

# metals & mining

The magazine for the metals and mining industries

Issue 2 | 2011

**SIEMENS**  
**V A I** 

## Finding Solutions To Meet the Challenges

Innovation and sustainability  
are the watchwords of steelmaking





# Material handling – making the right decision at the right time

SIMETAL SILOC – energy-optimized stockyard management for just-in-time delivery

Metals Technologies

Material handling is an energy- and time-intensive job. That's why stockyard logistics is an important performance factor at all steel plants. With SIMETAL SILOC, we offer an innovative logistics solution for energy-optimized throughput. The system automatically calculates the optimal transport orders based on ongoing production and delivery schedules of the related

product or transport units. Even energy-saving functions like hot charging of slab are incorporated. In short: SIMETAL SILOC helps you make the right decision at the right time – and increase the overall efficiency of your material handling and logistic tasks to benchmark levels. [contact.metals@siemens.com](mailto:contact.metals@siemens.com)

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Werner Auer

**Dear Readers,**

As the global economy resumes its upward spiral, major investments in modernization and in new production facilities have started once again on a worldwide basis. However, the very same driving forces that had an impact on the steel industry prior to the economic downturn have moved once again to center stage. Issues dealing with, among others, growing demands for scarcer raw materials; globalization and increasing international competition; cost pressure and environmental concerns call for the implementation of new solutions. The challenges are immense but not insurmountable.

Steel is virtually 100% recyclable. The energy required to produce a ton of steel is approaching its theoretical minimum limit. Highly profitable steelmaking with the use of lower-grade raw materials is now reality thanks to the introduction of advanced technologies such as Corex and Finex. The seamless integration of production steps as exemplified by the Arvedi ESP process minimizes production costs. Solutions are available today to achieve a truly green, zero-waste steelworks. Optimum energy usage and maximum recovery of waste heat throughout the entire steelmaking production process can further drive down energy expenditures. Tremendous progress has been made, yet there is still much work to be done.

A steel mill built today must be sustainable on a long-term basis. This is only possible with the continual upgrading of existing plants and systems to ensure that their performance is state of the art with respect to escalating economic, ecologic and market demands. To help steelmakers to achieve these ambitious targets, Siemens VAI offers comprehensive life-cycle services that extend across the entire lifetime of metallurgical plants.

Innovation and sustainability are thus the watchwords of steelmaking. And not to be forgotten, it is especially the creative and innovative personnel of a company who must find the answers to meet the challenges of tomorrow. This issue of metals&mining therefore pays tribute to those persons at Siemens VAI who pioneer new solutions, and various examples of recent innovative developments that support sustainable steelmaking are presented.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'W. Auer', written in a cursive style.

Werner Auer

CEO of Siemens VAI Metals Technologies

## COVER STORY

**12 INNOVATION AND SUSTAINABILITY: Finding Solutions to Meet the Challenges**

It is the creative and innovative personnel of a company that must find and implement the solutions to ensure the long-term viability and sustainability of the steelmaking industry.

**12**

The pooling of creative ideas is the basis for generating new solutions for the steel industry. Recent innovative developments are presented.



## MINING

**22 BULK MATERIAL HANDLING: Three Key Components Add Up to Success**

Production restart at the Reichwalde open-pit mine of Vattenfall Europe Mining AG

## CONTINUOUS CASTING

**28 CASTER APPLICATION: Caster Data at Your Fingertips**

AppliCast – Worldwide access to online plant data with a new smartphone application

**30 AUTOMATION: Expert Money Saver**

Simetal Mold Expert saves customers half a billion euros

## ROLLING

**32 PLATE MILLS: Best-of-Class Plate Cooling**

Multipic plate-cooling technology for retrofits as well as new machines

**36 PLATE MILLS: Another Success Story**

Shougang 4,300 mm plate-mill extension project working well

**40 ARVEDI ESP TECHNOLOGY: Surpassing All Expectations**

Review of Arvedi ESP plant performance after two years of industrial production

**46 LONG-PRODUCT ROLLING: Endless Production of Long Products Too**

WinLink – a winning solution of linked technologies

**50 LONG-PRODUCT ROLLING: Solutions That Grow with Market Needs**

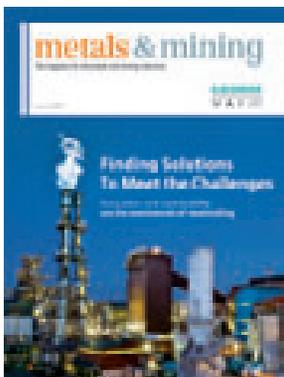
Long-rolling mills for all productivity and product-quality requirements

**54 LONG-PRODUCT ROLLING: The Best of the Best**

New roller-entry guide series for long-product rolling mills

**56 INTERVIEW: "Still a Few Ideas to Push Through"**

Portrait of inventor T. Michael Shore, 73



## COVER

Integrated iron & steel works of voestalpine Stahl, Linz, Austria – one of the most environmentally friendly steel producers in the world

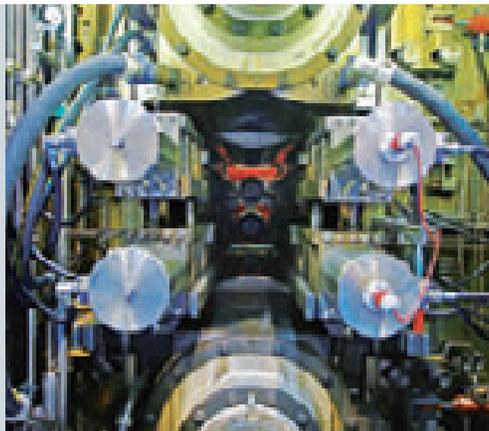
## 40

Following two years of industrial production, the operational results of the Arvedi ESP plant in Cremona, Italy, have exceeded expectations by far.



## 62

The sophisticated Triple-A rolling model allows the design of the mill stands of cold-rolling mills to be optimized for maximum rolling performance.



### 60 **COLD ROLLING: Taking Savings to the Limit**

Potential for saving energy and environmental protection in a PLTCM

### 62 **COLD ROLLING: For a Superb Mill-Stand Design**

Triple-A: an advanced cold-rolling model to optimize the design of the final mill stand

### 66 **COLD ROLLING: The Quest for Excellence**

Latest results in the development of tribological simulation models

#### **ELECTRICS & AUTOMATION**

---

### 70 **HOT-STRIP ROLLING : Smooth Path to Thinner and Better**

Effective modernization and extension strategies for compact hot-strip mills

### 74 **LIFE-CYCLE SERVICE: A Crucial Factor for Investment Decisions**

Electrical services – customer support for the entire plant operating life

#### **SERVICES**

---

### 76 **MAINTENANCE: Customer Embedded Maintenance Organization**

Continuous improvements in life-cycle services

### 78 **LIFE-CYCLE SERVICE: Fast, Professional, Competent**

Electrical and automation services for the entire operating phase of a plant

#### **6 FACTS & FIGURES**

---

#### **82 AWARDS & EVENTS**

---

#### **86 SOCIAL MEDIA**

---

#### **DIALOGUE**

---

### 87 **Contact Imprint**

New orders, plant start-ups and FACs since January 2011

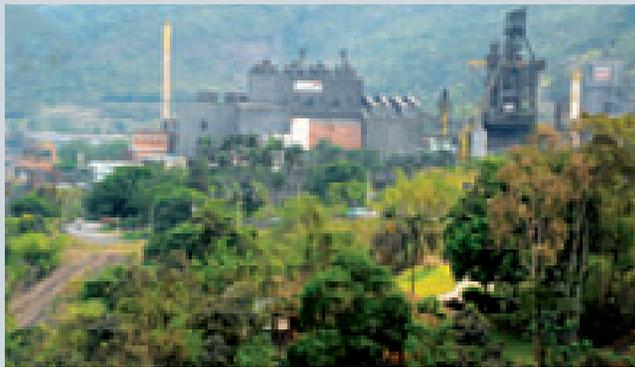
# Selected Examples of Recent

FACTS & FIGURES >

## BRAZIL: Siemens VAI to Expand ArcelorMittal Monlevade LD Steel Mill

ArcelorMittal Monlevade S.A., part of the ArcelorMittal Long Carbon Americas Division, is a long-product manufacturer with a production capacity of about 1.2 million tons of crude steel per year. The company is currently implementing a comprehensive expansion program to double production capacities throughout the entire process chain by 2012. In the course of this program, both of the existing 130-ton oxygen converter plants in the João Monlevade steel mill will be equipped for parallel

operation. Siemens VAI received the order for this project that includes engi-



João Monlevade steel mill of ArcelorMittal Monlevade S.A.

neering and the supply of equipment for the hot-metal desulfurization sta-

tion, ladles, deslagging stands, the ladle and slag-pot transfer cars, and the associated electrical and automation equipment. The material-feeding system will be expanded and its alloying capacity doubled. Two secondary dust-cleaning systems will also be provided with cleaning capacities of 800,000 m<sup>3</sup>/h and 1,000,000 m<sup>3</sup>/h each for the treatment of offgas from hot-metal desulfurization, the steelmaking converters, the hot-metal supply and secondary steel refining.

## CHINA: Start-up of Second Corex C-3000 Plant at Baosteel

On March 28, 2011, the second Siemens VAI-supplied Corex C-3000 plant was started up at Shanghai Baosteel Pudong Iron and Steel Co. Ltd. (Baosteel), located in Luojing, near Shanghai. The total annual production capacity of Corex hot metal at this steelworks is now 3 million tons. For this project Siemens VAI was responsible for the complete process technology, engineering and the supply of key equipment and components, including electrical and automation systems. An aerial gas distribution (AGD) system was applied for the first time in the second module, which considerably improves the gas distribution within the shaft. The result is a more homogeneous reduction of the burden as well as enhanced productivity. Export gas from both Corex plants is



New and existing (right) Corex C-3000 plants at Baosteel, Shanghai

used for the generation of electrical energy as well as for heating applications throughout the Baosteel steelworks.

Corex technology is characterized by the production of liquid hot metal on the basis of non-coking coal as the energy source and iron-ore reductant. Compared to the conventional coke-oven, sinter-plant and blast-furnace production route, ironmaking operations are carried out at lower unit costs and with significantly reduced environmental emissions. Baosteel's decision to install a second Corex plant underlines the company's commitment to cost-effective and environmentally friendly iron production that fully meets the strict emission regulations imposed by the Shanghai municipal government.

# Siemens VAI Project Activities

## CHINA: New Bar Mill Started Up at Handan Iron & Steel

Siemens VAI started up a new bar mill at Handan Iron & Steel Co. (Handan) within only six months following the delivery of



Rolling of first billet on the new bar mill at Handan

equipment to the plant site. This top-of-the-line rolling mill, which replaces an outdated production facility, is capable of producing approximately 800,000 tons of carbon and special-bar-quality (SBQ) steels. The mill expands both the production capacity and product range of Handan.

For this project Siemens VAI was responsible for the supply of the mechanical equipment that comprised a 6-stand roughing train, an 8-stand intermediate line, a 6-stand pre-finishing mill and a 3-stand sizing train. The supply scope also comprised portions of the cooling system, the pinch rolls, a convertible dividing shear, a fixed shear with a cutting force of 1,200 tons, guides, equipment for the oil-air lubrication system and spare parts that included 15 rolling stands.

## CHINA: Start-up of New Bar Mill at Dongbei

A large bar mill was started up by Siemens VAI at the Chinese special-steel producer Dongbei Special Steel Group Co. Ltd. (Dongbei), located in Dalian, Liaoning Province. This state-of-the-art rolling facility is capable of producing more than 600,000 tons of special steel grades, including alloy, high-speed tool, bearing and stainless steels. The finished products are large rounds with diameters up to 360 mm; square billets; and slabs with a cross section up to 150 mm x 650 mm.



Reversible blooming train outfitted with Siemens VAI technology

For this project Siemens VAI was responsible for the supply of the mechanical equipment that included a blooming reversible stand, a 4-stand intermediate train and a 4-stand finishing train. The supply scope also included two abrasive disk saws for hot and cold cutting, retrofitting of existing equipment, and engineering services for the billet shear, quick-change stand devices, cooling beds, slow-cooling boxes, bundling and handling areas, equipment for the oil-air lubrication system, and spare parts.

## CHINA: Rod Outlets for Two Rod Mills at Lianfeng Steel

Siemens VAI received a contract from Lianfeng Steel (Zhangjiagang) Co., Ltd. (Lianfeng Steel) for the supply of rod outlets for two single-strand rod mills that will be installed in Yonglian Industrial Park in Zhangjiagang City, Jiangsu Province. Depending on the product mix, each strand will be capable of producing approximately 700,000 tons of rolled steel products per year. Plain rod will be rolled in sizes from 5 mm to 25 mm and rebar at 6 mm to 16 mm. The steel grades will include quality carbon, low-alloy, cold-heading (CHQ), spring and bearing steels in addition to welding wire. Hot commissioning, scheduled in four phases, will commence in late 2011.

The Siemens VAI project scope for each strand comprises engineering and the supply of equipment that includes a horizontal/vertical pre-finishing mill; a Vee pre-finishing mill; an 8-stand Morgan No-Twist mill; a 4-stand Morgan Rod Reducing/Sizing Mill; and pinch rolls and laying heads for each strand. Mechanical, fluid, electrical and process-control systems will also be provided.



Rod outlet equipped by Siemens VAI

### CHINA: High-speed Rod Outlet at Zhasan Youfa To Expand Product Range



Siemens VAI wire-rod mill at Tianjin

The Chinese steel manufacturer Tianjin Metallurgy Group Zhasan Youfa Iron & Steel Co. Ltd. (Zhasan Youfa) placed an order with Siemens VAI for the supply

of an advanced high-speed rod outlet for a new rod mill that will enable high-end products to be produced by means of thermomechanical rolling. Depend-

ing on the product mix, approximately 700,000 tons of rods will be produced per year. The guaranteed rod outlet speed is 112 m/s. Mill commissioning is scheduled for late 2011.

The project scope for Siemens VAI includes the engineering of all rod-outlet equipment and the supply of special equipment sections. The latter includes a 2-stand 230 Vee pre-finishing mill; an 8-stand Morgan No-Twist Mill; a 4-stand Morgan Reducing/Sizing Mill; and a pinch roll and laying head. Thermomechanical rolling will be applied for online temperature control at different stages of the rolling process. This will simplify or eliminate the need for post-thermal treatment of many rolled products in order to achieve a defined microcrystalline structure.

### CHINA: Turnkey AOD Converter for Yunnan Tiangao

The Chinese stainless steel producer Yunnan Tiangao Nickel Industry Co., Ltd. (Yunnan Tiangao) awarded Siemens VAI a contract for the turnkey supply of a 120-ton AOD converter, which will be erected in the southern Chinese city of Qujing, Yunnan Province. The project scope comprises engineering and the supply of the entire mechanical and electrical systems. The mechanical equipment includes the converter vessel, the suspension system, the trunnion ring, the tilting unit and tuyeres, top lances, valve stations and a transfer car. The electrical equipment is comprised of the basic automation system, user software for the basic- and process-automation systems, and instrumentation. The drive system for the converter tilting unit, the drive for the oxygen lance and a motor control center (MCC) will also be supplied.

The project is scheduled to be completed at the beginning of 2012.



Siemens VAI-supplied AOD converter to China

## CHINA: Commissioning of 5 m Plate Mill at Xiangtan

The roughing stand and a finishing stand of a new 5 m plate mill were started up by Siemens VAI at Xiangtan Iron & Steel Co., Ltd. (Xiangtan). This plant, located in Xiangtan in Hunan Province, is designed for an annual production of 2 million tons of plates at a maximum finished width of 4.8 m. The rolled products include traditional plate grades, high-strength plate grades such as X80, and ultra-thick plate (350 mm) rolled from heavy ingots.

Siemens VAI supplied engineering; all key process technology; and mechanical equipment for the roughing mill stand, finishing stand, hot- and cold-plate levelers, and the shear line. Instrumentation, automation sys-

tems and process models were also provided. A Mulpic intensive-cooling section allows high-strength and other special steel grades to be produced. The installed microstructure monitor enables the mechanical properties of the steel to be predicted in advance of final testing.



Plate-mill roughing stand supplied to Xiangtan

## GERMANY: ArcelorMittal Bremen Orders Twin-Ladle Furnace

The German flat-steel producer ArcelorMittal Bremen GmbH placed an order with Siemens VAI for the engineering and sup-

ply of a 300-ton twin-ladle furnace. The plant will replace the two conditioning stands currently used for treating liquid steel and will substantially lower steel-treatment costs. The twin-ladle furnace will be installed directly downstream of the LD converter in such a way as to ensure the best possible logistic links to other parts of the plant and minimize crane movements. It will be possible to carry out fine alloying work and blowing operations in the ladle furnace. Optimum electrode control will be ensured by the Simelt AC electrode control system.

It is foreseen that all of the crude steel produced at ArcelorMittal Bremen – some 3.5 million tons per annum – will eventually be treated in the ladle furnace. This will allow the tapping tem-

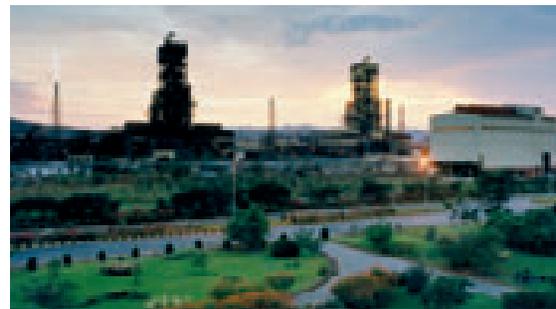
perature of the steel in the LD converter to be reduced by between 40°C and 60°C, decreasing the consumption of refractory materials.

Start-up of the new twin-ladle furnace is scheduled for February 2012.



3D schematic drawing of twin-ladle furnace to be supplied to ArcelorMittal Bremen

ply of a 300-ton twin-ladle furnace. The plant will replace the two conditioning stands currently used for treating liquid steel and will substantially lower steel-treatment costs. The twin-ladle furnace will be installed directly downstream of



Corex C-2000 plants at JSW Steel Ltd.

## INDIA: JSW Projects Ltd. Orders Corex Gas-based Midrex Direct-Reduction plant

Since 1999, two Corex C-2000 modules (nominal production capacity of 2,400 tons of hot metal per day) have been in operation at JSW Steel Ltd., India's largest privately owned steel company located in Vijayanagar, Toranagallu, Karnataka State. The Corex export gas has been used up until now for the generation of electrical energy in a company-owned power station. With consideration to the continually increasing demand for steel in India, JSW Steel decided to use this valuable gas for the production of additional iron in a direct-reduction (DR) plant. The project was awarded to a cooperation under the leadership of Siemens VAI that also comprises the companies Linde AG, Engineering Division, Germany; Midrex Technologies, Inc., U.S.A.; Linde Engineering Pvt. Ltd., India; and Siemens VAI Metals Technologies Pvt. Ltd., India. The new Corex gas-based Midrex direct-reduction dual-discharge plant with a shaft-furnace diameter of 7.15 m will have a nominal annual production capacity of approximately 1.2 million tons of hot and cold direct-reduced iron. Plant start-up is scheduled for mid-2013.

Another key feature of the new plant will be the installation of a Hot Transport System (HTS) that will transport the hot direct-reduced iron (HDRI) to an adjacent EAF steel mill currently under planning. A similar HTS was first installed at the Hadeed Steel Works at Al Jubail in Saudi Arabia in 2007, and offers the benefits of electrical energy savings during EAF melting and shorter tap-to-tap times for increased productivity.

**KOREA: FAC Received for Plate-Mill Expansion Project at Dongkuk**

Following the successful completion of the performance guarantee figures, Siemens VAI received the Final Acceptance Certificate (FAC) from Dongkuk Steel Mill Co. Ltd. (Dongkuk) for the new 5 m Plate Mill No. 3 installed at the company's Dangjin Works on the western coast of South Korea. The mill is capable of rolling a total of 1.5 million tons of plates per annum with thicknesses ranging from 5 mm to 150 mm and at widths between 900 mm and 4,900 mm. The high-quality products are used in the shipbuilding and construction industries and for the manufacture of pipes.

For this project, Siemens VAI was responsible for the complete mechanical

engineering and the supply of all automation systems, sensors and equipment. The 4-high mill stand is capable of exert-



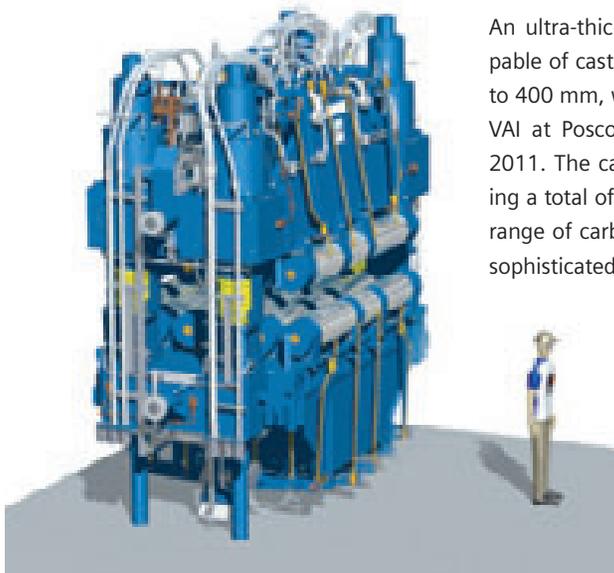
**Plate mill at Dongkuk Steel Mill Co. Ltd., Dangjin**

ing a rolling force of 11,000 tons. A shearing line, a hot leveler and three cooling beds were also supplied. A num-

ber of advanced technological packages and process-optimization models were installed in the plate mill for enhanced production efficiency, high operational flexibility and excellent product quality. Examples of the technological packages include work-roll shifting functions based on SmartCrown technology for optimized plate profile and flatness; thermomechanical rolling; and Mulpic accelerated plate-cooling technology for the production of special steel grades. A material-tracking system serves as the basis for the smooth

flow of material through the plant and the correct correlation of plates and processing data at all times.

**KOREA: Start-up of the Ultra-Thick Slab Caster at Posco**



**3D drawing of Smart Segment installed in Posco's jumbo caster**

An ultra-thick 2-strand slab caster, capable of casting slabs in thicknesses up to 400 mm, was started up by Siemens VAI at Posco Pohang Works in March 2011. The caster is capable of producing a total of 1.3 million tons of a wide range of carbon steel grades for use in sophisticated downstream applications

such as in the petroleum and shipbuilding industries. Slabs are cast at a thickness of either 250 mm or 400 mm, and at widths from 1,100 mm to 2,200 mm.

This high-performance production facility is equipped with a wide range of advanced technological packages to ensure stable casting conditions, flexibility in adjusting the strand width during casting, maximum plant availability, and superior surface and internal quality of the cast slabs. Thanks to the Connect & Cast capability of the installed technological packages, installation, assembly and production ramp-up to nominal capacity was carried out quickly and efficiently.



Siemens-supplied SAG mill

### UNITED STATES: Upgrading of Three Copper Ore Mills at Rio Tinto

The mining company Rio Tinto Group Siemens Industry, Inc. placed an order with Siemens to equip three of its SAG (semi-autogenous grinding) mills with new control and automation technology at the Kennecott Copper Mine (also known as Bingham Canyon Mine) in Utah. This mine is one of the world's largest copper mines and is the earth's largest man-made excavation.

Siemens is responsible for the hardware and software engineering, including installation and commissioning on site. The mills will be outfitted with a new control system based on Simatic S7 for the general control of the mill, and a Sinamics DCM (DC Master) converter for the drive-specific control of the rectifier. Simatic PCS7 is the central system for all visualization and diagnostic tasks of the three mills. The Siemens project scope includes the installation of an additional, diagnostic system for enhanced analysis capability, as well as operating-data acquisition and remote services. These features will enable unscheduled shutdowns to be largely avoided and maintenance costs to be reduced.

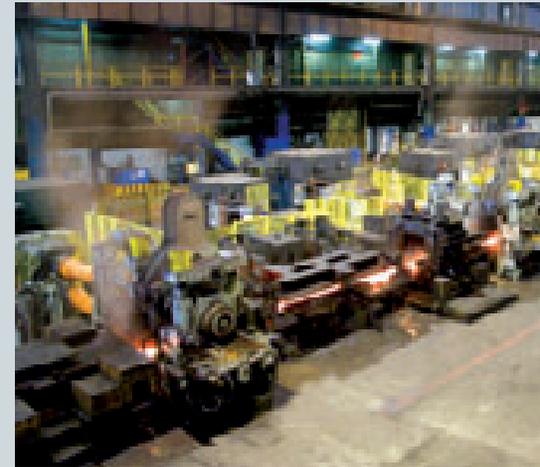
The mill upgrade is scheduled for completion in early 2012.

### TURKEY: New Medium-Section Rolling Mill for IDÇ

In order to expand its rolling capacity and increase its product mix to include sections with dimensions of up to 300 mm, the Turkish steel producer Izmir Demir Çelik Sanayi A.Ş. (IDÇ) placed an order with Siemens VAI for the supply of a new medium-section rolling mill that will be erected in the company's Foça plant, 70 km northeast of Izmir in Turkey. The mill will be capable of rolling 400,000 tons of section steel per year. Plant commissioning is scheduled for late 2012.

The project scope for Siemens VAI includes the supply of a reversing roughing stand, a 4-stand intermediate mill and a 6-stand finishing line. The intermediate and finishing lines will be equipped with Red Ring stands in horizontal-universal arrangement. All shear and sawing systems, a straightener and two strapping machines

will be provided. Furthermore, Siemens VAI will install the variable-speed main and auxiliary drives, motors and the complete basic automation system.



Siemens VAI medium-section rolling mill

### ROMANIA: MES and Planning Solution for ArcelorMittal Galați

ArcelorMittal Galați is one of the most important steel producers in Romania. Its integrated steelworks includes sinter plants, blast furnaces, an LD steel mill, continuous slab casters, a plate mill, hot- and cold-rolling mills and a galvanizing line. The company produces heavy plates, hot-rolled, cold-rolled and galvanized strip products that are used in shipbuilding, pipeline construction, and for the automo-

otive and construction industries. In order to improve delivery reliability, material-flow control and also to increase plant productivity and availability, Galați placed an order with Siemens VAI for the supply of a Manufacturing Execution System (MES) and a production planning and scheduling system.

The solution to be implemented will enable the entire plant production to be planned and monitored in real time. It will also provide the company with a basis for making continuous improvements along the entire production chain. The project will be implemented jointly with Quintiq, a planning and scheduling software company. This challenging project is scheduled to be completed by the end of 2013.



Galvanizing line at ArcelorMittal Galați

Fresh ideas and new solutions are called for to ensure the long-term economical and ecological sustainability of steelmaking



COVER STORY >

Recent worldwide trends pose immense challenges for which urgent answers are required. The pivotal role that creative and inventive people will play in finding solutions for continued progress without adverse effects cannot be overemphasized. This is especially true in the iron and steel industry. In the following, the recognition and support that Siemens VAI accords its innovative personnel is underlined, and recent examples of technological developments that support viable, environmentally friendly and sustainable growth are presented.

Innovation and sustainability are the watchwords of steelmaking

# Finding Solutions To Meet the Challenges



**A**n interesting experiment took place in the subway system of Washington, D.C. on January 12, 2007. *The Washington Post* commissioned Joshua Bell, one of the most gifted violinists of his generation, to play in the L'Enfant station during the early morning rush hour. The purpose of this experiment was to see whether people would recognize or acknowledge extraordinary capability in an unusual place and at an awkward time.

Donning a baseball cap and positioning himself next to a trash can, Bell removed his Stradivari violin from its case and lifted it to his chin. This exquisite instrument, made in the year 1713, has an estimated value of some \$3.5 million. He began his solo concert by playing the monumental Chaconne from the

Partita No. 2 written by Johann Sebastian Bach around 1720. Of the Chaconne it has been said that never in the history of music had such a composition been written like this, and never thereafter. His stunning performance was followed by an interpretation of five other well-known classical music pieces.

Joshua Bell played the violin for a total of 43 minutes. During this time, more than 1,000 commuters passed by, most without even turning their heads or stopping to listen. In fact, only seven people lingered for more than a minute to eavesdrop on an amazing acoustic display of musical glory. Only days before, Bell played to a sold-out audience in a Boston concert hall where the average ticket sold at \$100.

>>

>> **Honoring the heroes of progress**

In all companies and organizations throughout the world where challenges must be met and urgent answers to pending problems have to be found, innovative and creative people are at work. Despite trendsetting advances – even the introduction of quantum-leap solutions – most of those people who deserve the credit remain anonymous and go unrecognized.

At Siemens VAI, however, the eminent importance of its innovative and creative personnel is held in the highest esteem. Knowledge and know-how are the treasures of a company – an asset that must be preserved, maintained and promoted at all costs. Without the pioneers of innovation, a company will eventually lose its competitive edge. A working environment must be established that is conducive for the generation of new ideas and, of course, their implementation. As the sum is more than its parts, creative people must be provided with the means to

R&D activities was outlined, and the concept of the Key Expert career path was presented.

“Siemens VAI has introduced the Key Expert career path to support and foster those persons within our company who drive ideas into new products,” said Werner Graf, Head of Human Resources for the Business Unit Metals Technologies at Siemens. “This is the basis for our future business activities and success. This company-wide program focuses on providing such people with the opportunity to concentrate on innovative activities, and to not be distracted by time-consuming administrative tasks and duties. The Key Expert career is a distinctive trademark within the entire Siemens organization. It supports creative company personnel in technological, engineering and other departments, and it is designed to attract gifted and motivated people from universities and industry to pursue a rewarding career in a future-oriented company.”

COVER STORY >



Siemens VAI Innovation Days 2011 conference in Linz, Austria: Dr. Klaus Weinzierl (center) was Siemens Inventor of the Year in 2002



Werner Graf, vice president for human resources, presents the Key Expert career path

share and exchange their ideas not only in a direct and personal manner but also in the form of company-supported information platforms.

In line with this concept, Siemens VAI held its latest “Innovation Days 2011” conference in Linz, Austria, on May 26–27, 2011. First-rate innovators from all company locations across the world were invited to participate in this event, to be informed of the latest technological developments, and to brainstorm new ideas in dedicated workshop sessions. The company policy with respect to innovation and

**Expert networking**

A solo performance by a gifted musician in the L’Enfant subway station of the U.S capital only drew the attention of a few commuters on their way to work. Had Joshua Bell been accompanied by the Washington Philharmonic Orchestra, the passersby most certainly would have been overwhelmed.

Similarly, an individual inventor may have exceptional capabilities, however, if he is part of an innovative team where ideas are shared and mutually inspired, the creative output would be of a completely



**Dr. Alexander Fleischanderl, vice president and head of technology for minimills, steelmaking and the environment, spoke about the green steel mill of the future**



**Prof. Dr. Oliver Gassmann, University of St. Gallen, Switzerland, lectures on innovation to a Siemens VAI audience**

different magnitude. Expert networking is a core element of creativity. Web-based innovation platforms have therefore been established at Siemens to allow engineers and R&D people to pool their knowledge, share ideas and discuss solutions. The goal is to provide a fertile ground for driving solutions forward and to implement long-term and sustainable innovations. This approach is particularly important for a company with numerous centers of competence dispersed throughout the world. Expert networking allows people to communicate in an efficient and un-

complicated manner. In this way, the cornerstone has been laid to ensure a systematic increase in innovation rates. Again, it is primarily the innovative people within a company that must find the solutions and answers to meet the challenges that lie ahead. But for which challenges must answers be found?

### **Progress at the crossroads**

Right now our world is at a particularly crucial threshold: The global population is fast approaching 7 billion people. The specters of famine and disease loom even larger when considering recent regional crop failures, acute food shortages and distribution bottlenecks. According to a study dated June 1, 2011, by the U.K. charity organization Oxfam, the price of staple foods such as maize, wheat and rice will more than double in the next 20 years. This development will place an even greater burden on today's over 900 million un-nourished people, who now spend up to 80% of their income on food. Up to half of this increase in food prices is attributed to climate change. Worldwide CO<sub>2</sub> emissions and their highly probable impact on global warming continue unabated. According to a report from the International Energy Agency dated May 30, 2011, energy-related CO<sub>2</sub> emissions from the burning of fossil fuels in 2010 were the highest in history, topping 30.6 Gigatons (Gt) – a 5% jump from the previous record year in 2008. The burning of coal and other fuels in the steel industry is responsible for a significant portion of global CO<sub>2</sub> emissions. For each ton of steel produced, an average of 1.9 t of CO<sub>2</sub> is emitted to the environment. With world steel production in the range of 1.3 billion tons, CO<sub>2</sub> emissions from the steel industry approach 2.5 Gt. The increased use of other energy sources instead of fossil fuels is also highly problematical. The recent disaster in the Japanese Fukushima nuclear power plant further emphasizes the need to adopt safe and long-term sustainable energy solutions on a broad scale.

Demographic migration in the world's most populated countries will have a major impact on housing demands, construction, infrastructure, logistics and transportation. In China, less than 50% of its people currently lives in urban areas. This number is expected to increase to about 58%, or some 875 million people, by 2030. Only 30% of the Indian population now lives in cities, a figure which is expected to increase in the next 20 years to 40%, or roughly 590 million people (Source: ArcelorMittal presentation at CRU's 13<sup>th</sup> Stainless Steel Conference in Nov. 2010, France).

Throughout South America, various governments have introduced major social programs that have contributed to an increase in the living standard of a >>



Meeting of Siemens VAI experts to discuss new ideas and initiatives

>> rapidly growing population. For example, the measures initiated by Brazil's former President Luiz Inácio Lula, and which are being continued today under the presidency of Dilma Rousseff, have helped more than 20 million citizens to escape acute poverty and to enter the consumer market. Economic globalization will propel this trend worldwide, with the result that the living standard of hundreds of millions of people is expected to dramatically improve in the years to come.

**It is the innovative people within a company that must find the solutions and answers to meet the challenges ahead.**

Increasing urbanization and a growing middle class worldwide will have an enormous effect on industrial growth and on the demands placed on raw

materials, energy and the environment. Available supplies of the required input materials to make steel, in particular coking coal; alloying elements; and high-grade, easily accessible iron ores, will become increasingly scarce. The recent recovery of the world economy has only heightened the demand for steel, as can be seen by the relentless upward surge in prices. The challenges are immense and answers are needed now.

Steel is indispensable for progress and prosperity. It is the most versatile of all materials and the most universally applied commodity in the industry. Steel is fundamental for growth, and its consumption serves as a benchmark for the affluence of a nation. An investment in a new integrated steelworks, however, is prohibitively expensive. Depending on location, labor costs, installed technical features and the environmental standards applied, the costs for a flat-steel production facility that includes raw material blending yards up to the strip-processing facilities lies in the range of \$1,400 to \$1,700 per ton of installed annual steelmaking capacity.

**Gerlinde Djumlija, head of business excellence for casting and rolling at Siemens VAI, asks a probing question**



**Specialists discussing the latest innovations at Siemens VAI**

For a medium-sized integrated steelworks with a nominal production output of 5 million t/a, investment costs would be in the range of \$7 billion to \$8.5 billion. A plant lifetime extending over decades is a prerequisite for an investment of this magnitude. To ensure the long-term economic feasibility of a steelworks, permanent modernization measures are necessary to satisfy increasing demands for productivity, flexibility, energy efficiency, safety and environmental compatibility. According to Werner Auer, CEO of Siemens VAI, “By optimizing individual components and processes in steel production and integrating them into the production process, we can ensure flexible and competitive operation of plants for service lives of 50 years and more.” Siemens VAI offers a continually expanding portfolio of modernization and service solutions that are available over the entire life cycle of metallurgical plants. These solutions are comprised of numerous technical innovations and modular system packages that ensure a steel mill will remain state of the art.

The production of steel places an enormous burden on the environment. Major strides have been made to reduce particulate, fluid and gaseous emissions to unprecedented low levels. Although the technical means are available today to nearly attain the goal of zero-waste steelmaking and a truly green steelworks, this still remains a vision for tomorrow. Investments in comprehensive environmental measures to achieve this goal are still hampered by cost, competition and the absence of a global commitment and an effective regulatory mechanism. New solutions are called for not just to achieve mere downcycling but true recycling.

### **Innovation is the key**

With consideration to these and numerous other challenges confronting the steel industry, innovative engineers and R&D personnel are pondering the solutions necessary to achieve long-term sustainable steelmaking. In the following, several recent innovations at Siemens VAI are reviewed, which serve as examples of the intensive R&D activities within our company.

#### **Technological and mechatronics packages:**

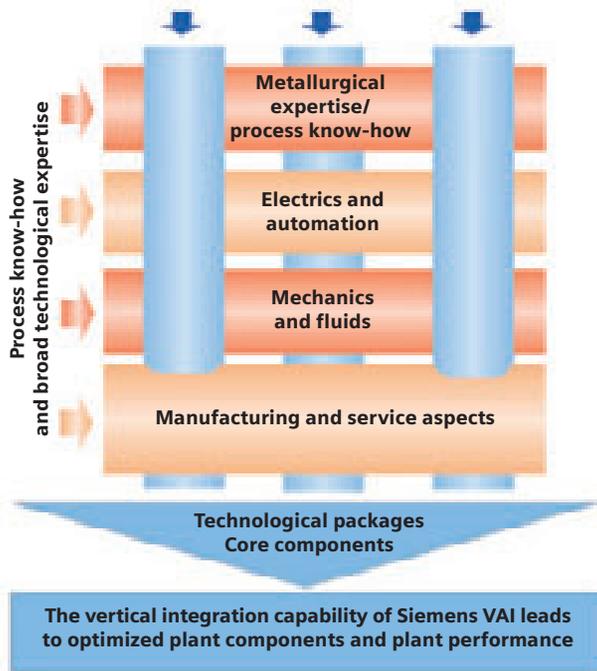
The unique strength of Siemens VAI is its expertise and capability to supply virtually its entire product portfolio with vertically integrated solution packages comprising mechanics, E&A, fluids, manufacturing and service. The installation of technological and mechatronic packages that are designed on the basis of metallurgical and process know-how is a decisive factor for maximizing plant performance. For example, Siemens VAI slab casters feature the application of technological packages throughout the entire casting machine – from the mold to the slab run-out area. These tools and the use of advanced process models is the key reason for high plant reliability, operational flexibility and excellent product quality.

#### **Circular pellet plants:**

Siemens VAI has developed a novel circular-type pellet plant in which high-quality, homogeneous pellets can be economically produced at low output rates down to approximately 0.8 million t/a. This technology is based on the proven straight-traveling-grate system, but with an innovative circular design. This solution for producing pellets is ideal for smaller-sized iron-ore mines. Recycled fines, sludges, and dust from other plant facilities within a steelworks can also be processed in the system.

#### **Energy recovery from dry-slag granulation:**

A technique for the dry granulation of blast-furnace slag is under development at Siemens VAI. Compared with conventional granulation methods, dry granu- >>



Siemens VAI uniquely offers horizontal plant-integration capability – from mining to the finished product – and comprehensive vertical-integration expertise

>> lation – in conjunction with a heat-recovery plant – leads to a notable reduction in water consumption and offers the possibility to utilize a considerable portion of the sensible heat contained in the slag for the generation of electrical energy and for heating applications. Energy savings and a reduction in CO<sub>2</sub> gas emissions to the environment are decisive benefits of this process. The sensible heat of blast-furnace slag is the largest unused source of energy in a steel plant.

**Waste-heat recovery from the EAF:**

In a special waste-heat recovery process, the heat of the offgas from an electric arc furnace (EAF) is intermediately stored by means of saturated steam or high-temperature molten salts. The energy can be used in the form of steam in a vacuum-degassing plant, or for the continuous generation of electrical power in a so-called Heat 2 Power system. This solution contributes to a reduction in the energy usage within a steel mill, and can reduce the EAF carbon footprint by 40–50 kg/t of tapped steel.

**Quantum EAF:**

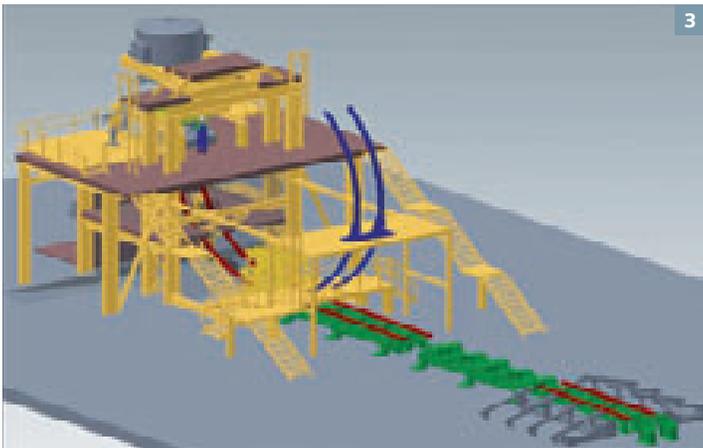
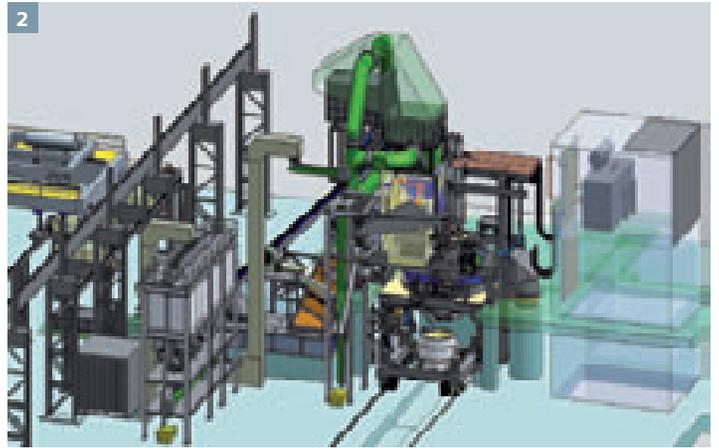
A new EAF from Siemens VAI, referred to as Simetal EAF Quantum, combines the proven shaft-type scrap-preheating technology from Siemens VAI with a number of new developments. These include a new

automatic scrap-charging process by means of an inclined elevator, a highly efficient preheating system, a novel tilting concept for the lower vessel shell, and an optimized tapping system. Unlike conventional EAFs, it is not necessary to raise the roof and retract the electrodes in order to charge the furnace. After the scrap has been preheated, the fingers of the retaining system are opened, and the scrap descends into the liquid steel bath. A reference furnace with a tapping weight of 100 tons achieves tap-to-tap times down to 33 minutes and a steel output of 1.35 million t/a. The electrical energy demand of only 280 kW/t of tapped steel is considerably lower than all other EAF plant systems on the market today. With the addition of an offgas heat-recovery system, the specific power consumption can even be reduced to 230 kWh/t – a world record! Coupled with a lower consumption of electrodes and oxygen, the total specific conversion-cost advantage is around 20%.

**New billet-caster design:**

A new Siemens VAI billet-caster concept with a designed throughput rate of up to 400,000 t/a enables quality products to be cast using a highly economical billet caster. On the basis of a reengineered plant design and complimented by an extended logistics and sourcing network, billet-casting projects can be completed within nine months of the start of a project. The highly compact plant design with a bow radius of 6 m foresees the installation of one to four billet strands, each with an annual casting capacity of approximately 100,000 tons of carbon-steel grades. Operation of the individual strands can be carried out independently of each other, thus assuring optimum caster utilization in accordance with the availability of liquid steel. Strand formats range from 100x100 mm to 200x200 mm. The cast products will be typically rolled to bars and wires for infrastruc- >>

- 1 **Recuperation of the sensible heat of blast furnace slag in an integrated dry-slag heat-recovery system can be used to generate electricity**
- 2 **Computer-animated view of Simetal EAF Quantum**
- 3 **New economy billet-caster design**
- 4 **Installation of the latest technological packages and process models from Siemens VAI is the basis for highest operational performance of the slab caster**
- 5 **Example of a Siemens VAI cooling unit in a hot-strip rolling mill**
- 6 **Siemens VAI-supplied reversing cold mill**
- 7 **The Simetal Energy Management System increases the transparency of energy usage within a steelworks**
- 8 **Optimized production operations is assured by state-of-the-art automation systems**





>> tural applications. The availability of different caster machine variants in combination with modular plant expandability allows producers to tailor their plants to current and future market requirements.

#### **WinLink – endless casting and long rolling**

On the basis of the experience acquired in the implementation of the Arvedi ESP process for the endless production of hot-rolled coils, Siemens VAI has developed a small-sized market mill for the endless production of long products. Steel cast in the billet caster is intermediately heated in an induction furnace, followed by rolling to rods or sections in the rolling mill. The endless production mode of this process leads to energy savings and a notable increase in yield. A WinLink-based minimill requires only 50% of the space of a conventional long-rolling mill. This solution is ideally suited for growing markets (see separate article on pages 50–54 of this issue of *metals&mining*).

#### **Power Cooling for hot-strip mills:**

Installation of the new Power Cooling solution in the cooling section of a hot-strip mill enables new steel grades and highest-strength steels to be produced in a wide range of thicknesses. The intensity of cooling in the cooling section is carefully regulated so that the desired microstructure of the rolled material is achieved with a high degree of precision. Power Cooling technology allows cooling rates as high as 400 K/s – three times higher than the rates achieved with conventional laminar-flow cooling processes. The production of higher-strength steels means that the weight of the steel in the final downstream application can be reduced. This allows steel to better compete with alternative lightweight materials such as aluminum, plastics and composites in many industrial applications.

#### **Economy single-stand reversing cold mill:**

The recently reengineered Siroll CM reversing cold mill offers steel producers a compact solution for the production of cold-rolled strip in small to medium capacities. This mill, with a 6-high mill stand, can process a



wide variety of steel grades that include low-carbon, deep-drawing, high-tensile-strength and low-alloy steels. The mill is designed so that it can be quickly installed and started up. Two mill types are available that allow strip to be rolled at maximum widths of either 1,250 mm or 1,450 mm. Coil weights can vary between 20 t and 30 t. Flexible rolling programs permit a rapid response to changing market demands, even for small batch sizes.

**Energy Management System:**

Energy costs in the iron and steel industry account for 20–30% of total production costs. Energy-efficient production is thus a decisive factor for a producer to remain competitive. A prerequisite for optimized energy utilization is the transparent and accurate monitoring of all energy consumers, efficiency rates, and energy losses throughout the entire production process. The Siemens Energy Management System records and analyses key values, and helps plant operators to monitor and optimize energy flows. This system not only detects

avoidable losses, it is also capable of minimizing peak loads and presenting forecasts.

**Concluding remarks**

Innovation is the key to finding solutions to ensure sustainable steelmaking on a long-term basis. And it is the creative people of a company who drive ideas and their implementation, establishing the foundation for a company's competitiveness and business success. Extraordinary performance in all walks of life, whether it be a solo violin concert in a cold subway station, or in the generation and implementation of new ideas, must be recognized and honored. In this rush hour of life, one should not forget that it is ultimately the creative and inventive personnel of a company who have to find the answers to meet the challenges of the future. ■

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Production restart at the Reichwalde opencast mine of Vattenfall Europe Mining AG

# Three Key Components Add Up to Success

In the framework of efforts to increase capacity at Vattenfall's Boxberg power plant, the Reichwalde opencast mine is being recommissioned. Siemens is involved with three key parts of the system that will move and store the excavated raw brown coal.

MINING >





An overburden conveyor bridge and coal excavators are used to extract lignite at the Nochten opencast mine

Annually the Boxberg power plant supplies up to 15.6 billion kWh of electricity. This year production will increase when an additional power-plant block with a gross capacity of 675 MW goes online. For this reason, coal extraction has begun again at the Reichwalde opencast mine, which holds approximately 366 million tons of raw brown coal. With an annual extraction capacity of up to 10 million tons, the opencast mine will supply the Boxberg power plant and other purchasers in the Lausitz area with coal up to the year 2050.

As part of the Reichwalde opencast mine's re-commissioning, Siemens created three key parts of the system for moving and storing raw brown coal. Thanks to the latest technology and innovative solutions, high availability of the materials-handling systems can be ensured while keeping operating costs down. Furthermore, low energy consumption and reduced emissions make the process more environmentally friendly.

The materials-handling systems created by Siemens are presented in more detail below:

#### Component 1: A new coal conveyor system for the Reichwalde opencast mine

Siemens installed a 13.5-kilometer-long conveyor system to move coal at a capacity of 6,000 t/h. The conveyor system has an overall total drive power of 19,350 kW distributed among six individual belt conveyors, each with their own drive stations. Three of the drive stations have an output of three times 1,250 kW each, and a further three with an output of three times 900 kW each. Four of the conveyor belts are stationary, while two bench belt conveyors are movable, allowing the route of the conveyor system to be constantly adjusted as mining progresses. The drive stations connected to the movable bench belt conveyors are fitted with crawler trucks.

To meet the specifications of Vattenfall Mining – namely that all drive stations and deflecting stations share the same underlying technical design – Siemens counted on its Simine CON drive and automation solution platform. Converter-fed Sinamics S120 three-phase drives in the sizes “booksize” (motor modules) and “chassis” were used for the regulated conveyor system. All of these drive components – from the supply infeed to the motor-side inverters – are configured in a clear, compact layout in the individual cabinet modules. One particular benefit is that the modules were specially developed to be easily built into multi-motor systems using the zone concept of the converter technology, which means they offer the utmost operational security. All of the converter systems are air cooled. >>

- >> Furthermore, Vattenfall Mining's particular requirements regarding the field bus structure were also taken into account.

#### Conveyor system characteristics

The speed-controlled drives allow for particularly reliable and energy-efficient operation and offer the option of using different operating modes. The system's start-up and braking times can be adjusted to suit the current technological requirements. This means that load peaks can be avoided and the system can be operated in a way that minimizes wear and tear. No special equipment is required to start up the conveyor system. Load distribution adjustments both between the motors on a drive drum and between the various drive drums of a drive station ensure the load is distributed evenly. If a drive fails or is turned off, the system can be operated in a special mode with a reduced transport capacity.

Because the coverings on the drive drums gradually wear down as the conveyor system operates, a corresponding control was installed to automatically adjust the drum speeds to the new drum diameters and peripheral speeds. Load and acceleration torques are also systematically adjusted so that the conveyor belt cannot slip or jerk forward accidentally. Here, the maximum amount that the drive's starting torque can overshoot is +/- 15%. Together, these features reduce wear and tear of the conveyor system's mechanical components and prevent damage to the gears, drums and belts.

What's more, the belt speed is adjusted to the current load, which saves even more energy. The control system also allows all belts to be started up simultaneously without overloading the supply grid. As a result, the start-up time of the system as a whole is significantly reduced. When electrical braking is applied, the energy is fed back into the grid.

#### Project execution

Working with various specialist companies, Siemens took on the entire engineering, manufacture, delivery and installation of the drive stations and deflecting stations as well as the assembly of and final adjustments to the conveyor system. During trial operation that started in December 2010, the functionality of the conveyor system was tested intensively and carefully. The system's interaction with the three mine excavators at the Reichwalde opencast mine were also an important part of the trials. Over the three-month period engineers were able to successfully demonstrate the availability of the conveyor system as contractually agreed with the customer. During the trial phase the Siemens service point at

the nearby Vattenfall opencast mine in Nochten assumed servicing and maintenance duties for the conveyor system.

#### Component 2: Extension of the existing coal storage area in Boxberg and conversion to fully automated operation

The coal storage area is the technological centerpiece for supplying the Boxberg power plant and the area with brown coal. The storage area has four stockpiles that ensure a reliable supply of coal to the power plants as well as allow the coal to be properly mixed. As part of the project, Siemens completed electrical engineering and some mechanical engineering work to prepare the storage area for the new technological requirements.

Essentially it was possible to integrate the new Boxberg power-plant block and the previously described Reichwalde coal conveyor system and coal-loading facility into the overall technological concept of the storage area. Innovation was necessary to create a continuous flow of coal from the



At the heart of the entirely new central control station is Simine CC, a modular and interface-optimized platform for the mining industry

excavator to the power plant's silo – a solution that also allows operators to save considerable amounts of energy.

#### The right mix

A quantity and quality management system ensures that the correct range of coal quality from Nochten and Reichwalde is used. This system is essential in order for the power-plant boilers to operate properly, as they are optimized for certain coal qualities. For example, during continuous operation the coal supplied to the Boxberg power plant has to be mixed

at a ratio of 70% Nochten coal to 30% Reichwalde coal. Furthermore, an attached coal-loading facility ensures that other Vattenfall power plants can be supplied with coal if necessary via the coal train network.

### Automatic operation

The new stacker/reclaimer and two reclaimers operate fully automatically. In addition, the existing combined machine has been upgraded for automatic functionality. The mode of operation is optimized for different variations and also takes collision protection into account. All the machines are equipped with 3D laser scanners to detect the actual profile of the stockpile. Highly accurate standard detection is carried out via GPS. Communication to the superior control station takes place via OTN (open transportation network); the bus system used is Profinet. The conveyor systems of the coal storage area also have controlled drives featuring Siemens converter technology. Together these components ensure that the technological requirements are met while also contributing toward energy-efficient operation and a long lifetime of the mechanical components.

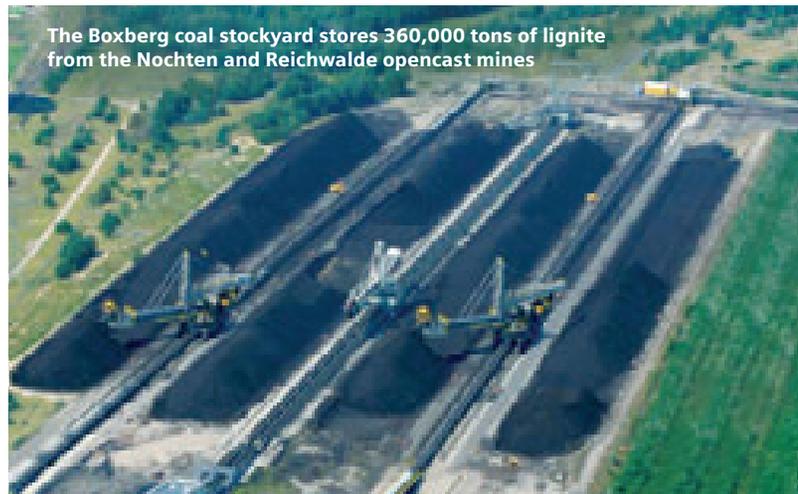
### Component 3: New central control station for the Nochten and Reichwalde opencast mines and the Boxberg coal storage area

Twelve years ago Siemens created a control station for the Nochten opencast mine. Now, as part of the recommissioning of the neighboring Reichwalde opencast mine and the expansion of the coal storage area at the Boxberg power plant, Siemens has built an entirely new central control station in the Nochten operational area of Vattenfall Mining. From here system components and operating procedures for coal mining and transporting excavated material at the Nochten and Reichwalde opencast mines and the Boxberg coal storage area can be centrally monitored and controlled.

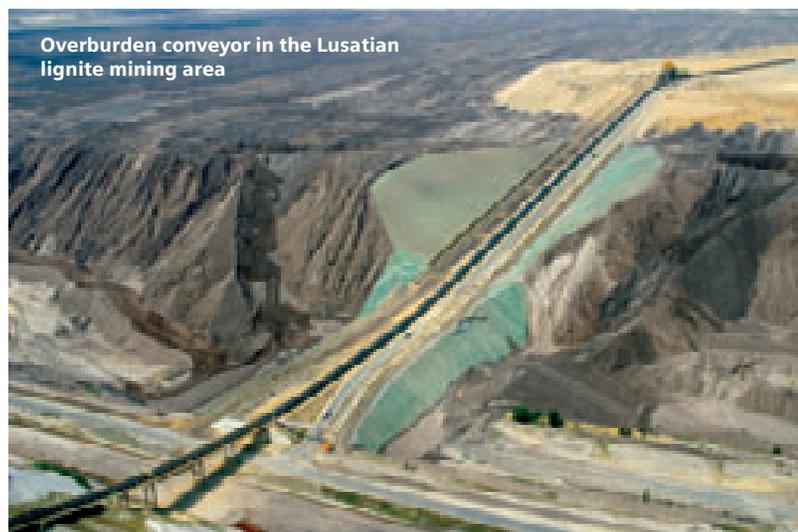
Transparency is absolutely essential in order for processes in the extensive systems of an opencast mine to be optimized. Materials and resources have to be directed in such a way that no bottlenecks, blockages or delays occur at any point. For this reason, all necessary data for evaluating the situation must be recorded and sent to the central control station. Simine CC is the modular and interface-optimized platform Siemens developed for the task, tailored to meet all the needs of the mining industry.

### Precise data collection

Several thousand variables are recorded and processed in the control station. The data is often collected several kilometers away and transmitted to >>



The coal storage area is the technological centerpiece for supplying the Boxberg power plant with brown coal.



Bucket-chain excavator with an output of 10,000 m<sup>3</sup>/h at the Nochten opencast mine



MINING >



Siemens direct drive 2 x 1,900 kW nominal capacity installed on 12 bucket-chain excavators at Vattenfall Mining

>> the control station via an OTN. The controls communicate with one another on the basis of the Industrial Ethernet Standard, and voice communication is made possible by IP telephony. The corresponding video signal is transmitted using the mpeg4 standard. An innovative feature is the integration of wireless communication via Industrial Wireless LAN (IWLAN) to link the mine excavators to the control station.

The various process levels are displayed using the proven WinCC client server structure. As such, well-founded forecasts can be made for optimized management of the opencast mine, which in turn brings about improvements in the processes and exchanges between individual components. IT-based tools help with the planning of mining operations and the direct use of analysis for controlling machines. Another procedure involves using scanners to record the profiles of the stockpiles in the coal storage area, which makes it possible to detect the interfaces. A combination of cube and LCD technology is used to visualize the conveyor layouts, video recordings, alarm messages and operating data analysis on the large screen in the control room. In this way, videos and WinCC process images can be displayed simultaneously. The images can also be ordered and assembled as desired.

#### Convenient and transparent operations

A central user interface allows internal and external applications to be operated conveniently and transparently – for instance, starting up and shutting down the conveyor systems or controlling and monitoring the automatic operation of the coal storage area. Furthermore, monitoring procedures make sure the technological materials-handling requirements are met, taking into account the necessary quantities and qualities of transported material, and coordinating monitoring and maintenance tasks during planned downtimes of the conveyor systems.

A dispatcher communications system combines the telephone network, the analog and digital radio network and the ancillary systems (PA equipment, etc.) into one central system. A total of five workstations are available in the control station, all of which share a common basic design in terms of operation and functionality. Every operational area can be controlled and monitored from any workstation, including the operation of safety-related functions.

It took just four days to switch over the functions of the previous control station to the newly built control station at the Nochten opencast mine. This outstanding result can be attributed in part to the



### Vattenfall

Vattenfall is the fifth-largest electricity producer and the leading heat producer in Europe. In Germany alone, Vattenfall serves around 3 million electricity customers. To meet this demand, the company extracts around 60 million tons of brown coal each year, which is converted into electricity at power plants in Jämschwalde, Schwarze Pumpe and Boxberg.

### Direct drives for bucket-chain excavators

Siemens has equipped 12 bucket-chain excavators for Vattenfall Europe Mining AG, Germany, with gearless drives. The drives reduce the wear on the chains and tumblers and require very little maintenance. These modernisations were made in stages, between 1995 and 2010.

highly focused communications between experts from Siemens and the technical department of customer Vattenfall Mining.

### Conclusion

Thanks to the new conveyor system, extension of the storage area and new central control station, Vattenfall Mining is able to efficiently and cost effectively transport coal extracted at the recommissioned Reichwalde opencast mine. The integration of proven solutions like Simine CON drive and automation platform and Simine CC platform for automation and management ensure Vattenfall a system that will work for years to come. ■

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AppliCast – worldwide access to online plant data with a new smartphone application

# Caster Data At Your Fingertips

For steelworks managers who are often on the go, Siemens VAI has developed a new user-friendly smartphone application that provides instant access to online and up-to-date information about the status and operating conditions of a continuous casting machine. Marketed under the name of AppliCast, this practical, hand-held tool allows urgent and fact-based decisions to be made from anywhere in the world with access to the Web. (Hint: for those stressed-out managers who may not be familiar with these newfangled contraptions, this innovative application is really useful and amazing!) The world's first implementation of AppliCast was for the Brazilian steel producer ThyssenKrupp CSA.



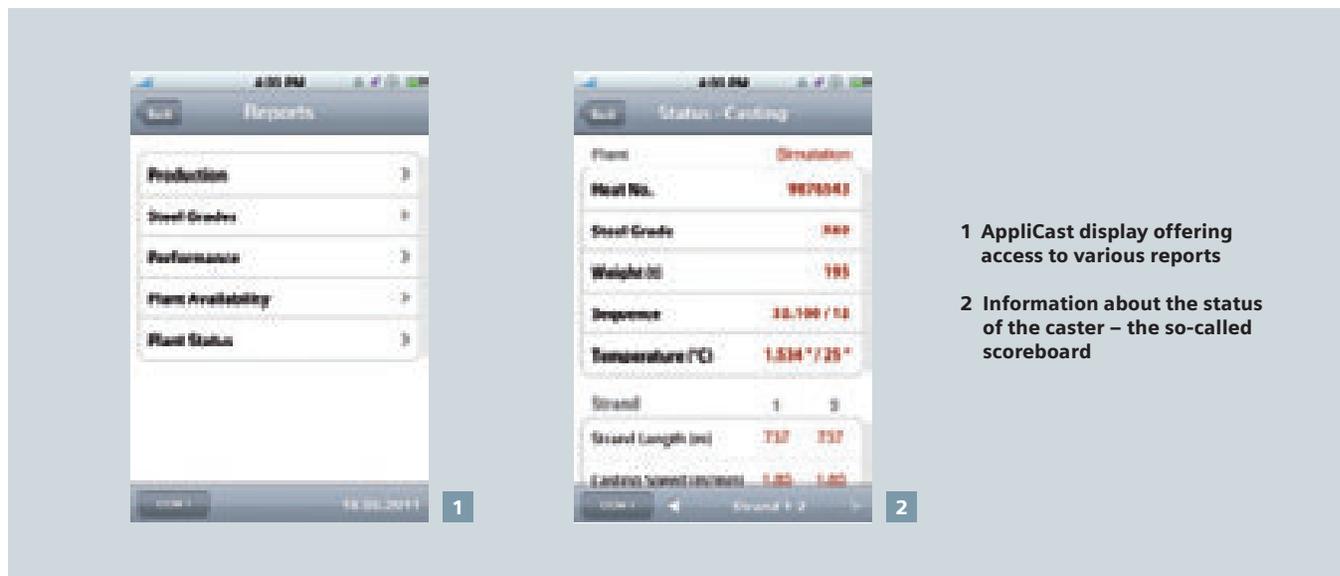
Important caster information is readily available to plant managers with the new AppliCast smartphone application from Siemens VAI

CONTINUOUS CASTING >

Immediate and accurate information is crucial for making the right decisions to ensure optimized performance of a continuous casting machine. When, for example, a steelworks manager is on a business trip or otherwise absent from the plant site, there can be a critical loss of time when urgent decisions need to be made. Normally, the manager must first be contacted, notified of a pending issue and then be informed in detail about operational conditions. It is extremely difficult, if not impos-

**Siemens VAI is the only company worldwide to offer this unique solution.**

sible, for a person not present on the plant site to acquire an overview of performance figures, stored data and product results. Wrong decisions or delays in the decision-making process can lead to production loss and even machine standstills.



- 1 AppliCast display offering access to various reports
- 2 Information about the status of the caster – the so-called scoreboard

### Comprehensive data at the touch of a finger

AppliCast presents a wealth of detailed online caster information including trending diagrams, vital operational and production results (e.g., temperature values, casting speed, strand dimensions, output, steel grades), and access to past production figures. This is made possible with the installation of a plant-site webserver into which all important caster data is uploaded from the existing Level 2 automation system. Access to the plant webserver is via the Internet using a password- or certificate-protected connection. Once the webserver is installed, AppliCast can be downloaded onto any number of smartphones.

AppliCast is available as an add-on feature for all new and existing continuous casting machines supplied by Siemens VAI. It not only provides access to all of a customer's continuous casting plants linked

by a common server, it also allows the operational parameters and production results of different casters to be compared and benchmarked. At the present time, Siemens VAI is the only company worldwide to offer this unique solution.

### First implementation

AppliCast was implemented for the first time at ThyssenKrupp CSA (Companhia Siderúrgica do Atlântico S.A.) in Brazil. The operational data from the two 2-strand slab casters is accessed and displayed. According to Dirk Gotthelf, manager of the continuous casting plants, "When Siemens VAI first told me about this new smartphone application, I wanted to have it immediately. AppliCast helps me to keep a close eye on operations in our continuous casting plants, even when I'm away on business trips."



### Main Benefits

- Worldwide access to plant-performance data in real time
- Clear overview and graphical displays of vital plant data
- Fact-based decision-making for optimized caster performance
- Reliable, secure and protected data transmission
- Suitable for all new and existing caster types

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Simetal Mold Expert saves customers half a billion euros

# Expert Money Saver

Wherever it's installed, the Simetal Mold Expert keeps casting molds firmly in view. As the most advanced system for early sticker detection, the system has saved customers altogether about half a billion euros since its market introduction a mere decade ago. This article details the phenomenal success story of Simetal Mold Expert.

**A**fter development and testing at voestalpine in Linz, Austria, the ten-year success story of Simetal Mold Expert began with the first system being commissioned at the IPSCO steel mill (today SSAB Alabama) in the United States in 2001. "Every other SSAB factory is now equipped with our system," states Oliver Lang, one of the founding developers of Simetal Mold Expert. The system's ability to look into the mold enables customers around the world to optimize their processes like never before.

## Evolution of an innovation

In the beginning, Simetal Mold Expert included just three algorithms for sticker detection. Today, the number of algorithms has increased to more than ten, and these are now able to recognize an enormous range of sticker patterns. This simplifies deployment of new types of steel while significantly reducing the number of false alarms.

Somewhat later the system was expanded to include a heat-flux calculation. This function helps describe the quality of the cooling. If cooling is too strong, cracks can occur as massive tensions act on the shell. The function makes it possible to determine the behavior of the casting powder.

The next step in the evolution of Simetal Mold Expert was the Friction Expert. It calculates the friction between the mold and the strand shell. Too much friction increases the potential for stickers and tears in the slab.

With some steel grades, clogging and mold level hunting are severe problems. To overcome these

challenges, Level Expert analyzes the casting level and driver currents, and at a very early stage warns the operator of both problems and recommends corrective action.

## A tradition of continuous improvement

The 100th strand with a Simetal Mold Expert was installed in 2007 at Novolipetsk Steel (NLMK), a Russian customer that bought its first Mold Expert system in 2003 and its latest one in 2010.

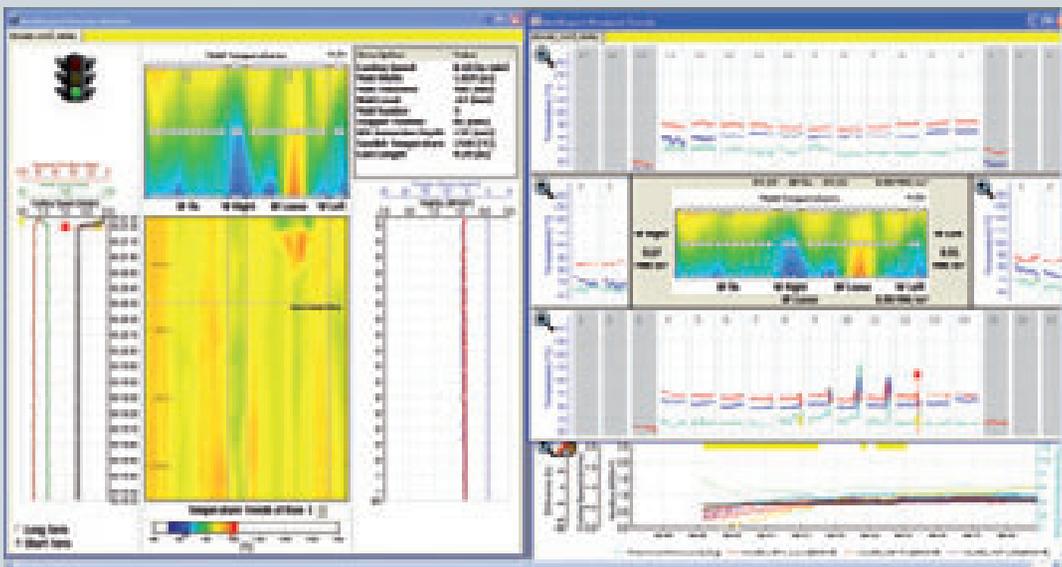
The continuous casting machine at Qinhuangdao Shouqin Metals Materials Co. in China, which started up in 2010, was the 100th plant where Simetal Mold Expert was installed. This also happens to be the first caster to produce slabs of 400 mm thickness on a curved casting machine.

Working closely with customers such as Aperam Genk in Belgium, the longitudinal crack algorithms used by the Simetal Mold Expert system are being improved.

Furthermore, new "Experts" are continuously being developed for still better insight into the activities inside the mold. Mold Surface Monitoring looks at the mold-casting powder surface. With this look at the "fifth side" of the mold, a missing link in mold monitoring has now been closed.

Simetal Mold Expert is also on the verge of taking over continuous monitoring of the casting process. With it, error quote, sticking, and the number of aborted casting operations can be drastically reduced.

There are also financial benefits: "The average annual savings amount to \$6.5 million. In some companies, this can even reach up to \$20 million per year,"



Mold Expert main display showing sticker detection

The 2001 commissioning team today

notes Oliver Lang. These numbers, reported by customers over the last ten years, are based on the number of prevented breakouts by detected stickers but do not include the saving as a result of improved slab quality.

Beyond this, many customers are getting close to breakout-free operation. Gerdau Acominas in Brazil reported just one breakout in 2010, and the sticker was detected by Simetal Mold Expert. Jindal South West of India noted that the last breakout in its Caster No. 3 occurred after almost 24 months of operation.



## Mold Expert solutions serve your success.

### Solutions that optimize performance

Nothing remains hidden from Simetal Mold Expert, and the data and registrations that it provides clearly show the optimization potential. Abhijit Sarkar, general manager of the steel meltshop in Jindal, India, knows why: "Optimized continuous casting is no longer possible with only human know-how; today this process requires state-of-the-art technology." Human intervention is no longer necessary, since adjustments of the system are fully automatic. While older casting facilities are not yet capable of this kind of automated operation, Simetal Mold Expert masters even the most complicated adjustments with ease.

Simetal Mold Expert can be upgraded simply and quickly, making it unnecessary to buy an entirely

new system to accommodate changes in the production parameters. Even third-party or self-developed mold monitoring systems can be upgraded into a Mold Expert system.

### Serving future customer success

The auto-adaptive concept of Simetal Mold Expert algorithms enables the system to operate properly from the very first heat. Nevertheless, the development team continues to work closely with customers to fulfill their unique requirements in future applications. ■

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Multipic plate-cooling technology for retrofits as well as new machines

# Best-of-Class Plate Cooling

Sophisticated steels are routinely used in the manufacture of large-diameter oil and gas pipelines and in the shipbuilding and construction industries. The characteristics required of the steels used in these and other demanding applications are high strength and toughness combined with good weldability. Helping to enhance online control of the thermomechanical properties of steel plate is the Mulpic plate cooling system from Siemens VAI. The authors explain how.



Fig.1: Mulpic in operation

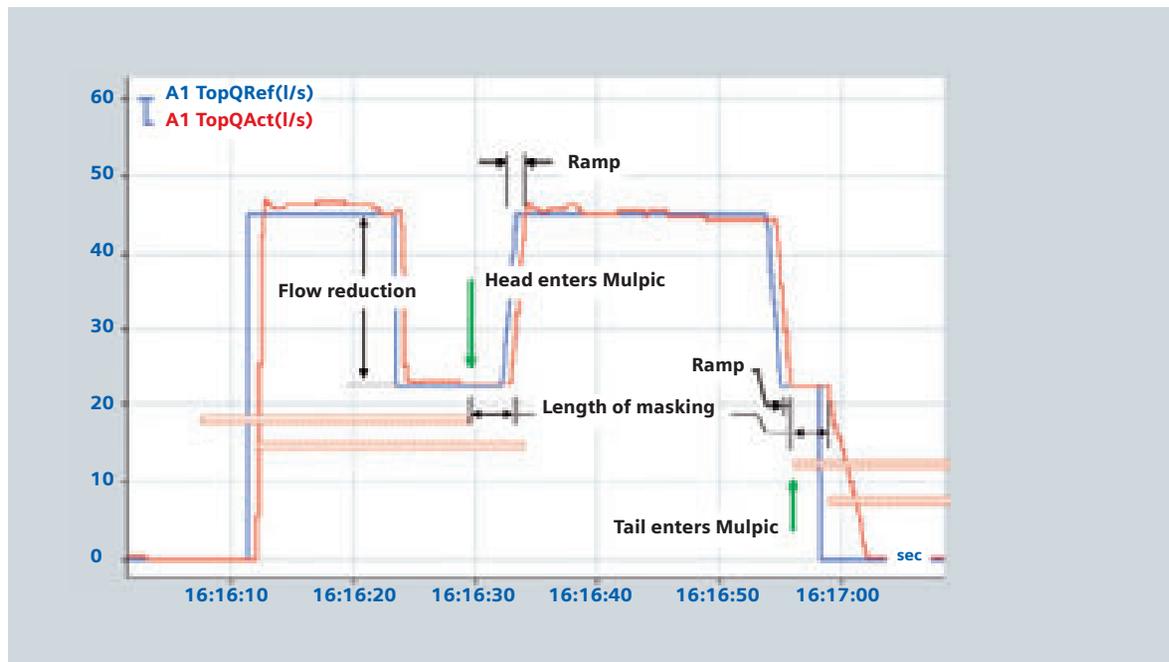


Fig. 2: Flow control during head and tail masking

**M**ulpic is an inline water-cooling system that is used when direct quenching or accelerated cooling is needed to achieve a target microstructure after final rolling of a steel-plate product (Figure 1). The Mulpic system comprises 24 top and 24 bottom headers: Headers are grouped into four banks – A, B, C and D – with six header pairs per bank. The top and bottom sections of each bank have a separate water supply.

Banks B, C and D are configured in such a way that six headers are fed from a single supply, with the flow being divided equally among the headers. The headers of bank A are individually supplied and controlled. The configuration of the water supply depends on the task at hand. If the Mulpic system is intended solely as an accelerated cooling machine, a low-pressure, gravity-fed supply is sufficient. However, for direct quench (higher cooling rates for thicker product) applications, high-pressure pumps boost the water flow to bank A.

### Homogeneous cooling

Cooled plates must have uniform properties over the entire area of the plate and remain flat during and after cooling. These requirements are satisfied only when the cooling of the plate is homogeneous. Techniques used to ensure homogeneous cooling include head and tail masking, water crown control and edge masking.

### Head and tail masking

After last-pass rolling in the mill stand, the head and tail of the plate are typically cooler than the main body. As a consequence, the head and tail ends of the plate tend to be overcooled. To compensate for this, the water flow in Bank A headers is reduced as the head and tail enter the Mulpic system. Using a scanning pyrometer at the entry of the machine, it is possible to track hot or cold portions in the plate length and use feed forward to avoid over- or undercooling these portions.

### Water crown control and edge masking

When the plate is within the Mulpic system, water flowing on to the top surface returns to the tank by first flowing sideways across the plate; this cross flow gives an increased water flow density at the edges of the plate compared to that at the center, resulting in overcooling of the edges. Two techniques are used to counteract this phenomenon. To prevent overcooling, the flow to the chambers is controlled using water crown valves. When the crown valves are fully opened, the water-flow density is uniform across the width. As the valves are closed, the water flow to the end sections is reduced, and a water crown is generated. Crosswise temperature variation is further controlled by edge masks under the top headers. The position of the edge masks can be set according to incoming plate width and adjusted using feed- >>

>> forward control if a scanning pyrometer is installed at the entry of the machine to detect any plate camber.

### Mulpic control scheme

Figure 2 shows the control scheme associated with the Mulpic system. The production schedule is downloaded to the furnace control Level 2. As plates are discharged from the furnace, the primary data input (PDI) is passed by the mill's Level 2 to the Mulpic Level 2. The PDI message defines the size of the finished plate and how it is to be cooled, including cooling strategy, cooling rate, and the target temperature after cooling. As a plate is rolled, the Mulpic Level 2 is notified of key events: piece discharged from furnace, start of first pass and start of last pass. For each event, a Mulpic setup is generated and passed to Level 1 for machine setup. After rolling, the temperature of the head end is measured using the radiation pyrometer and a further setup generated based on the measured temperature. Line speed is used to locate the head and tail of the plate relative to a defined point on the line, so that head and tail masking can be carried out.

### Mulpic performance

Key parameters for controlling the microstructure of the steel plate during cooling are the final cooling temperature (FCT) and the cooling rate (CR). The

graph in Figure 3 shows the final cooling rate performance against target and the achieved cooling rate against target for 377 plates tested. Each plate was 31.7 mm thick with a target FCT of 450°C and a CR of 21.5°C/s. The above results also demonstrate an excellent capability for achieving homogeneous cooling. Figure 4 shows an example of entry (left side) and exit (right side) temperature profile across the length and width of a plate.

### Further developments

A number of improvements to this innovative technology are currently underway. One of these involves removing the adjustable header height function, which provides improvements in cooling efficiency but makes maintenance requirements more complex. With this trade-off in mind, Siemens VAI offers a fixed-height machine as standard with adjustable height as an option. The fixed-height header allows for some simplification in the machine design, thus reducing maintenance time.

With an overall length of 24 m, the standard machine provides the best compromise for plate speed and length. While this length can easily be designed into a new plant, retrofitting existing plants can be more challenging. In a number of installations, shorter machines of 12 m or 18 m have been config-

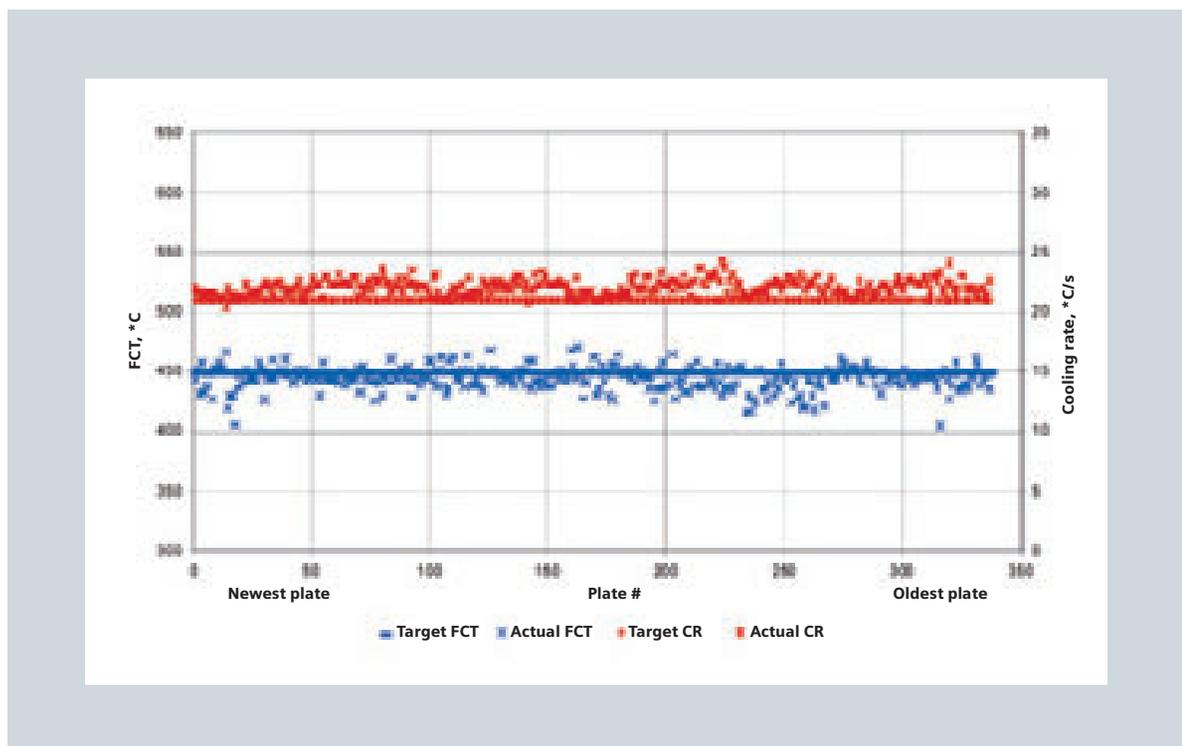
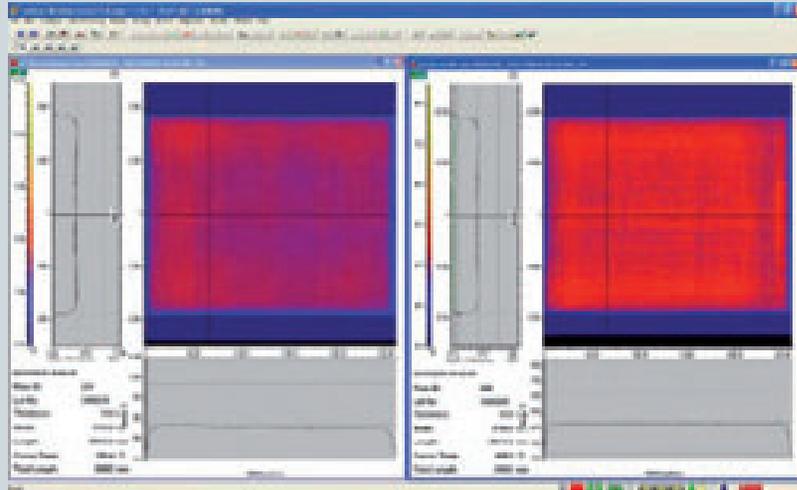
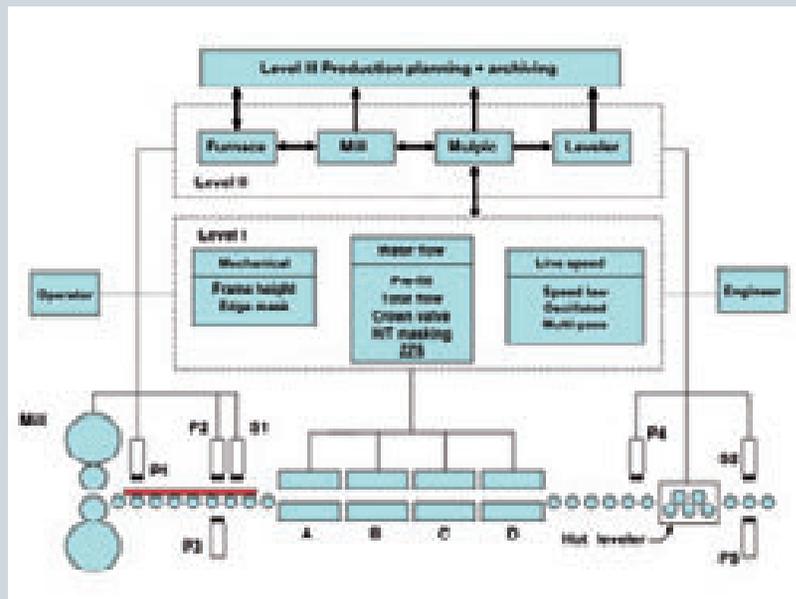


Fig. 3: Summary of final cooling temperature for 377 plates

**Fig. 4: Temperature distributions at entry (left-hand image, entry temperature 780°C) and exit (right-hand image, exit temperature 450°C) of a Mulpic machine**



**Fig. 5: Overview of the Mulpic control system**



ured to accommodate the reduced space without significantly compromising performance. Another development toward enhancing system performance involves the main control valves. Maintaining accurate flow control is essential to good cooling performance, and this performance is hard to achieve with conventional valves. Siemens VAI is developing a new valve and valve controller to improve cooling accuracy.

On retrofitted lines, the Mulpic is mainly used to determine the physical properties used in the cooling calculations. However, when installed with a

new Siemens automation system covering the re-heat furnace to the cooling bed, the Mulpic system can be incorporated into an overall Siemens VAI Microstructure Monitor in order to predict the final microstructure – and final mechanical properties of the finished plate. ■

Mulpic is exclusively licenced to Siemens VAI from CRM

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Shougang 4,300 mm plate-mill extension project working well

# Another Success Story

In 2006, Shouqin Metal Materials Company Limited, a member of Shougang Group, built a new 4,300 mm plate mill in the coastal city of Qinhuangdao, China. The Electrical & Automation business of Siemens supplied all the electrical equipment and the mill's entire automation system. Two years later the company extended production up to 1.8 million tons, and Siemens was contracted to once again commission the electrical equipment and automation system. Just in time for the 6<sup>th</sup> anniversary celebration of Shouqin Company the production of the new shearline started in September and Siemens received the FAC for the roughing mill in October 2010.

ROLLING >

**T**he Shougang Group is one of China's leading steel producers. In recent years Shougang established nine steel manufacturing bases with a total production capacity of 30 million tons. One of the most recent bases is the Hebei province. Previously, Shougang operated a production complex in and around Peking with an annual capacity of around 8 million tons of crude steel. In the course of comprehensive modernization and in an effort to improve air quality in Peking, production plants were moved to locations in the Hebei province. One of those locations is in the city of Qinhuangdao.

In Qinhuangdao, Shougang built a new plate mill designed for an annual production of approximately 1.2 million tons of carbon steel plate and high-layer building steel (low-alloyed plate and HSLA, including API-X pipeline plate). The mill is capable of thickness ranges between 5 mm and 100 mm with a maximum width of 4,100 mm. The plates are used in shipbuilding, for oil and gas pipelines and pressure vessels, and in the construction of bridges.

At the end of February 2008, Siemens was contracted to supply further electrical and automation equipment for an extension of the plate mill to expand annual production to 17 million tons. The new plate mill is made up of two furnaces, one primary descaler, one plate-mill stand, an ultra-fast and rapid cooling device and one hot-plate leveler. The finishing plant comprises cooling beds, one inspection line, two shear lines, one cold-plate leveler, a finishing line and a heavy-plate mill line.

## Siemens scope of supply

For the main drives and auxiliary drives, Siemens supplied primary synchronous and asynchronous motors configured with the Simovert D AC-AC frequency converter, and the Simovert Masterdrive system as already delivered for Phase I. As the key equipment for the mill, the twin drive is constructed in bottom motor forward design in order to attain the best control performance. The rated output power of the drive is 2 x 6.4 MW and the maximum torque is 2 x 3,820 kNm. Non-salient-pole synchronous motors work well under harsh operating conditions, especially with a thermo-mechanical rolling pass schedule with a big reduction on the heavy plate mill.

From the sensors up to the management system (Level 3 automation), the advanced Siroll PM system and equipment ensure the flexibility and reliability of production and assure that processing parameters meet strict tolerance requirements.

The basic automation system includes Simatic PCS7/TDC and Simatic ET200, which are used in the modification of the programmable logic controller (PLC) for sequence control and material tracking; roughing-mill-stand process control; and the newly built shear line control for the side trimmer, slitting shear and dividing shear. All process parameters are kept within close tolerance limits by a combination of analytical process models and sophisticated technological controls. Both the process and basic automation use a common HMI based on Simatic WinCC for operation, diagnosis and maintenance. The process automation systems for the furnace, mill and >>



Supplied twin drive

Batch rolling of five-piece batch

>> shear line are upgraded to meet the demands of the technology control for both stands. Additionally, Shougang ordered the exchange of the complete mill process automation hardware with the latest Fujitsu Primergy server types.

**Integration and commissioning**

A project team from Siemens in Erlangen, Germany, took responsibility for the management, instruction and collaboration in the whole design process. During the time that the team in Erlangen worked on

its part of the design, Shougang completed designs of the fluid system and the works itself. After detailed engineering, Siemens carried out a comprehensive system integration test on all automation equipment.

Detailed integration programming and a comprehensive transition strategy were behind the project's success. In order to have the lowest impact on normal production, a temporary roller table was used during the construction and commissioning of the roughing mill. From the primary descaler, the slabs



From left to right: Han Qing, General Manager of Shouqin; Zhu Haowen, Mayor of Qinhuangdao; Zhu Jimin, Chairman of Shougang; and Zhao Lixing, Chairman of CFHI

Official celebration ceremony in front of the mill bay



were lifted by a crane and brought to the entry side of the temporary roller table. After going through the temporary roller table beside the new roughing mill area, the slabs were lifted by another crane and brought to the entry side of the finishing mill.

The integration of the electrical and automation system was divided into the following steps:

**1) The integration of the temporary roller table (October 13–14, 2009)**

Modification of the existing production software, tracking software and operating HMI of the entry side of the finishing mill were completed in order to integrate the temporary roller table into the automation system. From then on, the temporary roller table could be put into production if needed, and the crane operators could be trained before the new mechanical equipment went into service.

**2) Maintenance (March 23–April 6, 2010)**

The mechanical and lubrication modifications in the finishing mill and other relevant areas were carried out during this time. Siemens also performed the interface test of the new process automation with the existing Level 3, ACC, hot-plate leveler and furnace.

**3) 48-hour maintenance (April 21–22, 2010)**

The primary tasks during this maintenance shutdown were to modify the Level 2 hardware and software, modify Level 1 software and add new Level 1 hardware for the additional roughing mill stand, integrate the new HMI server, make new arrangements for the existing HMI server of the shear line, and integrate new HMI client and network devices.

**4) 8-hour maintenance (May 7, 2010)**

The top and bottom back-up roll were checked.

**5) 12-hour maintenance (May 12, 2010)**

The whole set of work rolls and back-up rolls were installed for the roughing mill.

**6) First plate rolled through the newly built roughing mill (May 15, 2010)**

After the three-day cold commissioning with the complete rolling stack in the stand, the rolling could start in the “pass through” mode, which was used by the customer during production. On May 20, 2010, a 5-hour ghost rolling was carried out on both stands.

On May 21, 2010, after a 3-hour ghost rolling, the first plate and a further 33 plates were rolled continuously until rolling was interrupted to celebrate this great success with the customer. From that day on, rolling was possible in several operation modes as well as batch rolling with two stands.

**Flexible rolling mode**

During the integration of the newly built roughing mill, and in order to ensure maximum production, Siemens proposed the following operation modes, which have been kept in use:

- “Temporary roller table” mode

The temporary roller table in the new roughing mill area was used to keep single-stand rolling. Although its length in front of the finishing mill was limited, rolling with intervals could still be carried out to improve production as much as possible.

- “Pass through” mode with plates passing through the roughing mill without reduction

The customer adopted this mode during non-commissioning time (the night shift) and thus increased production by 20% compared with rolling under the temporary roller table mode. In addition, quality was improved because the big temperature loss associated with the temporary roller table was avoided.

- “Batch rolling” mode with the finishing mill

- “Continuous dual-plate rolling” with the finishing mill

- “Dual-stand batch rolling with both stands” mode

- “Two stand rolling” mode for thermomechanical rolling with one cooling pause

**Hot commissioning and further activities**

Since the first plate was rolled on May 21, 2010, in the new rougher, Siemens systematically optimized the complete mill line, completed all performance tests, and received the FAC for the roughing mill on October 1, 2010.

During the mill optimization Siemens installed and commissioned a new shearing line. After three weeks of cold commissioning, the first cut with the dividing shear was executed on August 20, 2010, and one week later the first cut with the double side-trimming shear was made. The first cut in the slitting shear was done on October 18, 2010. In the middle of September, Shougang already started with production during the late and night shift. The performance tests for the shearing line and cold-plate leveler have been successfully completed, and Shougang signed the final acceptance certificate on November 10, 2010. ■

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Review of Arvedi ESP plant performance after two years of industrial production

# Surpassing All Expectations

ROLLING >



High-reduction stands of the Arvedi ESP plant in Cremona, Italy



The skeptics said it wouldn't work, that the plant would never be able to produce coiled strip from liquid steel in a continuous, uninterrupted process. Following two years of industrial production of the Arvedi ESP plant since its start-up in June 2009, the operational performance and results of this linked casting and direct-rolling facility have surprised the critics, and have even exceeded the expectations of plant owner Acciaieria Arvedi SpA by far.

Invented by Giovanni Arvedi and implemented together with Siemens VAI, the vision of producing hot-rolled coils directly from liquid steel in an uninterrupted production process has become reality at the Arvedi ESP (Endless Strip Production) plant in Cremona, Italy. Already during the first year of industrial operation, a number of milestones were achieved including casting speeds of 6 m/min; continuous production of strip coils at widths of up to 1,570 mm and at thicknesses down to 0.8 mm; products characterized by excellent dimensional, metallurgical and mechanical properties; high yield figures; and particularly stable operating conditions.

Today, production sequences comprising ten ladles with a total of 2,500 tons of liquid steel are routinely processed in a single line to approximately 100 hot-rolled coils. A record casting rate of 360 t/h was achieved in April 2011. Continuous casting operations are especially reliable with only five breakouts registered during all of 2010. In fact, no breakout incidence occurred whatsoever for half a year during

continuous production beginning September 2010. More than 30% of the coils ready for dispatch have a strip gauge of less than 1.5 mm, thus commanding premium prices. Once the desired minimum gauge is reached, usually in the early stage of a production sequence, rolling at this thin gauge is typically carried out for the rest of the production campaign. Strip lengths of 150 km and more are normally generated. A cobble rate of less than 0.06% was demonstrated as a monthly average during rolling operations – underlining the stability and regularity of the process.

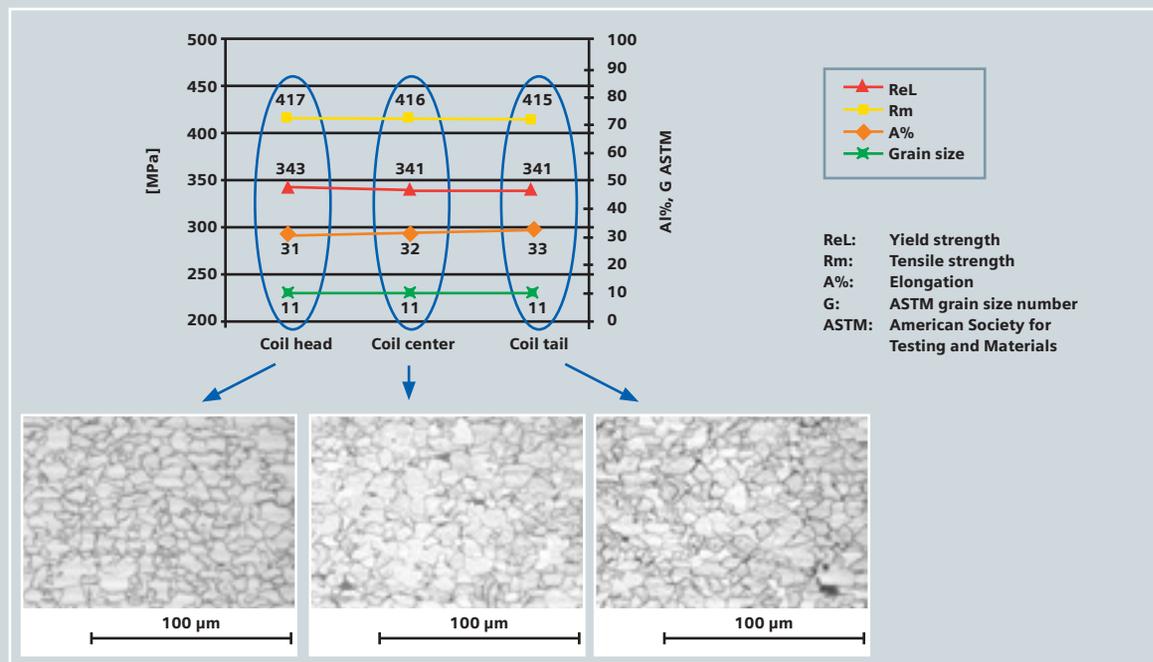
#### “Minute-made” coils

The excellent outcome achieved with respect to the dimensions of the rolled strip, product quality, yield, energy consumption and operational costs are the result of a number of unique features of the endless strip-production mode of an Arvedi ESP line: First of all, a “two-step rolling process” is applied. A 3-stand, 4-high reduction mill positioned at the end of the

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Members of the Siemens VAI start-up team at the Arvedi ESP plant



**Homogeneous mechanical properties of low-carbon Arvedi ESP strip along its entire length**

casting section takes advantage of the remnant heat content and soft core of the cast strand to adjust the crown and wedge geometry. Following reheating in a highly compact, 10 m long induction furnace, the intermediate strip with a thickness of only 10–20 mm is rolled to the final strip gauge with the required profile and flatness properties in the 5-stand finishing mill.

Secondly, as a consequence of the endless strip-production process, no strip threading into the individual rolling stands is necessary once operations are underway. As a result, there is no need to crop strip head and tail ends, thus contributing to enhanced yields in excess of 98%. Moreover, the endless production mode in an extremely compact production line of only 180 m and with a throughput time of just several minutes is the basis for ensuring constant process parameters (e.g., strip temperatures and rolling forces). This is a decisive factor for the production of hot-rolled strip products with superior and uniform metallurgical and mechanical properties along the entire coil length – from the first to the last meter. The standards typically set for conventionally produced strip products with respect to the homogeneity of the microstructure, grain size, yield strength, tensile strength and total elongation are generally exceeded and even meet the demands for automotive applications.

The fully optimized design of the entire Arvedi ESP facility and the installation of a broad range of

state-of-the-art technological packages and sophisticated automation systems are decisive for smooth, reliable and uninterrupted production operations and for the high quality of the coiled products. The plant’s built-in, online strand width- and thickness-adjustment capability offers a high degree of flexibility to supply products with a wide range of dimensions. Furthermore, the line enables Acciaieria Arvedi to produce numerous steel grades, including HSLA (high-strength, low-alloy), multiphase and other advanced steels as required by the market.

**From vision to reality**

The outstanding operational performance of the Arvedi ESP plant has been a “dream come true” for Giovanni Arvedi, the father of the process. The combination of farsighted vision, the operational experience of a renowned steel producer, and the expertise of the engineering and plant-building company Siemens VAI has been decisive for the successful implementation of this revolutionary process for the production of high-quality, hot-rolled coils. ■

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Interview with Giovanni Arvedi, inventor of the Arvedi ESP process, Acciaieria Arvedi SpA, Cremona, Italy

## “We Are Satisfied”



*Following two years of industrial operations, are you satisfied with the performance of your production line?*

**Giovanni Arvedi:** Yes, we are satisfied. The plant is working well and Siemens VAI did a good job, but I am sure that even more can be done. Technological innovation is for us our *modus pensandi et operandi*.

*Where do you see the limits of the Arvedi ESP production process with respect to casting speed, output and thin-strip gauges?*

**Giovanni Arvedi:** We are studying the limits of the process, concentrating on the operativeness of the mold and, in particular, on mold-level control. We have cast at a rate of six tons per minute, which is a world record, and we count on doing even better.

*What steel grades are you able to produce on this line and for which product applications?*

**Giovanni Arvedi:** To date, we have produced HSLA steel up to grade S500. Depending on the market demand, we count on soon developing even higher-strength steels and dual-phase steels. The plant started up at a very unfavorable time when the car sector – a very important market outlet for us – was in crisis.

*Will you be able to expand your customer base and enter new market segments? What has been the response of your customers up until now?*

**Giovanni Arvedi:** The ESP plant produces at a width of 1,500 mm, which, in the field of flat-rolled steel, is a real best seller. This allows us to approach a broader market than with ISP (In-line Strip Production) products, which only go up to 1,300 mm in width. Response regarding product quality has been very positive. End users have noted and appreciated the benefits of the product coming from the endless cycle – a very homogeneous product with flatness and tolerances similar to those of the best cold-rolled products.

*Can you tell us something about your operational costs and profitability with the facility?*

**Giovanni Arvedi:** Our processing costs from liquid steel to hot-rolled coils can be seen from our consumption and yield percentage figures, which are really the best in the world.

*In a nutshell, what do you see as the decisive advantages of the Arvedi ESP process?*

**Giovanni Arvedi:** Rapid response to the market, excellent quality, easy management of thin-gauge products that are unique in the world, and an interesting and economical possibility to directly produce hot-rolled coils as well as thin-gauge, cold-rolled coils at very low costs.

“Our processing costs from liquid steel to hot-rolled coil ... are really the best in the world.”

*You have said that the successful start-up and operation of the Arvedi ESP line has been “a dream come true.” What visions do you still have for the future?*

**Giovanni Arvedi:** The start-up of the ESP line, the world’s first truly endless line, was outstanding and benefited from our experience acquired from the first ISP plant. We are thinking of building the next plant with a width of more than two meters and applying it in our EAF and blast furnace production routes. The process will be able to generate all steel grades currently manufactured worldwide, in excellent quality and with strip gauges and geometrical characteristics not produced anywhere else in the world.

Interview with Josef Lanschützer, Head of Arvedi ESP Technology at Siemens VAI

## The Right Move

*What was the main challenge in the implementation of Arvedi ESP technology? Weren't you worried that this endless production process might not work?*

**Josef Lanschützer:** The main challenge was to link the individual production steps into a continuous, uninterrupted line. And we were convinced from the start that we would be successful. We not only had the experience and capability to optimize the performance of each technological step, but, on the basis of our unique and immense automation expertise, we also knew we would be able to link each of these steps into an endless production chain. I would also like to emphasize that the close cooperation with the plant owner Acciaieria Arvedi and their operational know-how were decisive factors for the success of this new technology.

*A rolling mill typically has twice the output of a slab caster. Doesn't this mean that with only one caster directly linked to the finishing train in an Arvedi ESP line the mill will operate far below its rated capacity?*

**Josef Lanschützer:** You can be sure that our ultimate target is to develop the casting machine to match the rolling capability of the mill. We are well on the road toward achieving this target because the caster already casts six tons of steel per minute and has operated for half a year without a breakout. So, the Arvedi plant runs at highest productivity levels with a high degree of stability. On this basis, we are working on the next generation of Arvedi ESP plants with even higher production capacities.

*Considering the fully linked and endless production mode of an Arvedi ESP plant, aren't potential customers concerned that the whole line will just "drop dead" if any problem occurs between the caster and coiler?*

**Josef Lanschützer:** The endless production mode offers tremendous advantages with respect to production stability and product quality. The installed, fully integrated automation systems ensure smooth and reliable operations while minimizing the potential for human error. And, as we have already demonstrated during two years of continuous operation, the Arvedi ESP line has never "dropped dead."



*Who will be the next owner of an Arvedi ESP plant?*

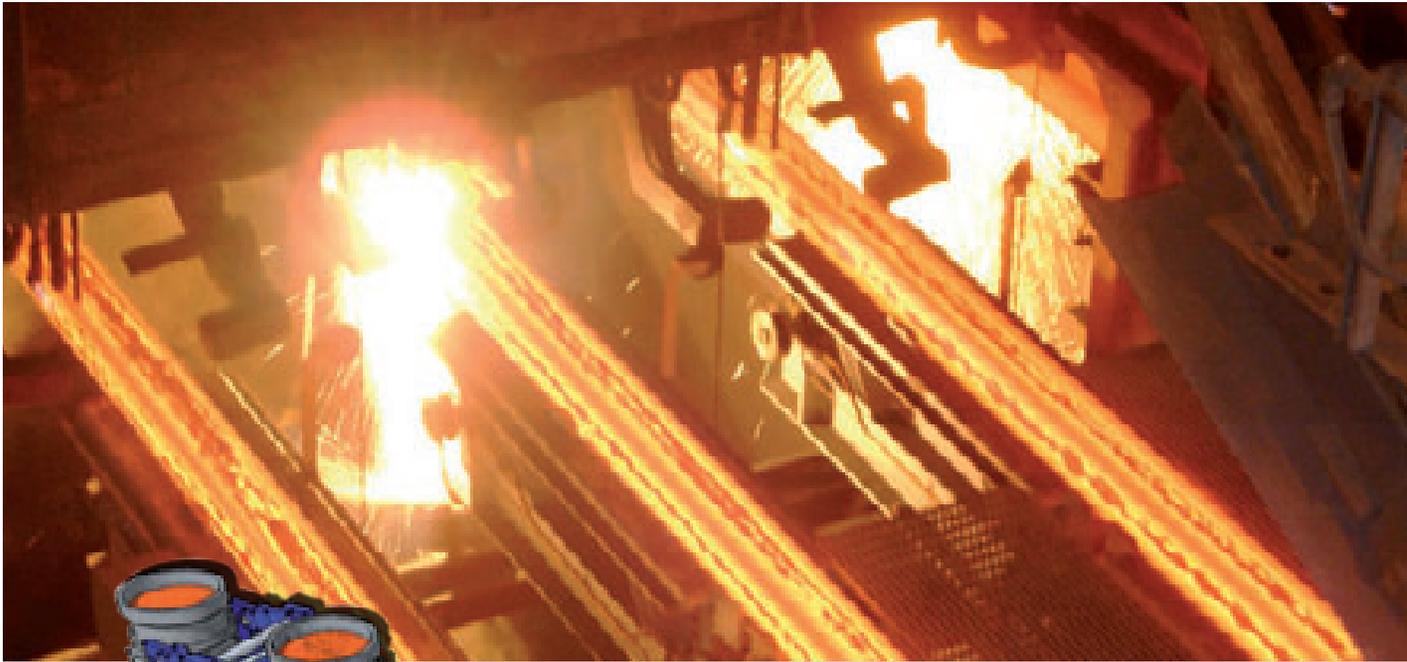
**Josef Lanschützer:** We see many possibilities for the next installations of this technology on the basis of intensive ongoing negotiations with interested customers. We have already been approached by producers from widely differing locations from across the globe with a keen interest in the Arvedi ESP process.

**"The early adoption of this future-oriented technology can be the right move for steel producers to maintain a competitive edge."**

*What impact will the implementation and further development of Arvedi ESP have on the overall scenario of the iron and steel industry? Is Arvedi ESP technology a threat to existing production facilities?*

**Josef Lanschützer:** Many industrial examples show that continuous production lines have successfully substituted batch-production routes in the past. Under the appropriate conditions, the early adoption of this future-oriented technology can be the right move for steel producers to maintain a competitive edge.

Questions by Dr. Lawrence Gould



Manufacturers of long products can now profit from the immense experience of Siemens VAI in linking individual production steps into a seamless, uninterrupted production flow

ROLLING >



WinLink – a winning solution of linked technologies

# Endless Production Of Long Products Too

WinLink is the name of an innovative technology from Siemens VAI for the endless production of long products from liquid steel. Through the direct linking of a billet caster with a rolling mill in a highly compact production line, producers benefit from low investment expenditures, reduced conversion costs, significant energy savings, lower environmental impact and the highly profitable manufacture of long products. WinLink combines proven high-tech solutions with the experience acquired from more than two years of industrial operation of the Arvedi ESP (Endless Strip Production) plant.

**T**he recent economic crisis has led steel producers to reconsider the advantages of the original minimill plant concept introduced to the market around 40 years ago. This plant type is characterized by small steelmaking capacities in the range of 300,000 to 600,000 t/a; the use of locally available scrap to produce steel that is sold on the regional market (reduced transportation costs); a low impact on the electrical energy grid; a high degree of flexibility to adjust production rates to market requirements; and comparably low investment expenditures.

Despite these advantages, the relatively long payback period has been the main obstacle for a much broader application of minimills for the production of long products. This is a consequence of the small profit margin and economy of scale inherent in low-output mills producing standard carbon-steel grades primarily for use in the construction industry and for infrastructure applications.

## A new minimill concept

In response to this situation, Siemens VAI is now introducing WinLink, a new minimill concept for the production of long products that combines the advantages of small plant sizes with a fast payback period. In WinLink, a billet caster is directly linked to the rolling mill whereby liquid steel is processed to rebars or other long products in a continuous, endless production line.

To ensure optimum utilization of the respective EAF (electric arc furnace), continuous casting and rolling facilities, the WinLink solution foresees a high-speed billet caster equipped with a minimum of two casting strands. The additional billet strands

support a full production capacity of the steel shop, ensure that the mill is reliably supplied with steel to be rolled to the required product mix, and additionally allows billet semis to be separately cast for external sales. This solution approach maximizes plant productivity and throughput while providing a high degree of flexibility to generate rolled products – in addition to rebars, small flats and profiles – or billet semis as required by the market. A WinLink-based minimill is capable of producing between 400,000 t/a and 500,000 t/a of billets of which 300,000–400,000 t/a is directly rolled to rebars and 100,000 tons of billets would be available for external sales. Siemens VAI offers different plant configurations and process options to enable a broad range of strand sizes and shapes to be cast, including rectangular and round formats. Producers thus have considerable flexibility to produce a wider range of product dimensions to also meet demands for small order lots. The main features of the individual plants installed in a WinLink-based minimill are outlined in the following:

## EAF and ladle furnace

The Ultimate EAF is designed for performance. All of the latest electric steelmaking solutions from Siemens VAI are applied to maximize furnace output and productivity. For example, the single-point roof-lifting system supports fast and efficient roof movements during scrap charging. The high sidewalls of the furnace shell allow single-bucket charging and thus reduced scrap-charging times. The application of RCB (Refining Combined Burner) technology fulfills numerous functions such as scrap preheating with a powerful burner at the start of the melting >>

>> process; postcombustion to promote exothermic reactions and thus accelerated melting; and supersonic oxygen lancing for steel-refining purposes. These and other features contribute to a high degree of efficiency, low consumption figures and short tap-to-tap times down to nearly 30 minutes. An Ultimate EAF furnace installed in a WinLink-based minimill would have a tapping weight in the range of 35–50 tons. Adjustment of the required liquid-steel temperature for continuous casting and minor alloy additions then take place in the ladle furnace.

**High-speed billet caster**

High-speed billet casters from Siemens VAI are installed with the latest equipment packages and systems to allow casting speeds in the range of up to more than 7 m/min. Special design features include the installation of Dynaflex hydraulic oscillation for the optimum adjustment of the oscillation parameters over a wide range of casting speeds; a new enhanced generation of Diamold mold tubes designed for accelerated strand-heat removal at high casting speed; and a fully optimized strand-guiding system for optimum strand containment. Furthermore, a well-proven secondary cooling system is installed to promote an ideal strand-shell growth while avoiding excessive temperature loss, which minimizes the need for subsequent temperature equalization of the strand prior to rolling. High-level automation systems are also applied to monitor the entire produc-

tion process and ensure that the required quality demands are met. Steel grades and products are carefully tracked throughout the process up to final product dispatch.

**Induction furnace**

A high-performance induction furnace is installed between the billet caster and rolling mill to equalize the temperature of a billet strand section. This setup represents the best technical solution to rapidly achieve the required rolling temperature. The induction furnace replaces the conventional gas-fired reheating furnace, thereby reducing CO<sub>2</sub> emissions and the environmental impact.

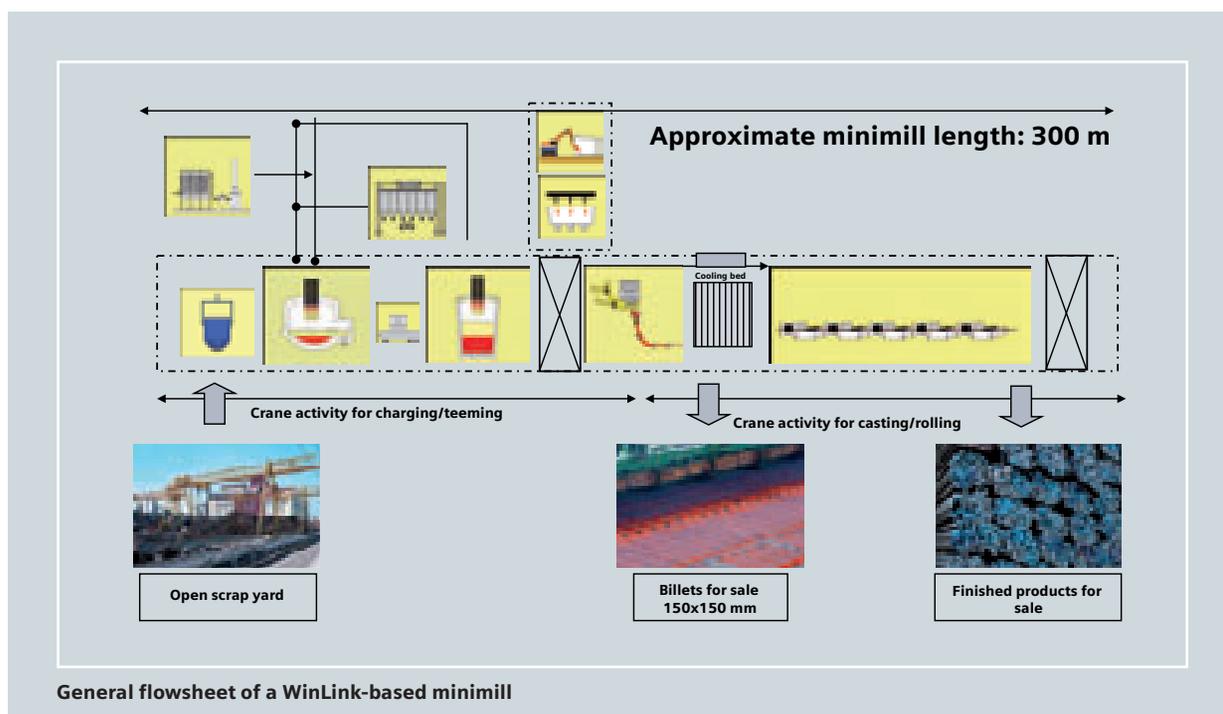
**Rolling mill**

All long-rolling mills supplied by Siemens VAI for the production of rebars are equipped with advanced mill components. Well-proven, highly rigid Red-Ring stands, Morgan-Ashlow guides and dedicated equipment such as the Power Slitter guide, high-performance PQS, stand presetting equipment and inline gap control allow producers to operate their mills for long campaigns as required in an endless process.

**Electrics and automation**

The comprehensive, worldwide experience of Siemens in the engineering and supply of electrical and automation systems, as documented by thousands of industrial plant references worldwide, is without parallel in the industry. Automation and process-

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| Ultimate EAF   |        | Ladle furnace  |           | Billet caster  |  | Rolling mill    |                               |
|----------------|--------|----------------|-----------|----------------|--|-----------------|-------------------------------|
| Transformer    | 45 MVA | Transformer    | 8 MVA     | Billet format  | e.g., 130 mm <sup>2</sup> or 150 mm <sup>2</sup> | Product (rebar) | 2x8 mm (min.)<br>40 mm (max.) |
| Tapping weight | 35 t   | Heating rate   | 4°C/min   | Casting speed  | 5.7–7.5 m/min                                    | Finishing speed | 1.3–16 m/s                    |
| Treatment time | 36 min | Treatment time | 25–36 min | Machine radius | 9 m  | No. of stands   | 18                            |

#### Typical plant parameters in a WinLink-based minimill

control systems from Siemens are the customer's guarantee for smooth plant operations, reliable process control and exact temperature regulation throughout the WinLink production line – all which contributes to maximum plant productivity.

#### Main benefits at a glance

In comparison with conventional minimill plant configurations, WinLink offers a number of decisive advantages for producers:

- Lower capital expenditures (Capex) for main equipment
- Lower operational expenditures (Opex) up to \$40/t of rolled steel
- Low inventory and working-capital requirements
- Reduced manpower requirements
- Reduced civil works and infrastructure costs
- Reduced energy consumption and related costs
- 24-hour continuous mill operation
- Higher product yield due to long uninterrupted casting and rolling sequences
- Low CO<sub>2</sub> emissions (no billet reheating furnace) and fluid consumption
- Smaller minimill footprint in terms of space requirements
- Production of finished rolled products from scrap in less than two hours

All of the experience acquired from the successful

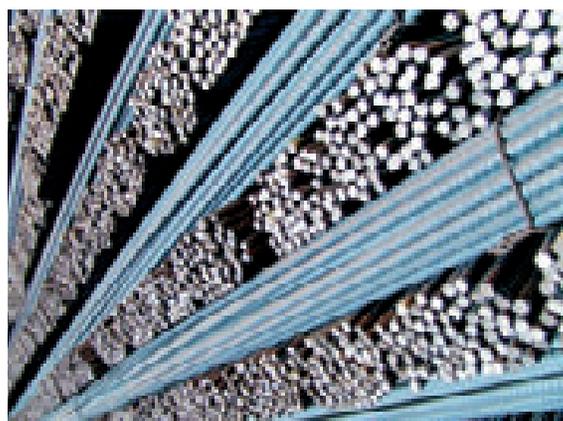
introduction of the Arvedi ESP process for the endless production of flat products is now available for a WinLink-based minimill facility. Siemens VAI is looking forward to implementing the WinLink solution with customers interested in highly profitable and flexible long-product production. ■

#### Authors

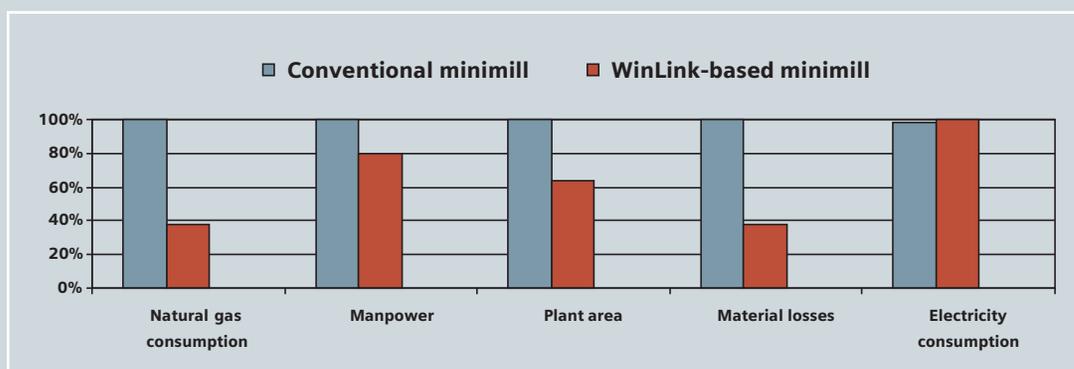
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Stacked bundles of rebars ready for dispatch



Comparison of key factors between a conventional minimill and a WinLink-based minimill



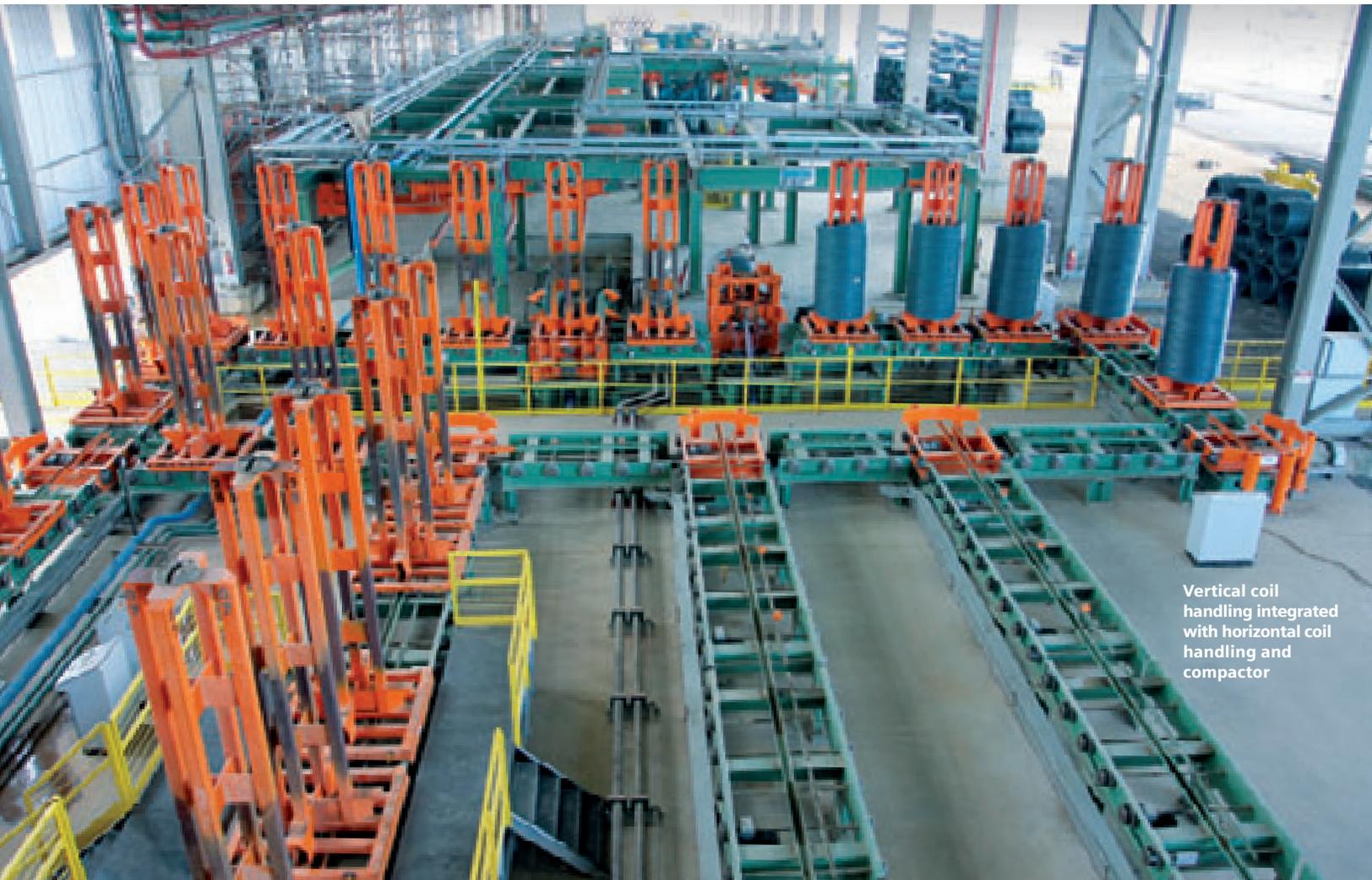
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Vee pre-finishing mill and water box

Long-rolling mills for all productivity and product-quality requirements

# Solutions That Grow With Market Needs

The world's ever-changing market for long-rolling products has created a demand for mill equipment that can be quickly and economically adjusted to match these changing needs. Thanks to its many years of experience in designing and building long-rolling mills, Siemens VAI is able to offer a wide range of solutions for different market segments. These solutions can satisfy any requirement, from a simple rolling mill to produce construction/industrial-grade products up to a sophisticated rolling mill for high-end, value-added products that meet strict specifications.



Vertical coil handling integrated with horizontal coil handling and compactor

Over the years, Siemens VAI has developed a range of core components necessary for every type of long-product rolling mill. These components are integrated in the entire rolling process, from billet charge and discharge through to handling the final product, such as compacted rod coils or tied bundles of straight bar. The core components consist of standardized rolling stands, shears, finishing blocks, pinch rolls, laying heads, cooling conveyors and beds, coil- and bar-handling systems, and other ancillary equipment.

#### Rolling-mill products – the starting point

In many locations throughout the world today, there is a significant need for rolling mills with the essential capabilities to make products that satisfy local markets, such as for concrete reinforcement, basic fasteners and fencing. These rolling mills typically offer low to medium rolling rates and production capacity on a limited number of product sizes. To minimize the capital cost for these facilities, the core

rolling-mill equipment components are provided in their basic configurations and therefore have limited processing capability that is able to meet market requirements. However, they are upgradeable for the future production of higher-quality products.

### Rolling-mill equipment can be quickly and economically adjusted to meet changing market needs.

On the other end of the spectrum, many rolling mills require very high functionality, with sophisticated capabilities and controls for the production of a wide variety of product sizes, steel grades and qualities, such as tire cord, alloys for cold heading, and spring, bearing and stainless steels. These mills often require a wider range of rolling speeds and >>

>> production rates, with capabilities to change sizes and qualities relatively quickly to satisfy customer markets. Rolling-mill equipment for these applications must be much more robust in order to accommodate the higher loads of the process and production, and it must be able to make products to more demanding standards. The same core equipment as in the lower-cost mills is supplied, but it is reconfigured with higher-capacity components and additional features.

Starting with well-designed equipment, customers can increase capacity or produce higher-quality products with subsequent upgrades.

**The mill layout – designed with the future in mind**  
Equipment layout in Siemens VAI rolling mills is one of the most important aspects of mill design. Chosen intelligently to meet the immediate process and production needs, the layout should allow for future expansion as market needs change. Important questions should be addressed in the layout: Can the furnace and roughing mill arrangement handle larger billets in the future? Can additional stands be provided to help with future demand for increased product-size ranges and higher qualities? Is there space allocated for the addition of post-finishing mill blocks to increase production, quality and mill utilization? Is there sufficient room to add water-cooling boxes for temperature control at faster rolling rates, possibly even thermomechanical rolling? Can the stands and finishing block be upgraded to roll at higher rolling rates and lower temperatures to produce a greater range of steel qualities? Is the controlled cooling conveyor or cooling bed capable of upgrading to higher rates and more demanding steel qualities? Can the product-handling system be expanded to accommodate higher rolling rates and special conditions? Is there room for a second strand?

#### Systems work together seamlessly

One crucial aspect of the Siemens VAI solution is the combination of equipment and process technologies in the optimized layout, with fully integrated solutions to drive the equipment and automation. From motors and drives to controls and automation,

Siemens VAI offers a full range of options. Controls ranging from Level 0 to Level 2, standalone systems to fully integrated mill systems – Siemens VAI mills can accommodate all degrees of mill complexity. A key feature of these systems is their modular design, which is able to expand if the operation needs to grow in response to changing markets. Supervisory and mill-management systems can be layered onto the basic solutions as product changes become more frequent, product quality standards for accuracy and consistency become more critical, and customer demands increase in regard to product certification.

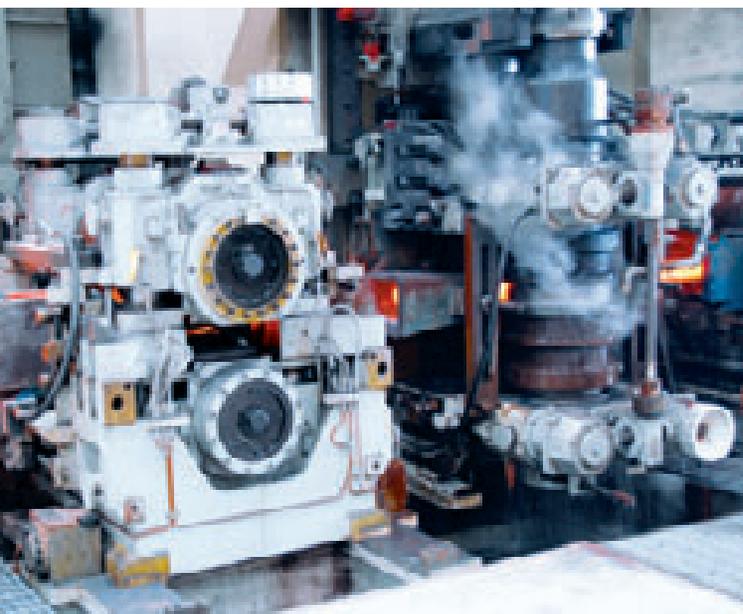


### Putting it all together

Although the initial product mix and production capacity can be satisfied with a very basic rolling-mill layout and equipment selection, a significant investment in buildings, foundations, electrics and other services is still required. Numerous mill owners and operators today regret that their predecessors did not consider future expansion when building their present facilities. The use of Siemens VAI upgradeable core rolling-mill components with an intelligent mill layout provides built-in flexibility for near-term as well as long-term needs.

The Morgan Stelmor-controlled cooling conveyor system can be upgraded with more cooling capacity or slow-cooling covers

Latest generation of Red Ring rolling stands



### Solutions in practice today

Two examples illustrate how rolling mills can begin with basic configurations of core equipment and then upgrade over time as they grow with the market:

About ten years ago, Celsa Atlantic wanted a low-cost solution to produce rebar in coil, so Siemens VAI was contracted to add a rod outlet to the company's bar mill. As the rod market grew, operators turned to Siemens VAI once again for the addition of horizontal/vertical roughing and intermediate stand groups, plus Vee pre-finishing mill blocks to have the functionality of an independent rod mill. To expand its product range to include higher quality products, Celsa Atlantic upgraded its Morgan Stelmor-controlled conveyor, and then had Siemens VAI add a vertical pallet system to interface with an expanded horizontal hook system and new compactor.

The ArcelorMittal Monlevade Wire Rod Mill No. 1 started as 2-strand rod mill for production of industrial-quality products, including simple coil handling with pole trucks. Over the course of about 15 years, ArcelorMittal has contracted with Siemens VAI to install a breakdown mill to handle larger billets and new side loopers to help with speed control. The increased loads generated by higher production then required the upgrade of the pre-finishing mill drives, and the addition of new water-cooling boxes and a temperature-control system. To increase the finishing speed of small-diameter rods, Siemens VAI installed a mini finishing mill, and then to improve cooling, the Stelmor conveyor was upgraded with larger fans, new nozzle decks and an OptiMesh air-distribution system. Also, Siemens VAI added a C-hook coil-handling system for the compactors and upgraded the mill CPUs with more up-to-date Siemens hardware.

### Conclusion

Siemens VAI experience with the supply of many long-rolling mills to meet a wide range of speeds and production rates for different product quality markets has demonstrated that rolling equipment can be initially installed to meet requirements of a basic market, and then be upgraded over the years to satisfy more demanding markets. Starting with well-designed layouts and core equipment, customers can increase process capacity for greater production or higher-quality products with subsequent upgrades. ■

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## New roller-entry guide series for long-product rolling mills

# The Best of the Best

The mergers of the former Ashlow and Morgan Construction Company businesses into Siemens VAI have led to the development of the innovative entry roller guide (ERG) series, composed of 11 different guide sizes. As such, customers now have access to the combined benefits of both companies' many years of expertise.

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**T**ypical long-product mills that produce rounds, squares, rebars and hexagons have their own special needs, including the ability to respond to ever-changing market demands for tighter finished product tolerances, increased rolling speeds and reduced cobble rates. In addition, operators are faced with pressure to decrease operating costs per ton. The new series of roller-entry guides meets these needs for both large and small sizes, as it is designed to guide leader sections as small as 15 mm in width and up to 280 mm for the largest of round and square sections.

The 18-month product-development project started with the overview of available designs and product offerings from Ashlow and Morgan. Results showed that the combined portfolios offered solutions for every imaginable guiding problem. But which solutions would best meet customer requirements for today's markets? The outlines of the new roller entry guide series soon emerged, revealing that the guides used for ovals and diamonds were the most critical components for consistent production of quality long-product bars and wire-rod process rounds.

**Siemens VAI supplies high-strength, durable assemblies for high-quality production at the lowest operating costs.**

#### Durable and long lasting

The primary focus points for any roller-guide design are durability as well as maintainability. The main guide body and roller holders for the smaller guides of the new series are constructed from higher-quality precision investment castings. When the components become too large for this casting process, parts are then made using the sand-casting process. Since strength and durability directly relate to the dimensional quality of the rolled product, the de-

sign priority was to ensure that the strength of the new guides would outperform any current designs for this application.

Strength and durability of the assembly also reduce the overall wear of assembly components, lowering the overall maintenance burden of stocking spare parts and the labor time to rebuild and set up for the next rolling campaign. In developing the designs, engineers recognized the importance of easy maintenance and fewer assembly components.

#### Simple, precise and versatile

The new guide series from Siemens VAI has fewer components compared with other designs with similar features and functions, and it provides quick and simple assembly and setup. No special tools are required for the full assembly and disassembly process, and a minimum number of tools are needed for the more common exchange and set up of wearing components like static inserts and guide rollers – which can also be changed without major disassembly. A further advantage is that a standard, open-ended wrench is all that is needed to make symmetrical adjustments of the roller holders and lock them firmly in place.

For a more accurate setup of smaller finished products, the new series offers vertical height adjustment of rollers as an optional feature on the smallest four sizes of the guide range. As an additional benefit, these guides can be converted to a fixed elevation design without any change to the main guide body and roller holders. This new design allows for maximum flexibility when preparing the guides for different types of finished products, without requiring specific guides for precision-rolled products.

Another new design feature is a simple yet innovative insert that allows for variable entry bellmouth/funnel dimensions to suit customer installation requirements. This bellmouth connects to the main guide box without affecting the design of the specific insert, reduces insert replacement costs, and simplifies the insert casting and machining processes.



**New series ERG  
2-roller entry guide  
(front and back)**

**Siemens VAI in  
Sheffield, U.K.**



### Conclusion

The Siemens VAI product-development team's creative energies drew on the depth of the combined expertise of Ashlow and Morgan engineers. By examining the challenges in today's mills and markets, a roller-guide series was designed with innovations worthy of the history of these world-renowned designers and manufacturers of guides and ancillary equipment for all long-rolling mill applications.

Whether a mill produces high-speed wire rod, bars, merchant products or special sections, the new Siemens VAI guides are robust, simple to set, easy to maintain, and made with modern materials and manufacturing techniques for maximum service life.

At Siemens VAI, teams of experienced engineers are available to adapt our large library of designs to suit

any rolling application or mill circumstance, whatever the particular guiding challenges may be. Now with more than 300 years of combined guides design and installation experience, Siemens VAI can solve any guiding and rolling challenge that may arise in a long-rolling mill. Our focus on guide technology ensures that our equipment continues to exceed the increasing demands for maximum productivity, quality and profitability in today's premier rolling mills. ■

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Portrait of inventor T. Michael Shore, 73

# “Still a Few Ideas to Push Through”

Seated at his desk stacked with rolling-mill drawings, proposals and notes, T. Michael Shore reflects on his career of more than half a century and the dozens of patents he holds. He also reveals his secret for coming up with great inventions.

*How many mills have your ideas installed in them?*

**T. Michael Shore:** I'd say 60 or 70. More than 50 alone have the Morgan Reducing/Sizing Mill, and a good number have the Morgan High Speed Laying Head. Some mills even have both technologies. At my age, I may be a rarity in the field, but I still have a few ideas to push through.

“Use your brain to its maximum ability and know what is out in the market.”

*Have you ever had an idea that wasn't patented?*

**Shore:** Oh yes, plenty. Maybe 20 or 30 were not considered worthwhile to pursue. When you've started more than 50 rolling mills, you see opportunities for improvement every day. You may find solutions and not be able to take out a patent every time. Or you might try something and then tell yourself, “I won't do that again.” Either way, you learn something new.

One European mill had a recurring problem in the 1960s with roll breakages. I thought of a possible solution, but in an era of telexes and with little access to long-distance calls, it would take weeks to get it approved back in Worcester. So I worked together with the mill manager and came up with a solution. The customer thought it was great, patented the idea and immediately put it into practice, which was my goal all along. Morgan liked it too, and promptly bought the patent from the customer.

*What's the secret to coming up with a great invention?*

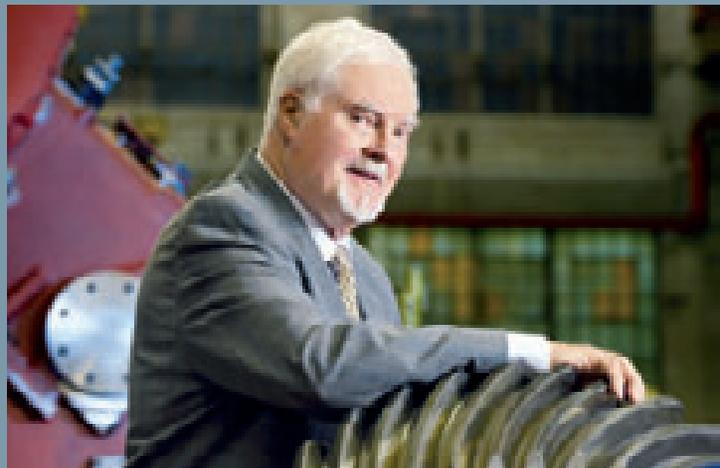
**Shore:** It's difficult to explain, but probably a combination of using your brain to its maximum ability and knowing what is out in the market. With those talents and resources you can recognize what can be improved. I also draw on my practical experience

from years of commissioning mills. I was shoveling snow when I came up with the idea for MORSHOR. I'd been playing around with many ideas in the office, but outside I had the freedom to think. That and the cold air opened my mind to new ideas.

*Who do you credit as your mentor?*

**Shore:** When I first started at Morgan I visited many mills with Eric Fors, a Swedish-American director and senior vice president of Morgan who served as my tutor. We would visit mills together and discuss what we saw there. He would explain to me what the problems were and what needed to be done to solve them. He shared his philosophy with me by asking constantly, “Don't you think we should be doing something differently here?” He was a very instructive man. ■

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Aerial view of Morgan Reducing/Sizing Mill with offline units



“When you’ve started more than 50 rolling mills, you see opportunities for improvement every day.”

Back in 1960, T. Michael Shore co-authored an industry research report on rolling-mill technology. That report caught the attention of managers at Morgan Construction Company, now Siemens VAI, and led to Shore’s recruitment for the Manchester, U.K., office. He has been looking for ways to improve rolling mills ever since, drawing upon his virtually encyclopedic knowledge gained

firsthand during the 28 years he spent in the field commissioning mills. Shore calls 61 inventions his own and more than 600 bear his name worldwide, many shared jointly with his colleagues. Undoubtedly, his inventions have raised industry standards. Last November, Shore was one of 12 innovators honored by Siemens as Inventors of the Year.

## T. Michael Shore's Most Significant Inventions

### Morgan Reducing/Sizing Mill

In the early 1990s, a customer wanted to produce multiple sizes of rods without adding additional strands to its rolling mill. Shore's solution sketched out the initial idea for the Morgan Reducing/Sizing Mill. Patented in 1994, this invention revolutionized rolling mills by allowing "single family rolling," or the ability to produce a variety of rod sizes from a single set of grooves through many stands of the mill. Steel can flow from the furnace to finished rod product with diameters ranging from the new smallest 4.5 mm size up to 25 mm. Rod tolerances are also far tighter than previous mills could guarantee, within 0.1 mm with an ovality of 0.1 mm, which reduces wire-drawing die wear and material losses in making finished products. The innovation also allows customers to expand their product range through thermomechanical rolling (TMR), which produces a fine-grain product of higher metallurgical quality, and can reduce required after-processing work. With lower-quality products, downstream annealing could take an additional twenty-four hours. TMR can save six to eight hours in annealing time, or for certain products, eliminate it altogether for significant cost savings. The Morgan Bar Reducing/Sizing Mill is an offshoot of this first invention.

### Morgan High Speed Laying Head

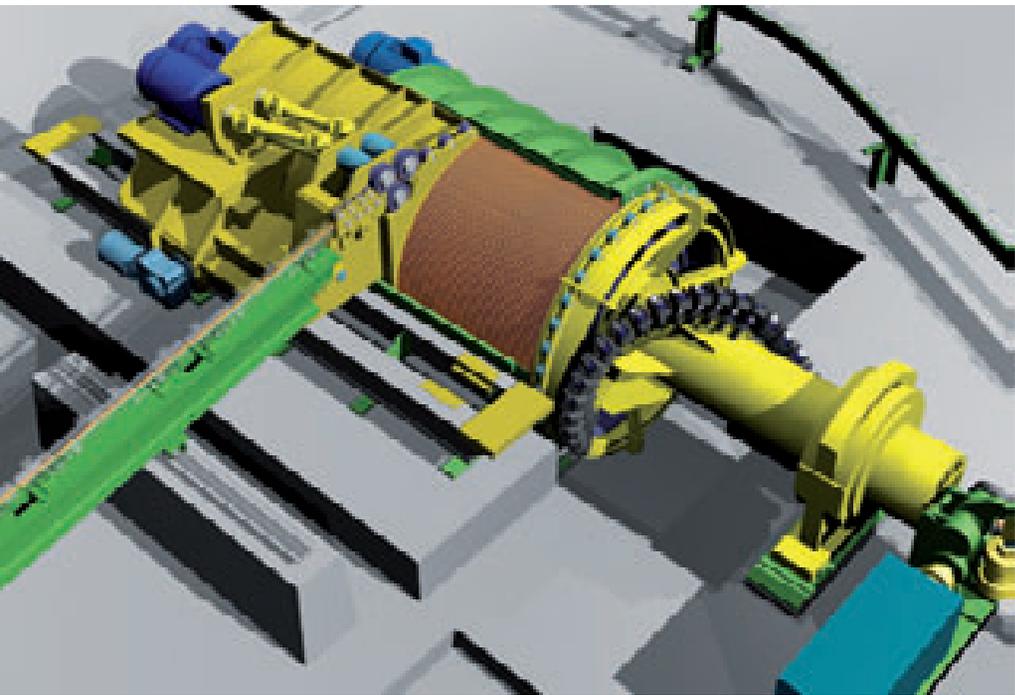
When a mill's speed increases, it becomes harder to manage the ends of the rods moving at 120 m/s, which roughly translates into 400 km/h or the speed of aircraft at liftoff. The rod is coiled for handling and transport, and the Morgan High Speed Laying Head provides a way to keep the first and last rings of a coil in the proper shape. The key to Shore's invention is the way it guides the head and tail rings so that even with rods blasting into the laying head at 120 m/s, it can produce 30 rings per second without deformity.

### MORSHOR

Titled "Method and Apparatus for Decelerating and Temporarily Accumulating a Hot Rolled Product," this invention allows long-rolling mills to significantly increase production rates on small-diameter products. The only Siemens VAI product to include the inventor's name, MORSHOR enables rolling mills to double their production of small diameter (5.5 mm) rods, usually a size with high market demand, and improve mill utilization on larger sizes. Since the maximum finishing speed limits the production of the small-diameter products, the drum-like storage unit of one MORSHOR can accumulate a billet at, for example, 150 t/h and feed one finishing block at 75 t/h. A second MORSHOR can take the next billet at the higher rate and feed a second finishing block at 75 t/h as well, therefore efficiently maximizing the mill's designed capacity of 150 t/h. MORSHOR has been tested and the first sale of this innovation is expected this year.

### Morgan Modular No-Twist Mill

Shore has several patents on this invention, the latest pending one together with his son, Mark. The Morgan Modular No-Twist Mill increases the efficiency of today's rolling mill. Like the Morgan Reducing/Sizing Mill, individual segments of this finishing mill can move on and off the production line to reduce downtime. All programming changes can be done offline on spare units, setting the guides and rolls for new sizes, so that once it moves into place, production can resume immediately. Maintenance is also far simpler, as it can be performed offline on the modular unit while the mill continues running.



The MORSHOR system increases production rates on small-diameter products

Morgan High Speed Laying Head with tail-end control





Potential for saving energy and environmental protection in a PLTCM

# Taking Savings To the Limit

Energy conservation and the minimization of emissions are key factors for environmental protection in today's highly industrialized world. CO<sub>2</sub> regulations and the limits imposed on the steel industry are already stringent and have a significant impact on the competitiveness of steel producers, particularly those operating plants in established economies.

The pickling and cold-rolling operations that are part of integrated flat-steel production plants are mostly perceived as having a low potential for energy-saving or energy-recovery measures, especially compared with those upstream and downstream processes in the chain that entail high temperature levels. However, there are a number of resources within these production units that can provide remarkable contributions to energy savings and also reduce emissions to zero. Today's highly productive and high-quality linked pickling line and tandem cold mills (PLTCM) are certainly a classic example of how energy-saving measures can be optimized to the limits of the state-of-the-art technology. Many of the measures in place are not immediately obvious, though there are a number of small processes that can provide a substantial contribution to the goal of keeping overall energy consumption and emission output as lean as possible.

## Today's challenges in cold rolling

To deal with the changing demands of their end users, steelmakers are forced to operate highly flexible production systems. In the future, new steel

grades like DP, TRIP and CP will be a considerable part of cold-rolling-mill product mixes. These new grades are distinguished by excellent forming characteristics and the highest strength properties.

The main focus of today's development can be seen in:

- Increased yield
- Reduced energy consumption
- Improved process stability
- Widened operational ranges
- Efficient and fast self-diagnostic systems
- Improved process models
- Reduced emissions

To satisfy these requirements, the demand for close cooperation between plant operators and suppliers will increase so that on the one hand they share their operational expertise on optimizing processes, and on the other they are able to take all environmental aspects into account. The list on the following page provides a brief overview of potential measures to improve a PLTCM with respect to environmental factors. The following is an example for energy improvement:

# Energy Improvement

- Automation systems
- Optimized energy consumption through continuous operation

## Pickling section:

- Scale-breaker optimization
- Patented water-seal tank covers for minimized emissions
- Optimized acid-control system – Faplac
- Use of residual heat
- Speed-controlled acid-circulation pumps
- Fume and scale-exhaust systems

## Tandem section:

- Basis: Precise models of cold-rolling process
- Direct application system
- Optimized emulsion quantity
- Cooling with ISV spray valves
- Minimum quantity roll-gap lubrication
- Drive optimization
- CMS – condition monitoring system
- Noise reduction through complete covering of drives



## Application of residual heat usage and other solutions in the pickling process section

The pickling process itself is energy intensive and, from an environmental point of view, critical due to the use of acid. The goal is to run a highly efficient process with a minimum of emissions.

The Siemens VAI acid jet system provides a high turbulence flow around the strip inside the tank; the turbulence intensity can be controlled by variable-speed circulation pumps. For high-speed pickling, each tank is equipped with a jet-pump-actuated exit-to-entry (horizontal) acid recirculation system, which ensures a minimum of acid drag into the wringer-roll tanks.

Thanks to a perfect gas-tight water seal between the tank and its lids, acid fumes are drawn off from the wringer-roll tanks and cleaned in a one- or two-stage scrubber to ensure minimum emissions to the environment. The rinsing section, typically a five-stage counter-cascade type with a high-pressure ramp, ensures the lowest possible chloride residuals on the strip surface after it leaves the process section.

The use of residual heat is a common energy-optimization measure. In the pickling lines, Siemens VAI recovers heat from the condensate in two areas of the acid-circulation systems. One measure is the preheating of the fresh acid delivered by the acid regeneration plant, and the other is the preheating of the last rinsing stage during restart after a line stop.

All of these approaches provide a highly efficient pickling process, which becomes even more effective when integrating the fully automatic pickling liquor analysis and control system (Faplac) with plug-and-play functionality into the overall control and model architecture of Siroll CM. From an environmental point of view, Faplac is the best system for optimizing the feed of fresh pickling liquor and minimizing the discharge of used pickling liquor. In addition, Faplac enables reduced operating costs and provides state-of-the-art pickling process automation.

## Conclusion

Even if the pickling cold-rolling operation is mostly seen as a low-potential field with regard to energy saving and environmental protection, there are a number of examples on how a PLTCM can contribute to energy savings and minimum to zero emission output. This paper is an extract of the solutions provided by Siemens VAI. For further information feel free to contact us. ■

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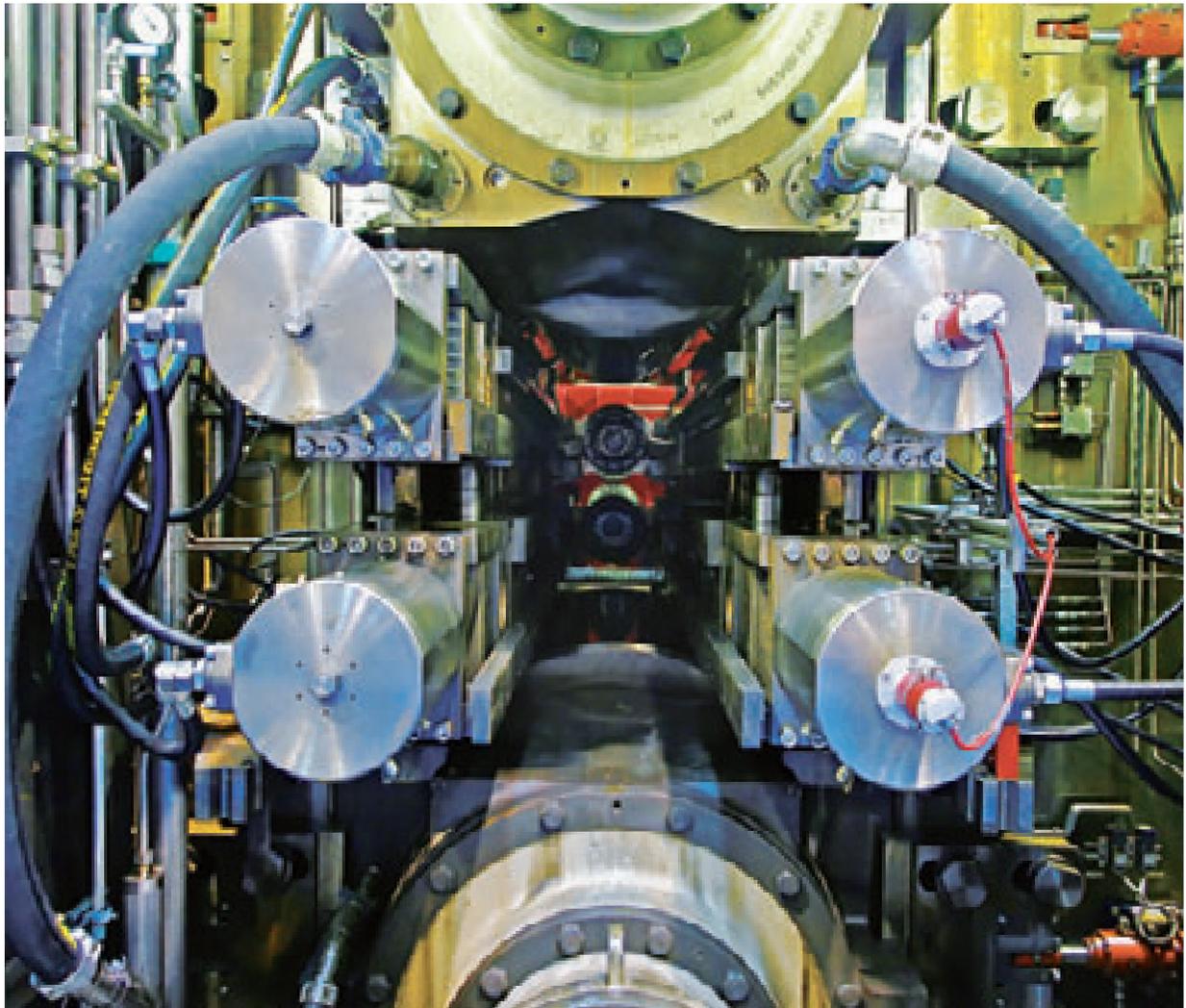
Triple-A: an advanced cold-rolling model to optimize the design of the final mill stand

# For a Superb Mill-Stand Design

The final pass in a cold-rolling mill involves the rolling of small strip gauges with high material strengths. High deformation forces are required to accomplish the final thickness reduction, which frequently leads to excessive work-roll flattening. This roll distortion places practical limitations on the rolling capability and thus on the final achievable product thickness. To ensure that a cold mill will be capable of rolling a defined product mix to the foreseen final strip thicknesses, Siemens VAI applies a highly sophisticated rolling model known as Triple-A to optimize the design of cold-rolling-mill installations. This tool can also be used to evaluate the performance of existing mill facilities as the basis for targeted upgrades to maximize rolling performance.

Siemens VAI uses the Triple-A rolling model to optimize the design of mill stands

ROLLING >



The rollability of a material (i.e., the aptitude for rolling) has to be distinguished between its theoretical and practical rollability. The theoretical rollability limit is reached when the strip thickness does not further decrease despite increasing work-roll pressure. This often results in pronounced work-roll flattening as illustrated in Figure 1: additional rolling forces applied only lead to an increased elastic deformation of the work rolls. In many rolling mills the practical rollability limit is reached before the theoretical rollability limit due to limitations in the installed rolling forces, mill power (or motor torque) and other technological constraints. The latter includes, for example, the maximum allowable draft to ensure that no slippage occurs between the work roll and strip, or reduced rolling forces that are applied to prevent strip-flatness defects. Figure 2 depicts an example of a deformed work-roll contour and the underlying calculated contact-pressure distribution between the work roll and strip during the final pass in a double cold-reduction mill for the production of tinplate.

Classical cold-rolling models typically apply simplifying measures to evaluate the conditions and operational parameters during the final rolling pass. For example, a constant coefficient of friction within the roll bite is often assumed. An enlarged work-roll circumference with a constant curvature radius is also applied to model elastic work-roll flattening. In extreme cases, work-roll deformation is ignored altogether, which often leads to inaccurate and useless calculation results.

### Features of the Triple-A rolling model

The Triple-A cold-rolling model was developed by Siemens VAI and is applied to optimize the mill-stand design of rolling mills of any type, including tandem cold mills, reversing cold mills, double cold-reduction mills and temper/skin-pass mills. The model is capable of evaluating a complete spectrum of rolling scenarios that include the rolling of very thin and hard strip of numerous steel grades produced at different capacities and in different qualities. The heart of the Triple-A simulation tool is a series of specially developed and highly sophisticated mathematical models that drastically reduce calculation efforts and costs in comparison with conventional FEM (Finite Element Method) models based on commercial software packages.

Triple-A, which stands for Advanced Arbitrary Arc, takes into account a noncircular arc deformation of the roll surface for the calculation of elastic work-roll flattening. In addition to the radial displacements of the work-roll surface, circumferential displacements, which are generated mainly by the acting shear stresses between the work roll and strip, are also taken into account. This type of roll-surface deformation considerably affects the relative speed (slip speed) between the surface of the deformed work roll and the strip. Consequently, the evolution of frictional forces between the work rolls and strip is further influenced by these displacements, which continually increase with decreasing strip thickness and draft – particularly when rough work rolls are used, such as in a skin-pass mill or in >>

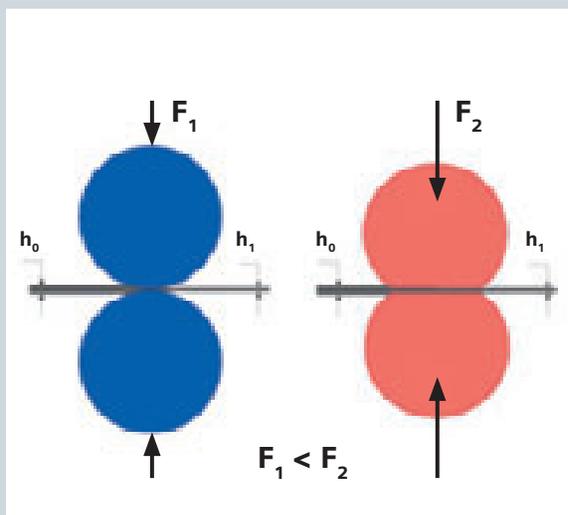


Fig. 1: The theoretical rollability limit is reached when additionally applied rolling forces ( $F_2$ ) result in elastic deformation of the work rolls

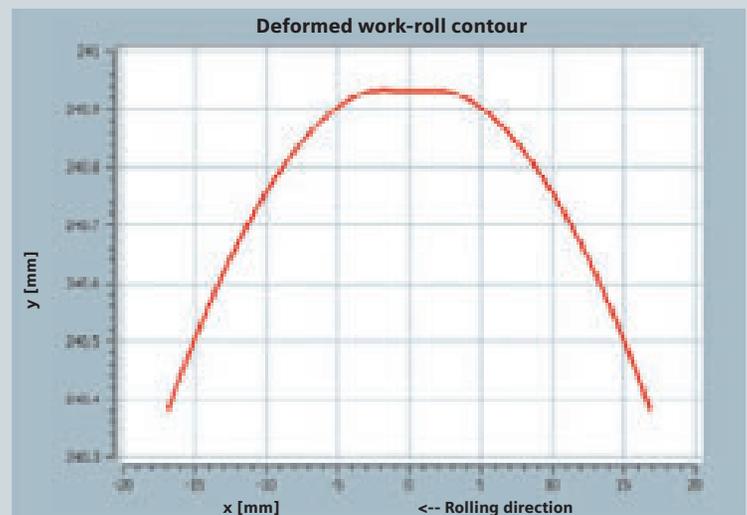


Fig. 2: Example of a deformed work-roll contour during the second pass in a double cold-reduction mill

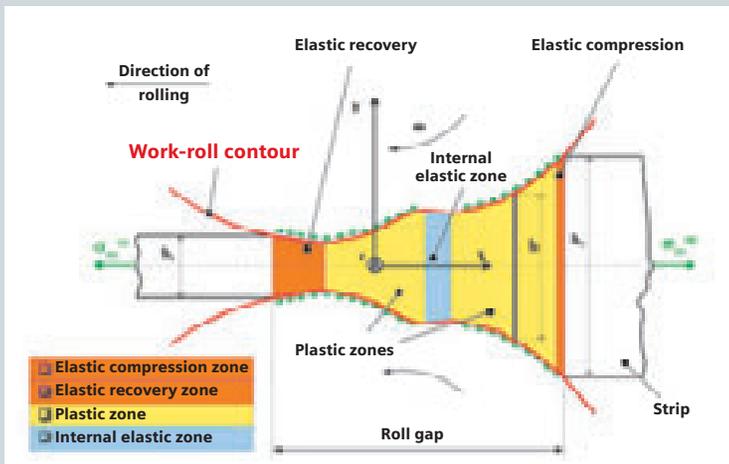


Fig. 3: Additional elasto-plastic strip deformations that can be accounted for by Triple-A

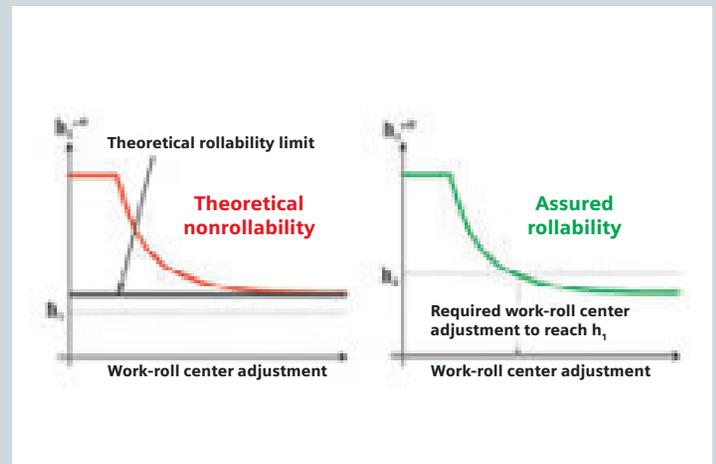


Fig. 4: Detection of theoretical nonrollability (left) and assured rollability (right) ( $h_1^{\text{eff}}$  = exit thickness of strip,  $h_1$  = targeted exit thickness of the strip)

$\gg$  the last stand of a tandem cold mill. Circumferential work-roll displacements that allow slip- and no-slip zones inside the roll bite can be accounted for. The formation of a neutral zone, where the tangential roll speed matches the strip speed – as opposed to a neutral point – is a consequence of this approach. Furthermore, a major benefit is derived in that the rollability and reduction capability of strip can be determined very accurately in comparison with existing cold-rolling models.

The Triple-A model is based on a strip-segment model in combination with the widely applied strip-rolling theory of Hungarian-American engineer and physicist Theodore von Kármán. However, Triple-A additionally considers an underlying rate-dependent elasto-plastic deformation of the strip, and includes several extensions such as an elastic compression zone at the roll-gap entry; an elastic recovery zone at the roll-gap exit; possible intermediate plastic zones; and internal elastic zones between the plastic zones (Figure 3).

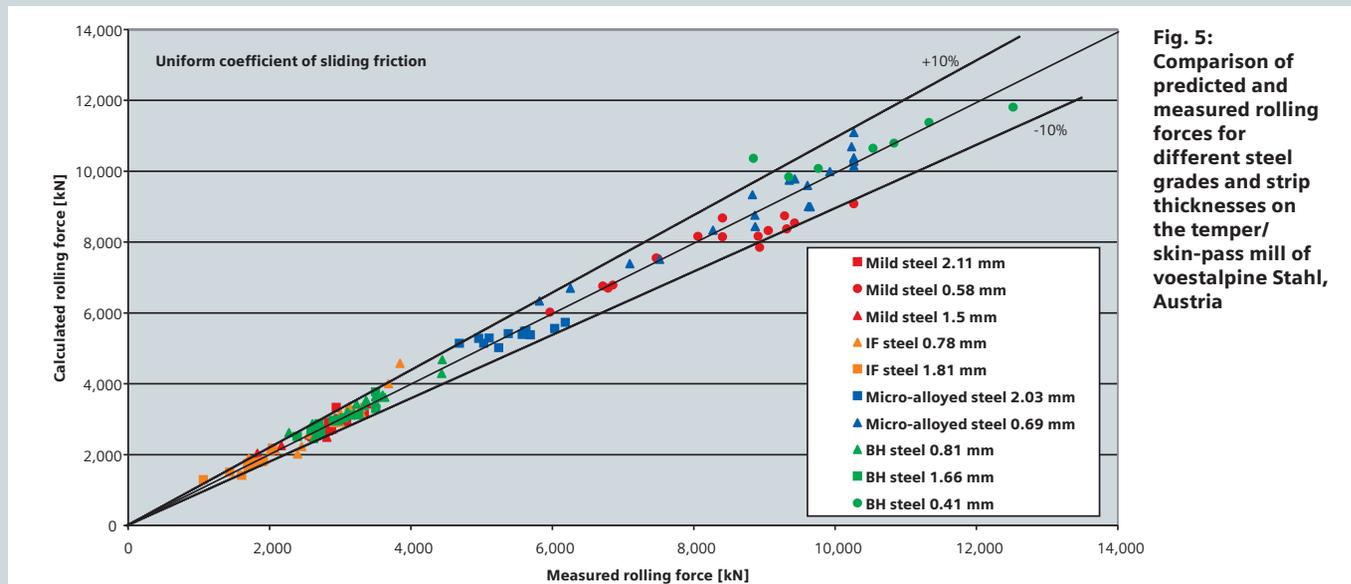
The algorithm for the determination of contact between the work roll and strip is based on an iterative procedure: The contact stresses (compressive and shear stresses) are calculated for a given distribution of strip thickness and slip speed on the surface of the strip. The resulting contact stresses are applied to the work-roll surface. This in turn yields a new deformation and speed state of the work-roll surface that serves as input for the next iteration step. In a first attempt, the resulting contact pressure is calculated

while keeping the strip thickness reduction constant. In order to ensure the prescribed draft, the work-roll center has to be adjusted during the iteration scheme according to the resulting work-roll deformation from the previous step. This method offers the key advantage that rollability can be evaluated on the basis of this approach: As can be seen in Figure 4, if the strip exit thickness  $h_1^{\text{eff}}$  does not decrease any further in the course of the iterations – although the work-roll center is adjusted more and more to the strip – then the nonrollability or theoretical rollability limit is detected. An advantage of the Triple-A model is that calculations can be continued up to and beyond the practical and even the theoretical rollability limits.

A comparison of simulation results from the Triple-A model with results from FEM simulations indeed shows good agreement for all rolling passes. However, under more extreme rolling conditions, for example during the final pass in a tandem cold-rolling mill, the results from a classical circular arc-based rolling model vary considerably from the results of Triple-A.

#### Industrial application

The Triple-A cold-rolling model was calibrated and is continually optimized on the basis of operational data from industrial cold-rolling mills. This modeling tool has already been applied by Siemens VAI in the design of more than 20 rolling mills of all types for the rolling of hundreds of steel grades and prod-



**Fig. 5:** Comparison of predicted and measured rolling forces for different steel grades and strip thicknesses on the temper/skin-pass mill of voestalpine Stahl, Austria

uct dimensions. A strong correlation between predicted and actual rolling forces can be shown on the basis of industrial plant operations. For example, Figure 5 illustrates the predicted and measured rolling forces for different steel grades, strip thicknesses, strip tensions and mill speeds on a one-stand temper/skin-pass mill at voestalpine Stahl in Linz, Austria. Nearly all of the predicted results lie within 10% of the measured results, demonstrating the validity and computational accuracy of Triple-A.

The performance of existing mills can also be evaluated using Triple-A. In cases where mills are operating at suboptimal performance, the tool is capable of indicating the required roll force, roll/motor torque and motor power that would be necessary for the mill to achieve its maximum potential. The post-installation of more powerful motors, or the use of rolls with different sizes and with other material properties, would enable producers to expand their product mix with respect to steel grade, product quality and final strip thickness – all at relatively minor investment expenditures.

Triple-A thus represents a powerful tool for the layout, design and optimization of new cold-rolling mills and for the modernization of existing facilities. ■

### Main Benefits of Triple-A

- Exact calculation of required rolling forces and motor torques as the basis for an optimum mill-stand design
- Assurance of the rollability of the foreseen strip products in the required dimensions
- Evaluation of existing mills with respect to rolling performance
- Suitability as tool to upgrade existing mill installations and to expand product mix



An optimized design of the mill stands is the basis for high-performance rolling mills

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Latest results in the development of tribological simulation models

## The Quest for Excellence

An accurate and comprehensive understanding of the rolling process, particularly with respect to tribological factors and diverse friction regimes in the roll bite, is essential for optimized and cost-efficient mill operations as well as high product quality. In a joint cooperation between renowned partners from different disciplines involved with rolling, new tribological simulation models are being developed and optimized to provide greater insight into the fascinating world of lubricants.

**R**olling forces, mill-power requirements and strip-surface quality are widely influenced by the composition of the lubricant and the manner in which it is applied. Therefore, in modern cold rolling a deeper knowledge of the interaction of tribological<sup>1)</sup> parameters (roughness of work rolls and strip, asperity<sup>2)</sup> flattening, lubricant composition, temperature evolution in the bite, plate-out<sup>3)</sup>, generation of boundary films, etc.) and their effect on friction in the roll gap is decisive for the continuous optimization of the rolling process. These factors are particularly important for the rolling of high-strength steel grades and thin gauges.

### **Demands placed on tribological simulation models**

A wide range of mathematical models already exist for simulating cold-rolling processes. From very basic analytical descriptions up to highly specialized, finite-element calculations, these models are based on the assumption that friction between a work roll and metallic strip may be characterized by a single parameter such as the coefficient of friction. In actual rolling processes, however, friction depends on many variables such as the rolling speed, surface roughness of strip and the work roll, steel grade, and the composition of the lubricant. Under normal rolling conditions, friction is expected to take place in a



5-stand cold-rolling mill of voestalpine Stahl – the Austrian steel producer contributes its operational experience to the development of tribological simulation models for improved cold rolling

so-called mixed lubrication regime where the rolling force is affected by the boundary contact forces at the asperities and by the fluid forces of the highly pressurized lubricant between the asperities. Consequently, accurate modeling of fluid-structure interactions involving coupled and highly complex nonlinear equation systems is one of the key characteristics of a mixed-lubrication numerical simulation. The challenge for the simulation process is to find submodels that cover all of the decisive influencing factors while still being able to solve the related coupled equations within a reasonable calculation time.

### Contributions from experienced partners

In order to improve the understanding of tribological interactions that influence friction and lubrication in the roll bite, several highly experienced and qualified partners from different backgrounds have been working closely together since early 2009. Siemens VAI contributes with its extensive know-how related to the engineering, supply and construction of rolling mills. In the company’s pilot mill facility in Montbrison, France, the rolling process and tribological parameters are investigated. The results serve as the basis for model calibration and parameter identification. Quaker Chemical Corporation, one

of the world’s leading suppliers of lubricants in the rolling industry, develops specialized lubricants for the pilot mill trials that allow the influence of various physical and chemical parameters to be investigated. Quaker also provides support in the mathematical description of lubricants. The Austrian steel producer voestalpine Stahl makes available its considerable know-how related to mill operations for the production of premium-quality steel products, and offers its profound insight into metal-forming processes and their impact on surface quality. The lion’s share and the essential portions of the modeling activities are performed at the Institute of Computer-Aided Methods in Mechanical Engineering at Johannes Kepler University (JKU) in Linz, Austria.

### Core components of tribological simulation models

Particular emphasis is placed on a modular approach for the development of a comprehensive model of friction and lubrication in cold rolling. This approach increases the flexibility of the process models with respect to the different degrees of complexity of the submodels (Figure 1).

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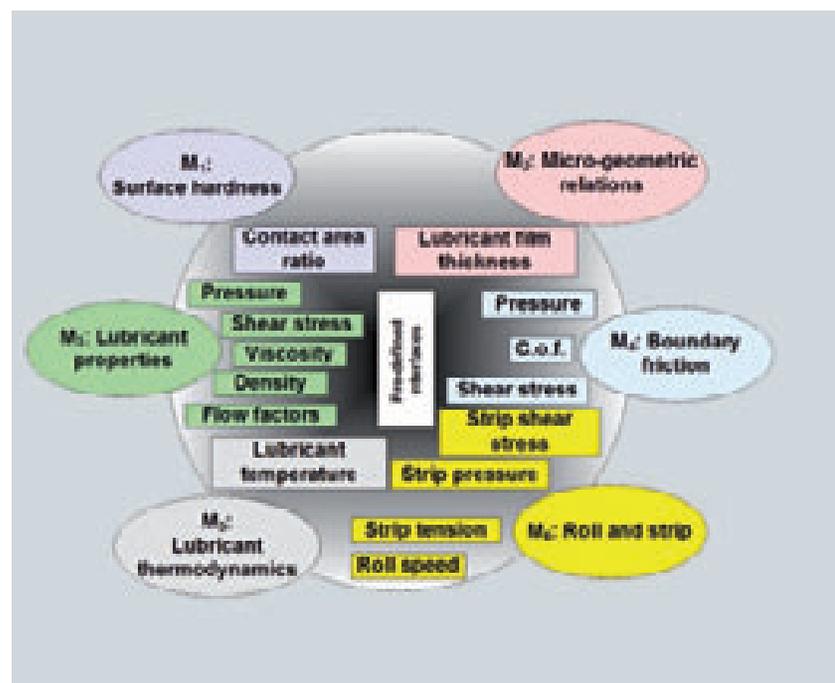


Fig. 1: Examples of parameters and their interaction considered in the tribological modeling of cold-rolling processes

- 1) Tribology is the study of interacting surfaces in relative motion with respect to friction, lubrication and wear.
- 2) Asperities are roughness peaks of strip and roll surfaces.
- 3) Plate-out is the spreading out of oil droplets from the emulsion on the surface of strip and work rolls.

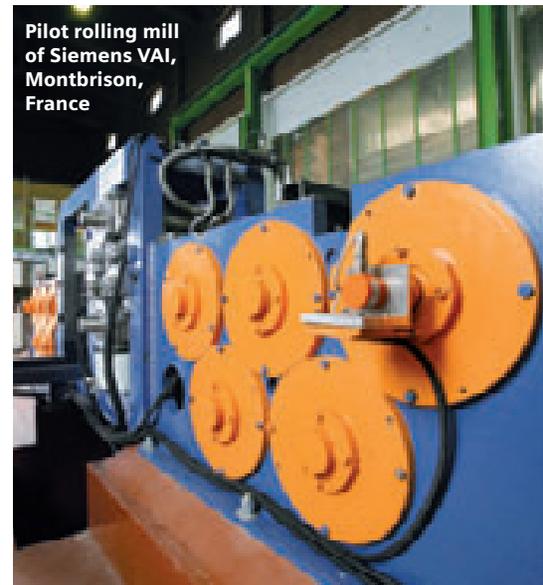
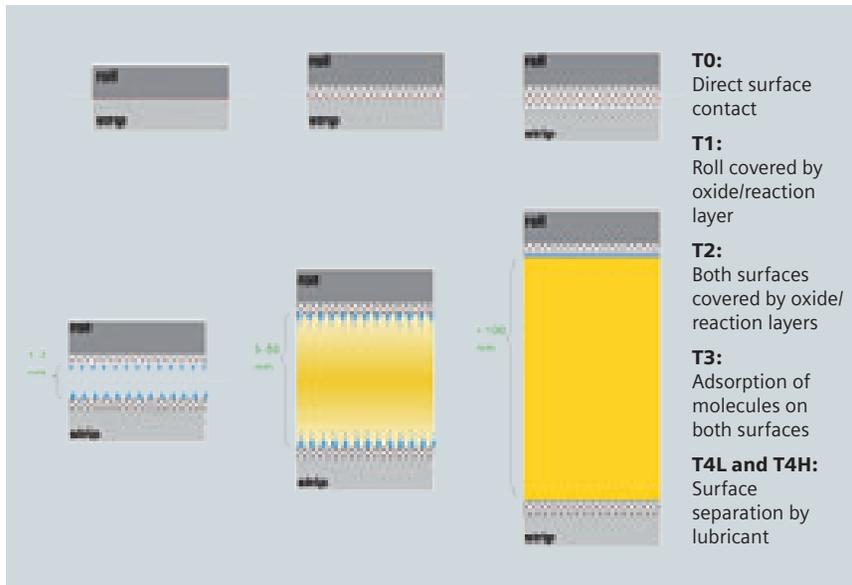


Fig. 2: Definition of contact conditions between strip and roll surfaces

>> An accurate description of the evolution of the surface geometry during a rolling pass is essential for an analysis of local friction types and their relative contribution. This is also important for accurate predictions. The model describes how the surface geometry evolves as a function of the lubricant properties, among other factors. Complex interaction mechanisms between local strip-surface deformation and bulk plastic yielding, which usually require the application of time-consuming, 3D finite-element simulations, are calculated by a simplified yet effective analytical “hardness model” that incorporates the combined influence of fluid and contact pressures. Due to strip deformation, friction and fluid

effects (e.g., heat dissipation), the temperature in the contact area is expected to significantly increase compared to ambient conditions. For this purpose, a comprehensive, highly efficient thermodynamic submodel is used that considers the strip, roll surface and lubricant film. The overall tribological model is formulated in a way that it can be coupled with different cold-rolling models.

**Investigation of the contact zone between roll and strip surfaces**

Several types of contact that exist between strip and roll surfaces in cold rolling have to be distinguished for proper prediction of friction regimes (Figure 2).

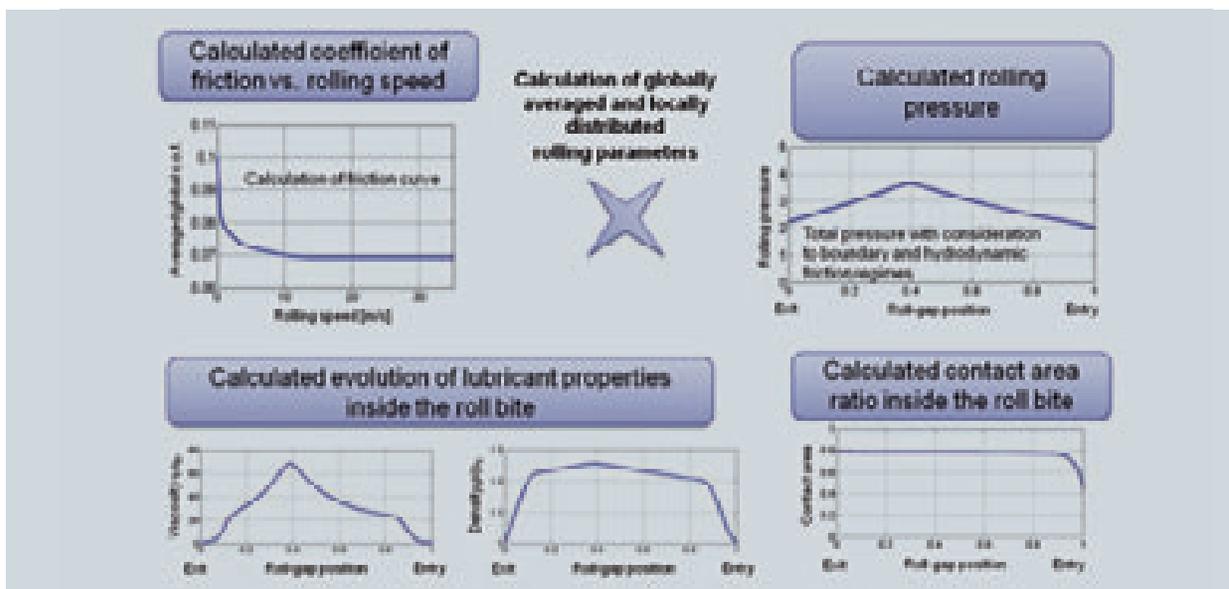
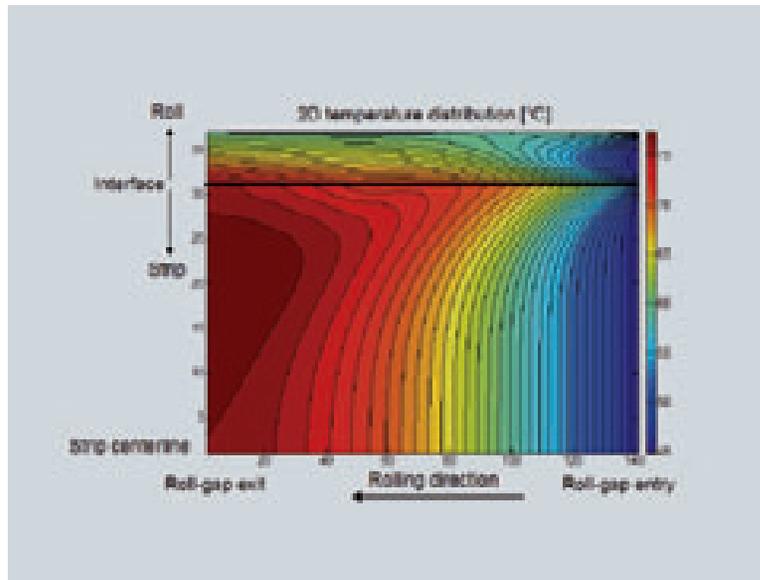
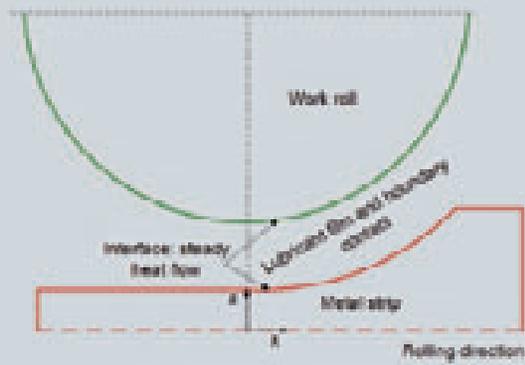


Fig. 3: Distributed and averaged roll-bite parameters



**Fig. 4: Temperature development and distribution at the interface between the roll and strip surfaces**

Friction and surface protection (i.e., avoidance of defects) are affected by a surface coverage of adsorption layers and layers of reaction products, especially during the occurrence of intensive, high-pressure contacts between the work roll and strip. Significantly reduced frictional forces arise in film-dominated contacts, the thickness of which depend on the applied lubricant and the prevailing rolling conditions.

Joint investigations between the project partners have led to a classification of these types of contact. Using these classifications and by applying state-of-the-art theories on the underlying physical and chemical effects, the respective mathematical formulations could be developed and integrated into the overall tribological model. As the interactions at a lubricated contact are strongly affected by physical and chemical mechanisms, one of the major challenges in modeling is the integration of these mechanisms into the descriptive equations. In this context, the participation of Quaker in the project team is an immense asset, as this lubricant manufacturer provides valuable laboratory equipment and evaluation methods necessary for the tribological investigations.

#### Solution aspects and simulation results

The calculation algorithm (i.e., sequence of calculation steps) is based on several iterations during which the contact conditions, lubricant, strip properties and roll shape are continually updated. Model results comprise the distribution of local lubrication values along the roll bite related to, for example, viscosity, density and temperature (Figure 3). These values are strongly affected by the distribution of the fluid pressure and the temperature along the roll bite (Figure 4).

From these value distributions a global characteristic value can be extracted through integration. For example, an accurate prediction of the relationship between the rolling speed and friction (with consideration to the specific lubricant and rolling conditions of a particular mill stand) eliminates the need to enter any assumptions into the pass schedule calculations with respect to the coefficient of friction.

#### Benefits from enhanced friction modeling

The application of specialized tribological models contributes to a considerably improved understanding of the relationship and interaction between various rolling and lubricant parameters. Results obtained from tribological process simulations may be used in a wide range of applications. The development of new rolling oils will be facilitated, leading to enhanced and customized lubricants to meet the exact requirements of a rolling mill. Furthermore, the utilization of accurate simulation tools will enable improved predictions of force and power requirements for new mills and for the optimization of existing mills. Mill operators will benefit from improved pass-schedule calculations and optimized mill-operation regimes; higher productivity; improved and uniform strip surface quality; and reduced energy costs. ■

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Effective modernization and extension strategies for compact hot-strip mills

# Smooth Path to Thinner and Better

Siemens has proven again to be the first choice when it comes to the electrics and automation of compact hot-strip mills. Two recent projects serve as excellent examples: The first project presented here involved the modernization of the automation system at the Hyundai Compact Steel Plant (CSP) plant in South Korea. The second project entailed the extension of the electrics and automation at the new Bhushan Power & Steel Ltd. CSP plant in India.

**T**he former Hanbo Steel compact hot-strip plant, commissioned in 1995, was shut down for several years during the Asian economic crisis of the late 1990s. In 2005, the plant was restarted by INI Steel, which ultimately became part of Hyundai Steel.

To bring the mill up to speed, several modernizations were planned and executed after the 2005 restart. Initial upgrades and extensions performed

by Siemens included converting the coiler control to Simatic TDC, upgrading the HMI from COROS LS to the WinCC system, and installing the SIAS surface inspection system in 2007.

In 2008, operators at Hyundai decided to revamp the rolling mill's automation system. The goals of the revamp were to consolidate several different automation systems, improve control quality and system availability, and ensure the availability of



Extended finishing mill with now six stands and the cooling section of the compact hot-strip mill

spare parts for the future. This upgrade replaced the basic automation including the stand controller, updated the HMI to the new Siroll WinCC-based HMI, and replaced the process automation models, including the profile and flatness model. Naturally, the revamp meant that the old automation from Siemens and other suppliers had to be replaced: SimadynD systems as well as systems from other suppliers for basic automation were replaced with the new Siroll system using Simatic TDC and S7 components; Windows server-based computers for process automation took the place of the old OpenVMS-based computers.

The innovative Siroll HM automation concept, which provides an extended modular approach compared to the previous generation, increased the effectiveness of the engineering and the commissioning for this new modernization step.

A yearly shutdown of several days as well as regular maintenance shutdowns allowed for the revamp to be planned and performed with a shadow mode period in which the new automation was tuned in parallel to the old automation. During this time the new system received the same data as the existing system. As a result, the new system could be pre-optimized before the switchover and could also be tested using tracking signals. The shadow mode allowed for a planned shutdown of just ten days for

the exchange of the automation system, including the cable work.

After an integration test in Erlangen, Germany, in November/December 2009, the automation system was then shipped to the site in Dangjin, South Korea, where it was assembled. The revamp period started in March 2010.

After the pre-optimization phase, the plant was shut down on August 9, 2010, and the old automation equipment was disconnected and the new equipment was connected. The work proceeded well ahead of schedule and the new automation equipment was ready three days before the planned restart of the mill. The first two test strips were rolled successfully on August 15. Subsequently, all production, including the caster, was started two days ahead of schedule on August 17. Pre-shutdown production levels were reached after only five days of the first coils, and just three days after the scheduled restart.

As a result of successful pre-optimization of the system and support by the improved modular Siroll concept for the basic automation, the rolling of thin strips was achieved quickly. The updated AGC in the new Siemens stand controller allowed for the first 1.8 mm strip to be rolled on August 18. On August 19, a 1.6 mm strip was rolled, and on August 20, four strips with thicknesses of 1.4 mm were rolled. Finally, on September 19 a strip with a thickness of 1.2 mm was rolled – a milestone in the plant's history.

Thanks to the continuous optimization of the technological controller, the setup models, the profile and flatness model, and the new cooling model during the optimization phase, the targets for the upgrade of the automation system were reached in a relatively short period of time and ahead of schedule. The final acceptance test was completed by the beginning of December 2010, and Hyundai issued the final acceptance certificate on December 14, 2010.

The highly efficient revamp of the CSP plant benefits Hyundai in the following ways:

- Better integration and a better-performing stand controller
- Improved profile and flatness control
- Higher production flexibility
- Ability to produce modern steel grades
- Higher availability of spare parts

#### **Bhushan CSP extension**

In 2004, Bhushan Power & Steel placed the first order with Siemens for electrics and automation for its new CSP plant in Jharsuguda, in the Indian state of Orissa. In February 2008 Bhushan Power & Steel >>



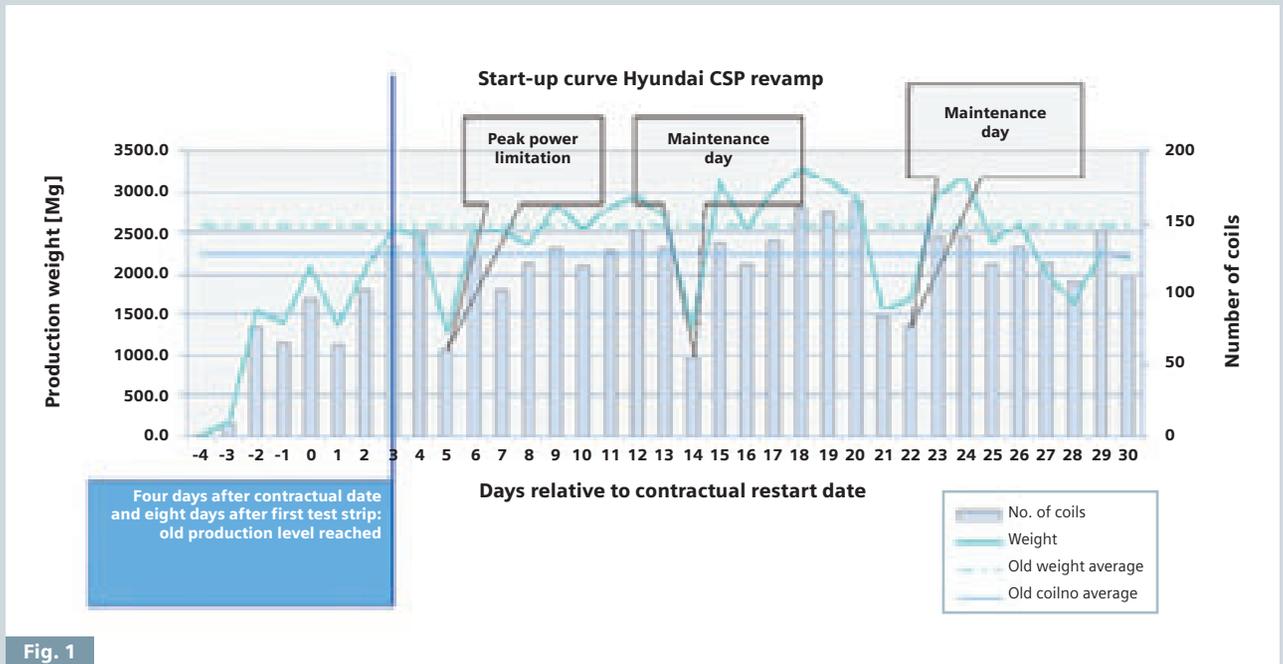


Fig. 1

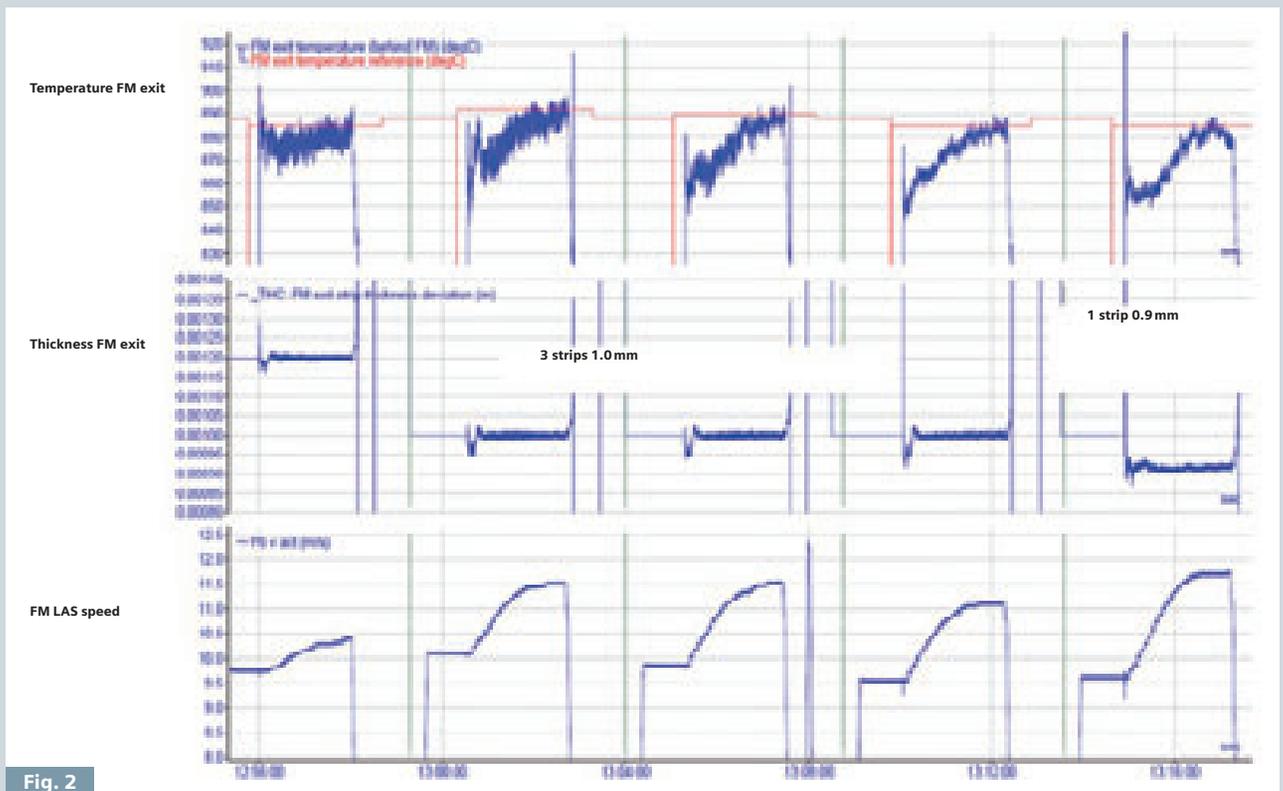


Fig. 2

Fig. 1: Start-up curve after the revamp shutdown at Hyundai

Fig. 2: Charts with the values for the 1 mm strips at Bhushan CSP plant after the extension

>> signed the contract to expand the 1-strand, 5-stands, 1-coiler mill to a 2-strands, 6-stands, 2-coiler mill. The extension was built and commissioned in 2010, and the first strip with 1.0 mm thickness was rolled on August 18, 2010.

Siemens delivered the entire electrics and automation, including the motors, drives and the automation for the extension. With the adaption of flexible models to accommodate the 6-stand setup – as well as the implementation of the stand controller for the new stand F6 and its integration in the automation system during the anticipated shutdown time – a smooth restart and fast ramp-up of production was ensured.

After only a few weeks of fine-tuning and commissioning, the efforts were rewarded with the successful production of the first strips with 1.0 mm exit thickness. In fact, as shown in Figure 2, a total of three strips were rolled with 1.0 mm target thickness, as well as one strip with 0.9 mm thickness. The engineering teams – formed of local employees from Siemens India and from headquarters in Erlangen, Germany – worked together during engineering and commissioning phases. Behind their success is a long tradition of close cooperation in the field of hot-strip mills in India.

The new main drive system for stand F6 consists of a Sinamics medium-voltage cycloconverter and a non-salient pole motor with a rated power of 7 MW at 160/560 rpm. The new coiler drive is a low-voltage system with 600 kW for the mandrel and 2x260 kW for the pinch rolls.

Since October 2010, more than 20% of production at Bhushan Power & Steel has been below the thickness of 1.6 mm thanks to a high-quality automation system. With the fast restart and effective commissioning of the electrics and automation equipment, Siemens ensured that the plant extension became a full success for its customer, who signed the acceptance for the electrics and automation on October 15, 2010.

### Summary

With these two recent examples, Siemens has again proven its competence, reliability and efficiency in providing state-of-the-art hot-mill rolling technology to its customers. The electrics and automation technologies from Siemens for modernizations and extensions use concepts that ensure minimum shutdown times with fast production start-up. ■



1 Produced coils on the coil conveyor after the production restart at Hyundai

2 Operator observing the fully automated rolling process at Bhushan CSP

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Electrical services – customer support for the entire plant operating life

# Life-Cycle Services – A Crucial Factor for Investment Decisions

Plant operators are increasingly considering the total cost of ownership when making investment decisions. In fact, recent studies indicate that total life-cycle costs can amount to three times that of an initial investment. Thanks to its wide experience, the Siemens VAI service network is in a position to help increase plant availability and productivity and keep production costs low.

## New service Agreement for the Hot-Strip Mill of Isdemir in Iskenderun, Turkey

Turkish steelmaker Iskenderun Iron & Steel Co. awarded Siemens VAI a new service agreement for its hot-strip rolling mill. The effectiveness and competitiveness of the plants are also being stepped up. The hot-strip mill has been in operation since 2009.

In order to achieve maximum customer benefit in operation of the hot-strip mill, a service strategy was tailored to the individual needs of Isdemir. This finally led to a service agreement with one of the most significant steelmakers in Turkey with an annual capacity of 3.5 million tons. The service agreement covers both preventive and reactive maintenance activities, training schedules for the operating personnel, and technological optimization of the entire roughing and finishing mills.

Essential reasons that the customer awarded the service agreement to Siemens VAI include early integration of the service organization during project execution (service-manager strategy), regular service assessments, reaction times promised by Siemens VAI in combination with the preventive maintenance activities, and involvement of the regional Siemens company in Turkey in the offer phase.

In order to prevent downtimes and reduce the number of negative effects, the service agreement includes a hotline with 24/7 service and clearly defined response times.

This service package is tailored to ensure that Isdemir will be able to comply with increasing market demands in the future.

After project completion, the Siemens VAI commissioning team leaves a site, making room – if the customer wishes – for Siemens VAI employees who carry out customized plant-related services during day-to-day operations. The Siemens VAI service network yields unique benefits: First service-level support is provided by local Siemens personnel who speak the customer's language and can respond quickly in the event of an unplanned shutdown. The regional Siemens VAI service experts are supported by a pool of specialists in headquarters to back up the local organization.

To ensure the shortest response times as well as the utmost technological support, Siemens VAI has set up a powerful, worldwide service organization: Leveraging its worldwide Metals and Mining Service & Support Center (MSC). The MSC with its core elements “expert help desk,” “dedicated service managers” and “integration of service into the project-handling process” covers all aspects of the metals industry, and it is closely linked with the Siemens VAI regional organizations. Customers can therefore discuss their problems with and address their support requests to the MSC help-desk personnel directly and can be sure that their queries have been understood correctly and solutions are found without delay.

Complementing the MSC is the cRSP remote access platform from Siemens VAI, which is integrated in all capital projects provided by Siemens VAI. This technology provides a safe and reliable remote connection that uses innovative methods for authentication and authorization, modern cryptography and logging mechanisms, and strictly supervised work-

flows within the MSC. The platform ensures highest data security and puts all data accesses under full customer control.

### Life-cycle service support

Life-cycle service agreements are not limited just to troubleshooting; the goal is to avoid unplanned shutdowns. Siemens VAI provides a wide spectrum of services, ranging from on-call service, corrective maintenance with guaranteed response times to planned maintenance with on-site health checks or taking over the complete plant maintenance. Further support options include remote service, remote data analysis with off-site health checks, changes, add-ons and process modifications, as well as support for software updates and upgrades, plus additional training.

The goal of all contracts is to work in close cooperation with customers, helping them to achieve a competitive edge.

### Spare-parts management

Another life-cycle issue is the availability of correct spare parts delivered at the right time. Having too many unneeded spare parts ties up capital. Conversely, a lack of critical spares can cause unplanned shut-

downs, creating considerable costs and potentially compromising contract fulfillment.

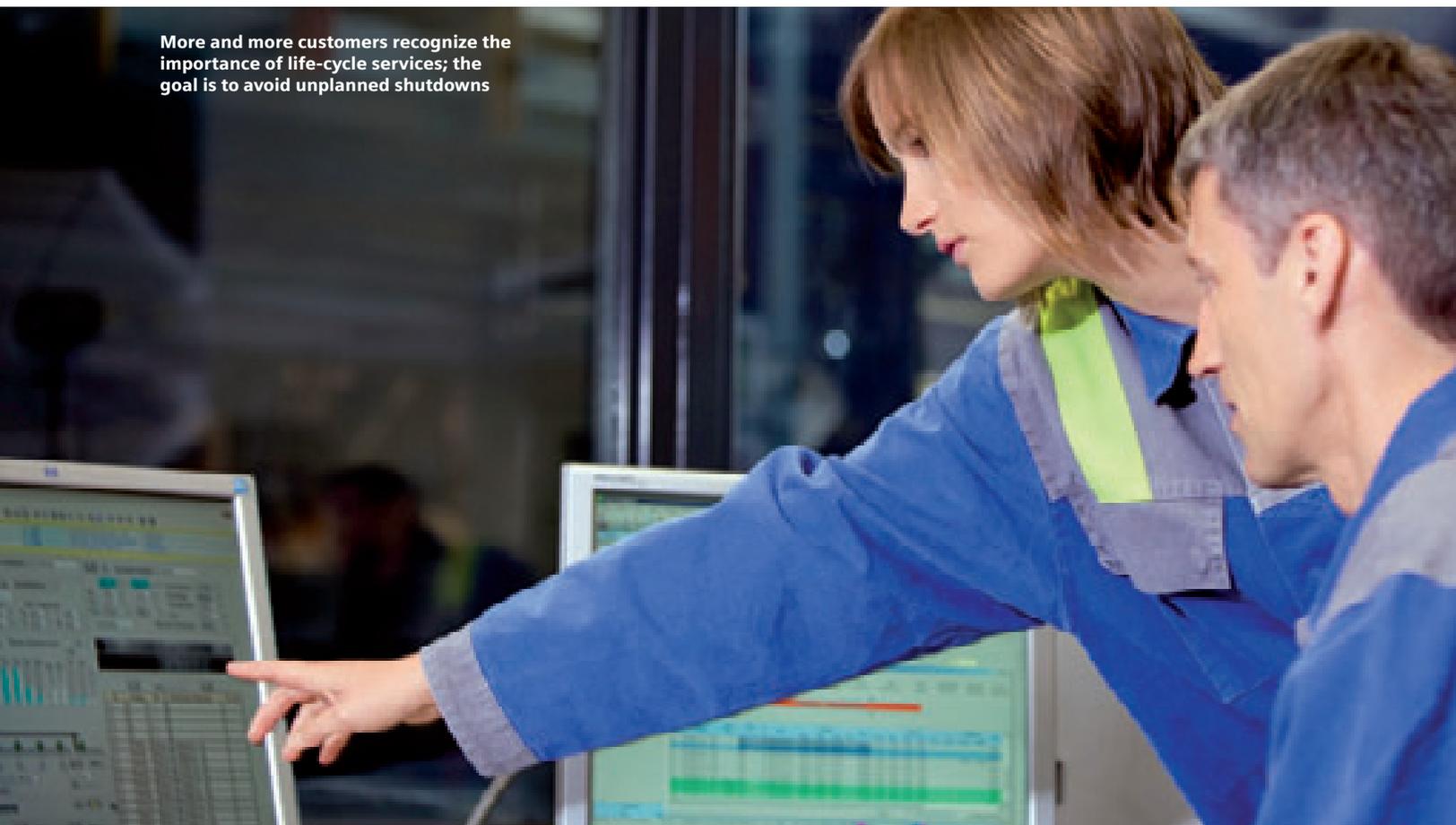
Siemens VAI can act as a long-term partner and cover spare-parts handling. With its global production sites and worldwide procurement network, Siemens VAI ensures shortest delivery times, especially in emergency cases. The company is set to deliver original components, and if these are no longer available, provide appropriate replacement solutions.

### Summary

More and more customers recognize the importance of life-cycle services and the advantages of a closely linked cooperation between capital project and the Siemens VAI service teams. This helps plant operators to lower their total costs of ownership. Siemens VAI offers a wide range of services to help cut both operating and maintenance costs. ■

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**More and more customers recognize the importance of life-cycle services; the goal is to avoid unplanned shutdowns**



Continuous improvements in life-cycle services

# Customer-Embedded Maintenance Organization

The implementation of a maintenance organization in full integration with the customer's company structure can yield continuous improvements in equipment performance, product quality and total cost of ownership for steel-plant operators.

SERVICES >



Siemens VAI experts discussing maintenance services

One of the primary goals for a plant operator is to reduce the overall cost of operations. A service department, therefore, needs to direct its maintenance spending to the areas where it obtains maximum leverage. Trying to save money in the wrong area – often associated with conventional concepts to reduce maintenance costs – can have detrimental consequences. Ensuring the highest efficiency for maintenance spending is of the utmost importance for every steel-mill operator.

## Equipment effectiveness as a service goal

Siemens VAI has offered maintenance services for a long time. With its strong worldwide network of maintenance operations – coordinated and supported by a business-development group in Austria – Siemens VAI develops new concepts for maintenance contracts and continuous process improvement.

Component life improvement is the key to boosting overall equipment effectiveness. This approach

helps to lower total maintenance costs and ensures meeting plant operators' performance criteria. "No wear" during the lifetime of a component is an example for a maintenance goal that helps to secure consistent slab quality. The successful implementation of this guiding principle can be seen from the wear pattern of bender zone rolls after processing 600,000 tons of slab cast. Virtually no wear (less than 0.2 mm) was observed before the end of the roll lifetime.

## Elements of successful life-cycle services

An important element of successful maintenance outsourcing is the awareness of risks and continued endeavors to avoid them. One of the most frequent pitfalls is that steel operators do not sufficiently acknowledge the value of indirect activities like predictive maintenance activities, continuous improvement and quality assurance. Purchasing maintenance services at the lowest price leads to a degradation of maintenance quality, compromising product quality, equipment performance and equipment lifetime. By contrast, most successful steel operators are continuously increasing the share of indirect maintenance activities.

Successful operators have changed the mindset of their purchasing organizations. Fighting for the lowest price and toughest terms may be effective in projects for delivery of equipment, but it is not a viable basis for a long-term partnership. Such cooperation requires a prequalification of partners and a contract model that aligns both parties' goals and strategies with performance-based payments. These payments need to reflect service cost structures and set incentives in line with a continuously evolving strategy.



### Siemens VAI – long-standing maintenance experience

With 25 years of experience in maintenance operations in the United States, Brazil, South Africa and China, Siemens VAI offers a sustainable partnership for steel plant operators with a specific focus on the area of continuous casting.

#### Service success stories

Bethlehem Steel in Sparrows Point, Maryland, U.S.A., contracted Siemens VAI in 1985 to provide offline maintenance services for their then new caster. Since the plant operator did not want to go through the maintenance learning curve for their two VAI-delivered slab casters, the maintenance scope included a wide choice of services: preventive maintenance activities, in-plant unit changes, repair and refurbishing work, service-life improvements of repaired units, and manufacture and maintenance of spare parts.

Companhia Siderurgica Nacional (CSN) in Brazil awarded a contract for offline caster maintenance to VAIS do Brasil (now Siemens VAI) in 1999. The contract was renegotiated in 2002 with several changes such as shifting to monthly payments per ton produced and streamlined administrative procedures. The contract scope was then extended to further services like refurbishment of molds, segments and

caster rollers as well as the nickel-plating of mold copper. Further services include spare-parts management and procurement.

The obligations of CSN were simplified to performance control and monthly payments. The new contract enabled further developments such as segment changes in the caster as well as measurement, adjustment and lubrication services. Siemens VAI subsequently introduced new developments such as internally cooled rollers or special welding wires for longer “no wear” roller lifetime.

The ThyssenKrupp integrated steel plant in Sebetiba, Brazil, commissioned Siemens VAI with a 15-year maintenance contract covering central maintenance for mechanical and electrical caster maintenance based on cost per ton, as well as online maintenance for the complete integrated steel plant. Siemens VAI won the contract thanks to its unique blend of engineering, service and operational experience coupled with market leadership in the design and installation of slab casters. Permanent R&D related to increasing the service life of components also played a role. ■

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Electrical and automation services for the entire operating phase of a plant

# Fast, Professional, Competent



On-site assistance for modification in a PLC

To be the life-cycle partner for customers is the highest but also most challenging target of Siemens VAI. This role entails helping customers to realize their planned bigger investments and to provide them with the most advanced technologies. And for customers, having such a partner means lower total costs of ownership.

**W**hile the prices of energy, raw materials and transport seem to follow their own global laws, more and more plant operators are concentrating on aspects they can control, such as operating and maintenance costs. This is where Siemens VAI as a provider of plant-related services enters the picture. Oftentimes, contracts for service come into effect after the completion of bigger projects. In other cases, customers turn to Siemens VAI in efforts to simply get a grip on skyrocketing costs. The life-cycle agreement is not limited to support for troubleshooting; the goal is to avoid unplanned shutdowns. From a simple on-call service to taking over complete integral plant maintenance, Siemens VAI offers a wide spectrum of contract options. By working in close cooperation with customers, both parties can achieve a competitive edge.

To provide professional, tailor-made services – and to fulfill customer requirements within the shortest possible response time – Siemens VAI operates the global Metals and Mining Service & Support Center (MSC). Part of the MSC is a 24/7 expert helpdesk for all topics in the steel-producing industry. Furthermore, the MSC is closely linked with the Siemens regional companies to ensure easy communication with customers.

A unique advantage of the global Siemens VAI service network is provision of the first service-level support by local Siemens personnel. In the background there is always a pool of specialists available in headquarters to support the local organizations. The well-organized MSC and the cRSP remote access form the basis for carrying out all service contracts. >>

#### Range of Services:

- On-call service and corrective maintenance with guaranteed response times
- Planned maintenance including on-site health checks
- Changes, add-ons, modifications
- Remote service capability
- Remote data analysis including off-site health checks
- Support for software updates/upgrades
- Additional training



>> Security first

Because security and data privacy are the most important and critical issues for remote services, Siemens developed a remote platform called cRSP. cRSP uses innovative mechanisms for authentication and authorization along with modern crypto technologies and logging mechanisms. A further advantage is the integration of cRSP in strictly supervised workflows within the MSC.

SERVICES >

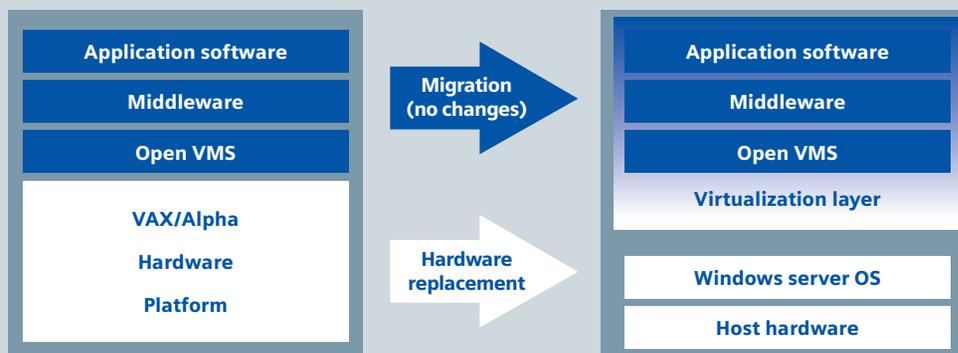
## ezzsteel Profits from a New Service Package

Al EZZ Steel Rebars (ezzsteel) is the Middle East's leading producer of high-quality long and flat steel for use in a wide range of end applications. At the company's plant in Egypt, the Alpha computer system running under OpenVMS was at the end of its lifetime – spare parts and replacement systems had been discontinued for three years, making a major change inevitable. Siemens VAI suggested migrating ezzsteel's process automation server using virtualization software onto a Windows server, a step that didn't require any

software changes or costly software upgrades.

As shown in Figure 1, everything above the hardware layer was moved into the virtualization layer of a Windows computer. The exchange of the Alpha computer system with new Windows servers was performed within a scheduled maintenance shutdown.

The change yielded performance gains, lowered energy consumption and did not require any operator training, as all operator stations and applications remained the same.



# The Future of Siemens VAI Electrical & Automation Services

## The Execution of a Service Contract

Example: A customer wants to change the cut-length optimization (CLO) rules in a caster:

- Experts in the MSC receive the new requirement to change the CLO rules.
- A Siemens VAI expert elaborates the required software modifications for the definition of the new rules.
- The new rules are implemented and tested off-site in a test system. The new software is installed via remote access in the customer's plant in close cooperation with operating personnel.
- The new logic is supervised and tested via remote access on the customer's development system.
- After the new software is proven and verified via stepwise replay of the CLO development/production files, it is released to the production system.

## Benefits:

- Fast adaption to changed preconditions
- Production CLO situations can be reproduced with CLO replay files
- Cost-optimized solution with no on-site activities from Siemens VAI experts
- No additional shutdowns are necessary

## Spare-part management

Siemens VAI services also extend to spare parts. A major concern of our customers is the availability of the right spare parts delivered at the right time. On the one hand, having too many spare parts on stock ties up capital. On the other hand, missing critical spares may cause unplanned shutdowns, which incur considerable costs and impact contract fulfillment in terms of delayed product delivery. Siemens VAI is able to serve as a long-term partner for the entire handling of spare parts. Thanks to the company's global production sites and global procurement network, the shortest possible delivery times can be ensured, especially in emergency cases. If original manufactured components are no longer available, appropriate replacement solutions are proposed. ■



Interview with Sven-Michael Böhm, head of global E&A services

*Do customers really need services provided by Siemens VAI?*

**Sven-Michael Böhm:**

Yes, definitely! More and

more, our customers are considering the total cost of ownership for new investments. This means that along with capital expenditure for an investment, operators also take maintenance as well as service expenses into consideration when making investment decisions. These concerns are justified: studies show that the total life-cycle costs are three times higher than the initial investment. The experience of the Siemens VAI service network can help customers to increase plant availability and productivity and at the same time keep production costs to a minimum.

*When do companies typically decide to issue life-cycle contracts with Siemens VAI?*

**Böhm:** A customer in India recently placed an order for the revamping of a hot-strip mill. At the same time, the customer signed a service contract for life-cycle services for the complete installed automation and drive systems for a period of five years. The contract will come into effect after the start-up phase. The placement of two contracts at the same time is becoming increasingly common as customers recognize the importance of life-cycle services and the advantages of a closely linked cooperation between capital project and service teams from Siemens VAI.

*How do you ensure that assistance can be provided quickly and competently?*

**Böhm:** An essential aspect in the service concept is the involvement of the regional company. A common language and culture, and the speed that can be ensured by geographical proximity, lend to excellent results. And by integrating local service resources to a certain extent during project execution, the response time in the case of unplanned shutdowns can also be reduced significantly. In addition, the local service team is strongly supported by the technological experts in the Siemens VAI headquarters either via remote access or, if required, an on-site visit. A clearly defined, well-established escalation cascade is followed to avoid losing time.

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5<sup>th</sup> Media Summit in Kolkata, India

# Longer Lifetimes For Steel Plants

Since the recovery of the worldwide market in 2010, the demand for steel and facilities to produce high-grade steel is growing. At the same time, escalating raw-material prices, energy costs and stricter environmental regulations pose new challenge for operators. "These developments have given rise to growth in the business with the modernization and optimization of existing facilities. In fact, this segment is growing faster than business with new plants," said Werner Auer, CEO of Siemens VAI, at press conference in Kolkata, India.



Around 70 journalists from 15 countries attended the 5<sup>th</sup> Media Summit in Kolkata

Siemens VAI has reacted to these developments by systematically aligning its technological innovations and modular facility packages to meet the needs of the modernization and service market. Together, these products are designed to increase the productivity of steel and rolling mills. "With the optimization of individual components and process steps in steel production as well as their integration in the production flow, we make it pos-

sible to flexibly and competitively run mills for a life cycle of 50 years and longer," said Auer.

With this market-oriented strategy accompanied by a series of further measures, Siemens VAI is emerging strengthened from the economic crisis. The company adjusted its capacities to match developments in the global market, solidified its structures with competence centers in Europe, and further increased its presence in China and India with the development of local

AWARDS & EVENTS >

engineering and manufacturing capability. “In 2011 we will also develop our business in China, India and Russia in the direction of maintenance and modernization,” described Auer. He also announced that plans were in place to cut by a third the time it takes technologies and innovations to reach the market. The construction of new manufacturing sites will help Siemens VAI achieve this goal. In India, Siemens VAI is concentrating on the development and production of new components for steelmaking, and in China the focus is on products for the casting segment as well as for strip rolling and finishing. Siemens VAI employs 800 people in India. “Our headquarters in India is in Kolkata where we are planning to hire about 60 new engineers by the end of September,” Auer said. “From the office in Mumbai we offer services

expansion stage up until the end of 2013, the company expects to have about 100 employees.

Around 60 journalists from 15 countries attended the Media Summit in Kolkata. Alongside China and Russia, the Indian market counts among the most important in the steel industry. Currently the Indian steel industry produces 66.8 million tons of raw iron yearly, making it the fifth-largest steel producer worldwide. According to analysts, the country’s output will nearly double in the coming five years.

At the beginning of the event, Werner Auer announced a new major contract: as consortium head, Siemens VAI will deliver a Midrex direct-reduction plant to Jindal South West (JSW) Steel, India’s largest privately owned steel company. The new facility, which JSW Steel will build in the southern Indian state of Karnataka, will have an annual production



◀ “The business with the modernization and optimization of existing facilities is growing faster than business with new plants.”

**Werner Auer,**  
CEO of Siemens VAI



▶ “A permanent flow of larger and smaller innovations supports steel producers in fulfilling the growing needs of their customers.”

**Andreas Flick,**  
Vice President Continuous Casting  
at Siemens VAI



▲ “One of the most meaningful milestones for the cooperation between Jindal and Siemens VAI is the recent construction and commissioning of India’s largest blast furnace in Torangallu.”

**P. Sashindran,**  
Chief Operating Officer, JSW Steel

for long-product rolling mills and Mergoill bearings, as well as engineering and services for electrical components, plant automation and maintenance. We are also constructing a new production and manufacturing works in India, which is due to be completed in the next 24 months.” Here Siemens VAI will concentrate mainly on manufacturing heavy welded structures such as hot-gas pipes, ladle furnaces and compressor systems. In the first

capacity of around 1.2 million tons of directly reduced raw iron. Export gas from the existing Corex facility will serve as the reduction gas.

The new direct-reduction facility at JSW Steel will be the second with Midrex technology based on the use of Corex gas. Werner Auer explained: “For the construction design we will draw on experience gathered with a similar plant that has been in operation since 2000 at ArcelorMittal Saldanha Steel Works in South Africa.” >>



Above: the hot-strip mill. Below: the control room for the two Corex facilities at JSW Steel in Toranagallu with a daily rated output of 2,400 tons of raw steel

>> The extension of operating periods and the demand for new steel grades fuel the market for modernization and service.

A special aspect of the new facility is the energy-saving hot transport system (HTS) developed by Siemens VAI, Midrex and the company Aumund of Rheinberg, Germany. HTS moves hot, direct-reduced raw iron to an adjacent electrical steelworks. At the end of the press event in Kolkata, journalists visited JSW Steel in Karnataka. It was here two years ago that Siemens VAI commissioned India's largest blast furnace. JSW Steel reports nearly 6,000 employees at the site, which also happens to be a forerunner in envi-

ronmental protection. For example, the two Corex facilities installed by Siemens VAI in 1999 operate with imported energy-saving coking coal rather than domestic coal.

Notable about the site are the many green trees and fields, which are not usually found at similar sites in the region. As such, the plantings at the site are an outward sign of the company's goal to become a green pioneer in India, as P. Sashindran, Chief Operating Officer of JWS, reported. The two Corex facilities combined with the Midrex facility are definitely another important step in this direction. ■

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# Siemens VAI Staff Honored With Professional Awards

The Institute of Materials, Minerals and Mining (IoM3) is the professional institution that represents metallurgists and materials scientists in the UK. Two Siemens VAI employees are among its award winners for 2011. This is the first time that two Siemens VAI staff members have received awards in the same year.

**T**he prestigious Hadfield Medal has been awarded to Ian Craig, technical director of the blast furnace ironmaking segment, based in Stockton, UK. The medal is awarded once a year in recognition of distinguished achievement in engineering within the iron and steel industry.

The citation accompanying Ian's nomination for the award explained his career-long association with ironmaking which began immediately with his first appointment as an assistant engineer with Davy Ashmore in 1975 and an assignment at Ravenscraig Ironworks. By 1980, Ian had risen to become assistant chief engineer in the Stockton design office, with his appointment as head of engineering following four years later. Ian's early exposure to cast-house technology helped him form the insight that blast furnaces are differentiated by their unit equipment, and he was the first senior manager in the business to advocate a design approach based on unit equipment solutions, complemented with process engineering methodologies adapted from the chemical and petrochemical industries. First under VAI and later Siemens VAI, Craig serves in the role of technical director. His leadership qualities and forthright style are well known and admired throughout the worldwide steel industry. His part in the reinstatement project on Port Talbot's No. 5 Blast Furnace stands as a notable career achievement.

Joe Lee, based in Sheffield, UK has been awarded the Frank Fitzgerald Medal. This medal is IoM3's award for outstanding young professionals, conferred annually to a member under 35 who has demonstrated excellence in the field of iron and steel technology.

Joe graduated with a master's degree in materials science and engineering from the University of Sheffield in 2005, and joined Siemens VAI in Sheffield as a graduate apprentice in the autumn of that year. Joe already had significant plant experience, with five months of undergraduate work experience on the galvanizing lines of New Zealand Steel. He was also a member of the first student cohort to complete the Making of a Plate group project at Corus Scunthorpe.



Ian Craig



Joseph Lee

Joe gained his first commissioning experience in a hot-strip mill in India, followed by an assignment to commission a shear in Turkey. During a commissioning in China, where he was originally assigned to an accelerated cooling system, he ultimately took charge of the whole mill. The decision to give Joe this responsibility was made possible by the remarkable confidence and maturity of judgment that he had already shown.

Joe is now acknowledged as the company's authority on the thermomechanical rolling of plate, and he has written and presented papers on this topic at international conferences in America and Asia. In March 2009, Joe was put in charge of the process and commissioning team for the Siemens VAI global plate-mill business. In years to come, there is no doubt that he will be a formidable ambassador for Siemens VAI and a recognized authority throughout the global industry.

Ian and Joe deserve the highest praise for their achievements. They will receive their medals at the IoM3 Bessemer Lecture and Dinner in London in October. ■

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Siemens VAI introduces its new social media platforms Facebook and Twitter

# Sign Up Now!

In order to improve the support and services with customers and company friends, Siemens VAI has recently introduced its new social media platforms Facebook and Twitter. Easy access to the latest company news, project highlights, innovations, conference activities, videos and much more is available at the click of a link.

**V**iktoria Steininger is in charge of social media marketing at Siemens VAI. She leads a global team responsible for the administration and further development of Facebook, Twitter and other Web 2.0 activities. "Siemens VAI was one of the first companies in the iron and steel industry to introduce these new forms of dynamic communication. We see this trend as a unique opportunity to get even closer to our customers, to promote an exchange of ideas, and to maintain an interactive and authentic dialogue with all interested community members."

Social media tools are becoming increasingly important for businesses and companies to stay abreast of ongoing developments and to be able to present exclusive and unique information not available elsewhere. For example, Siemens VAI applied these tools

in a particularly effective manner at the recent AISTech event in Indianapolis, U.S.A., where interviews, presentations, live insights and customer impressions were placed in real time on the company's social media channels. Reports from the METEC and other future fairs will also be on display for review and reference.

You are most welcome to join us and participate in a growing community of metals and mining professionals. Sign up now and find out more about the latest activities and developments from the world of Siemens VAI. ■

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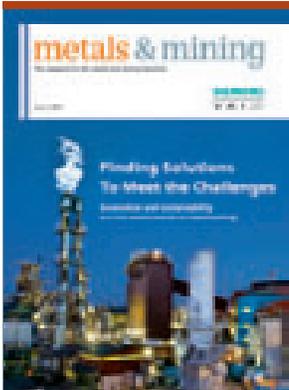


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