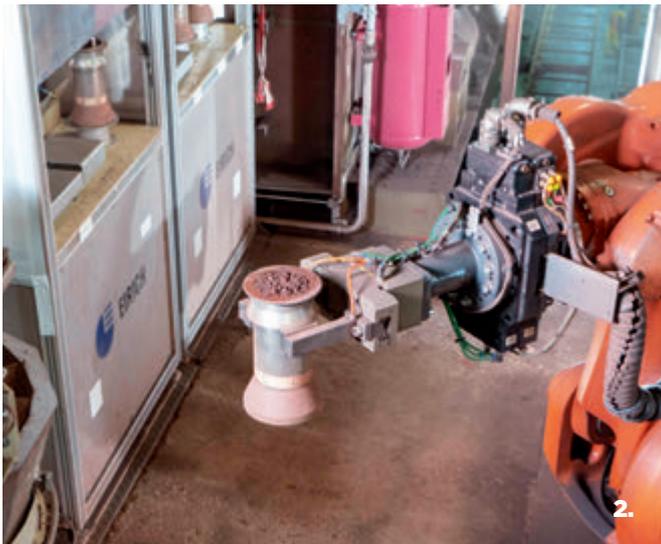
As things stand, however, the decisive factor in monitoring and controlling raw-mix properties is often the experience and expertise of a handful of operators working at the facility. In many cases, parameter control barely goes beyond visual and sometimes manual inspection by the operator in charge. Personnel and even shift changes can be detrimental or even disruptive to the process. The process of manual sampling and subsequent lab testing is too slow to be able to react to parameter changes. And proven online measurement solutions are scarcely available at this point.

THE GOAL: AUTOMATION & DIGITALIZATION

This is what motivated Primetals Technologies and its partners at voestalpine Stahl Donawitz, an Austrian steel producer, and at Eirich, a German supplier of machines, plants and services for mixing and granulation technology, to launch an R&D project for a completely new breed of sinter raw-mix analyzer. The ambitious goal was to comprehensively automate and digitalize the sampling process and feed the obtained data into Level 2 automation, combining them with process models and Expert Systems to reap the full benefits in terms of productivity and efficiency.

SINTERING AND PERMEABILITY

Essentially, sintering of fine iron ores is achieved by causing a combustion zone to move progressively through a suitably prepared porous bed of iron ore, different additives such as limestone and dolomite, and solid fuel (e.g., coke breeze). The granulated particles are agglomerated by fusion and the formation of a partial slag bond. Generally speaking, the faster the



2.



3.



4.

FIG. 2: The robot transfers the filled sample cups from the divider to the measuring station.

FIG. 3: The measuring station contains a scale and equipment for permeability and moisture measurements. Equipment for other measurements can be added easily.

FIG. 4: Operators can request additional samples for laboratory analysis, which the robot will place onto a turntable in a security gate for easy and safe manual access.

combustion zone passes through the bed, the higher the sintering rate will be—and therefore also the productivity of the sintering strand. As regards the relevant process parameters, it has been shown that *permeability*, i.e. the rate at which air can be drawn through the bed, is the key value in the properties of the sinter raw mix: High permeability allows for higher suction rates and thus higher sinter-strand productivity. The property can easily be adjusted by fine-tuning the amount of water that is added to the mix as a binding agent. But hitting and maintaining the “sweet spot” of the raw mix can only be achieved by frequent, high-quality online permeability and moisture measurements, ultimately combined with process models and Expert Systems.

A NEW CONTROL CONCEPT

One of the first tasks in the R&D project was to run an extensive series of tests to establish the exact correlation between moisture and permeability on the one hand, and the effect of permeability on sinter strand »

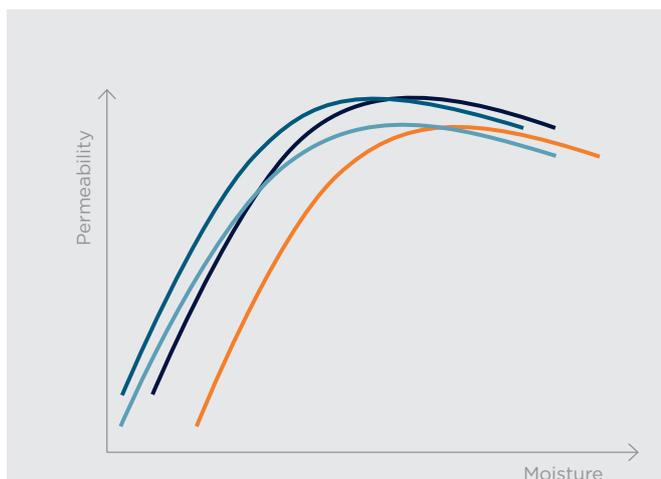


FIG. 5: For different raw-mix compositions, permeability increases with moisture—but only to a point.



FIG. 6: The control derives the perfect setpoint from data on permeability, moisture, and material analysis.



HELPING YOUR SINTER PLANT REACH ITS FULL POTENTIAL

Dr. Johann Reidetschläger is a process technologist at Primetals Technologies, specializing in agglomeration processes.

How was the idea of the fully automated raw-mix analyzer born?

Johann Reidetschläger: When visiting sintering plants and asking customers about their pain points, there always seemed to be a demand for automatic sampling and online analysis of the sinter raw mix in connection with optimization and continuous supervision of the process. This encouraged us to go ahead and develop a system to meet this demand—the idea for which we had been kicking around for quite a while.

What were the biggest challenges for you and your partners in the project?

Reidetschläger: Generally speaking, it was the implementation of the new robot system in a harsh industrial environment, and interconnecting it to the existing equipment and control system. An essential task was to streamline the collaboration between several companies and our own people—from such different fields as process technology, layout, automation, robotics, and mechatronics, as well as data modelling.

Which kinds of plant would benefit the most from fully automatic raw-mix analysis?

Reidetschläger: I think pretty much any plant could benefit greatly—I don't see any exceptions. Automatic and standardized sampling and analyzing is an unfulfilled wish in many plants I know. Now this can be rather easily achieved in sintering plants of any scale.

FIG. 7: The robot in resting position—equipped with a receiving hopper that catches excess material in the sample divider.



Continuous, automated analysis of the raw mix allows operators to run their sinter plants at moisture levels—and thus at levels of productivity—that they would not have dared before.

productivity on the other. The results formed the basis of an advanced moisture/permeability control concept that is implemented with real-time robotic measurements.

ENGAGING THE ROBOT

The point of discharge of the conveyor to the feeding hopper of the sinter machine was picked as the location best suited for installing the robotic sampling and measurement equipment, as it is easily accessible for cleaning and maintenance and allows excess material to be fed right back into the process (as depicted in Figure 1). There is no need for any additional conveyors or transport systems.

To take a representative sample, the robot first picks up a vessel from a tool-changing system and holds it into the material stream for filling. Then the material is fed into a rotary divider to fill several cups with screen bottoms. These cups are transferred to measuring stations (Figures 2 and 3) where the raw mix is first weighed to calculate bulk density and then tested for gas permeability and moisture: Air is drawn through the cups to obtain the necessary values of pressure drop and volume-flow rate for permeability. Additional measuring stations can be easily added and an operator can request additional sample cups for outside laboratory testing to be put onto the turntable of a security gate (Figure 4).

Once the measurements are all performed, the robot cleans up after itself: it empties the cups into the sintering belt's hopper and removes any remaining material with a rotating brush and stationary air nozzles.

PUTTING THE DATA TO USE

The moisture setpoint undergoes controlled variation as the robot continually runs tests to determine the effect on moisture/permeability. From this information, the control deduces the current position on the moisture/permeability curve (Figure 5) and reacts accordingly—by adding more or less water to the mix. In doing so, the Expert System also takes into account data on current moisture, the chemical composition of the raw mix, as well as other sinter-plant parameters.

This has allowed operators at voestalpine Stahl Donawitz to run raw-mix moisture levels that they previously would not have dared—and increase productivity as a result. ●

Dr. Johann Reidetschläger

Process Technologist, Primetals Technologies Austria

Dr. Johann Zirngast

voestalpine Stahl Donawitz GmbH

Dr. Andreas Seiler

Maschinenfabrik Gustav Eirich GmbH & Co KG

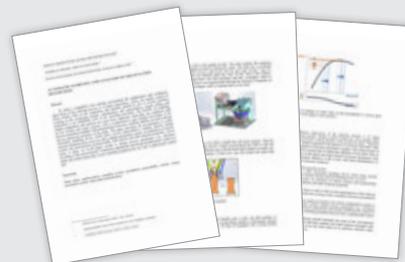


WATCH THE ROBOT IN ACTION

Scan the QR code or type in the link below to watch the robot system installed at voestalpine Stahl in Austria.

meta.is/srma

LEARN MORE



READ THE FULL ARTICLE

Reidetschläger, J. et al.: First Installation of a Fully Automated Raw-Mix Analyzer. ESTAD 2019.

meta.is/srmaestad



DRI PLANTS, TAILORED TO YOUR NEEDS

TWO MIDREX DIRECT-REDUCTION (DRI) HOT-BRIQUETTED IRON (HBI) PLANTS, RECENTLY COMMISSIONED IN THE U.S.A. AND RUSSIA, DEMONSTRATE THE OPERATIONAL FLEXIBILITY OF THE MIDREX DIRECT-REDUCTION PROCESS FOR ALL CLIMATIC CONDITIONS.

With more than 90 direct-reduction plants installed and commissioned since 1971, Midrex is the world's most proven and reliable technology for the production of direct-reduced iron. Midrex plants account for approximately two thirds of all direct-reduced iron (DRI) on a worldwide basis and about 80% of all DRI produced in shaft-type furnaces. Based on these achievements, Midrex technology continues to set the standards for excellence in this dynamic field of ironmaking.

Two of the world's largest Midrex hot-briquetted iron (HBI) plants recently started commercial production. On September 27, 2016, a 2 million t/a facility—the largest plant module of its type—went into operation at voestalpine Texas LLC, Corpus Christi, in the state of Texas, U.S.A. At Lebedinskiy GOK III in Gubkin, Russia, a 1.8 million t/a HBI plant module—the second largest in the world—produced its first iron briquettes on March 11, 2017. The plants operate at or above their nominal capacity and reliably produce iron briquettes that meet the highest-quality standards.

Both HBI plants share a number of similar features, yet differ in various design details to meet the local production demands and climatic conditions. The Texas plant was built to cope with hot, humid, and muggy summers and strong winds from the Gulf of Mexico, while the Gubkin plant must withstand the cold and icy winters in Russia. Thanks to a highly adaptive technological basis, Midrex plants can be flexibly engineered to perform at their optimum in any type of environment.

JOINT ENGINEERING

Both the Corpus Christi and Gubkin HBI facilities were engineered by a consortium comprising Primetals Technologies and Midrex Technologies. The project scope included the supply of mechanical and electrical equipment, steel structure, piping, ductwork, as well as training and advisory services. The production capacities and plant configurations of both plants are also similar. A 7.15-meter-diameter Midrex shaft furnace and a 6-row reformer were installed, differing only in the number of installed reformer bays (20 vs. 18 bays). The latest design concepts were also applied for the major equipment items that include:

- Seven state-of-the-art briquetting machines and two cooling conveyors outfitted with a spray-water system for improved HBI quality

- Centrifugal compressors placed in the process gas loop to minimize the consumption of electricity and to improve the operational flexibility of the process gas compressors
- An iron oxide coating system for enhanced production output and product quality
- Environmentally friendly burners for heating the reformer box
- Wet and dry dedusting systems designed to minimize dust emissions
- Elevated top gas pressures to increase furnace productivity
- Heat-recovery units to preheat different gas streams and save energy

TWO PLANTS, SIMILAR BUT DIFFERENT

Lebedinskiy GOK produces iron ore pellets from its own pelletizing plant. The pellets are used as a charge material for its direct-reduction facilities. The voestalpine Texas plant operates on the basis of high-quality DR grade iron oxide pellets sourced on the global market.

Resulting from the contrary environments where the two HBI plants were installed, they are also characterized by various differences in their design and configuration. The Russian plant was integrated into the existing production operations of Lebedinskiy GOK, while the Texas plant was constructed on a greenfield site—a former cotton field.

The applied norms and standards also differ. While both plants were engineered according to the metric system, the process information shown on the screens in the control room is in metric units in Russia and imperial units in the U.S. The plants are engineered to perform according to the prevailing climatic conditions—from extreme hot to extreme cold ambient temperatures.

**VOESTALPINE
TEXAS LLC,
CORPUS CHRISTI,
TEXAS, U.S.A.**



PLANT SPECIFICATIONS

Furnace type:	Midrex Megamod
Annual capacity:	2 million t/a HBI
Input material:	Direct-reduction-grade iron-oxide pellets purchased on the world market
Inner diameter of reduction furnace:	7.15 m
Number of reformer bays	20
HBI metallization:	Minimum of 93%
Carbon content:	1.5% C

OTHER PLANT FEATURES:

- 7 briquetting presses, including a hot DRI fines recycling system
- 2 HBI cooling conveyors
- Increased top gas pressure for higher furnace productivity
- Seawater cooling circuit
- Oxide-coating system
- Ferrous-material briquetting system
- Heat recovery system

PLANT START-UP:

The first briquette from the Midrex HBI plant at voestalpine Texas LLC was produced in late September 2016. All required performance tests were successfully completed by February 11, 2017. The Corpus Christi plant represents North America's first HBI merchant HBI facility.



Watch the project video by scanning the QR code or pointing your web browser to meta.is/ccvid

**LEBEDINSKIY
GOK III,
GUBKIN, RUSSIA**



PLANT SPECIFICATIONS

Furnace type:	Midrex Megamod
Annual capacity:	1.8 million t/a HBI
Input material:	100% Lebedinskiy GOK iron oxide pellets produced from company-owned open-pit iron ore mine
Inner diameter of reduction furnace:	7.15 m
Number of reformer bays	18
HBI metallization:	Minimum of 93%
Carbon content:	1.5% C

OTHER PLANT FEATURES:

- 7 briquetting presses
- 2 HBI cooling conveyors
- Increased top gas pressure for higher furnace productivity
- Oxide coating system
- Fresh water cooling circuit
- Heat-recovery system

PLANT START-UP:

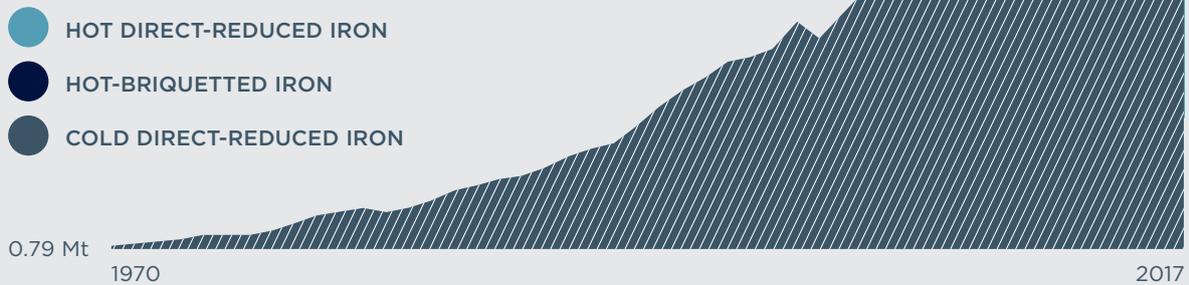
The first HBI product from the Lebedinskiy GOK plant was produced in March 2017. The performance guarantee tests (PGT) were completed two months later by May 13, 2017. The Gubkin plant represents Russia's largest HBI production facility.



Watch the project video by scanning the QR code or pointing your web browser to meta.is/igokvid

WORLD DRI PRODUCTION BY YEAR (MT)

Worldwide DRI production is expected to rise significantly over the next decade. Producers like the fact that DRI can be used as input material with both EAFs and blast-furnaces. DRI can also be easily transported. In 2016 alone, production rose by 14 million tons.



All data obtained from Midrex Technologies, Inc. Midrex is a registered trademark of Kobe Steel, Ltd.



Johannes Rothberger, Technical Sales Manager for DRI Plants at Primetals Technologies, with one briquette from the U.S. plant and one from the Russian plant. They look almost identical.

“The performance tests of both plants were successfully passed within a very short period.”

Different water sources are used for process water and cooling applications. At the Texas site, a reverse-osmosis system is applied to generate the required make-up water for the process, and seawater cooling towers and heat exchangers are used to cool the water in the plant water circuits. Fresh water is the source of both the process make-up water and the cooling water at the Gubkin plant.

Lebedinskiy GOK produces HBI for the world market. The briquettes are transported from the works site to external markets by means of rail transport. A train-loading station was part of the supply scope. Approximately half of the HBI from the voestalpine Texas works is consumed in the steelworks of voestalpine in Europe. The other half is sold mostly to North American steel producers. HBI from the Corpus Christi facility leaves the plant via ocean ships.

The performance tests of both plants were successfully passed within a very short time period. All performance targets were met, and most of them even exceeded.

SETTING PERFORMANCE BENCHMARKS

Regardless of the environmental conditions where they are installed, Midrex plants are designed for performance. The process is well proven, dependable, and reliably produces an iron product with a high degree of metallization that is ideally suited for the manufacture of highest quality steel grades. Thanks to the use of natural gas or other metallurgical plant process gases, the carbon footprint of Midrex direct-reduction plants is significantly lower than metallurgical processes based on the combustion of coal or coke.



POISED TO EXCEED DESIGN CAPACITY **JUST TWO YEARS AFTER STARTUP**

Interview with Oleg Mikhailov, Managing Director of the mining and ore-beneficiation complex at Lebedinskiy GOK

What were the main reasons behind your company's decision to invest in a new Midrex HBI plant?

Oleg Mikhailov: We are the only European producer of HBI and one of the three largest HBI producers in the world. We already had two HBI plants and the strategy of Lebedinskiy GOK and the entire company Metalloinvest was to diversify and further increase the production of HBI to 4.5 million tons per year.

Why was the consortium comprising Primetals Technologies and Midrex selected as the main partner for this project?

Mikhailov: We already implemented an HBI plant project together with this consortium with good results and a positive partnership history. When we compared the efficiency and operational figures of different plant types, it was an easy decision in favor of Midrex technology. The plants are reliable and user-friendly, and they offer considerable development potential for the future.

What were the main challenges that had to be dealt with during the course of this project?

Mikhailov: First of all, it was coordinating more than a dozen different companies involved with engineering, planning, securing permissions, production solutions, environmental matters, and also safety measures so that they all work together toward a common goal. Secondly, there were more than one thousand people on the construction site, so you can imagine what was involved in coordinating so many people. Then the entire production chain had to be reorganized—we had performed a grand-scale modernization of the ore preparation plant and the pelletizing plant. Commissioning took place in winter at temperatures below

zero, which, according to consortium colleagues, had never been done before. But we managed to successfully complete everything together and achieved good results.

Does the installed HBI plant meet your expectations in terms of operational reliability and flexibility?

Mikhailov: On March 11, 2017, we produced the first briquette. Within three months, our specialists and the specialists from Midrex and Primetals Technologies were able to ramp up the plant's production curve to nominal capacity. All of the target figures were met. I'm sure that with this plant we will be able to exceed its design capacity within two years.

Has the investment in a new HBI plant allowed your company to increase its market share for this product and to enter new market segments?

Mikhailov: Yes, definitely. We have become a production leader of commercial hot-briquetted iron. Our goal was not only to excel in the international market, but also to increase our production share in Russia, and we have made the progress that we wanted to make.

How would you characterize the cooperation with Primetals Technologies?

Mikhailov: We were always able to work well together and to resolve any issues that arose during project implementation. In my opinion, the Primetals Technologies staff are very good problem solvers. The fact that we were able to build this plant complex within one and a half years is a major credit to them. I would therefore like to thank Primetals Technologies for the excellent job done. I hope that we will be able to work together again one day on some other project. ●



THE NEXT-GENERATION COPPER STAVE

PRIMETALS TECHNOLOGIES HAS DEVELOPED A NEW COPPER-STAVE DESIGN THAT ENSURES MORE EFFECTIVE AND RELIABLE COOLING OF TODAY'S BLAST FURNACES.



FIG. 1: Primetals Technologies created a new copper-stave design to address common issues with blast furnaces such as the one shown here.

Many of the issues affecting blast-furnace operation are related to premature wear of the furnace's hot face and failure of the cooling-pipe connections. The experts from Primetals Technologies have studied these issues in detail and created a new copper-stave design that not only significantly increases furnace lifetime and reliability but also improves overall furnace-cooling efficiency.

Since the late 19th century, when the rapid increase in blast-furnace capacity brought about the use of steel shells, the shell-water cooling system has been an important factor in extending the life of a blast-furnace's operating campaign. Increasing furnace operating pressures and the incorporation of a free-standing design necessitated increases in furnace-shell thickness and required greater reliability of the cooling systems, in order to ensure the structural integrity of the blast furnace could be maintained.

In the mid-twentieth century, the predominant cooling system relied on copper-plate coolers inserted through

the shell, but as campaign durations increased, the limitations of this plate-cooler solution led to its replacement with a cast-iron stave solution that facilitated full cooling coverage of the shell. Initially developed in Russia and further enhanced through developments within Japan, the stave solution allowed for more consistent campaigns.

As blast-furnace development continued, the drive for even longer campaigns with higher productivities began to expose certain limitations in the functionality of cast-iron staves within the higher heat-load zones of the furnace. In order to improve the heat-removal »

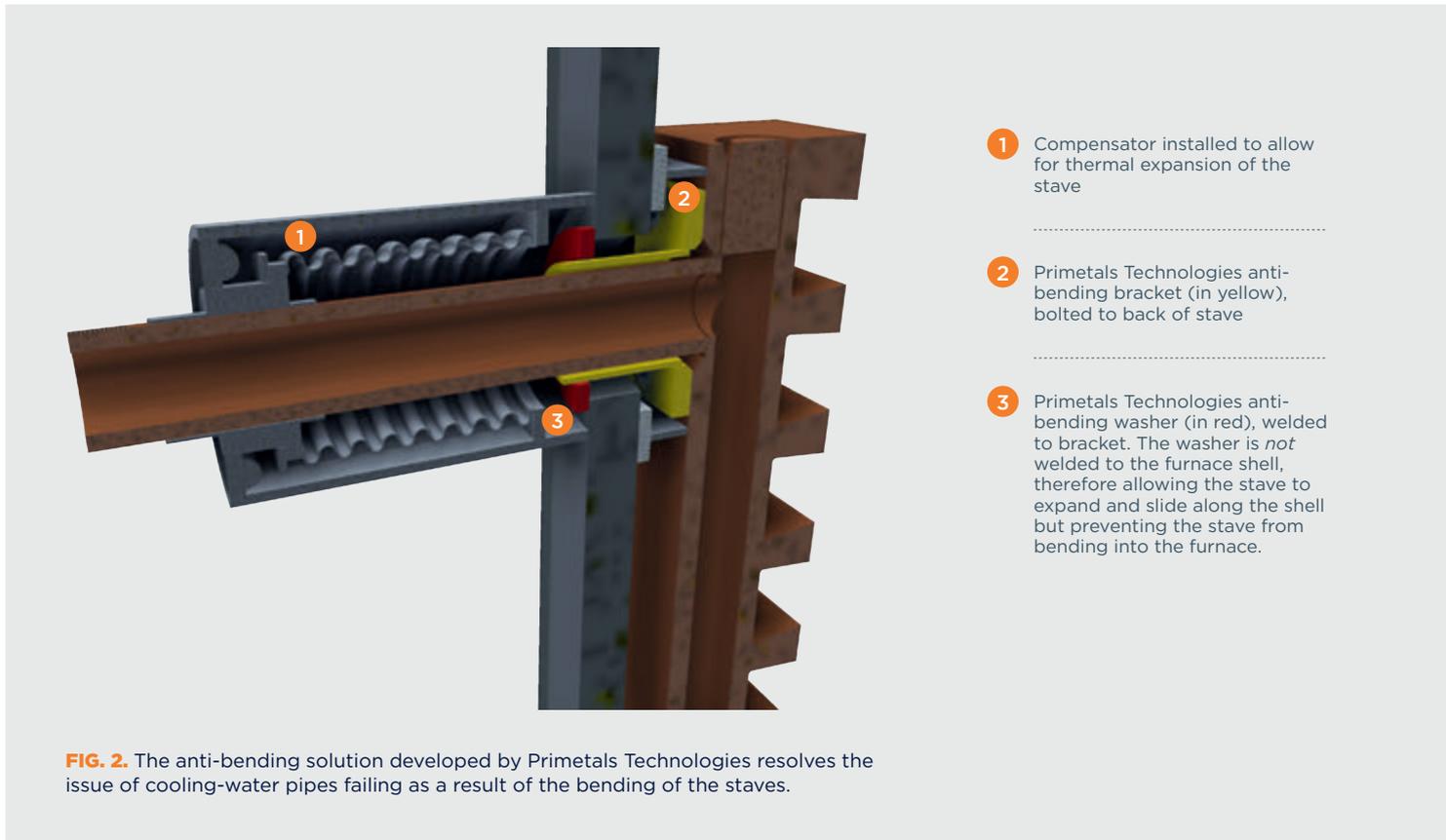


FIG. 2. The anti-bending solution developed by Primetals Technologies resolves the issue of cooling-water pipes failing as a result of the bending of the staves.

- 1 Compensator installed to allow for thermal expansion of the stave
- 2 Primetals Technologies anti-bending bracket (in yellow), bolted to back of stave
- 3 Primetals Technologies anti-bending washer (in red), welded to bracket. The washer is *not* welded to the furnace shell, therefore allowing the stave to expand and slide along the shell but preventing the stave from bending into the furnace.

capabilities of these areas, copper staves were introduced that increased the ability of the cooling system to handle higher heat loads.

Although copper staves have—in many plants—proven to be very reliable in protecting the structural integrity of the pressure vessel, there are multiple instances in which premature failure has led to significant furnace downtime with associated costs. Developing an understanding of these failure modes was part of the continued search for an ideal cooling solution to protect the integrity of the blast furnace shell.

COMMON ISSUES WITH COPPER STAVES

From the early testing of copper staves, the ability to form a protective layer during operation was seen as critical in promoting a long campaign life. The superior thermal conductivity of copper allows for rapid freezing of liquid phases on the front face of the stave, thus building up a layer that can protect against the impact of other moving unreduced burden materials. Once formed, the accretion layer also provides additional insulation against the thermal movements within the furnace. The robustness of this accretion layer is therefore very important in avoiding constant exposure of the softer copper front face to both descending solids and ascending hot gases.

As a leader in copper-stave design, Primetals Technologies was asked by a number of steel companies to investigate issues they were experiencing where the copper-stave systems provided by third-party suppliers were unable to deliver the expected performance. The type of issues experienced generally fell into three main areas:

- Manufacturing faults
- Premature wear of the hot face
- Failure of the cooling-pipe connections

It was found that issues caused by manufacturing faults usually stem from a failure to ensure that quality-assurance and quality-control requirements are established and then fully monitored during the manufacture and supply of the staves. For that reason, this article will focus on issues unrelated to manufacturing faults.

COPPER-STAVE WEAR

Premature wear of the stave hot face is not a phenomenon detected in all copper-stave furnace installations and therefore is likely to be a combination of a variety of factors. Over the course of several plant investigations, Primetals Technologies encountered designs where the furnace profile was optimized for size rather than for good furnace operation. This was first observed in rebuilds but was also seen in new furnaces with designs that incorporated profiles from rebuilt furnaces.

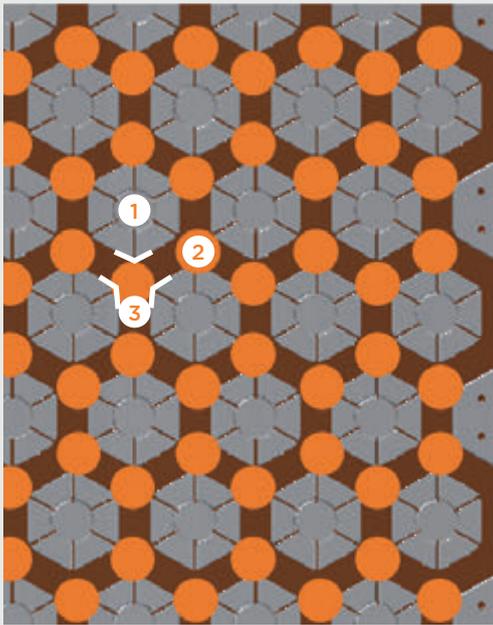


FIG. 3. The new copper-stave design uses a honeycomb pattern that leads to significantly improved retention of the burden material.

1 Honeycomb pattern

The new honeycomb pattern promotes the capture of burden material between the inserts.

2 Burden material

The staves' active cooling allows the burden material to build up and form a protective layer.

3 3-point grab

The pattern of the honeycomb allows the material to be more securely "held" by three points.

The main cause of loss from the stave hot face is abrasive wear from unreduced burden materials moving down the furnace with varying forces transmitted through the solid layers normal to the face. Uncontrolled wall temperatures also weaken the stave material and promote increased abrasive wear. An incorrect furnace profile can bring about conditions that lead to excessive wear—but these conditions can also occur as a result of other events, such as furnace-process disturbances, changes in position of the cohesive zone, high rates of reductant injection, errors in furnace-charging patterns, and poor burden quality.

Excessive wear can cause water leaks into the furnace through exposure of the cooling-water channels and ultimately the complete loss of the stave and shell damage. The rate of wear has been seen to increase rapidly under certain conditions and to be reduced again by process adjustments. This shows that certain operational input is critical. Leakage can be temporarily arrested by the insertion of flexible pipes or through the use of nitrogen injection, but ultimately a replacement of the stave will often be required.

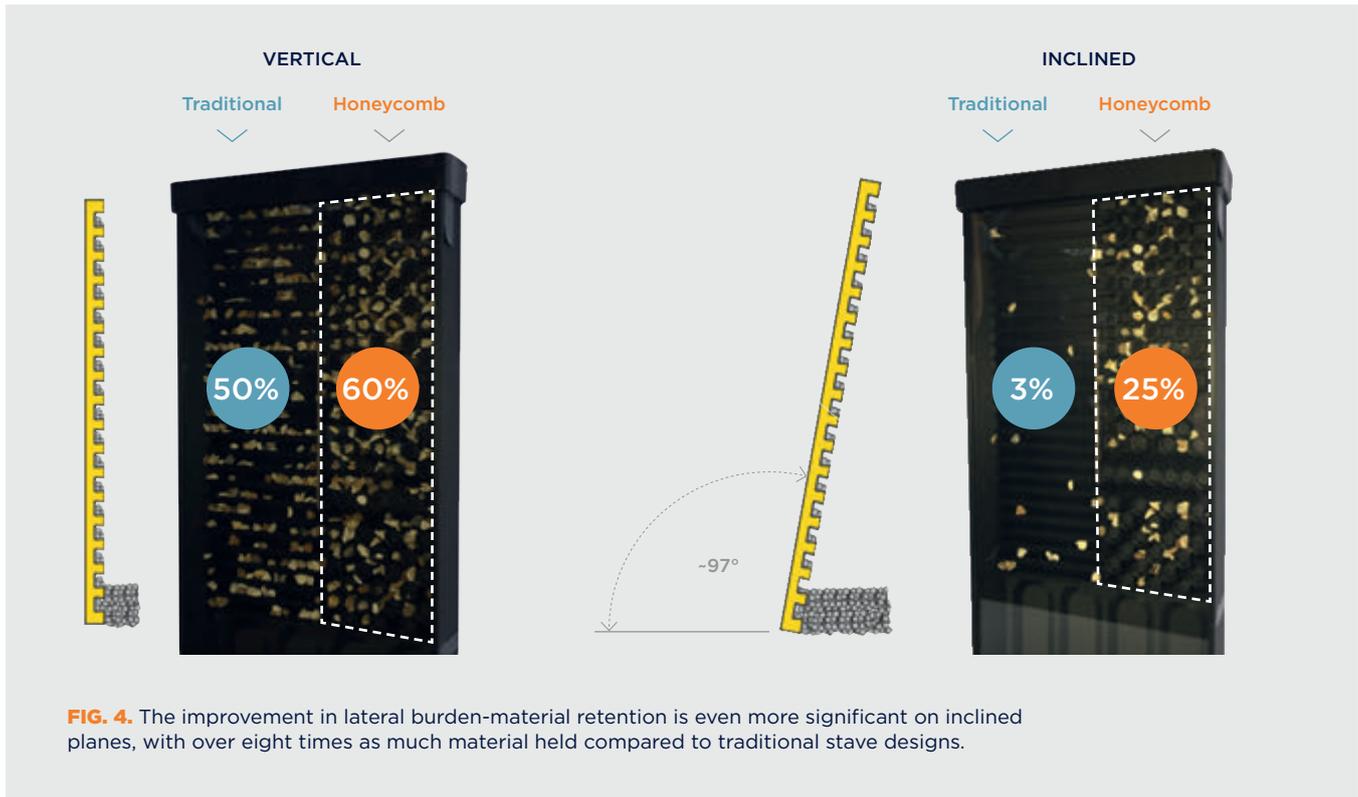
Therefore, in order to avoid wear problems and ensure a correct furnace profile, it is important to try to promote the build-up of an accretion on the stave front

face and to ensure it either has a permanent presence or is swiftly replaced when lost.

COPPER-STAVE BENDING

Relatively prevalent in current installations but with some external remedial measures is the failure of cooling-water pipes through stave bending. Thermally, the copper stave experiences a controlled cold-face temperature driven by the cooling-water system and a higher hot-face temperature that varies significantly during day-to-day operations. This thermal variation results in the stave relieving expansion stresses and—without control measures—causes stave bending. Rapid changes of temperature due to variations in furnace conditions or the loss of the protective layer force the stave temperature to cycle and deflect at the points where the stave is least restrained.

Deflection of staves at their corners is a relatively common issue that allows material to get behind the stave and then enter into the bellows of the compensator. In these instances, the compensator, which is installed around the stave pipes to allow for stave movements, becomes blocked and locks the pipes in place, causing stress of the welded connection between the pipe and the stave body. As thermal cycling continues, further bending occurs, resulting in more material getting »



behind the stave. This cycling results in failure of the weld connection of the water pipe to the stave body and ultimately in cooling-water leakage into the furnace.

Primetals Technologies closely examined this problem and determined that it was crucial for new copper-stave designs to include provision to handle these movements in such a way that the areas of the cooling pipes and joints are not compromised. Existing measures to help control the bending had thus far focused on improving the details of ribs and grooves, and on repairing any compromised staves.

THE NEXT-GENERATION STAVE

Based on the experience gained from numerous successful blast-furnace installations and many failure investigations of third-party furnaces, Primetals Technologies developed a new design concept for the next-generation copper stave.

The basic stave design essentially remains the same in terms of size limitations and thickness, which means that engineering solutions must still be included to cater for bending phenomena. The anti-bending solution previously employed by Primetals Technologies is therefore still part of the new stave design and allows the cooling pipes to move during thermal expansion but prevents any bending of the stave corners inwards (see Figure 2).

This solution prevents the fatigue failures associated with other designs. The original concept of this bracket was implemented to great success with campaign durations of 15 years or more. Later versions were incorporated in other furnaces and are now included as part of the standard stave from Primetals Technologies. This stave is not prone to bending issues thanks to the incorporation of the anti-bending solution in conjunction with other critical design parameters responsible for the correct positioning of the fixed and moving pins.

The wear mechanism requires other adjustments. It is known at the outset of a campaign that a correct furnace profile is very important for avoiding wear issues, and this must always be the starting point in correct stave design. However, once furnace operation is in full effect, it is always likely for process conditions to change on both short and long timescales. As furnace operators push for higher productivities and longer campaigns, the staves have to cope with ever-more arduous conditions. The staves therefore require additional protection against wear, and their design must take into account the possibility of changes in raw-material type and quality during a long campaign.

The best way of protecting a copper stave against wear in operation is to ensure that a protective layer can not only build up on the front face but rapidly reforms during process excursions and reaches an extended lifetime. The technology specialists of

Primetals Technologies has found that optimal furnace-cooling design starts with understanding the furnace profile and process conditions.

Primetals Technologies have looked at how to make this layer more robust and concluded that the original rib concepts, which followed from the original cast-iron stave development, could be modified in order to improve the hold on the protective layer. A different arrangement was considered to lock the layer in place, and this led to the development of the honeycomb stave.

Making use of modern machining techniques allows for much more complex patterns to be formed on the stave hot face. After evaluating many different arrangements and shapes, it was the honeycomb pattern that stood out as the most advantageous.

In this arrangement, the bare stave has a machined honeycomb pattern, which on its own forms discrete pockets for adherence of an accretion material. The design of these pockets was engineered in a way that would enable the retention of hexagonal inserts of a metallic or ceramic wear-resistant material. This was done because the pattern of the hexagonal inserts acts in a similar way to existing staves, either providing a stone-box effect with unreduced burden material or utilizing the excellent cooling of the copper face to freeze on a protective accretion layer. The honeycomb arrangement, however, promotes the capture of the material between the inserts, allowing the material to be more securely held by three points (see Figure 3).

It was established that this 3-point hold mechanism would provide better support for any protective layer developed on the copper staves, thus improving the robustness and durability of the stave overall. The Primetals Technologies team then produced scale models to demonstrate the design concept. When testing a current stave design against the new arrangement, the initial hold is similar, but as the inclined plane shows, the material is held much better by the honeycomb pattern (see Figure 4). In a real situation where the material is likely to be a mix of gases, liquids, and solids, this will produce a far more robust protective layer.



STAVE PORTFOLIO SUMMARY

As a leading supplier of copper-stave designs, Primetals Technologies continues to develop blast-furnace cooling solutions to meet the expectations of today's steel producers for long, consistent campaigns. Although standard features are important, Primetals Technologies has found over time that optimal furnace-cooling design starts with understanding the furnace profile and process conditions. The new stave developments will allow this understanding to be applied flexibly through different materials, shapes, and arrangements to provide even more stable operation. ●

Richard Harvey, Technical Manager, Blast Furnace Ironmaking

Robert Horwood, Product Owner, Furnace Cooling

Ian McDonald, Innovation Manager, Blast Furnace Ironmaking

David Osborne, Director, Blast Furnace Technology

(All with Primetals Technologies U.K.)



DynaJet Flex is the new cooling system that takes the discretization of cooling zones at casting machines to the next level.

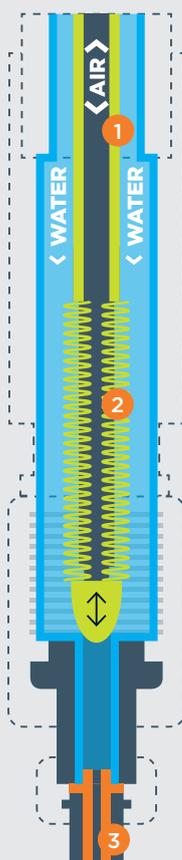
A NEW STRATEGY FOR **SECONDARY COOLING**

PRIMETALS TECHNOLOGIES HAS DEVELOPED A NEW SECONDARY-COOLING SYSTEM THAT CAN BE DYNAMICALLY ADJUSTED TO THE STRAND'S WIDTH AND REMEDIES ISSUES ASSOCIATED WITH CORNER DEFECTS.



A NEW NOZZLE DESIGN

The DynaJet Flex nozzles use a shaft design with a standard connector to the spray header. The shaft is adapted to the design of the segment, and different nozzle tips (flat spray, thickening flat spray, full cone) can be mounted on the modular nozzle to fulfill the requirements for long and flat products. The bellow-seat type nozzle is actuated by pneumatic pilot pressure, controlled by a pneumatic pilot valve.



- 1 "Pipe-in-pipe" shaft**
 A proven design, similar to conventional air-mist nozzles that use a standard connection flange
- 2 Metal bellow**
 Expansible metal bellow realizing on-off valve function when actuated with air
- 3 Standard nozzle tip**
 The nozzle-tip holder ensures proper alignment of standard water-only nozzle tips

Today, secondary cooling of continuous casting machines is typically equipped with air-mist nozzles to achieve a wide turn-down ratio, which is the highest-to-lowest water flow, without jeopardizing the spray-pattern uniformity. To prevent corner cracks, the zones are additionally split into center and margin strips across the casting direction. DynaJet Flex is the new cooling system that takes the discretization of cooling zones at casting machines to the next level. By using water-only nozzles, which are driven with a pulse-width modulated signal, it is possible to increase the turn-down ratio compared to air-mist systems and significantly reduce operating costs through lower air consumption.

PREVENTION OF TEMPERATURE-INDUCED CORNER DEFECTS

Air-mist nozzle
margins completely off



Temperature increase
at corners too high



Corner cracks



DynaJet Flex
pulsating water nozzle



Optimized corner
temperature



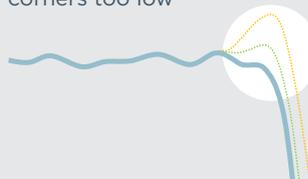
No corner cracks



Air-mist nozzle
margins fully on



Temperature at
corners too low



Deep corner cracks



FIG. 1. The DynaJet Flex system optimizes the temperature during secondary cooling, which significantly reduces the risk of slabs developing corner cracks.

With secondary-cooling systems, the resolution with which the water is distributed over the width of the strand is crucial. To achieve a higher resolution in terms of water distribution over the strand in secondary cooling, the water flow of each nozzle needs to be independently controllable and the number of nozzles should be increased.

OPERATING PRINCIPLE

By employing so-called “pulse-width modulated cooling,” the spray-intensity control range can be decoupled from the limitations imposed by nozzle-spray uniformity. The water supply of the nozzle is repeatedly switched on and off at a high enough frequency, ensuring that the desired cooling intensity is directly proportional to the duty cycle. The water pressure does not need to be changed; thus, the nozzle design can be perfectly optimized for a very narrow supply-pressure range to guarantee a homogenous, constant spray pattern, without any

trade-off between an extension of the control-range and good spray pattern uniformity. Further optimizations with regard to droplet size and speed (and therefore impact), and robustness against clogging and scaling can be achieved without compromise.

The DynaJet Flex system has significant metallurgical advantages (Figure 1) compared to air-mist systems. Thanks to the higher turn-down ratio, any overcooling of the slab corners—as well as of the regions adjacent to the corners—can be avoided, thus reducing the risk of surface defects.

A NEW NOZZLE DESIGN

The DynaJet Flex system can be easily integrated into both new and existing machines. The nozzles have a shaft design that uses a standard connector to the spray header. The shaft is adapted to the design of the segment, and a variety of nozzle tips (flat spray, thickening flat spray, full cone) can be mounted on the

PNEUMATICALLY ACTUATED NOZZLES, GROUPED IN ZONES

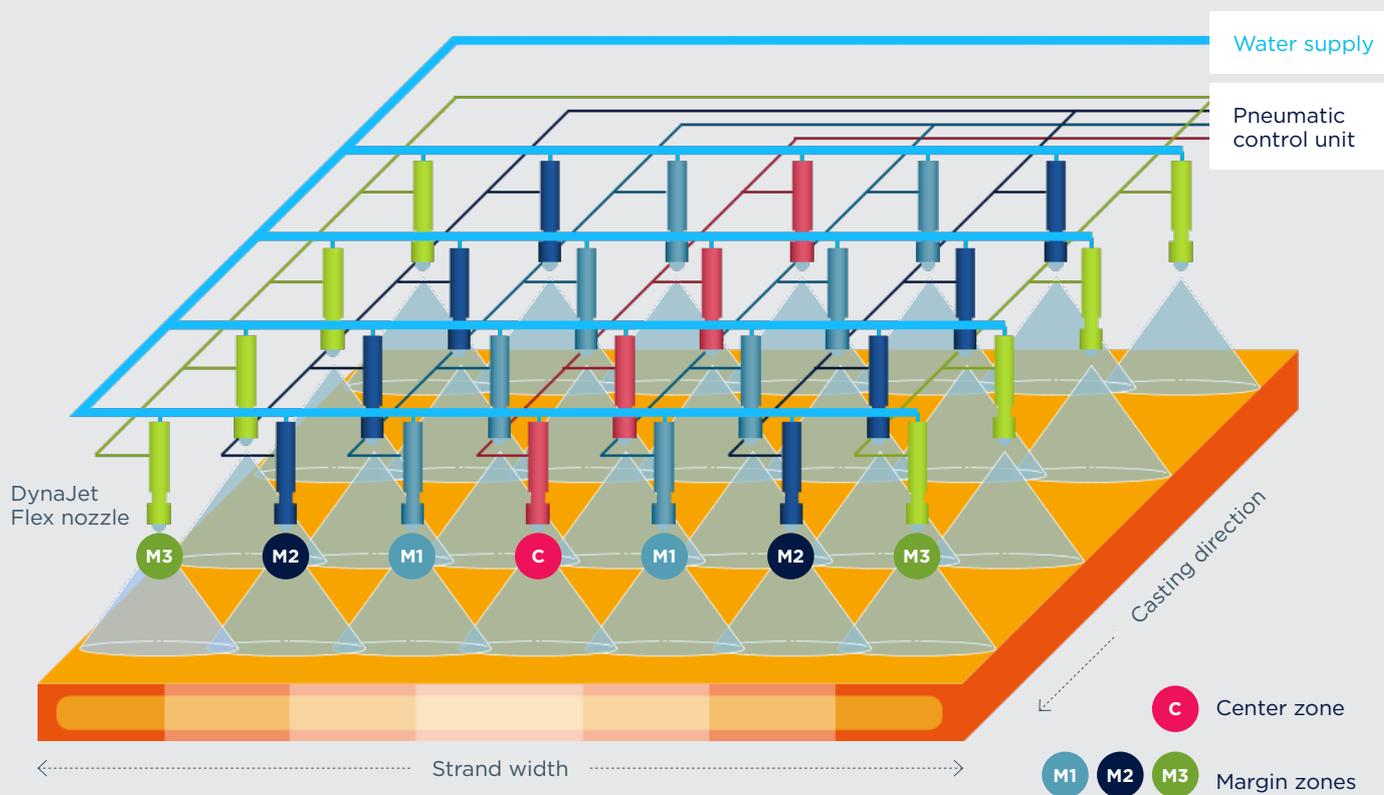


FIG. 2. Because a DynaJet Flex system consists of several independent cooling zones, it can be easily adapted to match the current width of the strand.

Any overcooling of the slab corners—as well as of the regions adjacent to the corners—can be avoided, which reduces the risk of surface defects.

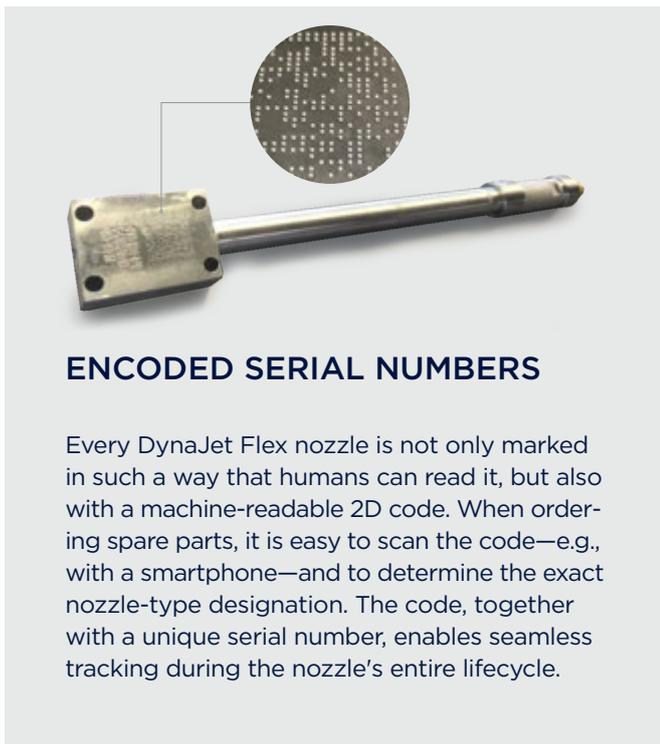
modular nozzle to fulfill the requirements for long and flat products.

The turn-down ratio of the nozzle is increased compared to conventional water-only cooling solutions, from 1:4 to 1:15 or higher, without the requirement of air mist generated by high-pressure pumps. Nozzles that are switched off because of smaller slabs are prevented from clogging by opening them for a very short period, e.g., one pulse every 30 seconds.

The pilot-actuated nozzle valves offer a flexibility never before realized in secondary cooling. Even with the existing water-supply connection at the segment, the existing zone can be split up into any number of separate zones, limited only by the number of existing nozzles. The pneumatic control unit located close to the cooling chamber has to be configured accordingly. In the scenario shown in Figure 2, for instance, one water-control valve supplies all nozzles simultaneously. »»

Another big advantage of DynaJet Flex is that operating costs can be significantly lower compared to air-mist solutions.

FIG. 3: DynaJet Flex nozzles in action. They are installed at Hyundai Steel's Dangjin, Korea, plant.



ENCODED SERIAL NUMBERS

Every DynaJet Flex nozzle is not only marked in such a way that humans can read it, but also with a machine-readable 2D code. When ordering spare parts, it is easy to scan the code—e.g., with a smartphone—and to determine the exact nozzle-type designation. The code, together with a unique serial number, enables seamless tracking during the nozzle's entire lifecycle.

Across the casting width, the zone is divided into four subzones (one center and three margin zones) to enable perfect cooling of the slab edges. Of course, with more pneumatic pilot valves, a higher resolution in the cross-casting direction is possible.

The pneumatic actuation of the nozzles is handled by the so-called Mechatronic Control Box, mounted outside the cooling chamber. The DynaJet Flex automation, which runs on a dedicated controller, ensures optimal control of the related cooling zones. The system automatically adjusts the parameters of the pulsation—mainly water pressure, frequency, and duty cycle—to achieve the required cooling intensity.

IMPLEMENTING DYNAJET FLEX

When implementing a new secondary-cooling system, DynaJet Flex is far superior to state-of-the-art systems. Typical air-mist systems require extensive piping installations as well as additional water and air connections at the equipment interface in order to enable width-dependent cooling—for instance, in a bender. However,



in comparison, the DynaJet Flex system can be installed in a configuration where it re-uses the existing water piping in combination with minimal additional air piping. Consequently, the machine can be upgraded during the annual maintenance downtime of the caster.

The additional air instrumentation and automation can be installed while the machine is in operation. Exchange benders or segments can be upgraded to use DynaJet Flex nozzles before maintenance, tested offline, and then installed on maintenance day. The connection between air piping and bender or segment is established via multi couplings to start casting with the DynaJet Flex cooling system. In fact, a lot of time and money can be saved by upgrading those machines that don't possess center-margin cooling zones with the DynaJet Flex system.

Another big advantage of the system is that operating costs can be significantly reduced in comparison to an air-mist solution. High amounts of air are used for atomizing the water in air-mist solutions, whereas »



FINDING THE PERFECT SOLUTION FOR SECONDARY COOLING

Paul Pennerstorfer is one of Primetals Technologies' highly experienced casting experts. He led the development of DynaJet Flex.

What prompted you to start the development of DynaJet Flex?

Paul Pennerstorfer: In continuous casting, slabs frequently show corner defects. Our 3D Sprays nozzle-adjustment system takes care of this problem as it helps to avoid overcooling. However, we couldn't implement this solution in pre-existing plants. DynaJet Flex is the next logical step. It can be integrated as part of an upgrade, for instance, in benders, without any significant downtime of the caster.

Was there any moment in time when an unexpected breakthrough was made?

Pennerstorfer: We had a breakthrough at the start of the project when we discovered that the spray pattern of the nozzles used with DynaJet Flex produced a homogeneous trapezoidal spray pattern—despite being controlled by pulse-width modulation. Normally, you'd expect the pattern to collapse when the water is repeatedly switched on and off.

What's next for DynaJet Flex?

Pennerstorfer: We already had the opportunity to implement DynaJet Flex twice, since Hyundai Steel wanted the solution to be installed at both strands of its Dangjin plant. When we integrated DynaJet Flex into the second strand, we were able to add many refinements—with positive effects on both the installation itself and later maintenance. Plus, we recently received two more orders.



the amount of air needed to actuate DynaJet Flex is significantly lower. Instead of using a dedicated air compressor, it is also possible to drive the system with nitrogen at a pressure of up to 30 bar for additional cost savings.

NOZZLE MANUFACTURING

During manufacturing, every single DynaJet Flex nozzle is individually coded. The code is not only printed onto the nozzle in the form of text and a serial number that can be interpreted by humans, but also as a machine-readable snippet of data-matrix code placed on top of the nozzle's mounting block. In the workshop where Primetals Technologies manufactures the DynaJet Flex nozzles, every nozzle is individually tested before delivery. This includes performance checks that cover the complete operational range intended for the nozzle, as well as leakage tests. Thanks to the combi-

nation of these tests and the unique, code-based identifier, every nozzle can be precisely tracked throughout its entire lifecycle.

A PRECISION SOLUTION

For optimum control of the DynaJet Flex system, the Dynacs 3D process model is used, which calculates and dynamically controls a three-dimensional temperature profile along the entire length of the strand. This control capability enables the setpoints of the strand cooling, and thus the final strand solidification, to be precisely determined as a function of casting parameters such as the casting speed, slab format, and steel grade.

PILOT INSTALLATION

As an industrial pilot installation, the DynaJet Flex spray cooling system from Primetals Technologies was

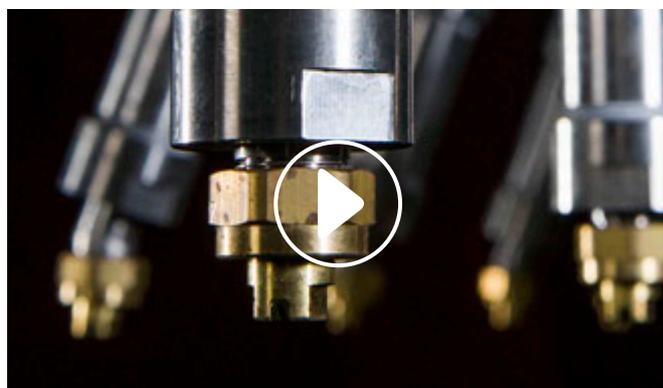


The pilot installation was started up at the 2-strand continuous slab-casting machine of Hyundai's Dangjin plant in late 2018.

FIG. 4: The DynaJet Flex secondary-cooling system can be precisely monitored and controlled via a tablet, if desired by the producer.

started up in November 2018 at the 2-strand continuous slab-casting machine CCM2 in the Dangjin, Korea, plant of Hyundai Steel. Hyundai Steel produces special steels for the automotive industry (Hyundai Motors and others), such as AHSS of the second and third generation. Crack-sensitive steel grades like these require width-adjustable secondary cooling to avoid potential overcooling of the slab corners. In order to adjust spray cooling in the bender area for slab-width ranges from 800 to 1,650 millimeters, a 4-step margin control with the Dynajet Flex system was installed on CCM2. As a result, these slabs can be rolled in non-scarfing condition—even without inspection. ●

Andreas Mittermair, Mechatronics Expert, Continuous Casting
Paul Pennerstorfer, Vice President, Continuous Casting
 (Both with Primetals Technologies Austria)



DYNAJET FLEX NOZZLE VIDEO

Scan the QR code to the left or point your web browser to meta.ls/dynajetflex to see the Dynajet Flex nozzle in action. You will be automatically redirected to the YouTube platform.

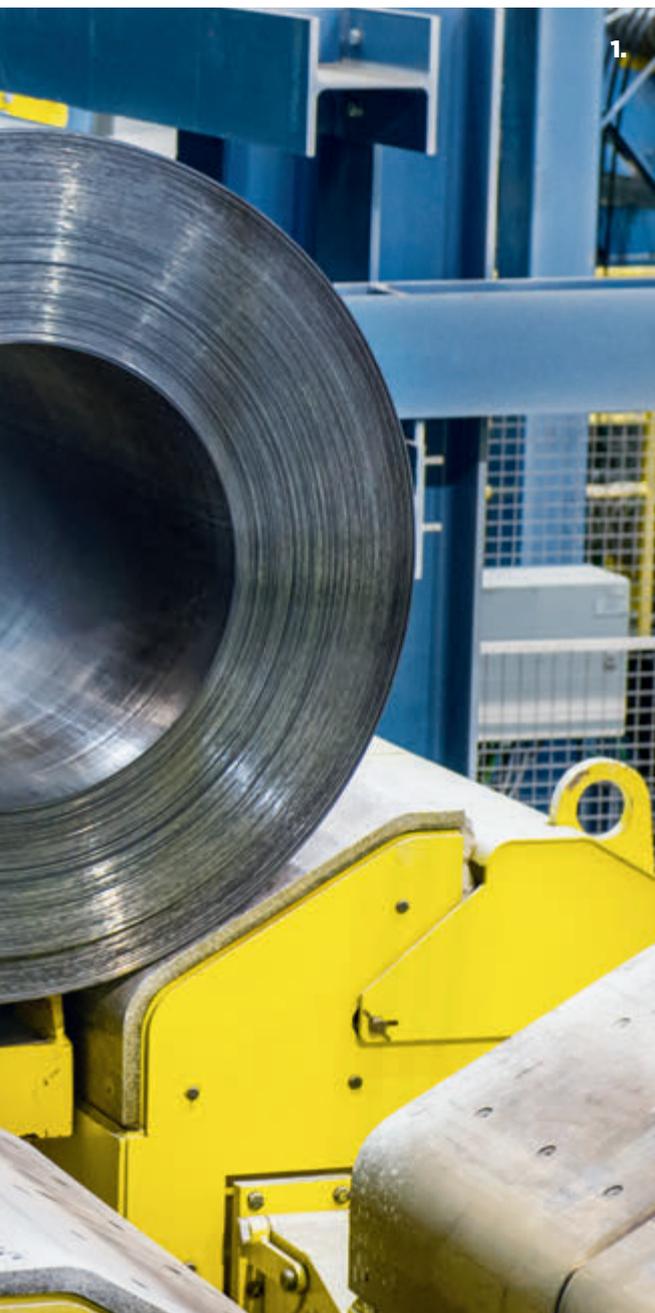
FIG. 1: Cars of the Modular Coil Shuttle system, waiting to be loaded at the down-coiler section of a hot-rolling facility.

FIG. 2: Two loaded shuttle cars moving along the tracks of the Modular Coil Shuttle system.



COIL LOGISTICS, MADE SIMPLE

THE MODULAR COIL SHUTTLE SYSTEM FROM PRIMETALS TECHNOLOGIES IS THE COST-EFFICIENT SOLUTION OF CHOICE FOR COIL LOGISTICS IN HOT-ROLLING, ARVEDI ESP, AND COLD-ROLLING PLANTS.



Primetals Technologies has developed an innovative modular coil-logistics system that relies on self-driving, remote-controlled shuttle cars traveling on dedicated rail tracks. Austrian specialists were responsible for all of the engineering, design, and manufacturing, as well as the associated electrics and automation. The cars have built-in motors and are orchestrated by an automation system that ties in perfectly with existing plant automation and enables streamlined interaction between the coil-transport setup, the plant's cranes, and all involved coil-treatment stations.

Coil logistics tend to vary significantly between rolling plants, as no two plant layouts will ever be identical. The Modular Coil Shuttle System from Primetals Technologies was designed to meet the logistics requirements of almost any cold- or hot-rolling facility thanks to its modular design and its smart and flexible components. The system was originally created for the transport of hot-rolled coils but can be easily adapted to move coils in cold-rolling facilities as well; in these cases, the heat-protection measures implemented in hot-rolling coil-logistics setups can be omitted.

THE SHUTTLE SYSTEM AT A GLANCE

At its core, the Modular Coil Shuttle System is a rail-based coil-transport system arranged in a loop

design. There is a loaded track (coils are transported from the down-coiler area to the coil yard or the next processing facility) and an unloaded track (for empty cars making their way back to the coiler). Both tracks are essentially identical and only differ in the cars' direction of travel. At certain points of the tracks, the cars can be shifted, turned, lifted, or lowered. This is done through specialized stations that follow the system's modular-design principle and can be flexibly positioned for the coil-logistics system to work perfectly in tandem with the pre-existing plant setup.

The Modular Coil Shuttle System is capable of incorporating many typical coil-logistics operations such as marking or strapping into the flow of shuttle cars. All modules can be arranged to accommodate a steel pro-

CURRENTLY AVAILABLE MODULES



MOVABLE STATION

The movable station is used to shift loaded or empty Modular Coil Shuttle cars perpendicularly to the cars' main transport direction, in order to facilitate lateral movements if the transfer route is changed. A movable station is therefore typically placed at the end of the transport system to ensure that the loop is closed.



TURNTABLE

The turntable module allows for a directional change of the Modular Coil Shuttle car of up to 90° by creating "T"-, "L"-, and "+"-shaped rail-track connections. Depending on the respective layout of the coil-transport area, the turntable can be equipped with either one or two rail segments.

ducer's existing plant layout and therefore their equipment. The newest member in the family of modules is a lifting device designed to elevate or lower shuttle cars. Depending on the requirements the logistics solution has to meet in a plant, the lifting device can be operated either hydraulically or electrically.

SIMPLE INSTALLATION AND EXTENSION

The shuttle cars travel on simple rails that are mounted at floor level, thereby necessitating only minimal foundation work when the system is installed. The capacity of the coil-transport system can be flexibly adjusted to match changing operational requirements by simply varying the number of active cars. The self-driven cars are equipped with on-board electronics and allow "plug & play" introduction into the system. The removal

of superfluous shuttle cars is just as straightforward; this can become necessary at times of lower overall production and a correspondingly reduced number of coils. The Modular Coil Shuttle System is also capable of buffering (temporarily storing) finished coils alongside the track without compromising production. Because the system features inherently high redundancy and uses particularly robust and durable components, its reliability is second to none.

Easy extensibility is another one of the system's strong points and results from the use of standard-type rails for all tracks. If required, the logistics solution can be extended in several stages. Should a steel producer's product mix change after the installation of a Modular Coil Shuttle System, the coil-logistics system can »



SHIFTING STATION

The shifting station is used to remove a Modular Coil Shuttle car from the main track for coil inspection or maintenance, or to reintroduce a car to the main track after coil inspection or maintenance. Up to three segments can be shifted simultaneously (as one station), so that the main track remains uninterrupted when cars are removed.



WEIGHING AND MARKING

At this station, the coil is weighed and marked on its circumference (the wound side of the coil) and on its face side. The weight of the empty Modular Coil Shuttle car is derived from its calibration weight, which is assessed on a regular basis. The weight of the coil is determined by weighing the loaded car.

EXISTING INSTALLATIONS

ALLEGHENY TECHNOLOGY, U.S.A.

Allegheny Technology Inc. first installed the Modular Coil Shuttle System in 2014. Allegheny's system features two down coilers, both of which are equipped with a circumference strapping device. After strapping, the coils are loaded onto shuttle cars, which travel to the turntable where they are rotated by 90 degrees. The cars then take the coils to the weighing and marking section. If a coil is selected for inspection, its car will make a stop at the shifting station and be removed from the main transport line. The shifting station can also be used to introduce additional cars to the transport system—or to temporarily retract them by moving them sideways and passing them on to a parking station located next to the main track. Once a car has made it all the way to the two-bay coil-storage area, one of the automatic cranes unloads the coil from the car and takes it to the targeted storage location. The car is then free to travel back to the down coiler to receive the next coil. Since the Modular Coil Shuttle System at Allegheny was designed as a loop, its overall setup is optimized for highly streamlined operation.

PLANT DATA

Coil diameter	950 - 2,150 mm
Strip width	660 - 2,083 mm
Strip thickness	1.78 - 25.4 mm
Max. coil temperature	840 °C
Min. coil temperature	Ambient temperature
Plant capacity	3.5 million tons/year
Coil weight	40 tons (max.)
Number of coils/hour	48 (max.)
Cars in circulation	13
Rail distance (1 full loop)	340 m

compensate by accommodating any changes in coil dimension or weight.

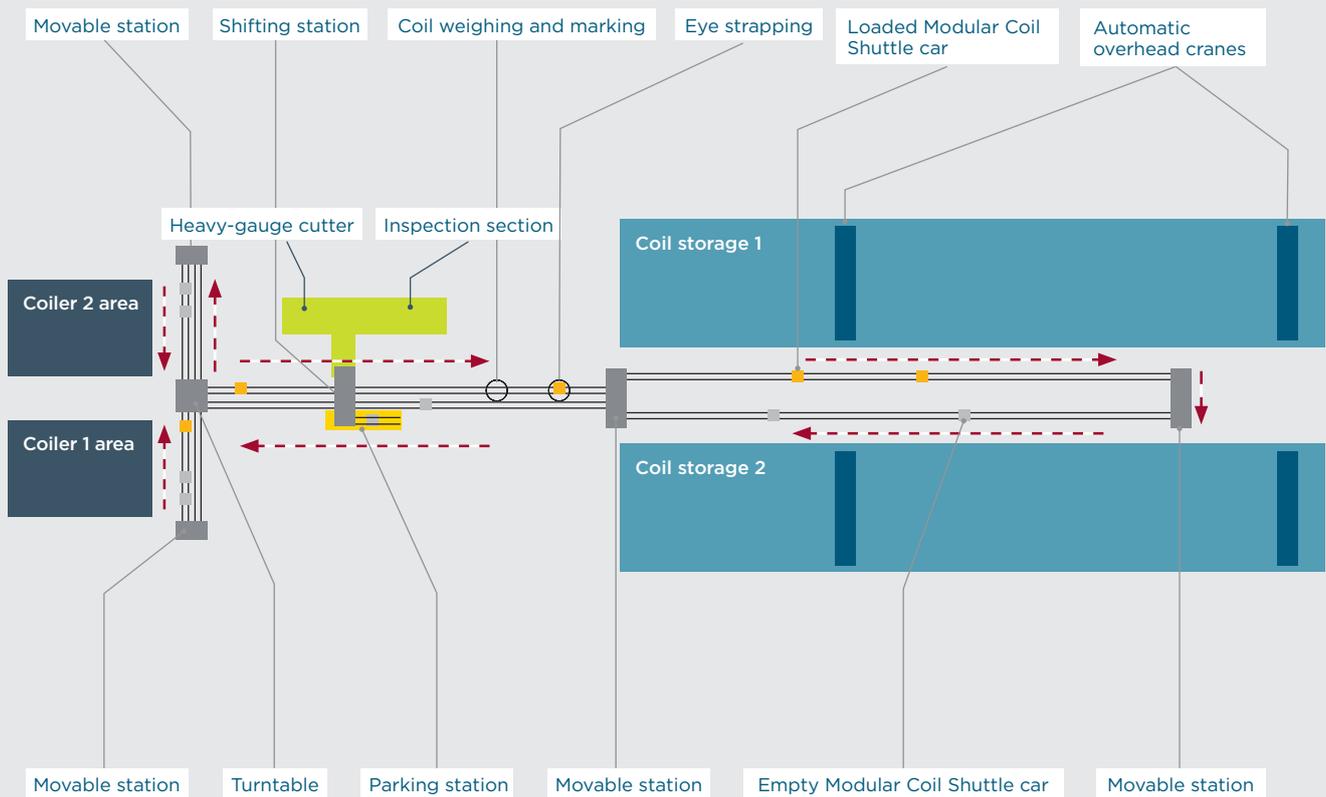
MOTORIZED, INTELLIGENT CARS

The shuttle cars can be operated in harsh conditions (e.g., hot and dusty environments) and are capable of handling coils with the highest surface and strip-edge requirements (i.e. free of dents, scratches, etc.). All cars are equipped with an electrical gear motor and can travel at a maximum speed of one meter per second when loaded and up to twice as fast when empty. The power is supplied via conductor rails and current collectors, which are mounted on a swiveling arm on each car. Attached to the arm is an antenna that enables communication with the central programmable logic controller via industrial Wi-Fi. The cars are equipped with a tracking system to monitor their exact position on the tracks. Tracking is accurate down to five millimeters and enables the precise control of all shuttle-car movement, which is especially important when loading coils onto shuttle cars in the down-coiler section via a coil-loading device. The cars are also equipped with coil detection for material-tracking purposes.

EASY ADDITION AND REMOVAL OF CARS

Whenever a shuttle car needs to be removed from the track, its swiveling power arm is retracted from the tracks and fixed in a raised position. The car can then be picked up by crane. Adding a car to the transport system is just as easy; once it has been placed onto the rails, the swiveling arm is brought into position and locked. The car is then ready for operation. If the car is in a position where it is not accessible by crane (crane shadow zones, tunnels), it can be towed into a better

One of the Modular Coil Shuttle System's greatest benefits is its affordability.



spot using another, operational car, irrespective of whether it is loaded or not.

IDEAL FOR HIGH PRODUCT QUALITY

To ensure highest-possible strip quality, it is best to manipulate the coils as little as possible between coiling and storage. Although coil-transport systems typically have to cover wide distances, they should ideally consist of only a very limited number of movable parts so as to minimize the associated maintenance effort. This necessitates the use of few, quickly replaceable, durable wear parts, as well as the implementation of a common spare-parts strategy. All of these factors are equally crucial in the context of hot- and cold-rolling mills. Conventional coil-transport solutions such as walking-beam, chain, and pallet-conveying systems cannot sufficiently fulfill these requirements, giving the Modular Coil Shuttle System a unique selling point.

AFFORDABLE AND EASY TO MAINTAIN

Another one of the Modular Coil Shuttle System's benefits is its affordability. Both the initial investment and operational costs are comparably low. A crucial factor is that only very limited foundation work is required »



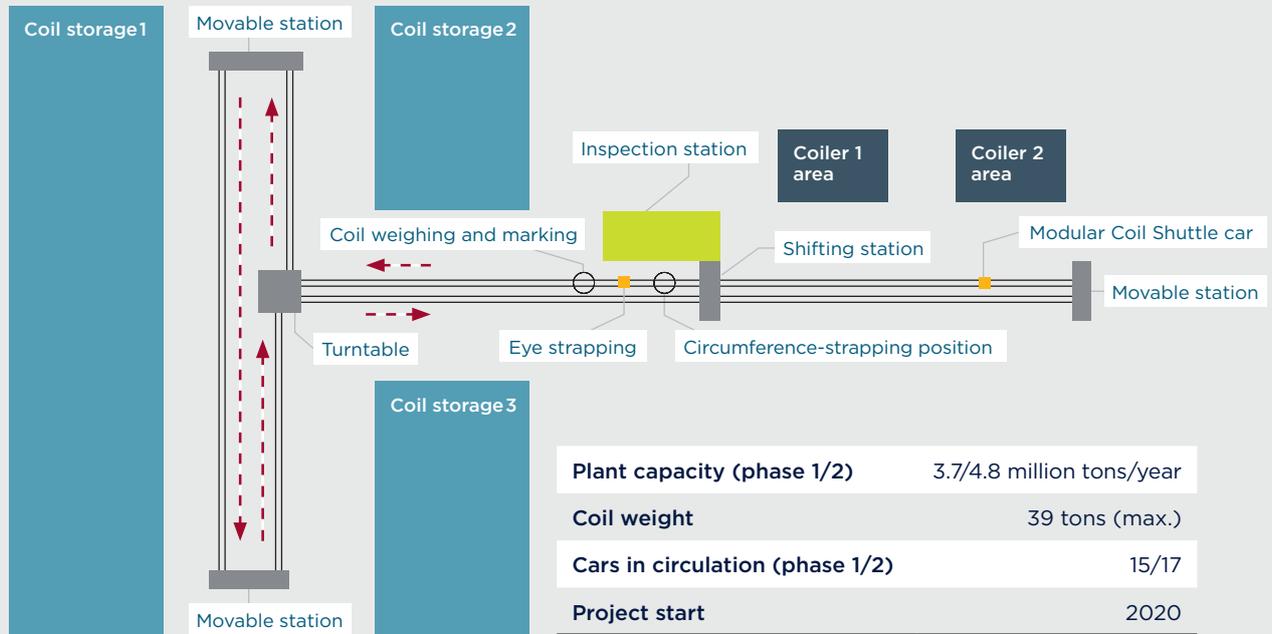
SMARTER COIL LOGISTICS

Fabian Schopf, Roland Hofer, Lukas Pichler, Christoph Salzmann, the team behind the Modular Coil Shuttle System at Primetals Technologies, have had their shuttle car 3D-printed for demonstration purposes. The model is used to convey the strengths of the coil-logistics system to steel producers—and potential new customers—worldwide.

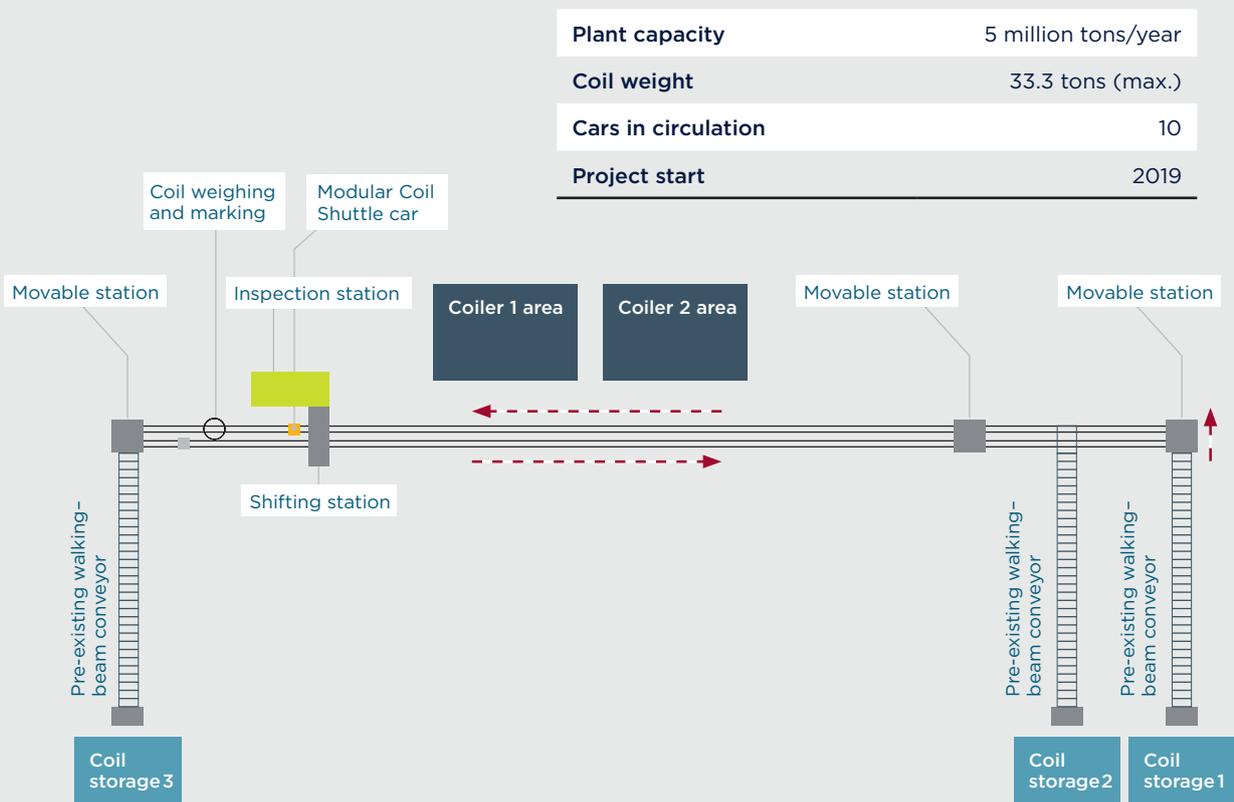
FUTURE INSTALLATIONS

Primetals Technologies is currently implementing Modular Coil Shuttle systems at several customers' sites. The two examples below demonstrate the versatility of the system.

INSTALLATION AT A MEXICAN PLANT



INSTALLATION AT A CANADIAN PLANT



BENEFITS OF THE MODULAR COIL SHUTTLE SYSTEM

- Highly customizable coil logistics
- Low investment and operational costs
- Fast erection and commissioning
- “Plug & Play” type installation and removal of shuttle cars
- High operational flexibility
- Outstanding reliability
- Low maintenance with close-to-zero wear on the tracks and extended spare-part service life
- Simple integration into existing automation systems
- Reliable tracking of all active shuttle cars even in the event of a power outage
- No deterioration of the coils’ surface and edges during transport
- Easy and low-cost system extension
- Smart and fully automated design (including crane handling)

for the system to be introduced. This is particularly valid for any extensions to existing setups and for revamps. There is no need for hydraulics or piping installations, with the exception of the lifting station, which is available as both hydraulic or electric versions. As a result, the Modular Coil Shuttle System can be implemented, commissioned, and started up with full functionality in a short timeframe. Maintenance costs are also minimal thanks to the small number of wear parts. The rail tracks are particularly low maintenance, and this is further simplified by the fact that both hot- and cold-rolling setups use identical components.

THE COIL-LOGISTICS SOLUTION OF CHOICE

The Modular Coil Shuttle System is the next generation of coil-logistics solutions. It is very cost-efficient as well as incredibly flexible and reliable, can be comprehensively automated, and requires only minimal maintenance. The system is particularly attractive as it helps steel producers manufacture coils of perfect surface quality with zero deformation on the edges, in line with current market demands. ●

Dr. Lukas Pichler, Product Lifecycle Manager, Hot Rolling

Christoph Salzmann, Product Owner

Roland Hofer, Product Engineer and Patent Owner

(All with Primetals Technologies Austria)



EXPLORING THE POSSIBILITIES OF A SMART MODULAR DESIGN

Dr. Lukas Pichler is an expert in product development and the commissioning of new solutions in the field of hot rolling.

When you worked on the development of the Modular Coil Shuttle system, was there any aspect that proved particularly tricky?

Dr. Lukas Pichler: The development of the Modular Coil Shuttle system had already been finalized and the first industrial installation completed (at ATI, see article) when I joined the product team in 2015. It was quite challenging to position the new technology—which is far better than other coil-transport systems—in a relatively conservative market.

What in your view is the greatest strength of the Modular Coil Shuttle system?

Pichler: The system’s modular design—with a variable number of cars, moving and shifting stations, turntables and lifts, and custom-length rail tracks—is its main benefit. It is a solution that becomes even more economical as track length increases, thanks to the minimal foundation work. On top of this, the system ensures very gentle coil handling. There really is no comparable solution on the market.

What does the future hold for the system—more modules and further installations?

Pichler: We have recently received orders for several new projects scheduled for startup in 2020. Some of them might even be extended in terms of track length and possible outdoor operation. Overall, I see great potential for the system to be implemented in the scope of plant modernization in multiple steps.



PIONEERS AT HEART



meta.ls/explore

GREAT PIONEERS

THAT INSPIRE US



At Primetals Technologies, we constantly strive to pioneer new and groundbreaking solutions for the steel industry. We work with passion, inspired by our close partnerships with steel producers from all around the world. Another source of inspiration are the great pioneers that have come before us—innovators who have made a profound impact on the way we live and changed the course of history. In this series, we look at the life, the challenges, and the achievements of some of the most outstanding pioneers of all time.

TIMELINE

1897

Amelia Mary Earhart is born in Atchison, Kansas, USA.

1920

Earhart takes her first plane ride in California with famed World War I pilot Frank Hawks.

1921

Earhart begins flying lessons in January and passes flight test in December.

1922

Earhart sets her first record, becoming the first woman to fly solo above 14,000 feet.

1931

Earhart sets a world altitude record of 18,415 feet in a Pitcairn PCA-2 autogyro rotary-wing aircraft, the predecessor to the helicopter.

AMELIA EARHART

AVIATRIX AND EMPOWERER OF WOMEN

The tenacious “girl in brown” who became a heroine of the skies and an inspirational figure worldwide

Amelia Earhart is perhaps best known as the first woman to fly solo across the Atlantic Ocean and for her ill-fated attempt to circumnavigate the globe. Indeed, her disappearance—which still ranks as one of the great unsolved mysteries of the 20th century—tends to actually overshadow her enduring legacies as an aviation pioneer and role model. Her contributions to women’s equality have cemented her place as a historically significant figure both within and beyond the field of aviation. Not only did she break through the glass ceiling, she soared high above it.

FLYING IN THE FACE OF CONVENTION

Earhart’s pioneering spirit, love of adventure, and defiance of traditional gender roles was evident at an early age; she loved sports and the great outdoors, activities that went against the conservative and restrictive grain of the era in terms of attitudes towards women. A stunt-flying exhibition got her hooked on flying, and in 1920, Earhart and her father, Edwin, visited an airfield where Frank Hawks gave her a ten-dollar ride that would change her life: “By the time I had got two or three hundred feet off the ground, I knew I had to fly,” she exclaimed.

Earhart’s can-do attitude and fiercely independent nature were perhaps a product of her home life. She idolized her father, but his alcoholism taught her not to be reliant on men, while her mother Amy made a very bold move in relocating and taking her two daughters to Chicago. Earhart learned a crucial life lesson: how a woman could be the breadwinner, and that a woman’s life need not necessarily revolve around a man.

Throughout her childhood, Earhart remained unfaltering in her aspirations and kept a scrapbook of successful women in male-dominated fields, such as film direction, law, advertising, and engineering. Her high school yearbook from Chicago described her as “A.E.—the girl in brown who walks alone,” undoubtedly a result of »



THE NINETY-NINES

After placing third in the 1929 Women’s Air Derby—the first transcontinental air race for women—, Earhart called a meeting of female pilots and the Ninety-Nines was founded. The Ninety-Nines was set up as an association dedicated to the advancement of females in aviation, and its name was based on the number of charter members at the time. In 1930, she became the organization’s first president. The Ninety-Nines still exists today, representing women flyers from 44 countries, and is still dedicated to the advancement of aviation through education and scholarships. Earhart’s birthplace is now the Amelia Earhart Birthplace Museum and is also maintained by the Ninety-Nines.

1932

Earhart becomes the first woman to fly solo across the Atlantic Ocean, and only the second person after Charles Lindbergh.

1937

Earhart sets off on ill-fated flight around the world on June 1, accompanied by navigator Fred Noonan.

1939

Earhart is declared legally dead on January 5.

1973

Earhart is inducted into the National Women’s Hall of Fame.

2006

Earhart is inducted into the California Hall of Fame.

her family's frequent moves and being forced to switch high schools six times, which made it tough for Earhart to make friends.

With attitudes to women slowly beginning to change and the campaign for women's suffrage gaining traction, Earhart impulsively dropped out of school during a trip to visit her sister in Toronto in 1917, feeling compelled to help with the war effort. She trained with the Red Cross as a nurse's aid and remained until the end of the war. Here, Earhart would observe pilots in the Royal Flying Corps training at a local air field and an intense passion for aviation was fueled.

BITTEN BY THE AVIATION BUG

Earhart survived the Spanish flu pandemic of 1918 that hit Toronto, but was herself hospitalized with pneumonia and chronic sinusitis that later affected her flying. After the war, she enrolled at Columbia University as a pre-med student, but quit a year later. It was at this point, in 1920, that she took her life-changing ten-minute ride with pilot Frank Hawks.

Earhart threw herself into her new passion and began flying lessons in January 1921 with female flight instructor and pioneer aviator Neta Snook, the first woman to run her own aviation business and commercial airfield. To pay for lessons, Earhart worked various jobs; as a photographer, truck driver, and a filing clerk at the Los Angeles Telephone Company. Within just six months, she had saved enough to buy her own plane, paying \$2,000 for a bright yellow second-hand Kinner Airster biplane that she nicknamed "The Canary," in which she went on to set the first of many records by rising to an altitude of 14,000 feet. By December 1921, she had earned her National Aeronautics Association license.

“ Amelia Earhart came perhaps before her time ... the smiling, confident, capable, yet compassionate human being, is one of which we can all be proud.”

Walter J. Boyne

Aviation writer, retired US Air Force officer, and former director of the National Air & Space Museum of the Smithsonian Institution



DID YOU KNOW ...?

- ... that 10-year-old Amelia Earhart was left indifferent by her first sighting of a plane at the Iowa State Fair: "It was a thing of rusty wire and wood and looked not at all interesting," she said. It wasn't until 1920 that she took her first plane ride, and then only as a passenger.
- ... that Amelia Earhart was one of the earliest supporters of the Equal Rights Amendment first proposed to Congress in 1923. She was also a member of the National Women's Party, who campaigned for the right of women to vote.
- ... that publisher George P. Putnam, whom she married in 1931, fed the nickname "Lucky Lindy" to the press because of Earhart's likeness to aviator Charles B. Lindbergh. By all accounts it was a nickname that she despised.
- ... that Amelia's mother Amy was another record-setter, the first woman to ever climb Pikes Peak in Colorado. Amy encouraged her daughter's passion for flying and used some of her inheritance to help pay for The Canary, Amelia's first self-owned plane.
- ... that Earhart struck up a friendship with First Lady Eleanor Roosevelt in 1932 and inspired her to sign up for flying lessons. Roosevelt did get her student permit, but took her plans no further.

EARHART'S BIG BREAK

Following the buzz surrounding Charles Lindbergh's solo Atlantic crossing in 1927, Earhart was invited to join an expedition that would make her the first woman to fly across the Atlantic—but only as a passenger. She accompanied pilot Wilmer Stultz and co-pilot Louis Gordon, and kept the flight log on a journey that took them from Newfoundland to South Wales in 20 hours and 40 minutes. Upon returning to American soil, a ticker-tape parade was thrown in New York in their honor, and a reception was held at the White House by President Calvin Coolidge.

Earhart's newfound celebrity enabled her to finance her flying, and her career took off. She undertook a lecture tour, wrote a book, endorsed various products, and became one of the first celebrities to launch her own clothing line, featuring aviation-inspired details. Earhart was also appointed Aviation Editor at *Cosmopolitan* magazine, leveraging her position to popularize commercial air travel and, in particular, to campaign for the advancement of women in aviation. She published 16 articles, including "Shall You Let Your Daughter Fly?" and "Why Are Women Afraid to Fly?" In response to a letter sent in by a 13-year-old girl with ambitions of becoming a pilot, she said: "As far as a woman's opportunities in flying go, I think they will improve as they have in all industries."

A WOMAN OF MANY FIRSTS

It was during the Atlantic crossing project that publisher George Putnam entered Earhart's life. The two struck up a friendship that eventually led to marriage in 1931—after she agreed to his sixth proposal—, but even then, Earhart was keen to retain her independence; she believed in equal responsibilities and insisted on keeping her own name.

In the meantime, the pair began hatching a plan for Earhart to become the first woman to fly solo across the Atlantic, and on May 20, 1932, Earhart left Newfoundland in a single-engine Lockheed Vega 5B, bound for Paris in a bid to emulate Charles Lindbergh's flight from five years earlier. After 14 hours and 56 minutes, all the while battling strong winds, icy conditions, and mechanical problems, she landed in Culmore, Northern Ireland. It was an achievement that earned her the distinction of becoming the first woman to be awarded the Distinguished Flying Cross by Congress.

Earhart went on to set a succession of records, but had her sights set on the big one: becoming the first woman to fly around the world. A first attempt in March 1937, in a twin-engine Lockheed 10E Electra built by Lockheed to her specifications, ended in a crash after the forward landing gear collapsed, but did nothing to deter her spirits. She took off again in the rebuilt Electra on June 1, accompanied by navigator Fred Noonan, departing from Miami in an eastbound direction and following a roughly equatorial route.

WHAT REALLY HAPPENED TO AMELIA EARHART?

The US government spent \$4 million on the search for Amelia Earhart in what was, at the time, the most expensive and extensive air and sea search in history. The crash-and-sink theory, the most popular one and the line held by the US government, suggests that Earhart and Noonan simply ran out of fuel before reaching Howland Island, crashing into and perishing in the Pacific Ocean. The theory put forward by the International Group for Historic Aircraft Recovery (TIGHAR) speculates that they veered off course, landed 350 miles to the southwest on the then uninhabited Gardner Island (now Nikumaroro), and survived as castaways for up to several weeks. Conspiracy theories surrounding their disappearance claim that they were spies for the Roosevelt administration, returning to the United States and assuming new identities, or that they were captured and executed by the Japanese.

Earhart and Noonan reached Lae, New Guinea, on June 29, having notched up 22,000 miles and with 7,000 still to go before reaching Oakland. On July 2, they set out for Howland Island, their next refueling stop, lost radio contact with the US coast guard cutter *Itasca*, anchored off the coast of Howland Island, and disappeared. President Franklin D. Roosevelt launched a two-week search, but on July 19, 1937, Earhart and Noonan were declared lost at sea. Had the pair completed that final flight, it would also have made Earhart the first to fly around the world at the equator.

There is no doubt that the mysterious circumstances surrounding Earhart's disappearance have helped lift the aviatrix to legendary status, but she should be remembered for her courage, determination, pioneering spirit, and her achievements in advancing women's rights. Earhart knew the risks, and in a letter to her husband—in hindsight written with unnerving clairvoyance—before her final flight, she wrote: "Please know I am quite aware of the hazards. I want to do it because I want to do it. Women must try to do things as men have tried. When they fail, their failure must be but a challenge to others." Earhart always fought against the stereotypes, and although she did not consider herself a feminist, her story inspired a generation of female flyers, and is as valid today as it ever was as a motivational tale. ●

STRAIGHT FROM THE LABS OF PRIMETALS TECHNOLOGIES

THE SERVER ROOM

In this secure server room, Primetals Technologies houses its infrastructure for big-data analysis.



MANFRED KÜGEL

In his role as data scientist, Kügel develops advanced algorithms for the IT solutions from Primetals Technologies.

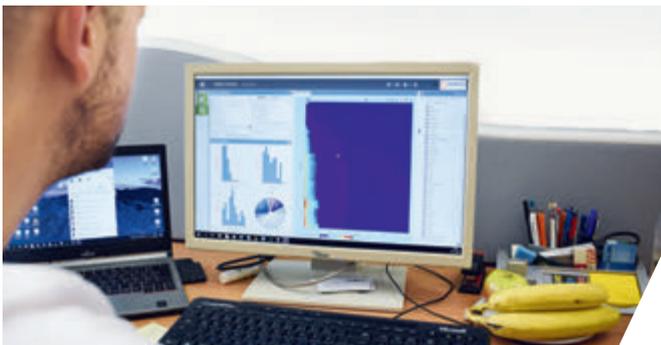


FIG. 1: In order to pioneer new software-based solutions, Kügel relies on his computer, his expertise, and his vitamins.



FIG. 2: Kügel likes to use a traditional white board to visualize his ideas when discussing a new approach with colleagues.

The extensive R&D efforts of Primetals Technologies are an integral part of the company's larger strategy to continually promote innovation for the metals industry. In this series, we present new, remarkable solutions pioneered by Primetals Technologies' engineers—solutions that may still be in their infancy today but have the potential to change the way steel and other metals will be produced in the decades ahead.

CREATING ALGORITHMS FOR THE DIGITAL FUTURE OF METALS

Manfred Kügel, data scientist at Primetals Technologies, has a colorful and diverse job. While his main tool clearly is his computer, his tasks range from data analysis and the evaluation of rule-sets to the creation of entirely new algorithms to solve problems that previously remained unaddressed. He does all this with great ingenuity and persistence—as well as a very high intake of seasonal fruits (see Figures 1 & 3), which give him the energy to come up with fresh ideas.

CUSTOMER-ORIENTED DEVELOPMENT

Much of Kügel's work starts with specific issues that steel producers are dealing with. These issues may be related to quality concerns over the respective manufacturer's end products or the need to improve certain aspects of the steel-production chain—for instance, the alloying concept. Whatever the problem, Kügel will use production data provided by the customer to make data-driven assessments and draw his conclusions as to what's going on and what needs to be improved. Of course, his work is highly dependent on the domain experts of Primetals Technologies, who support him with their knowledge and experience of the more intrinsic details of the steel-production process.

Since he works in tandem with non-programmers, it is indispensable to occasionally visualize the objectives of new projects in a straightforward manner. Kügel says he has found that using a rather "non-techy," classic white board is the best way to sketch out mutual challenges and goals. It allows him and his colleagues to brainstorm and ensures that everyone is on the same page regarding the project's objectives.

THROUGH-PROCESS OPTIMIZATION

Kügel has the important role of being one of the main designers of Primetals Technologies' Through-Process Optimization (TPO). This renowned technology consists of the Through-Process Quality Control IT system and an expertly crafted rule-set called "Through-Process Know-How." With the combined power of these two components, TPO enables steel manufacturers to make the inner workings of their production process more transparent, to increase end-product quality, introduce higher levels of flexibility in terms of batch sizes and raw materials, and realize easier and faster product development. Kügel crafts and improves the algorithms used in TPO and ensures that the solution remains at the cutting edge of technology. ●



FIG. 3: One of the steel-production issues Kügel is investigating is called the "orange peel" effect, which he demonstrates here.



FIG. 4: Kügel draws his conclusions from up to 8,000 process parameters to optimize product quality.

**STEFAN LECHNER**

A technology innovator and business developer, Stefan Lechner is one of Primetals Technologies most prominent pioneers.

IN THIS INTERVIEW FORMAT, WE ASK ONE OF PRIMETALS TECHNOLOGIES' EXPERTS TO USE THEIR IMAGINATION.

Stefan Lechner has led many major innovation efforts at Primetals Technologies as Global Head of R&D of the company's Metallurgical Services department. In another role, he carried out further pioneering work in the field of global insourcing. Lechner now uses his extensive knowledge of steel production and the metals industry at large in his current position as a business developer. We asked him for his personal view on what if ...

“It may be possible to replace steel with other materials in certain areas, but none of them is as environmentally friendly in the long run.”



... STEEL AS A BASE MATERIAL BEGINS TO FACE EVEN STIFFER COMPETITION? WILL STEEL REMAIN RELEVANT?

Stefan Lechner: Our idea of economic development is still based on continuous growth, and the world's population is projected to increase by a billion every 10 to 12 years. Everyone will require housing, resulting in space for new settlements becoming increasingly scarce. Buildings will have to become taller and this will necessitate the use of reinforced concrete in their construction. This will increase total steel consumption. What's more, everyone will still go to work somewhere, resulting in a need for office buildings, workshops, and factories—all of which will be partially made of steel. Add to that an upsurge in public and private transport. New streets, tunnels, ships, lorries, and cars all require steel as a base material. The same applies to the respective terminals, airports, ship yards, and train stations. Then there's the leisure sector and all the things we use in our everyday lives—household appliances, sports gear, hotels, and hospitals. Greater need for steel across the board. Another aspect that will make steel even more relevant in the future is its recyclability. It may be possible to replace steel with other materials in certain areas, but none of them is as environmentally friendly in the long run.



... HYDROGEN BECOMES A MORE VIABLE ENERGY SOURCE FOR STEEL PRODUCTION? WILL THERE BE A GREEN REVOLUTION?

Lechner: It is already technically feasible to use hydrogen as a reducing agent in iron-making. In fact, direct-reduced iron has been produced using hydrogen-rich natural gas. The complete substitution of coke with hydrogen, however, is very challenging, because coke acts both as a reducing agent and an energy source. Also, coke ensures proper air flow in the blast furnace. This limits the current use case for hydrogen in iron-making; it "only" makes the process more environmentally friendly. Together with Siemens and other partners, we are already pioneering a very ambitious pilot project, but one has to be realistic. For economic reasons alone, it will likely take several decades for fossil fuels to be fully replaced by hydrogen. Steel plants require vast amounts of energy, and the production of hydrogen is also very energy-intensive. I recently read that if Austria's steel plants were to be run on hydrogen, half of the country's electrical-energy consumption would be absorbed by hydrogen production. This is why it would only make sense to use hydrogen in our industry if it could be produced using renewable energy. I think it will take a while until hydrogen reaches maturity in steel production.

The growth of the world's population will pose great challenges, Lechner points out.



... YOU IMAGINED THE WORLD IN 30 YEARS' TIME? HOW WOULD IT COMPARE TO THE WORLD OF TODAY?

Lechner: Elon Musk believes that artificial intelligence is the greatest threat mankind has ever faced. Jeff Nesbit claims that, in 2050, the human species will be all but gone. Personally, I think we'll still be here, but I couldn't speak as to how we will live. Of course, it is today that we shape our own future. But the elites who are trying to agree on one single challenge that stands above all else are in fact only making things worse. We are facing a complex problem—that of a rapidly growing population. If prognoses are correct, our planet in 2050 will be no larger than in 2019 but home to some 10 billion people—almost a third more than today. Correspondingly, the number of cities of over a million people has already reached 400 and continues to rise. We will be facing challenges in terms of inhabitable space, resources, food, air, water, energy, and more. This is why I think that the biggest change in the next 30 years won't be of a technological nature. It will be the fact that humankind realized it was heading toward the abyss and began to make societal changes by use of technology and other means. As a result, the economy as we know it will be transformed and no longer exclusively target growth.



... YOU WERE ASKED TO CHOOSE YOUR FAVORITE DIGITAL STEEL-PRODUCTION SOLUTION CURRENTLY AVAILABLE?

Lechner: There's a simple answer to this question. My favorite technology is Through-Process Optimization (TPO). Let me tell you why. If I were a steel producer, I would know what *not* to do: I wouldn't waste my time implementing a number of independent solutions only to realize how difficult it is to properly connect them to one another. Rather, I would choose a proven, holistic solution that is capable of comprehensively optimizing all steps of the value chain in steel production. TPO can, for instance, optimize production costs in tandem with end-product quality. It can allocate just the right amount of raw materials for the targeted production volume. It can find the root cause when a problem arises and suggest corrective measures. Also, importantly, the functionality of TPO can be extended with a powerful production-management system and a Level III system, which help ensure product quality as well as delivery times. With this kind of technology in place, it is much easier to fulfill and even exceed end-customer expectations. No other company offers a system that is even close to TPO. Knowing the strengths of TPO, I almost wish I were a steel producer myself.



... STEEL PRODUCERS APPROACHED PRIMETALS TECHNOLOGIES ABOUT NEW AND INNOVATIVE CONTRACT MODELS?

Lechner: At Primetals Technologies, we have a long tradition of developing innovative cooperation models with our customers. We have been offering performance-based service contracts for almost two decades, and we've successfully initiated license-based software-service agreements. Only recently, several customers approached us about new cooperation models for projects involving raw-material recycling, energy recovery, and green-production solutions. Primetals Technologies not only pioneers new technologies but also new business models that support steel producers in achieving their goals.

“We have a long history of developing innovative cooperation models with our customers.”



... AFRICAN NATIONS BECOME MORE SIGNIFICANT PLAYERS IN THE WORLD OF STEEL?

Lechner: There are two major reasons why Africa has not yet become a significant player in the world of steel production. The first reason has to do with finances. It is true that Africa as a whole has seen annual growth rates of 5–6%, but this development is largely driven by only a few countries, namely Mozambique, Tanzania, Kenya, and Ethiopia. Most other countries are worse off. Africa's oil-exporting nations are suffering from low oil prices; others struggle with declining commodity prices, a tightening of monetary policies, and large trade and fiscal deficits. In many cases, the result is a depreciation of the local currency. The second major reason is the lack of proper infrastructure, which is crippling large parts of the continent. 94% of all funding received by Africa is directed toward the energy, water, and transport sectors, but the infrastructure still has a long way to go before large-scale construction projects can be executed more easily. Because of these challenges, the African continent of today is a net importer of steel—mainly of long products, but demand for flat products is increasing. On the plus side, Africa is extremely rich in natural resources. To many African countries, mineral exploration and production are an integral part of the economy and key to economic growth. With many minerals—for instance, bauxite, cobalt, industrial diamond, phosphate rock, platinum-group metals, vermiculite, and zirconium—, Africa ranks first or second respectively in worldwide reserves. Africa is also rich in gold, which is targeted by most of the continent's current mining efforts. The consequence of all this is that while many governments and strategic investors are focusing on Africa, the financial power of the African nations themselves remains limited. Today, African steel producers are looking for technical solutions that are both simple and low-cost, also because skills for steelmaking have to be developed. But the continent will prepare itself for more advanced solutions. It is therefore crucial that Primetals Technologies continues to adapt its portfolio to meet Africa's needs and support the continent in its development. ●



THE PIONEER'S GUIDE TO **BOOSTING CREATIVITY**

In this series, we look at different ways of getting the creative juices flowing. This time, we focus on multitasking—the technique of alternating between multiple projects—as a tool that can increase your productivity. Multitasking may not be for everyone, but if it suits you, it can help you to maximize your creative output.



PART 2: MULTI- TASKING

Some are quick to dismiss multitasking as a productivity killer, but studies have shown that the right approach can help to boost creative output.

Opinion about multitasking remains heavily divided, but whichever way you look at it multitasking has become an inevitable side effect of our busy lives. While some are quick to dismiss it as a productivity killer, recent studies have also shown that the right approach to multitasking might ultimately help to boost creative output. So which camp do you fall into?

Research cited by Forbes claims that our limited cognitive resources prevent us from doing multiple things at once; in fact, we'll end up doing one or both of those things poorly. This is bad for productivity and impacts our ability to concentrate and remember things. Distractions as brief as a couple of seconds could even double the number of mistakes, another study argues.

So if multitasking is so detrimental, why do we do it? The answer is that our brains are wired to love multitasking. First, there is a crucial neurotransmitter in the brain called dopamine—our “motivation chemical”—, which is responsible for rewarding certain activities, like the feeling of anticipation and unpredictability when we receive a new e-mail or text message. Dopamine is also triggered by the satisfaction of completing a task, driving us on to tick off as many things on our to-do list as possible. The makers of video games leverage precisely these triggers to make their games addictive.

Second, we love to be distracted. The anti-multitaskers claim that we perform at our best when we are focusing on just one thing, yet in actual fact our »

“One common practice of exceptional creators is that they tend to have multiple projects underway at the same time, and if they get to a stump or an impasse in one project, they can start working on another project.”

Dr. Robert Keith Sawyer

Scientific expert on creativity, collaboration, and learning

perception is that we're accomplishing more when we have multiple projects on the go, and though it's not the most efficient way to work, they argue, multitasking feels like less of an effort and even keeps us entertained.

WORKING SMART

But what about those of us who thrive on multitasking? Dr. Robert Keith Sawyer, author of “Explaining Creativity: The Science of Human Innovation,” says that creative people tend to have multiple projects on the go at any one time, and switching to another project actually increases the potential for problem-solving as well as identifying unexpected connections between projects. Sawyer, also an advocate of the “work hard, play hard” philosophy, suggests that creative people work smart, structuring their day to alternate between hard work and idle time, which allows them to frame their problems differently and look at them from new perspectives. This can be positive in that it allows them to use their time much more effectively and efficiently.

The secret is to turn your attention to something completely different. For example, more creative people also take breaks from a current work project to read a book, play a board game, or take a walk, says Sawyer. “These are times where distant analogies can happen—meaning something on the board game might provide an idea regarding the current project. Something in a book might connect two ideas together. A walk might allow for viewing of new concepts.” In a recent interview Sir Paul McCartney, commenting on Billy Joel's admission that frustration had led to him giving up releasing new music, said: “These things happen to

you. You get disappointed in what you're doing [and say], 'I'm never doing this again.'" But whenever it happens to Sir Paul, he says, “I just go and do something else, maybe go on holiday or something, and that can get you hungry again.”

Taking a step back allows the creative person to join the dots between two superficially dissimilar things. Good examples are the 15-year-old James Watt, who realized the power of steam after watching the lid on a kettle rise, going on to make improvements to the steam engine that sparked the Industrial Revolution, or George de Mestral, who noticed the tendency of burrs to stick to his dog's fur and, after examining the tiny hooks under a microscope, invented Velcro. This is why Sawyer also emphasizes the importance of taking a vacation to recharge the batteries and reinforce creativity.

SUBCONSCIOUS LABOR

Another argument that will delight enthusiastic multitaskers is that alternating between several creative projects allows the subconscious to work on each of them. Taking a break to work on something else can help us avoid becoming so obsessed with a problem that we hit a brick wall. Albert Einstein, for instance, used to take breaks from his scientific work to practice the violin.

So how is the brain able to process things without you consciously being aware? The brain is incredibly complex—it is believed that it processes over 200 billion bits of information every second—and more than capable of handling several simultaneous tasks. For instance, the brain keeps us breathing while we »

IF YOU'D RATHER MONOTASK ...

If you're not convinced and you're still keen to break the multi-tasking habit, try monotasking instead! Monotasking does require a certain level of motivation and dedication, so you need to be prepared. To find what works best for you, on a typical day you might try making a note every time you get distracted, or of any times when your work is interrupted. That way you can decide what action to take that will help you increase your focus. Here's our list of top five tips:

BREAK IT DOWN

How do you eat an apple? One bite at a time. Break one big task down into smaller, bite-size pieces. Several, smaller accomplishments can be more rewarding, and it's better to avoid the disappointment of setting yourself one big target and then falling short.

DON'T GET DISTRACTED

Turn off e-mail and message notifications during periods of work time when you need to be focused, during meetings, and even during the evenings when you need to relax and give your brain a rest.

LISTEN AND ENGAGE

Be a good listener. During conversations or meetings, put your phone away and really engage with the person you're talking to. It's also good manners, and your conversation partner will appreciate you even more.

BE MINDFUL

You can start your day with a brief period of meditation, or schedule "mindfulness breaks" throughout the day. Close your eyes, take deep breaths, and disconnect.

PLAN AHEAD

Plan out your day in advance. Take a few minutes at the end of each day to organize your time and your agenda for the following day. That way, you can avoid having to alternate between projects throughout the next day.

sleep, and we can easily slip into “autopilot” mode while driving and still get home safely.

This type of subconscious problem-solving can be partly explained by incubation theory. According to writer and professor David Burkus, research has given us some insight into not only how eureka moments happen, but how we can actually *make* them happen. Burkus says: “Eureka moments feel like flashes of insight because they often come out of a period when the mind isn’t focused on the problem, what psychologists call a period of incubation. Incubation is the stage where people briefly step back from their work.”

Burkus cites a project carried out by researchers at the University of Sydney, in which groups of students were given creativity drills called “alternate uses tests.” The study found evidence that incubation periods, even

INCUBATION THEORY

Incubation suggests that taking a break from a project or trying to solve a problem can boost creativity by allowing an idea to sit in your mind without being tampered with. It works because during the break, the brain is able to forget any misleading thoughts or inappropriate strategies, and because working on any one thing for any length of time will inevitably stress those parts of the brain dealing with it.

Research has given us some insight into not only how eureka moments happen, but how we can actually make them happen.



DID YOU KNOW ...?

... that multitasking is managed by mental executive functions that control other cognitive processes and determine how, when, and in what order tasks are performed.

... that people who engage in media multitasking—using more than one form of media or type of technology at once—are potentially better at integrating visual and auditory information.

... that multitasking is a skill that you can learn. The American Management Association suggests you can boost your multitasking skills through dedicated practice, by recognizing when one task requires your undivided attention, by using project management and efficiency tools, and by taking regular breaks so that you can consistently function at your best.

... that one of the keys to multitasking is to match high cognitive activities (e.g. writing or anything that involves complex thinking) with physical tasks that your brain can handle while on “autopilot.” There is no reason we shouldn’t be able to read a book while exercising on a cross-trainer, or watch TV while ironing. These are tasks that involve different parts of the brain, so there is no conflict.

those as brief as a few minutes, can significantly boost a person’s creative output. He goes on: “Taking a break from the problem and focusing on something else entirely gives the mind some time to release its fixation on the same solutions and let the old pathways fade from memory. Then, when you return to the original problem, your mind is more open to new possibilities—eureka moments.”

What’s also fascinating—and good news for those with a heavy work schedule—is that the University of Sydney researchers found that the group of students who were given a break to work on an unrelated task generated the most ideas. Which means that switching to an unrelated, but still work-related, task like responding to e-mails, can take your mind off the problem at hand and give your mind a rest, increasing the potential for a eureka moment when you return to the problem.

Ultimately, you need to find what works best for you. But the evidence would seem to suggest that alternating between projects opens you up to different perspectives and can, therefore, boost your creativity. ●



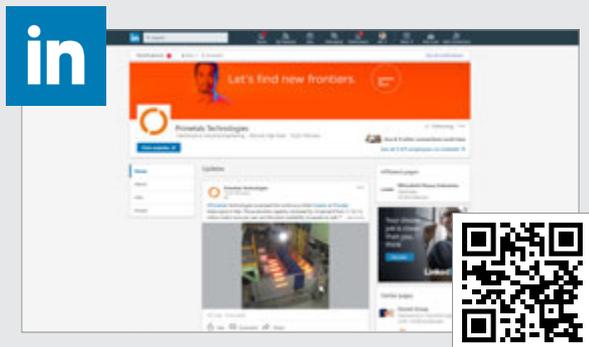
STAY UP TO DATE

Read about the latest project highlights, technological developments, events, and more.

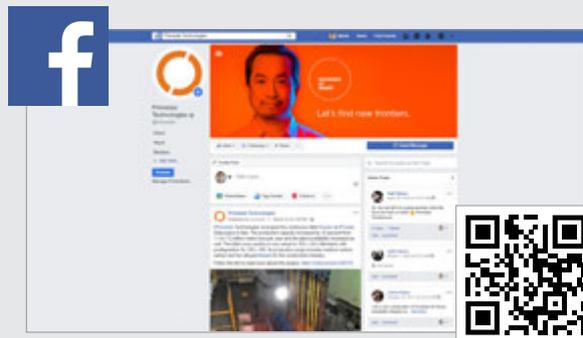


meta.ls/newsletter

 FOLLOW US ON SOCIAL MEDIA



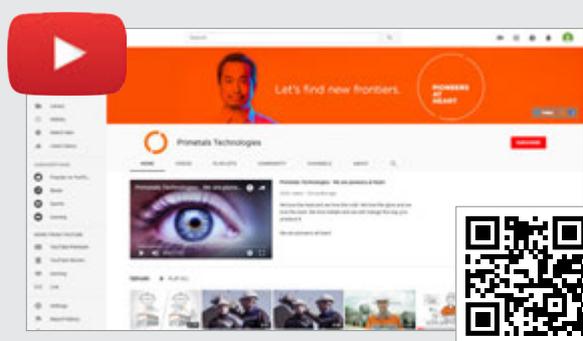
PRIMETALS TECHNOLOGIES ON LINKEDIN
linkedin.com/company/primetals



PRIMETALS TECHNOLOGIES ON FACEBOOK
facebook.com/Primetals

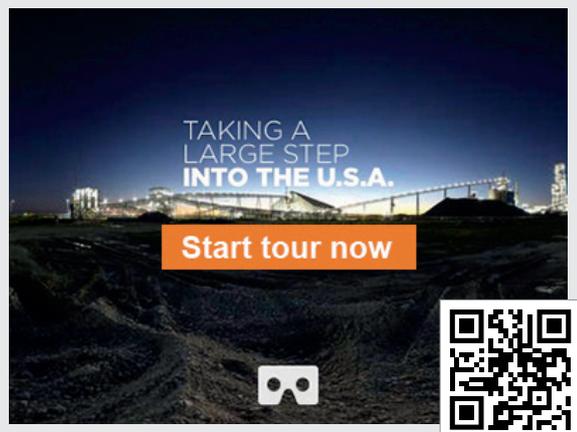


PRIMETALS TECHNOLOGIES ON TWITTER
[@primetals — twitter.com/primetals](https://twitter.com/primetals)



PRIMETALS TECHNOLOGIES ON YOUTUBE
youtube.com/PrimetalsTechnologies

 EXPERIENCE OUR SOLUTIONS IN 360°



A virtual reality tour through the direct-reduction plant of voestalpine in Corpus Christi, Texas, commissioned by Primetals Technologies and Midrex Technologies. Send an email to contact@primetals.com to get a free pair of Google Cardboard VR glasses.

meta.ls/gowestvr



An immersive 360° experience of a fully equipped company service workshop, installed recently at the steelworks of Ternium Brazil in Rio de Janeiro. Send an email to contact@primetals.com to get a free pair of Google Cardboard VR glasses.

meta.ls/riovr



Publisher: Primetals Technologies, Limited
Chiswick Park, Building 11, 566 Chiswick High Road,
W4 5YS, London, United Kingdom

Metals Magazine team: Dr. Tom Widter, Editor-in-Chief;
Martin Reitbauer, Editor; Alexander Reindl, Art Director;
James Gray, Independent Contributor and Editor;
Dr. Lawrence Gould, Fmr. Managing Editor;
Dr. Rainer Schulze, Contributing Editor;
Allison Chisolm, Contributing Editor

Publishing house: Red Sam Media GmbH, www.redsam-media.at

Publication date: May 2019

Circulation: 8,000 copies

ISSN: 2194-5381

Cover page: Photography by Robert Josipovic; cover design
by Red Sam Media with Primetals Technologies

Illustrations: Page 18-29: Stefan Thiel;
Page 44: Jakob Hoffmann;
all illustrations via Red Sam Media

Photo/picture credits: Primetals Technologies, unless otherwise
indicated and with the following exceptions:
Page 2: Forafilm (Linz) with Eat My Dear (Vienna);
Pages 3-7; 18-21, 28-29 (basis for illustrations); 88, 107, 108:
Robert Josipovic;
Pages 40, 100: shutterstock.com (Ryzhi, OPOLJA);
Pages 90-92: public domain;
Page 98: istock.com (ferrantraite)

List of registered products: ChatterBlock, Connect & Cast, COREX,
CTC Caster Technology Consulting, DRIPAX, DSR, DYNACS, DynaGap
SoftReduction, EAF FAST DRI, EAF Quantum, ERT-EBROS, FAPLAC,
FINEX, Gimbal Top, HCMILL, HCMW, HCX, HYPER UCM, HYPER UC-
MILL, HYROP, iBox, idRHa+, IMGS, IT4Metals, JETFINE, KL, KLX, KZR,
LIQUIROB, LOMAS, MEROS, MORGOIL, MORSHOR, MQL, NO-TWIST,
PLANICIM, Red Ring, RSM, Sheetflat, SIAS, Si-Filter, SMART, Smart-
Crown, SR SERIES, STELMOR, TCOptimizer/TCOPTIMIZER, UCM,
UCMILL, UCMW, WinLink, X-HI, Xline are registered trademarks of
Primetals Technologies, Limited in certain countries.

- CSP is a registered trademark of SMS Siemag AG.
- EBROS is a registered trademark of Steel Plantech Co.
- EMspec, a registered product of the University of Manchester, U.K.,
is exclusively licensed to Primetals Technologies, Limited.
- HYQST is a trademark of Siemens Industry, Inc.
- MIDREX, DRIPAX are registered trademarks of Midrex Technologies, Inc.
- MULPIC is a registered trademark of Centre de Recherches
Métallurgiques ASBL.
- SCR is a registered trademark of Southwire Company, LLC.
- SVC Plus is a registered trademark of Siemens AG.

All figures and values cited in this issue of Metals Magazine
are in metric units unless otherwise indicated.

© 2019 Primetals Technologies, Limited
All rights reserved by the publisher.

For inquiries and more information:
contact@primetals.com

EXPLORING WHAT'S NEXT



THE PIONEER'S JOURNEY

Innovation is the result of curiosity, determination, and perseverance. At Primetals Technologies, innovation is what drives us. We pioneer the solutions that will change the way metals are produced. Before too long, our journey will lead us to the fully automated steel plant of the future. The digital tools we develop today will be a cornerstone of the production methods of tomorrow. Together with our worldwide customer base, we explore what's next.

For inquiries and more information:
contact@primetals.com