

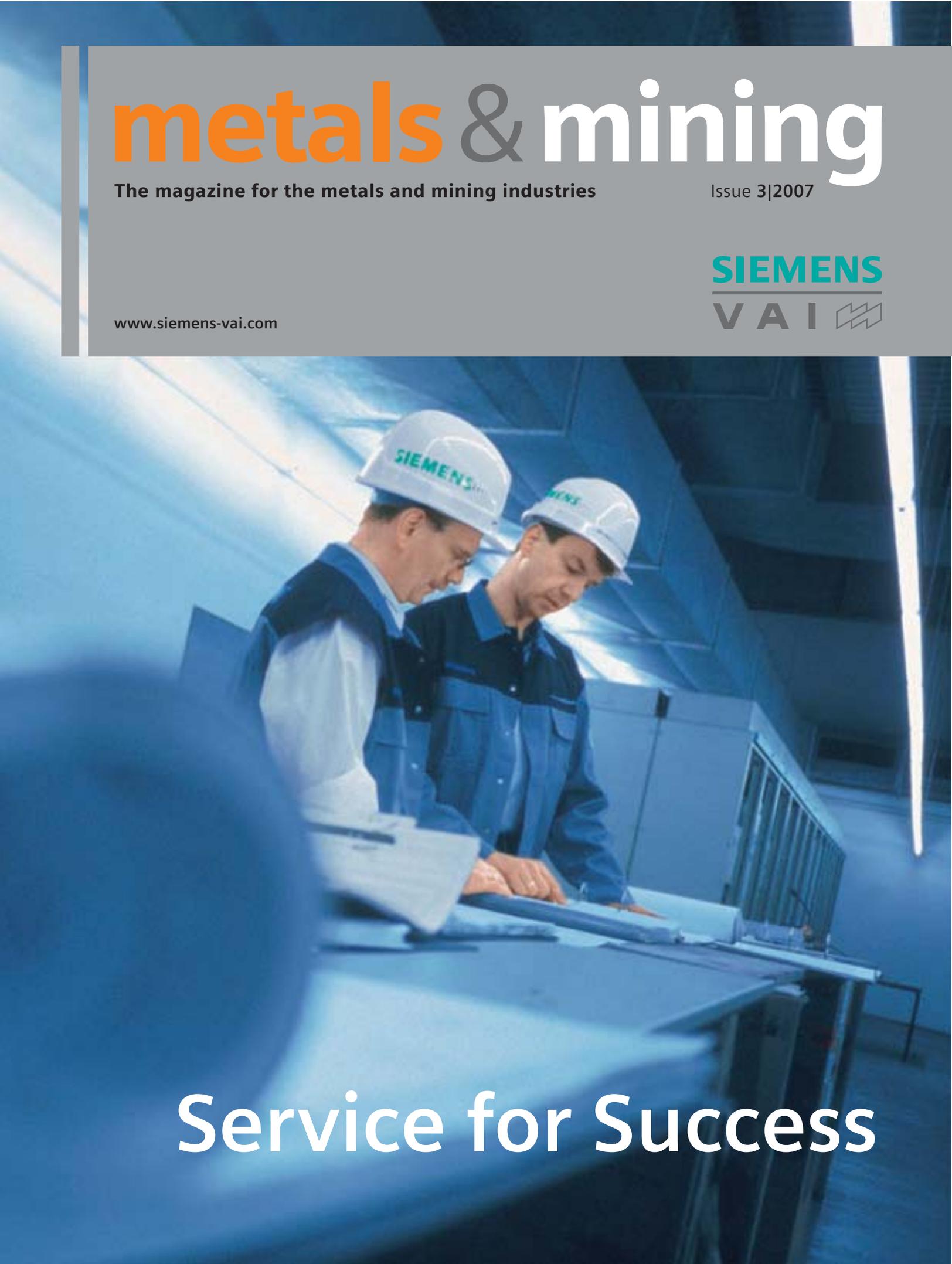
# metals & mining

The magazine for the metals and mining industries

Issue 3|2007

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Metals Technologies





Robert Wagner



Dr. Anton Stallinger

**Dear Readers**

According to current forecasts, worldwide demand for steel is predicted to grow by 25 percent by the year 2015. This expected growth will partly be met by newly installed plant capacity. The remaining demand is expected to be met by an increase of installed plant capacities as well as an increase of plant productivity. In order to face this challenge, steel producers focus more and more on efficient maintenance services and operational support utilizing synergy potential to a maximum in order to keep production costs at a minimum.

As the world's only full-liner in the metal and mining industry, Siemens VAI is your competent partner for the entire life cycle of your plant with innovative maintenance and service technologies.

We offer the complete spectrum of services you would expect, perfectly designed for the optimization of your plant operation – from classical services, like customer personnel training and spare parts, to emergency services with 24/7 hotline support, remote plant access and on-site support, from maintenance services like component refurbishment, workshop repairs and complete plant maintenance to plant modernization and system migrations.

We combine more than 100 years of experience in plant construction with core competences in technology mechanics, electrics and automation. We build on thousands of service projects worldwide successfully concluded as a result of our knowledge of both global and local market structures: Out of a global network of 250 Siemens locations in about 190 countries, more than 40 are at your service with Metals and Mining know-how. Benefit from the many years of experience of 3000 specialists dedicated to Metals and Mining Services.

In this issue of **metals & mining** we focus on Services as part of the entire life cycle of plants in the mining, steel and aluminum industries. We convincingly demonstrate our innovation competence and also showcase our proven maintenance expertise with selected articles.

Enjoy reading the articles!

Robert Wagner  
**Head of the  
 Metals & Mining Services Division**

Dr. Anton Stallinger  
**Head of the  
 Metals & Mining Services Division**

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#### **Correction Note**

On page 7 of Metals & Mining Issue 2|2007 the correct title should have been New Orders, Plant Start-ups and Final Acceptances. We apologize for this error.



## Expansion Phase 2

Siemens VAI has signed a contract with Wuyang Iron and Steel Co. Ltd., for a new roughing mill stand and cooling bed required for the Phase 2 expansion of their 4,100 mm wide plate mill. It is planned that the Phase 2 expansion project will be complete by January 2009. The company's plate mill, also supplied by Siemens, commenced rolling plates in February 2007 and the plant is now in the final stages of hot commissioning. The new roughing mill will have a rolling load of 8,600 tons and will incorporate hydraulic gauge control cylinders and a Mae West work roll balance system. As well as the new roughing mill stand, a new walking beam cooling bed will be installed in parallel with the existing cooling bed. ■

## New Flotation Cell

In the framework of a joint pilot project with the Minera Los Pelambres copper mine, Siemens has commissioned a newly developed flotation cell for separating molybdenum into their metal and rock components. The intention is that, compared to conventional flotation cells, the new system should feature the special floatability of very fine particulate materials, the possibility of substantially higher concentration, low gas requirements, and low power consumption. The flotation cell can be used in cas-

## New Drives for Salzgitter Flachstahl

Siemens has received an order from Salzgitter Flachstahl GmbH to supply new main drives and the associated control technology for the company's hot-strip mill. The order value amounts approx. 29 million euros. The drive systems will be supplied, installed and commissioned in several stages beginning in spring 2009. In the course of the project, Siemens will replace the main drives of the seven-stand finishing line; at present they are DC drives, but these will be replaced by advanced AC drives stage by stage. The new cylindrical-rotor synchronous motors will be fed via Sinamics 150 DC-link converters with a total output of about 100MW. The hot-strip rolling mill produces normal low carbon and high-strength grades, carbon steels up to C75 and pipe steels up to X75. The thicknesses of the hot strip range from 1.23 to 25mm at widths of 900 to 1,880mm. ■

## New Hot-Strip Mill

Siemens VAI has received an order from Jindal Stainless Ltd., New Delhi, India, for a new hot-strip mill. The order includes the plant layout, the mechanical equipment, the drives as well as the entire basic and process automation. Production start is scheduled for 2009. In the course of an expansion and investment program, Jindal Stainless decided to build a new 1,800mm wide hot-strip mill to be located in Kalinganagar Durubi, Orissa. After the first project phase, the mill will be able to produce 1.6 mtpy of austenitic and ferritic stainless steel strips, including a minor quantity of plates. ■

aded design for separating different metal components in an ore, and in stand-alone mode for increasing the concentration of a specific metal component. With the new method, operating costs and the amount of space needed can be reduced considerably. Flotation cells are used in the mining industry to extract the metal components from finely grinded ore which has been made into rock slurry. ■

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# Plant Start-ups and Final Acceptances (April 1 to August 31, 2007)

Company	Country	Project
AHMSA	Mexico	Level 2 process optimization and expert systems installed in Blast Furnaces Nos. 4/5
Alchevsk Iron & Steel Works	Ukraine	New 2-strand slab caster
Anshan New Steel Company	China	Electrics and automation for two continuous galvanizing lines
Arcelor Laminados Zaragoza	Spain	Upgrading of relocated DC EAF and supply of new 5-strand billet caster
Arcelor Mittal	Poland	New hot-strip mill
Arcelor Mittal Tubarao (formerly CST)	Brazil	Start-up of new No. 3 Blast Furnace (nominal capacity of 7,840 tpd of hot metal)
Baosteel	China	FAC for new bar mill at Shanghai No. 5 for rolling of high-alloy and special alloy steels – benchmark plant in China for rolling of special grades
Benxi Iron & Steel Co.	China	PAC for revamping of existing long-product-rolling mill for carbon and special steels
Celsa Huta Ostrowiec	Poland	Upgrading of 6-strand billet caster
Çolakoğlu Metalurji	Turkey	New 2-strand slab caster
Corus Imjuiden	The Netherlands	FAC for upgrading of slab caster and installation of vertical mold
Corus	The Netherlands	Revamping of basic automation for hot-strip mill (operation of complete mill with new system)
Corus Scunthorpe	United Kingdom	Start-up of new gas-cleaning plant
Erdenet Mining Corporation	Mongolia	Largest slurry pump (6 MW) ever supplied to a mine
Gonar Sp.z.o.o.	Poland	Upgrading of 2-strand billet caster to enable casting of new round sections
HADEED	Saudi Arabia	Start-up of world's largest DR plant (1.76 Mt/a) featuring hot DRI transport
Hunan Valin Iron & Steel Co.	China	New 1-strand slab caster
ILVA	Italy	Upgrading of 2-strand slab caster
Isdemir	Turkey	Level 1 and 2 process automation, including expert system, for Blast Furnace No. 3
Lianzhong Stainless Steel Corp.	China	FAC for new 1-strand stainless-steel slab caster
MaSteel	China	New continuous-annealing line
Mittal Steel Ostrawa	Czech Republic	Upgrading of 1-strand medium-slab caster
Mittal Steel South Africa	South Africa	Start-up of the relined Blast Furnace "D" equipped with new stoves
Novelis	Korea	Upgrading of cold mill for rolling of aluminum
OAO Severstal	Russia	Upgrading of billet strand for casting speeds of up to seven meters per minute
Outokumpu Stainless	Sweden	Upgrading and FAC of 1-strand stainless-steel slab caster
Posco	Korea	Start-up of the new Finex 1.5M Plant (nominal capacity of 1.5 million tons of hot metal per year) at Posco's Pohang Works
SAIL Bokaro	India	Upgrade of finishing train of hot-strip mill
Salzgitter Flachstahl	Germany	Installation of Dynacon process optimization system for three converters
Shanghai Shenhua	China	Three foil rolling mills (Acceptance)
Shougang Qian'an	China	FAC for new 2-strand slab caster (CC2)
ThyssenKruppSteel	Germany	Process automation cooling section for hot-strip mill Beekerwerth
TIFAST	Italy	New long-product-rolling mill for titanium and Ti-alloy bars and coils – extending the scope of Siemens VAI rolling expertise to include titanium alloys
Tolide Foolad Sepeed Farab Kavir	Iran	New long-product-rolling mill for low-medium-carbon bars and coils
Ugine & ALZ Genk	Belgium	Upgrading of 1-strand slab caster
Villares Metals	Brazil	FAC for new turnkey multi-line rolling for high- and special-alloy steels
voestalpine Stahl	Austria	Upgrading of 1-strand slab caster
voestalpine Stahl	Austria	New continuous tandem cold mill and new push-pull pickling line
Zhangjiagang Hongfa Shagang	China	Upgrading of 1-strand slab caster

Siemens VAI offers a comprehensive service portfolio  
for mining, steel and non-ferrous metals

# Service for Success

COVER STORY >



D. Charras

As a globally acting full-liner, Siemens VAI provides solutions and services for the entire life cycle of plants in the mining, steel, and aluminum industries from one source. Siemens VAI combines mechanical, technological, electrical, and automation expertise to deliver comprehensive services tailor-made for every need of the customer's plant life cycle.

**T**he total commitment of the Metals and Mining Services department to the strategy of Life Cycle Management enables Siemens VAI, the only full-liner in this business, to set the pace for services. Comprehensive and scalable service packages and solutions form the basis to satisfy the ever-growing needs for plant performance enhancement and increased plant production.

The Siemens VAI service portfolio is focusing on different customer's needs. The requirements of customers with a mature maintenance infrastructure are different from the needs of customers with greenfield sites. Siemens VAI service solutions aim to provide the most cost-efficient solution for the customer.

As a single source plant builder, Siemens VAI is sure to define unique process approaches to comply with serviceability needs. Already early in a project, the needs and expectations regarding operational support allow the introduction of the most effective service concepts. Implementation and control of services is part of Siemens VAI's Quality Management QM and checked by Quality Gates.

#### **Comprehensive service portfolio**

Siemens VAI is the world's leading provider of mechanical and E&A services for the global mining, steel, and aluminum industry, offering a unique and complete range of services in the field of:

- Operational support, technical assistance, and training
- Spare parts/components
- Maintenance
- On-site and on-call services
- Modernizations and migrations creating customer value by combining unique sector competence with a decentralized setup.

#### **Main Benefits**

- Global presence
- Comprehensive services
- Individual packages
- Spare parts expertise
- Automation leadership
- Service round the clock
- Coordinated full service partnership





### >> Operational support

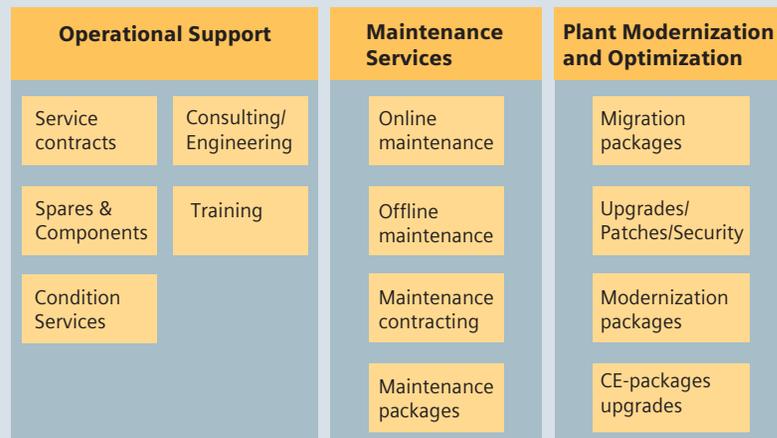
The operating lifetime of a plant offers various possibilities for savings. Supported by Siemens VAI, customers can explore these possibilities, implement improvements and thus effectively increase plant availability and productivity. Siemens VAI offers operational expertise and experience from numerous successful projects. A plant operator can mitigate operational risks and multiply the experience base of its work force through a relationship with Siemens VAI. The relationship gives access 24/7 to Siemens VAI worldwide expertise in plant operation and fault elimination. Support is structured in 3 hierarchical levels. The first level is troubleshooting via help desk. The second level is fault elimination by online support by remote access to the plant automation system. The third and final level of support is the immediate dispatch of experts at shortest possible dispatch times.

### Lowering costs of spares

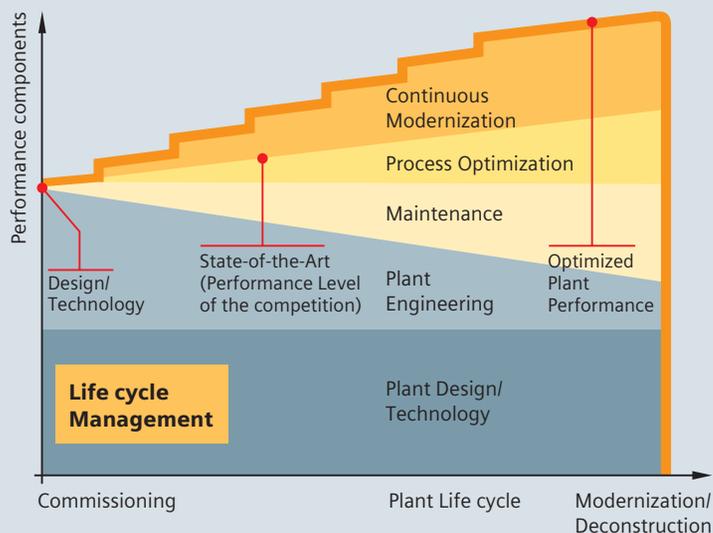
For an individual plant to hold a complete inventory of spare parts is an expensive undertaking and in some countries (e.g. Brazil) particularly costly. Siemens VAI supplies spare parts to thousands of sites around the world and is thus able to consolidate its worldwide inventory and avoid wasteful duplication. Through this approach major cost savings in the provision of spare parts may be achieved. For plants that wish to have their 'own' stock of spares Siemens VAI can provide consignment storage. When new equipment is installed an initial stock of spare parts may be provided by the equipment supplier. There will also be the need for spares replacement of older equipment on a planned maintenance basis and finally the requirement for emergency spare parts in the event of plant breakdown or accidental damage. In all cases Siemens VAI always provides genuine original high-quality branded replacement parts.

### Consulting and training for results

In case a plant operator wishes to introduce a new technology or product that is outside its experience base, Siemens VAI can provide a consulting and training service. A case in point is the introduction of new metallurgy such as advanced high-strength steels. Siemens VAI will analyze the customer's current equipment profile, working practices and skill levels of the workforce. On the basis of these studies an upgrade plan is developed for implementation in conjunction with the plant operator's own specialists. All projects aim for a minimum level of investment and the shortest possible amortization period. Simulator training and complete process documentation are provided so the operator can run the new process at optimum efficiency on a continuous basis.



The Siemens VAI service portfolio covers all aspects in a plant's service life cycle



From commissioning to modernization and deconstruction, the Siemens VAI service portfolio helps steel customers design, maintain, and optimize their plants

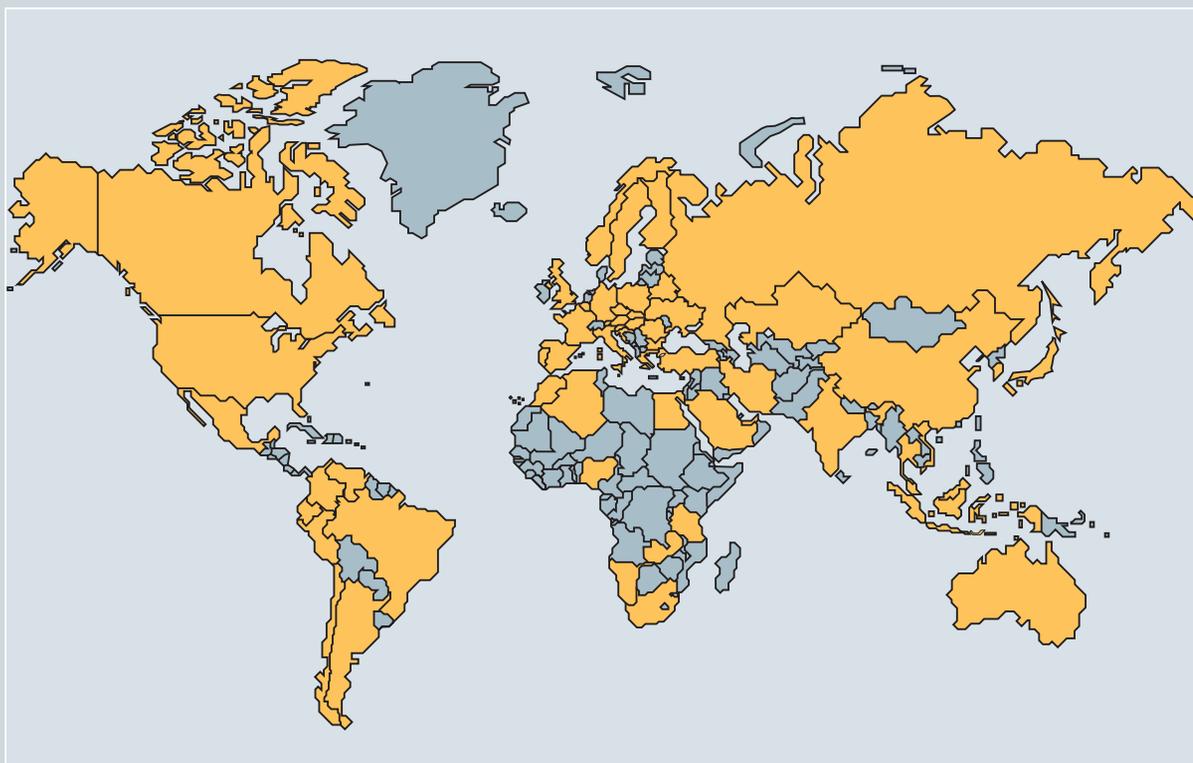
### Maintenance drives productivity

Building on its service contract operation and spare parts capability, Siemens VAI can provide a complete online and offline maintenance program. All moving parts in a metals or mining plant will have a limited lifetime due to wear, corrosion, or fatigue. The plant operator can minimize the occurrence of breakdowns and unplanned stoppages by the implementation of a maintenance program. But running a maintenance program effectively requires knowledge. Taking a plant out of service and changing parts more frequently than necessary is wasteful. Siemens VAI uses its depth of experience in plant operation to implement the most cost-effective maintenance program for any given plant. Key success factors are working to a documented unit change practice, professional refurbish-

ment of exchanged units and zero breakdown of refurbished units during reuse.

### World-class plant modernization

Plant modernization will involve one or more of the following objectives – new technology, higher efficiency and competitiveness, lower maintenance costs, improved pollution control. To achieve these goals and ensure a rapid return on investment Siemens VAI employs a range of standardized platform migration packages that have been developed over the course of thousands of plant modernization projects. The open communication standards and standardized interfaces of the Siemens technology, such as used in the Simatic product range, enables plant modernization to be implemented with minimum >>



Out of a global network of 250 Siemens locations in more than 190 countries, more than 40 are at your disposal for Metals and Mining Services

>> downtime while maintaining the value of existing assets.

Plant modernization consists of both mechanical upgrades and equipment replacement and update of automation systems. Siemens VAI employs its breadth of experience in metals technology to choose state-of-the-art replacement equipment using lightweight materials to reduce wear and provide maximum plant availability. Upgrade packages for automation systems provided by Siemens VAI can be integrated into existing software configurations, avoiding the need to replace the entire system. In this way major performance improvements may be achieved with relatively modest investment.

As a complete service provider, Siemens VAI can manage all elements of a major plant modernization project to ensure on-time and on-budget delivery. With more than 250 locations in more than 190 countries, the company has the global reach to provide the logistical and technological services to maximize system availability and productivity.

#### Plant operators profit from service

With the trends that are occurring in services for the metals industry, the change to modern technologies,

the upgrading of obsolete plant, and the pressure for lower energy consumption and reduced emissions, Siemens VAI offers many advantages as a service partner. The company can call upon 3,000 specialists worldwide, combining expertise in mechanical, electrical, and automation engineering. Technology and plant upgrades are tailored to the customer's precise needs and plant maintenance provided in the most cost-effective manner using top-quality spare parts and round-the-clock support. As a leader in the modernization and migration of automation systems, Siemens VAI can ensure optimal cost of ownership through the entire life cycle of a plant.

#### Growing demand for services

A study by the Boston Consulting Group states that the growth in world demand for steel over the next few years could be satisfied by the manufacturing plant already installed today, but is not utilized to the fully possible extent. Services aimed at plant modernization will gain significance in coming years, particularly with increasing calls for energy conservation and pollution reduction.

Around 50 percent of the world market volume in metals and mining industries is produced with the

involvement of the services market and this proportion is forecast to increase. Central European countries are emerging from the massive restructuring following the liberalization of their markets and are now refurbishing and reequipping their outdated plant. This process is strongest in those countries that have recently joined the EEC but is by no means exclusive to them.

Moreover, many operators are increasingly constructing their plants at locations where they have direct access to sources of raw materials or energy – such as South America, the Middle East and the CIS states. In these regions the local infrastructure may not exist to support advanced manufacturing operations.

The internationalization of business is also leading to a change in philosophy. At one time services providers tended to be called in only when there was a problem. Now the services provider may take over parts of the plant operation. This will be backed up by performance-based contracts with payment by results. Market liberalization and the greater competition worldwide between companies is prompting them to make greater use of outsourcing packages to further reduce costs.

#### Ready to meet the challenge

These trends all increase the demand for third-party services and raise their importance and contribution within the metals sector. One company has come to the front in meeting this need, Siemens VAI. From being a partner to the metals and mining industry for decades, Siemens VAI has more than 100 years of plant construction experience and thousands of successfully concluded service projects worldwide. Through this experience the company is at the forefront of recent developments in the metals market and understands the resulting challenges for its clients. It has built up a core expertise in all areas of mechanics, electrical, and automation with knowledge of both global and local market structures and is applying this expertise to enhance reliability, productivity, and competitiveness in customer's plants throughout the world. ■



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Pictures: D. Oberweis

Interview with Dr. Essam E. Y. Badawy,  
Abu Zaabal Engineering Industries

## Successful Know-how Transfer

The partnership between the Egyptian special steel producer Abu Zaabal and Siemens VAI under a know-how and technical assistance contract has brought remarkable success. In order to stabilize and expand Abu Zaabal's production in terms of quality and steel qualities, an amendment to the existing contract was concluded between the parties in July 2007, prolonging the partnership until 2010. We spoke to Dr. Badawy, chairman of Abu Zaabal Engineering Industries, about the motivation for this partnership.

*Dr. Badawy, you have already worked with Siemens VAI under a contract in which the company agreed to provide metallurgical know-how for some special steel grades. What were the results of this collaboration?*

**Dr. Badawy:** The collaboration was excellent, with very positive results. We received complete know-how documentation, and our employees were trained in simi-

lar European steel mills, so we are now fully capable of producing the alloyed steel. Long-term technical assistance in our mill is still ongoing.

*What was the content of the know-how documentation you mentioned?*

**Dr. Badawy:** Siemens VAI has provided Abu Zaabal with a so-called Metallurgical Cookbook that specifies

## Goals in extending the partnership

Increase production in the next three years by 200 percent

Implement the possibility to cast large and special steel ingots and jointly develop this market

Upgrading equipment and processes to improve production yields

Human resource development to reach higher skill and motivation levels among staff



Electric Arc Furnace at AZE Egypt

all the relevant metallurgical processes and procedures required to produce the 18 new steel grades. We have also received a business plan and software for calculating production times.

### *Have you seen the first results in production yet?*



*“There is an excellent spirit of collaboration between the Siemens VAI team and our staff.”*

**Dr. Badawy,  
Abu Zaabal**  
Engineering Industries

**Dr. Badawy:** Of course. We are already producing the steel grades in our plants, so this was not a training exercise. The contract execution began in February 2005 and the know-how documents and the training were provided within the first six months of the contract. The technical assistance began in June 2005. There is an excellent spirit of collaboration between the Siemens VAI team and our staff, which gives us hope for further success.

*Part of the contract includes selling certain quantities of steel to European clients. Has this aspect also been fulfilled?*

**Dr. Badawy:** As you can imagine, this is very important, as it will provide the final proof of our competitiveness. Salzgitter, the consortium partner of

Siemens VAI, is responsible for the steel sales. We were able to confirm the first purchase orders as early as October 2005. To date, more than 4,000 tons of special steel grades have been sold to various clients, primarily in Italy, Germany, and the UK, but also in other regions. In fact, a substantial share of the know-how contract has been financed by the revenues from these sales. With the technical assistance of Siemens VAI, we have established a consistently high steel quality so that today Abu Zaabal is a known and accepted supplier of special steel grades.

*The contract is scheduled to run until 2010, so now you are right in midterm. What are your expectations for the next two and a half years?*

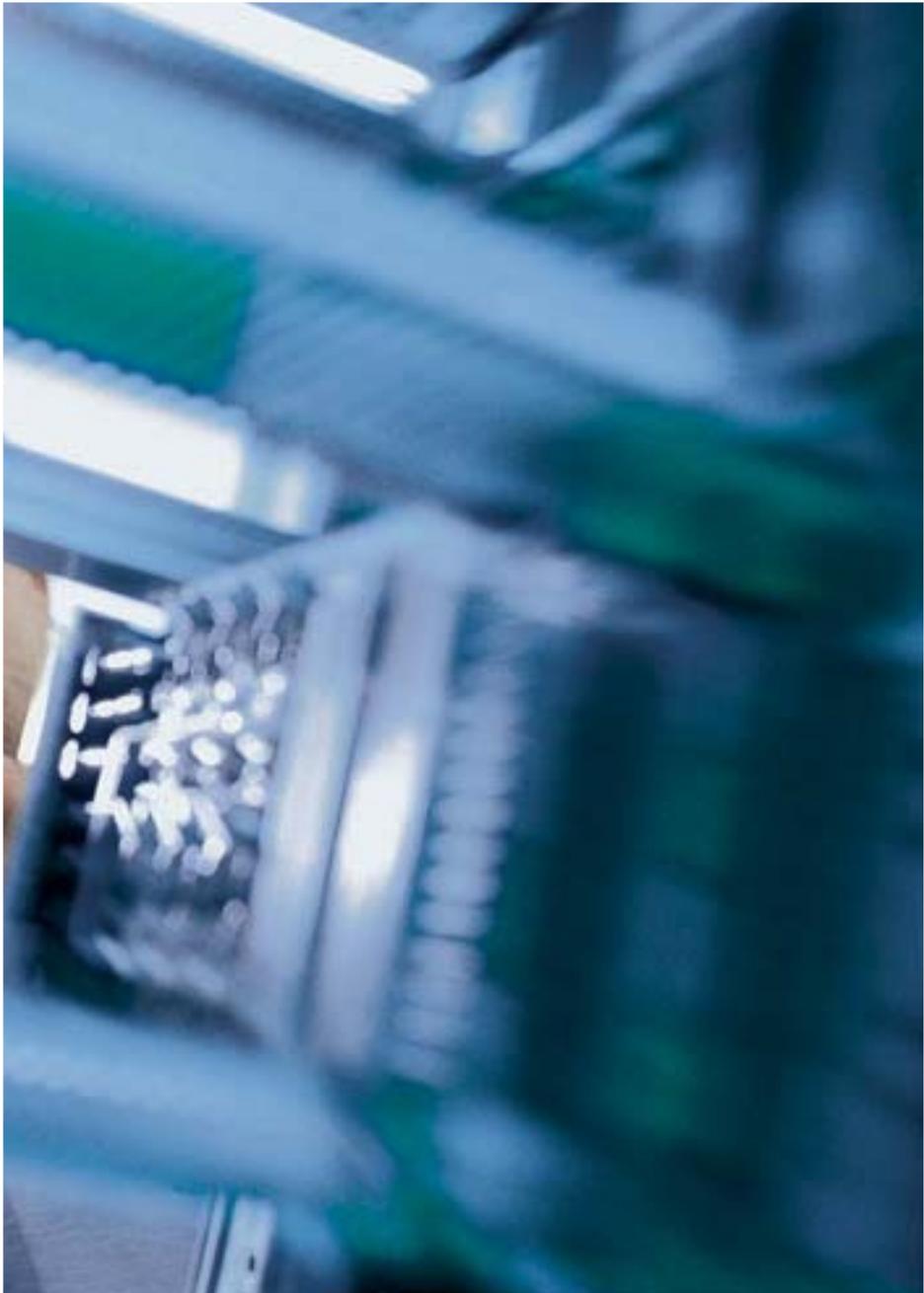
**Dr. Badawy:** Together with the specialists of Siemens VAI, we want to steadily increase our production capabilities and continuously reduce our production costs. We also have to continue to satisfy our existing clients and search for new clients.

*Dr. Badawy,  
thank you for taking the time to speak with us.* ■

**More Information**  
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COVER STORY >



# Superior Service Concept

SSAB in Sweden is a leading producer of high-strength steel sheet and steel plate. Members of the SSAB group include SSAB Tunplåt and SSAB Oxelösund for steel plant engineering; Plannja for processing; and Tibnor, which handles trading. The steel operations of SSAB Svenskt Stål are run by two subsidiaries – SSAB Tunplåt, which produces steel sheet, and SSAB Oxelösund, which makes heavy plate. Because it needed a superior service concept to ensure the continuous high performance of the company's tandem mill, SSAB turned to Siemens VAI.

In 2003 SSAB Tunplåt in Borlänge awarded a contract for a modernization of their tandem cold mill to Siemens VAI. The scope of this contract comprised the delivery of technological controls such as thickness control, tension control, dynamic load balancing and new drive systems.

Also part of the contract was the supply of process optimization models (level 2) for physical modeling of the rolling process, and an optimization strategy expressing all the rolling constraints and the objectives at individual costs.

## After-commissioning service crucial

One important demand of SSAB was to get excellent service right after commissioning to ensure a best possible plant availability and quality. So already in the pre-project phase a detailed service concept was developed by Siemens VAI.

The service packages for the warranty period are aligned to support the plant automation maintenance staff in automation software/hardware maintenance and troubleshooting. They comprise assistance by remote support center, and by an on-call pool of specialists, as well as spare parts management. Systems cov-

ered include HMI, PLCs, technological control systems, process optimization, and drives.

## Remote, on-call and spare parts support through 2009

Remote support is handled by SiemensVAI Linz, which has installed all equipment needed for seamless connection between the plant automation network onsite and the Siemens VAI company network. By this online data link, automation engineers are available to assist SSAB staff on site by providing technical assistance in automation software maintenance, troubleshooting, minor software modifications, and control loop and model performance tuning.

If remote support is not successful, SSAB can request on-call support, which is then carried out by the Siemens VAI pool of specialists. Qualified engineers from Siemens VAI are made available at a European airport within 24 hours of the customer call and travel to the customer's site to provide technical assistance and troubleshooting. During the warranty period, maintenance is performed with spare parts procured during the contract, available in the customer's stock, or secured by a hardware contract directly with the OEM hardware supplier. Spare parts taken from stock during the warranty period will be replaced as part of the hardware warranty service.

Begun in November 2005, the SSAG warranty period will end with October 2007. After this period, an additional service agreement for 2008 and 2009 will come into force to ensure continuing high performance of tandem mill facilities. ■

## Scope of Services

- First Level Support by remote support center
- Second Level Support via an On-Call Expert Pool
- Spare Parts Management

## Covered Systems

- Operator HMI System
- Sequential Control Systems (PLCs)
- Technological Control System
- Process Optimization System
- Drive Systems

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## Drive equipment for open-cast mining trucks

# Second Generation

Siemens has changed its drive solutions for open-cast mining trucks in favor of a new generation of IGBT drives. The new technology provides more power at the same size and weight – or less – than the previously used drives. At the same time, maintenance expenditure and operating costs are lower. The new drives are now available for all truck classes with loading capacities from 190 to 360 metric tons.

The second generation of open-cast mining truck drives from Siemens is based on IGBT (insulated gate bipolar transistor) converters which have now been developed further. They convert rectified voltage into a finely adjustable voltage source that feeds the electrical wheel motors on the rear axle of a truck. The high torque they provide means that the vehicle can accelerate quickly when carrying heaving loads or driving on soft roads, even from a standstill. The converters also enable high truck speeds thanks to their high power output. Improved electric braking characteristics are also provided by the drive system. As a result, there is less wear on the mechanical brake.

The new air- or water-cooled IGBT converters are characterized by their high efficiency and by their reliability. Apart from this, they feature good control qualities as well as a higher degree of operational safety and reliability.

In discontinuous mining, the trend is clearly toward larger trucks, shorter cycle times, higher loading capacities – and thus a leaner fleet with a correspondingly lower Cost of Ownership.

### Uniform IGBT drive platform

Siemens offers a uniform drive platform for the haul trucks, shovels, and draglines typically used in open-cast mining. An addition to the integrated Simine<sup>CIS</sup> solutions for open-cast mining, the new drive concept reduces the costs for operation, training, maintenance, and technical support significantly.

The drive system is based on IGBT (Insulated Gate Bipolar Transistor) technology, which is characterized by low performance losses, high reliability, robustness, and high overload capabilities, which makes it

ideal for variable speed motor power supplies in mining applications.

The uniformity of the drive platforms for haul trucks, shovels, and draglines helps to lower costs and increase productivity by putting subsystems governing control, power, harmonics, traction, and other parameters onto a single foundation. Fewer parts, less



More power with IGBT drives

maintenance, better dynamic performance, and lower harmonics reduce system complexity and training effort while enhancing the efficiency of power output and torque generation.

A further advantage of this uniform drive concept is its ability to unify maintenance systems for the mon-

Loading capacities from 190 to 360 metric tons: the new drives with IGBT-technology are available for all truck classes



itoring of all drive equipment onsite. Simine<sup>CIS</sup> Siras (Siemens Remote Access System) can be coupled seamlessly to the drive, giving the mine operator monitoring and diagnostics capability for all electrical and mechanical systems by wireless communication link. Simines<sup>CIS</sup> Siras is a member of the Simine<sup>CIS</sup> product family for open-cast mining.

#### Solutions for the mining industry

As a comprehensive industry-specific solution for the mining industry, the Simine<sup>CIS</sup> product family integrates all the products and services needed for sustained maximization of the plant's performance.

For each particular task, a solution has been defined that

- horizontally improves all production processes – from excavation to beneficiation
- vertically integrates the company's information flow end-to-end, helping corporate management to make better-founded decisions
- and chronologically enables optimized maintenance and comes with assured further development over the whole life cycle of the plant.

Because of this unique combination of horizontal, vertical and life cycle dimensions, these solutions all carry the genes of an exhaustive and sustained plant productivity in their very core.

#### Worldwide in use

Siemens has been supplying drive systems for open-cast mining trucks since 1996. Having been used in railway vehicles and trams for many years, the converters have proved their quality regarding long distances covered and their outstanding robustness against continuous vibration. They have therefore also demonstrated their suitability for open-cast mining trucks. In the meantime, more than 300 trucks with the drive technology developed by Siemens are in use worldwide. ■

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Modern automation technology for new coal terminal  
in the port of Rotterdam

# Moving Coal



ThyssenKrupp and HKM decided to build a new terminal for handling coal. Like the old ore terminal, it would unload the ocean-bound ships, hold the coal in interim storage and then load the coal onto inland waterway barges. The core automation technology was supplied by Siemens.

**A**n additional train-loading facility at the new coal terminal was also envisaged for continued transportation of coal by rail. The ocean quay, which provides mooring space for three ocean freighters, would also be used for coal freight ships. Stockyards for piling coal were established on a newly developed area of 35 hectares. An additional inland waterway quay opposite the ore loading area increased the capacity for loading coal onto barges on the inland waterway side.

EECV, a company jointly owned by ThyssenKrupp Steel AG and the Krupp Mannesmann GmbH (HKM) steelworks, has been operating a terminal for iron ore in the port of Rotterdam since the early seventies. Along the over one-kilometer-long ocean quayside, three grabbers unload the ore from ocean freighters at a rate of 2,300 tons per hour each. Conveyor belt systems totaling 9.5 km transport the ore to the stockyards where it is deposited by stackers. A total of 3.5 million tons can be held in transit on a surface area of 47 ha. Before the ore can continue its journey by inland waterway, the piles are dug off by reclaimers and transported to the inland waterway dock. There, at a rate of 5,500 tons per hour, two barge loaders load the pusher barge trains each comprising four or six barges and a maximum capacity of 16,000 tons.

## Automation of the entire plant

EECV awarded erection of the entire conveying technology of the coal terminals – from ship unloading through intermediate storage to loading onto inland waterway barge and rail – to a consortium comprising FAM Magdeburger Foerderanlagen und Baumaschinen GmbH and the Siemens Group Industrial Solution & Services (I&S). While FAM was responsible for the mechanical equipment, Siemens installed the electrical and automation technology. The customer made heavy demands regarding the automation technology in particular. Useful experience had already been gained with the automation solutions implemented in the ore terminal. Personnel had been reduced by up to 60 percent both in the stockyard and barge loading areas.

“The customer made very heavy demands,” recalls Bernd Zehentbauer who is responsible for worldwide mining business at Siemens. The ore terminal, too, had been equipped with automation solutions based on WinCC. “We were responsible for the design and installation of the entire electrical engineering,” explains Bernd Zehentbauer: “which means the customer can now meet performance and environmental demands. EECV was interested in implementing the very latest technology.” Therefore, all components are networked by Profibus, allowing the status of each individual fre-



**The new terminal for handling coal in the port of Rotterdam**

quency converter and circuit-breaker to be called up in the control room.

#### **Largest Conti ship unloader in the world**

At the ocean quay, ship freight has to be discharged as quickly as possible. Delays of even one day at today's standard freight rates mean additional costs of up to 100,000 US dollars. So to achieve an unloading rate of maximum 3,000 t/h, the largest and most powerful Conti unloader in the world was built for the new coal terminal. The machine weighing 2,200 tons has a hoisting height of 38 meters and an outreach of 46.5 meters. The automation technology based on Simatic S7 and WinCC allows the Conti unloader to be operated by a single operator in semi-automatic or fully automatic mode. The controller coordinates the various movements for most efficient unloading: The entire Conti ship unloader can be traversed along the quay wall by rail, the jib can be turned through 220° and moved vertically, and the foot containing the bucket conveyor can be turned through 360°. Scanners on the machine protect against collision inside the loading hatch.

#### **Conveyor equipment and stacker-reclaimers**

The conveyor equipment that transports the unloaded coal to the stockyards and from there to the inland

waterway quay operates fully automatically. Its controller is also based on WinCC and Simatic S7. Belt scales integrated into the system settle the bills for the transported quantities directly with the shipping company. The controller generates a transport model from the data so that coal can be stored in the designated stockyard with a precision of 10 centimeters. The speed of the conveyor belts is servo-controlled to ensure an even loading of the belts and therefore reduced dust emission during stockpiling.

Two combined devices operate on the stockpile which both stack and remove the coal again. These fully automatic stacker-reclaimers are also operated from the central control room. The combined equipment has a reach of 46.5 meters, a bucket wheel diameter of 7.8 meters and can stock pile up to a height of 13 meters. The stacking capacity is 4,000 t/h, and the reclaiming capacity, 2,400 t/h.

#### **Loading pusher barges and trains**

The stockpiled coal can be transported to its final destination either by ship or rail. The lion's share of the volume handled in the port is conveyed on inland waterway on barges. With a loading capacity of 4,000 t/h >>



The largest Conti unloader in the world has a hoisting height of 38 meters and an outreach of 46.5 meters



All components are networked by Profibus so that personnel in the control room are always kept up-to-date with the status of each individual device

>> and an outreach of 29.5 meters the barge loader ensures that the pusher barge trains are efficiently filled. It is fully automated and controlled from the control room. The main drives are speed controlled by frequency converters, the routing control is performed by incremental position encoders. The greatest challenge in the development of the controller was to ensure even loading of the barge trains. To avoid uneven loading, the barge loader empties the coal into the loading hatches in a precisely calculated sequence. Inclinometers monitor the loading process and output an alarm if imbalance occurs so that the controller can act against it.

Some of the coal is transported by rail to coking plants in Germany. Loading onto train wagons is also fully automated. The coal is transported by conveyor belt first to a preliminary bunker and then into four weighing bunkers each of which is closed from below by a gate. Trains consisting of up to 44 wagons each with a storage capacity of 60 tons drive under the plant. Scanners and light barriers detect the wagons fully automatically so that the controller can open the gate at the correct moment. The various wagon types are stored in the software and are automatically identified by the system. At the end of the plant, a large roller smooths off the cone in the wagons which is not allowed to protrude beyond the upper edge of the wagon during transportation. Loading a train comprising 44 wagons takes just under two hours. No personnel is required to perform this task.

#### Controlling procedures from the control room

Ship unloading, storage logistics, barge and train loading are all controlled and operated from a single control room. Only the unloaders on the ocean quay are constantly staffed. The software for the stockyard

#### Key data of Rotterdam coal terminal

Handling capacity:	per year	5.5 million t
	per day	30,000 t
Capacity of the bulk freighters:		180,000 t
Storage capacity of stockyard:		750,000 t
Inland waterway vessel loading:		4,000 t/h
Loading onto rail:		2,000 t/h
Stacker-reclaimers:		4,000 t/h

logistics makes it possible to control the entire process consisting of unloading, transportation by conveyor belts, intermediate stockpiling, and loading onto barges or wagons. The personnel in the control room initiate a request in the software, for example, to load a particular type of coal from a stockpile onto a barge train. Digging off by the stacker/reclaimer combination, transportation by conveyor belt to the barge loader and loading of the barges at the inland waterway quay is then performed fully automatically. The personnel in the control room control the entire process by WinCC throughout. A dozen cameras also monitor the complete plant.

“The automation solution now in operation is very reliable,” Thomas Heyer, director at EECV sums up: “Of course, quite a few adjustments were needed during the configuration phase and after commissioning. But this is only to be expected for a project of this size. Overall, we are extremely satisfied with this collaboration with Siemens.”

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Gearless drives for excavator to Vattenfall

# New Drives Reduce Maintenance

As the head of a consortium, which includes FAM Förderanlagen Magdeburg and Baumaschinen GmbH, Siemens equips two bucket-chain excavators of Vattenfall Europe Mining AG, Germany, with gearless drives. The drives will reduce the wear on the chain and tumblers and require very little maintenance. The completion of the project is scheduled for the middle of 2010.

**V**attenfall Europe Mining AG extracts brown coal in the Jänschwalde, Cottbus-Nord, Welzow-Süd and Nochten opencast mines in Germany. To ensure supplies for the Jänschwalde, Schwarze Pumpe and Boxberg brown-coal power stations, 60 million metric tons of brown coal per year have to be extracted. Resumption of coal extraction in the Reichwalde opencast mine in 2010 is intended to secure long-term stable supplies for the Lausitz brown-coal power stations, especially for the Boxberg brown-coal power station to which an additional power unit is being added.

## Less mechanical stress

During the reopening of the Reichwalde opencast mine, Siemens and FAM are equipping two Buckau bucket-chain excavators of the type Es 3750 with two gearless drives for each chain. These drives have slow-running motors whose speed can be controlled steplessly by way of the frequency. Power is supplied by cycloconverters. Compared to geared drives with high-speed motors, the moment of inertia acting on the chain is reduced considerably. As a result, the mechanical stress on the chain is reduced and its useful life is increased.



Bucket-chain excavator used in the Welzow opencast mine

## Good experience

The order includes technical design, delivery, installation, commissioning, and trial operation of the drive systems. After the handover, Siemens will continue to look after the drive systems in the framework of existing service contracts using its service base for Vattenfall in the Nochten opencast mine. Between 1995 and 2000, the Siemens/FAM consortium equipped 10 Magdeburg bucket-chain excavators of the types ES 3150 and ES 3750 of Vattenfall with gearless drives. The good experience gained in this case was one of the reasons the contract was awarded to the same consortium. ■

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The longest single-belt conveyor in the world

Siemens technology drives belt conveyor system in Texas

# Large-Size Conveying

MINING >



Siemens has equipped a 19-kilometer-long belt conveyor system with drives for Alcoa Inc., based in Texas (USA). The system offers precise methods of control and is reliable, efficient and flexible.

**A**lcoa is a leading producer of primary and fabricated aluminum. The company's smelter facility in Rockdale, Texas (USA), requires a steady supply of lignite coal to the power plant to keep operations humming along. This critical fuel need is being met by the world's longest single-belt, overland conveyor. The system links the mine's blending station to existing overland conveyors, which in turn feed the Rockdale site's power plant.

The critical section in the middle of the transport route, which is approximately 19 kilometers long, is bridged with the longest single-belt conveyor in the world, parts of which have to pass over uneven terrain. It is the link between the blending station (lignite and high coal mixed) and the existing conveyors of the power plant.

The rolling hill country created significant height differentials and load variations. The installation required three drive stations and 10 horizontal curves to cover the distance between the mine and the existing conveyors.

#### No real alternative solution

The project designers considered a mechanical solution using hydraulic motors with flow control, but Siemens was able to demonstrate that an electrical drive system provided a more flexible, reliable, and efficient solution for this application.

"Using a conveyor to move coal from the Three Oaks Mine to our power plant in Rockdale seemed like the way to go – if we could make it work technically and financially," said John G. Tucker, Maintenance Manager at Alcoa. "With the Simine<sup>CIS</sup> CON system and vector controlled master drives, we were able to implement a solution that delivered on both counts. It has given us the precise control and affordable operation we need to meet our energy production requirements for years to come."

#### Individual belt speed

The belt system was fitted with a solution from the product family Simine<sup>CIS</sup> CON, which features robust and energy-efficient drive systems. Five drives of the type Simovert Masterdrive Regenerative VC, each with 556 kW, were installed. The drives are strategically positioned in such a way that the complete system can be optimally operated, stopped, and started up. One drive has been installed at the loading point, two drives in

the middle of the route and two at the unloading point. An application-specific integrated circuit (T400 technology board) quickly calculates rotor speed and position for the system controllers. Fiber-optic cables between the conveyor belt stations enable the operator to individually control the belt speed, for example slowing down when the load is extremely heavy, accelerating, or stopping quickly. The belt control system prevents oscillations of the conveyor belt during starting and stopping. The system was matched to the following loading situations: no load, partial load, and full load. This method of operation uses considerably less energy than conventional uncontrolled belt drives. Moreover, the mechanical components are protected. High round-the-clock availability with low operating costs is attained. The drives are first powered up to ten percent of the total speed and, after a stabilization phase of approximately 60 to 120 seconds, the system is accelerated to its 100 percent target speed.

With the Simine<sup>CIS</sup> CON system, Siemens deliver higher availability and reliability, lower cost, and local support. It's the right solution for uphill or downhill operations and sites where there is a need for curved conveyors and long conveyor systems with special start-up characteristics.

#### "Height" solution

Simine<sup>CIS</sup> CON lead also to peak performance in Chile. The ore from the Los Pelambres mine in Chile is mined at a height of up to 3,200 m (10,500 ft) and must then be conveyed over a distance of 12.7 kilometers. This is made possible by Simine<sup>CIS</sup> CON solution with ten 2,500-kW squirrel-cage motors. Transport of the copper ore from the mine to the concentrator generates approximately 17 MW of electrical power, which is fed back into the plant network. This reduces the production costs for copper concentrate considerably. Additionally, the lower conveyor belt tension reduces wear and increases maintenance intervals. At the same time, load-dependent controlling of the conveyor speed cuts power consumption. ■

#### Main Benefit

Efficient use of electric energy not only during starting and stopping periods but also during operation thanks to the load-dependent regulation of the belt speed.

Reliable operation through the use of robust, innovative, and proven technology.

Increased productivity of the belt systems through simultaneous starts and stops of the entire conveyor systems.

Higher system availability, longer service life of mechanical components, and reduced operating and maintenance costs due to wear-minimizing operation.

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Electric arc furnace

Hadeed steel plant expansion project, Al-Jubail, Saudi Arabia

# Steel Works!

On March 27, 2007, a complete new steel mill for the production of 1.4 million tons of flat products went into operation at Saudi Iron & Steel Company (Hadeed). This project represents the culmination of a series of steelmaking projects implemented at Hadeed and is yet another example of a longstanding and outstanding cooperation between a technology supplier and steel producer.

**T**he Saudi Arabian steel producer Hadeed and Siemens VAI can look back on a long tradition of cooperation and project activities. This commenced back in 1983 with a project for the supply of an integrated iron- and steelmaking complex and its subsequent expansion to enable the production of more than 2.6 million tons of long products for the construction industry. In 1996, Siemens VAI received a project from Hadeed for the turn-key installation of an integrated flat-steel production facility with a design capacity of 800,000 t/a of hot-rolled and cold-rolled coils and sheets. This included the engineering and supply of a complete EAF steel works and slab caster, hot-strip mill, cold-rolling mill as well as the downstream strip processing

and finishing facilities. This was followed by a contract signed on July 26, 2004, for the expansion of the rolling capacity of the existing hot-strip mill to two million t/a.

On December 22, 2004, Siemens VAI was awarded another major order from Hadeed for the installation of the world's largest direct-reduction plant with a nominal production output of 1.76 million tons of direct-reduced iron (DRI) per year. On the same date, Siemens VAI was commissioned to implement a project for the turnkey expansion of the Hadeed flat-products facility to enable the additional production of 1.4 million tons of steel for use in the petroleum, pipe, and household-appliance industries. This mammoth project featured the supply of an electric arc furnace, ladle furnace, slab caster, automation, and dedusting systems in addition to the auxiliary facilities. The steel mill was built adjacent to the existing flat-steel production facility and started up on March 27, 2007. Key plant details are outlined in the following.

## Electric arc furnace

The AC EAF is designed for a nominal tapping weight of 150 tons of liquid steel. DRI is primarily charged to the furnace in addition to smaller quantities of local and return scrap. To boost production, three refining combined burners (RCB) are installed to enable supersonic oxygen

lancing (for accelerated initial melting), postcombustion (to promote melting and reduce energy costs), and oxygen lancing at the end of the heat (for steel-refining purposes). The process off-gases are collected and treated in the dedusting system to ensure that environmental emissions fully comply with requirements.

A highlight of the EAF charging system is that DRI from the direct-reduction plant is hot-charged by a hot-transport system directly into the EAF. This solution further reduces energy costs and electrode consumption, and results in shorter tap-to-tap times for a corresponding increase in the output of liquid steel.

### Ladle furnace

In the ladle furnace the steel temperature and composition of the steel bath is adjusted according to the requirements of casting and the end product. The ladle furnace is designed for a heating rate of five degrees per minute and the transformer capacity is 25 MVA. Automatic temperature measuring and sampling are carried out. For an improved and accelerated steel-bath homogeneity, inert gas is injected into the steel bath employing both top and bottom stirring. Gas connections are carried out fully automatically.

### Slab caster

The single-strand continuous slab caster employs a straight mold design to minimize nonmetallic inclusions. Slab widths range from 850–1,650 mm at a thickness of 220 mm. To ensure a high product quality, production flexibility, and operational reliable the caster is equipped with state-of-the-art design features and technology packages. These include LevCon (automatic mold-level control), DynaWidth (online mold-width adjustments), MoldExpert (automatic breakout prediction and strand-shell friction monitoring), and

also DynaFlex mold oscillation (flexible and online adjustment of the oscillation parameters). The caster is also equipped with the Dynacs secondary-cooling system and with a slab quality-control and yield optimization system.

### Automation

Fully optimized and integrated automation systems, extending from the steelmaking facilities to the finished rolled products, ensures that the optimum results are achieved in terms of product quality, plant performance, and cost efficiency. These cover process control, production automation, production planning, and control-management information respectively.

### Concluding remarks

According to Karl Fürnhammer, head of the Siemens VAI team for the Steel Plant Expansion Project, “Hadeed and Siemens VAI have been working closely together and at a high professional level since the start of this project. This has been a key factor for the smooth project execution up to the successful start-up of the Hadeed steel mill. Up until now, production ramp-up has proceeded according to plan and the production targets have been met.” This latest Hadeed project is another example of the continuation of a life cycle partnership with a major steel supplier. Long-term business relations are the basis for mutual benefits and mutual success! ■

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## Production Record at Hadeed

During the commissioning tests of the new EAF, which were conducted from August 31 to September 1, 2007, a new production record was achieved at Hadeed. A total of 50 heats were produced in 48 hours and 27 heats were tapped in a single day employing 75 % cold DRI and 25 % scrap.



Caster start-up



Production ramp-up curve (March 27 to June 10, 2007)

## EAF upgrade and supply of billet caster for Arcelor Mittal

# Linking the Old with the New

On April 12, 2007, steel was tapped and billets were cast for the first time in the new minimill of Arcelor Laminados Zaragoza, a Spanish-based company of Arcelor Mittal. Siemens VAI was responsible for upgrading a relocated DC EAF and installing a new 5-strand billet caster. This project underlines a key strength of our company – the integration of existing and new plant facilities to meet the performance and production targets of a regional steel producer.

**A**rcelor Mittal, accounting for 10 percent of the world steel output, is the leading steel manufacturer in the world. From industrial sites situated in 27 countries worldwide, the company offers the full range of long- and flat-steel products comprising commodity steels up to highest quality value-added goods. The produced carbon-, alloyed-, and stainless-steel grades find use throughout the entire industry, particularly the automotive, construction, household-appliance, and packaging sectors.

In 2005, Arcelor Laminados Zaragoza commenced with the relocation of its steel mill from the center of Zaragoza to a new industrial site on the outskirts of the city. A completely new minimill was built with a nominal production capacity of 500,000 tons per year. An existing DC EAF (direct-current electric arc furnace) was relocated from Carsid in Belgium and brought to the new steel site. Siemens VAI was awarded a contract in October 2005 for the upgrading of the EAF and the supply of a new 5-strand billet caster. This project included the supply of electrical equipment, software, furnace and caster automation, installation of the new EAF equipment and the complete caster as well as advisory services for installation, start-up, and commissioning.

## Technical supply

The project activities in connection with the EAF included the engineering and modification of the existing furnace shell, the replacement of the previous anode system with the patented Fin-Type Anode System and the installation of RCB (Refining Combined Burner) technology (see Side Bar). With these solutions a fur-

nace production performance of 140 tons of tapped steel per hour could be assured.

The supplied 5-strand billet caster is a top-of-the-line high-speed casting machine from Siemens VAI. It has a nominal production capacity of 144 tons per hour and is capable of casting 120x120-mm, 120x160-mm, and 130x220-mm billet formats. Each caster strand is equipped with DynaFlex Mold Oscillators to ensure good billet surface quality as well as with Diamold tube molds to enable high-speed casting (see Side Bar). According to Mr. Anton Himmel, Technical Project Leader for the Billet Caster, “The caster start-up proceeded smoothly without any problems and the ramp-up to full production fully met customer expectations. Continuous operation was quickly achieved and the billet quality was well within tolerances.”

## Concluding remarks

This project has demonstrated that fully satisfactory production results can be achieved with the combination of existing and new plants – simultaneously at considerably reduced investment expenditures! Through the installation of state-of-the-art technologies, an existing out-of-date melting unit can be upgraded to match the performance and production level of a modern facility. The upgraded EAF was linked to a new high-speed billet caster and the output and quality targets were quickly met. ■

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**Fin-Type Anode**



**EAF upgrading to a high-performance production unit**

**Successful start-up of the 5-strand billet caster**

### Fin-Type Anode System for EAF

The patented Fin-Type Anode System is comprised of a series of steel sheets (fins) which are vertically welded onto horizontal plates in an annular arrangement at the base of the furnace hearth. This configuration is filled with a rammed magnesia mass. The unique anode design promotes a smooth and uniform transfer of the electric current through the melt, fins, steel plates, and the current-conducting elements. Because of the favorable thickness-to-surface ratio of the sheets, bottom water cooling is not required, which contributes to increased furnace safety and availability (see figure).

### RCB lances for EAF

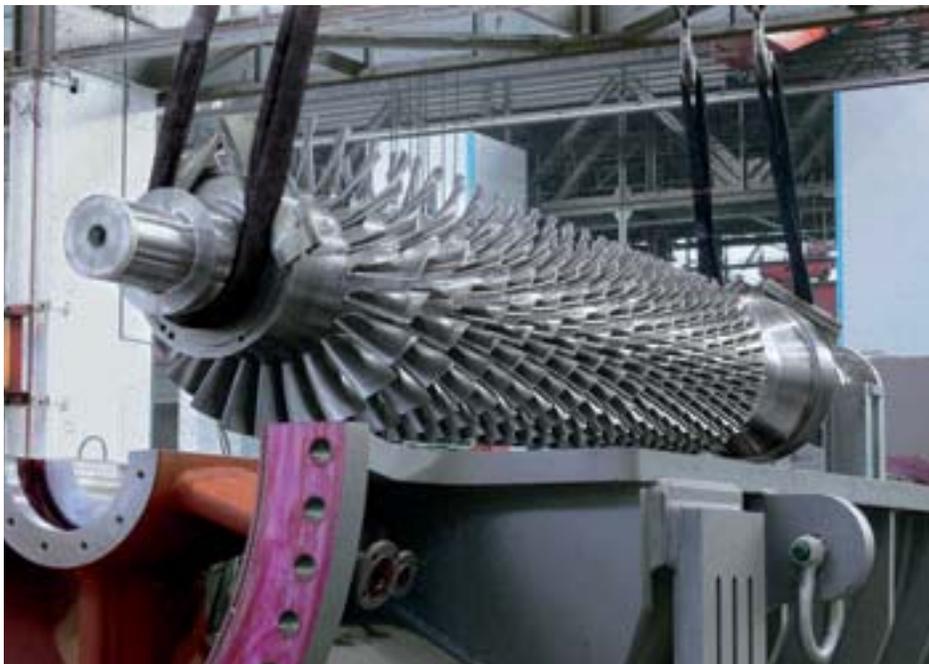
The RCB (Refining Combined Burner) system includes oxy-gas burners and postcombustion lances through which oxygen, fuel, gas and carbon, etc. can be injected into the furnace. Thanks to the exothermic energy released by the combustion of carbonaceous materials, the electrical energy consumption for the melting of scrap is considerably reduced. The application of RCB technology enables supersonic oxygen lancing for accelerated initial scrap melting, postcombustion for additional energy input into the furnace and oxygen lancing near the end of the heat for steel-refining purposes.

### Diamold high-speed billet mold

Diamold is a patented, specially designed copper tube mold which allows more than 50% higher casting speeds to be achieved in billet casting compared with conventional systems. The mold is designed with an enhanced tapered shape in the lower section which improves the surface contact with steel. This accelerates strand-shell cooling and growth, thus allowing higher casting speeds to be achieved. An "open-corner design" at the Diamold tube exit reduces frictional forces with the strand shell, promoting a homogeneous strand-shell growth and an improved surface quality.

### DynaFlex oscillator for billet casters

DynaFlex is a hydraulically driven mold-oscillation system which allows the mold-oscillation parameters (i.e., frequency, stroke height and wave form) to be flexibly and dynamically adjusted during casting. Employment of a wear-free leaf-spring oscillator-guidance system is the basis for precise guiding accuracy, improved operational safety and low maintenance costs. Mold and oscillator exchange is facilitated by quick coupling connections of all media supplies. Mold and oscillator alignment is done automatically. DynaFlex substantially improves billet-surface quality.



Siemens-supplied axial blower for blast furnace of Tata Iron and Steel Co Ltd. (TISCO), India

The blast furnace blower house as a fully complete solution package

# An All-in-One Solution

The increasing demand for hot metal worldwide has led to a market boom both for new blast furnaces and for the modernization of existing facilities. Companies today increasingly prefer complete sub-packages from a single source rather than partial supply packages from different sources. The described Blast Furnace Blower House (BF-BH) is a fully equipped and all-inclusive solution package for providing compressed blast air to the cowpers of the blast furnace.

**B**F-BH incorporates fully engineered systems and components that are well proven in a blast furnace working environment. An optimized and concerted system solution reduces the number of interfaces to, for example, the cowper, the blast-furnace automation system, the take-over terminal for power supply and to the medium supply.

The BF-BH package solution includes power supply and distribution from the incoming feeder (high or medium voltage) to the transformers and blower drives as well as to the low-voltage distribution of the auxiliary drives and sensor. This solution also includes the Static Var Compensator (SVC) – or just filter circuits – to meet the demanding requirements of the power authorities for power quality in addition to the blower-string (comprising blower and drive system).

Siemens has extensive experience in the supply of turbocompressors for blast furnaces and has at its disposal the required blower-string competence in this field of application.

## Blower

The required volume of blast air and blast pressure is provided by the blower. It is supplied in axial or axial/radial design, and includes all auxiliary systems (oil-lubrication system, air filter, etc.). The main features of the blowers are as follows:

- Large flow volume (up to 1,300,000 m<sup>3</sup>/h)
- Large-sized highly efficient machines

- Pressure ratios up to 6.0 for axial blowers and up to 16 for axial/radial blowers
- Reliable, robust design as the product of continuous research and development
- Fabricated casings in different sizes, according to customer specifications
- Use of high-tech materials (e.g., duplex steel for the first rotor stages) for a long service life and low maintenance costs

### Drive system

The drive system, comprising 2-pole or 4-pole synchronous motors which can be driven with a static starting-converter or with a variable-speed drive system (VS-DS), is based on Sinamics GL150.

The advantage of the static starting-converter is its low Capital Expenditure (CAPEX). One starting-converter is used for the run-up of several blower motors. When the range of ~40 % of effective power is reached, the motor will synchronize and switch from the starting-converter direct to the power line. After this, the static starting-converter can be used to run up the next blower drive.

The variable-speed drive system (VS-DS) opens up further possibilities for flexible operations. The blast wind quantity no longer has to be adjusted to the guide blades of the blower, but is regulated by the speed control of the drive. This means that all mechanical equipment for the guide-blade adjustment of the blower, including the respective automation and control system, becomes redundant.

Depending on the required speed range of the blower, the gear box between the blower and motor may also no longer be needed. A detailed vibration analysis of the total system (motor and blower) assures trouble-free operation. The advantages of the gearless solution are the reduction of maintenance costs. Costs for personnel, material (oil) and for the subsystems of the gear can also be saved.

An additional option is to use the synchronous motor for reactive-power compensation and for the stabilization of the power system of the steel works. Frequency and voltage drops can be balanced and the rating of the blower is constant at any time. This is only possible with the VS-DS. Intermittent pressure variations can be corrected with the fast closed-loop speed control of the VS-DS in the shortest possible time. This allows manual interventions (bulging), which reduce the blast wind quantity for a short time without further flow losses in the butterfly valve.

### Main Benefits

Turn-key BF-BH solutions – “one-stop shopping”

Optimized blower-string design

Reduced interfaces and minimized risks

Proven, flexible and customized solutions

### Scope of supply

BF-BH supply includes basic and detail engineering, civil works, construction activities, all “balance of plant” installations (e.g., piping, cooling-water supply, fire detection, lightning protection, heating, ventilation, air-conditioning, illumination, cranes and communication) as well as the design and supply of lock valves and control butterfly valves to control the volume of blast air. The integrated automation and control system for all systems and components ensures the high availability, efficient diagnostics and ease of maintenance of the complete system. This is complemented with experienced project management services, on-site management, commissioning, production supervision and the supply of spare parts.

### Concluding remarks

The flexible selection of the optimum systems and components within the BF-BH scope of supply provides the



H-Modyn synchronous motor

customer with the most efficient solution for the specific requirements. Our focus is placed not only on CAPEX, but also on Total Cost of Ownership for green-field, plant extension, or blast furnace revamping projects. There is one qualified and responsible contact person of the entire BF-BH for the customer. It is no longer necessary for the customer to coordinate the different suppliers and sub-suppliers of blower house systems and components. A customized after-sales service rounds off the scope of supplies and services for this unit. ■

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New flexible separator for dust recovery

# Maximizing Returns

IRON & STEEL >

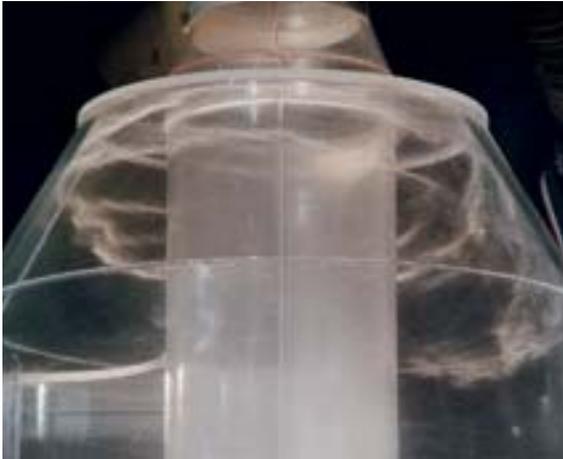


Figure 1: Cyclone model

Siemens VAI has developed a new and highly flexible cyclone design for the dedusting of top gas exiting from the blast furnace (patent pending). With this solution the dust-separation efficiency can be flexibly adjusted in such a way that the highest possible dust quantity – and hence iron recovery – can be recycled to the ironmaking process without exceeding certain limitations in permissible concentrations of zinc and other heavy-metal components. The first industrial unit will be installed in a new blast furnace currently being built at JSW Steel Ltd, India.

In modern blast furnace practice the top gas exiting the furnace is normally cleaned in a two-stage dedusting process comprised of a dry-type dustcatcher or cyclone (first stage) and a wet scrubber (second stage). Whereas the dust which is trapped in the first stage of cleaning is usually recycled to the ironmaking process, the dust (sludge) from the wet scrubber is normally discarded, incurring extra costs for disposal or dumping. For blast furnaces with, for example, hearth diameters from 8.5 to 14 meters, between 250,000 and 700,000 Nm<sup>3</sup> of top gas are generated per hour and have to be treated. The quantity of dust contained in these gas volumes ranges from 5–14 tons with an iron content of 15–35% – representing a valuable by-product.

Therefore, in order to maximize iron recovery, there is an increasing tendency among blast furnace operators to employ higher-efficiency dust-separation cyclones instead of low-efficiency dust catchers. However, not all top-gas dusts are desired for recycling to the ironmaking process. High concentrations of heavy metals in the burden, especially zinc, can potentially affect blast furnace process parameters resulting in higher coke-consumption rates, the formation of skulls in the upper shaft area and also shorter furnace refractory lifetimes. Whereas the fine dust particles with their elevated contents of zinc normally pass through dust



**Figure 2:**  
Conical design  
of cyclone top



**Figure 3:**  
Scale model (1/10)  
of the new cyclone  
with bypass pipes

catchers, cyclones, with their better separation efficiency, remove a higher portion of the fine zinc-bearing and other heavy-metal-bearing dusts which are then recycled to the process. The danger is that concentrations of unwanted metallic compounds may accumulate due to the repeated sequences of evaporation, separation and recycling. Thus, an optimized dust-separation efficiency in the first stage of top-gas treatment is vitally important, both from cost and operational perspectives.

#### Improved cyclone model

On the basis of CFD (computer fluid dynamics) modeling, the performance of cyclones with various geometry changes was first investigated. A physical 1/10-scale model was then constructed which incorporated a number of features allowing various geometries to be tested (Figure 1). This included inlet bends with and without guide vanes, variable barrel lengths and the position and geometry of the vortex finder. Fine sawdust and hollow glass microspheres were used for testing. Flow visualization investigations using smoke and sawdust clearly showed the downward spiraling flow around the wall of the cyclone and the upward flow in the center to the exit duct or vortex finder. These tests enabled a number of modifications to be proposed, the most important being a conical design of the cyclone top which served as a pressure envelope (Figure 2).

#### Development of an industrial unit

Although the cyclone model was designed on the basis of recognized modeling criteria, a scale-up by a factor of ten to an industrial-size unit is nevertheless a major step. In addition, distribution of blast furnace dust across the downcomer is not exactly known and cannot be replicated in the model. The evidence indicated that the cyclone could actually be too efficient, trapping zinc-bearing dust instead of allowing it to pass to the wet scrubber as desired.

In the final stage of the model development simple design modifications were carried out which would allow a reduction in efficiency. The solution took advantage of the crude classifying effect of the inlet bend and, by the addition of several bypass pipes, allowed dust and gas from the top of the cyclone to be diverted to the outlet pipe, thus reducing efficiency, generally in the required size range (Figure 3). The proportion of the inlet gas flow that must be diverted depends on the unknown distribution of zinc over the vertical cross-section of the inlet duct. Consequently, the model was modified so that a wide range of flows could be diverted.

The industrial version would be additionally equipped with a blank flange installed at some position along the length of each duct. Depending on the content of zinc in the recycled dust, the number of blanked-off bypass ducts can be changed during a planned furnace shutdown to vary dust-collection efficiency. In this way, a maximum dust-recycling ratio could be achieved, without exceeding acceptable zinc concentrations, thereby fully meeting the varying requirements of the blast furnace operator. Finally, pressure drop tests were conducted. A full-sized cyclone was then designed on the basis of the model investigation results.

#### Industrial application

The first installation of the new full-sized cyclone will be in the new No. 3 Blast Furnace of JSW Steel Ltd in India for which Siemens VAI is providing engineering, technology and equipment. The start-up is scheduled for mid-2008. ■

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Advanced explosion-proof design of secondary-offgas-treatment systems

# A Safer Converter Environment

The offgases released during steelmaking operations, particularly when low-quality scrap is charged, frequently overload the exhausting and cooling capability of conventional treatment systems. The subsequent combustion of these gases can lead to uncontrolled fume emissions, high gas temperatures and even explosions that may cause excessive damage. A thoroughly optimized offgas-treatment system from Siemens VAI, featuring plate-type coolers and a hot-metal-pouring speed-control system, eliminates these problems and leads to a host of other benefits.

IRON & STEEL >

**Figure 1:**  
Explosion risk from  
uncontrolled fume  
emissions during  
converter charging



Converter steelmaking operations involve several process steps such as charging, oxygen blowing and steel tapping as well as various upstream and downstream liquid-metal-treatment steps. All of these involve emissions of hot and dust-laden gases. The major quantity of these gases is emitted mainly as carbon monoxide during the oxygen-blowing phase.

Following partial or complete combustion, the gases are cooled and treated in specially designed primary-offgas systems after which they are stored for subsequent use or flared.

The hot fumes emitted during scrap and hot-metal charging, steel tapping and from the various liquid-metal-treatment steps are evacuated, cooled and de-

dusted in secondary offgas-treatment systems. Such systems are usually comprised of gas-collection hoods, gas-mixing chambers, spark separators, bag filters, ID (induced draft) fans and an offgas stack.

### Limitations of conventional offgas-treatment systems

Conventional secondary-offgas-treatment systems are frequently overloaded during the charging of hot metal into the converter onto precharged scrap (or vice versa) when enormous quantities of hot gases with temperatures of up to 1,500 °C are emitted. This is particularly the case when cheap, low-quality scrap with its inherent contents of combustible substances (e.g., hydrocarbons such as paint, plastics, grease and oil in addition to galvanized and tin-coated metallic contaminants) is charged. When the scrap is immersed in the hot metal, the hydrocarbons cannot combust due to the lack of oxygen, and large quantities of so-called pyrol-

This has been a problem for many steelmakers for which no fully satisfactory answer has existed up until now.

### A new advanced design solution

Siemens VAI has introduced an improved secondary-offgas-cleaning system with high-performance cooling capabilities. Engineering of the system took into account the content of combustibles in the scrap, the maximum thermal power emissions from a converter on the basis of the charged scrap and hot-metal characteristics, the required cooling capabilities, and the combustion requirements. A series of different sized steel plates are installed in

### Main Benefits

- No danger of explosions during hot-metal charging
- No spark arrestors required prior to bag filters
- Shorter hot-metal pouring times – down to even less than 40 seconds – for increased productivity
- Improved evacuation capacity and cooling performance of existing systems at relatively low investment costs



Figure 2: Result of overloaded offgas-treatment systems during converter charging

ysis gases such as CO, H<sub>2</sub> and CH<sub>4</sub> compounds as well as vapors of Zn or Sn form. When they exit the converter and come into contact with oxygen from the surrounding air, they combust and occasionally explode (Figure 1). The capacity of the offgas-treatment system is exceeded and this becomes visible by major fume emissions from the top of the steel plant (Figure 2).

the patented coolers which rapidly absorb and cool the exhausted gases, even during slopping when the large gas volumes are generated. This is combined with a thermal-power emission-control system during hot-metal charging to maximize the pouring speed with consideration to the offgas-treatment capacity and safety factors.



**>> Industrial applications**

The first major application of this solution was for the steel mill of Sidmar in Gent, Belgium, consisting of two 295-ton converters and two ladle-treatment stands. The dust emission level inside the building had to be kept to below 5 mg/Nm<sup>3</sup>, the gas-cooling system had to cope with a thermal load of 180 MW and the dedusting units had to ensure a clean-gas dust level at the stack that was less than 10 mg/Nm<sup>3</sup>. To achieve these targets the evacuation system was designed with a capacity of 2,400,000 Nm<sup>3</sup>/h and plate-type convection coolers and a thermal-power emission-control system were installed (Figures 3 and 4). The coolers are designed to

**Plant Improvements**

The described solution has since been implemented in a number of existing plants. The improvement in the heat-removal efficiency achieved with the installation of plate-type coolers is indicated in megawatts.

– Alchewsk, Ukraine:	+75 MW
– Thyssen-Krupp CSA, Brazil:	+65 MW
– voestalpine Stahl, Linz, Austria:	+28 MW
– Unnamed German steel mill:	+80 MW



**Figure 4: Plate-type convection cooler**

**Figure 3: Outside view of plate-type cooler system at Sidmar, Gent, Belgium**

ensure a maximum cooler outlet temperature of 250 °C at a maximum cooler inlet temperature of about 750 °C. Following the system start-up, the improved heat-removal efficiency was in the range of 90 MW compared with the previous offgas-treatment system. Accumulated heat energy in the plates is removed by an air stream sucked through the coolers during the regeneration phase.

**Concluding remark**

With the described solution for secondary-offgas-treatment systems, the exhaustion, treatment and dedusting of the emitted gases during converter operations

can be carried out in a safe and efficient manner. Sufficient cooling capacity is provided so that a plant can operate without the need for emergency cooling-air flaps, while assuring a high enough air flow through the system to provide safe combustion conditions. The described system can be installed in both new and existing steel mills. ■

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## Start-up of a new RH degassing plant

# Quality Driven

A new Siemens VAI-supplied twin-station RH degassing plant was successfully started up at the steel works of the Chinese producer Nanjing Iron and Steel Co. Ltd., (NISCO). The installation of RH technology is a consequence of the company's continued emphasis on increasing its production of high-quality steel grades for demanding products applications. The twin-station RH design is an efficient cost-saving solution for increasing the output of treated steel at reduced unit costs on a tonnage basis.



Twin-Station RH Plant, NISCO, China

**N**ISCO produced in the year 2006 a total of 4.9 million tons of carbon and alloyed steel grades which were sold as wire rod, bars, wire, sheets, coils and plates to the domestic and international markets. In order to further improve the quality of the produced steel and to increase its range of high-end products, NISCO awarded Siemens VAI a contract for the supply of a new 150-ton RH (Ruhrstahl Heraeus) vacuum-circulation plant.

### Equipped for excellence

The RH plant was designed as a twin-stand concept to ensure a high productivity rate (treatment of up to more than 40 heats per day) and also to reduce the number of crane activities for delivering and removing ladles. In addition to engineering, the Siemens VAI supply scope included a hydraulic ladle-lifting system,

T-COB (Technometal Combined Oxygen Blowing) lances, RH vessel-transfer cars, the alloying system (direct feeder and vacuum hopper), the vacuum pump system and a stand-by preheater. Siemens VAI provided advisory services for erection and commissioning.

A T-COB lance was installed on each stand for vessel heating, oxygen blowing for chemical heating, decarburization as well as for quick skull removal. The powerful vacuum system designed by Siemens VAI is generated by a combined steam-ejector vacuum pump consisting of five ejectors, two condensers and four watering pumps. Two snorkel maintenance cars equipped with a snorkel-gunning machine were installed for each RH stand to increase the snorkel lifetime. The steel circulation and all events during treatment, e.g., alloying additions and oxygen blowing, can be clearly observed with the mounted video camera. Off-gas analyses and measurements of the gas-flow rate enable the process to be controlled for optimum metallurgical results. Level 1 and Level 2 automation systems were installed for equipment and process automation. The operators were trained by Siemens VAI specialists.

### Start-up and outlook

The RH plant commenced operations in early 2007. During the hot-commissioning period API (American Petroleum Institute) steel grades and carbon structure steels were treated. The plant will also be employed for the production of automotive steel grades, ship steel, silicon steel in addition to boiler and vessel plate steel. The project was successfully completed and NISCO is now in a position to enter into new and lucrative markets. ■

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Ultra-thick slab casting at voestalpine Stahl, Austria

# World Record

For a certain downstream high-quality product application, it was necessary for the steel producer voestalpine Stahl to produce ultra-thick slabs on their existing No. 5 Slab Caster for rolling to plates. Siemens VAI, which had previously supplied the machine, was contacted to modify the caster to make this possible. But the requested slab size exceeded by far the original design specifications. The technological challenge was immense and the outcome all but certain ...

**"N**o one had ever produced a slab that thick on this type of caster," said Dr. Michael Stiftinger, Technological Project Leader, "355 millimeters – 14 inches, at a width of 1,600 millimeters. That is a massive quantity of molten steel to be cast, cooled and

bent to shape in a conventional bow-type caster with a straight-type mold."

Time is money. When a lucrative market opportunity opens up, a steel supplier has to move fast. The engineering, equipment delivery, modification work, and start-up of the caster had to be carried out within an incredibly tight time schedule of less than 12

months. The thickest slab previously cast on the CC No. 5 was 285 millimeters. And now a world-record thickness was required!

A team of voestalpine and Siemens VAI specialists quickly assembled and worked feverishly together. They did their numerical calculations, simulated casting conditions, and specified the process parameters. A new mold and bender for this slab thickness was de-

signed and the technological packages were fine-tuned to perfection. A critical factor was the casting speed. To cast too fast runs the risk that the steel will solidify too late, leading to slab deformation and the need to shut down the machine. If the casting speed is too slow, the slab may become too rigid in the straightening zone, resulting in possible equipment damage. Therefore, casting had to be carried out within a narrow speed window, which was monitored by a "machine-protection" technological package.

Only six days were available to carry out all on-site modification work and cold testing. Installation personnel worked round the clock. On Friday, June 29, 2007, one day ahead of schedule, everything was in place and tested. The countdown began. Says Stiftinger, "To be honest, everybody was nervous. We were worried that something might occur that was overlooked. We knew that this start-up would either be a huge technological success ... or a disaster."

At exactly 19:46 p.m., the operators started the casting sequence. In the critical zone, where slab bending and straightening take place, everything proceeded according to plan. There were no surprises. All casting parameters were correctly defined and the technological packages functioned as designed. A total of 321 tons were cast in two successive heats.

The outstanding cooperation and teamwork between two capable partners was the decisive factor for success. This project shows that a pioneering spirit and the courage to undertake formidable challenges can set new milestones in continuous casting. Siemens VAI takes this opportunity to thank the voestalpine Stahl project team for their commitment and dedication to this notable casting achievement. ■

## World-Record Cast

Slab thickness: 355 mm

Slab width: 1,600 mm

Mold type: Straight mold

Machine radius: 10 m

Casting speed: 0.7 m/min

Highlight:

Excellent inner quality with DynaGap SoftReduction

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Faster slab-thickness changes with Smart Solutions

# Thickness on Demand

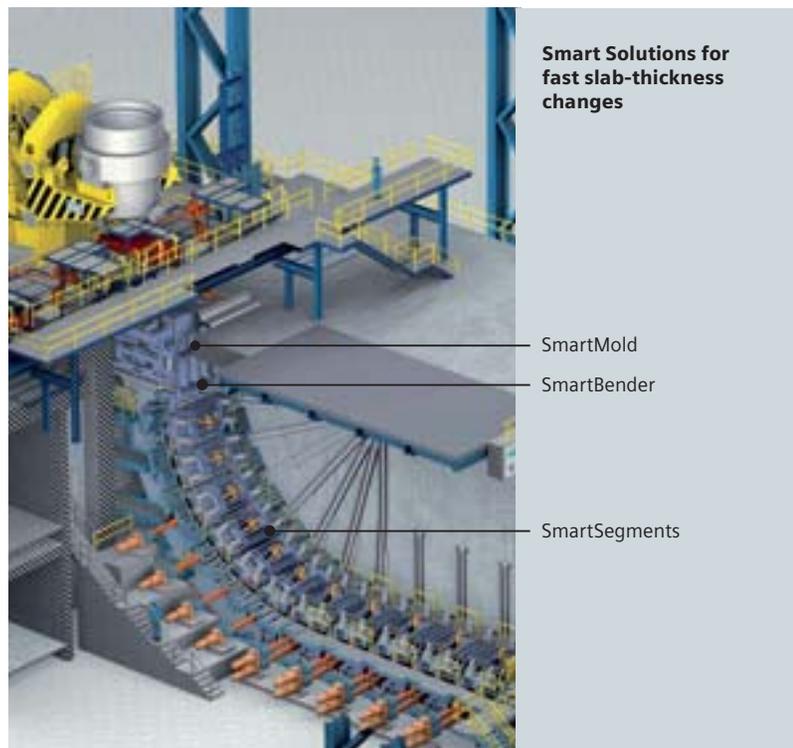
A unique solution package is now available from Siemens VAI which allows slab-thickness changes to be carried out more quickly and efficiently than today's benchmark time of 30 minutes.

This is made possible by the combination of the well-proven SmartMold equipped with exchangeable mold narrow faces, the SmartBender for the first caster segment and SmartSegments for the subsequent strand-guiding system. This provides producers with a high degree of production flexibility while maintaining caster productivity at a high level. The first order for the new "thickness on demand" solution package is scheduled for start-up at Cosipa, Brazil in early 2008.

The ability to quickly and efficiently adjust the mold and strand-guide system of a slab caster to cast different slab thicknesses is an increasingly important factor for maintaining a competitive edge. Producers must be able to flexibly respond to rapidly changing order demands to meet the requirements of the slab market or the rolling mill. Fast equipment adjustment times improve overall caster availability and productivity.

## Combining three good ideas

The latest development by Siemens VAI for flexible slab-thickness adjustments is the introduction of low-weight, cassette-type SmartMolds equipped with quick-exchange narrow-mold faces. These narrow faces can be easily removed and replaced with new faces by means of a single-purpose lifting hook to enable the casting of different slab thicknesses. The new mold is complimented by the downstream SmartBender and SmartSegment solutions. The SmartBender is a remotely adjustable first caster segment that allows quick strand-thickness changes to be carried out in the bending zone of a caster. The remaining slab-containment system is equipped with the well-known SmartSegments, which allow online and remote roll-gap adjustments to be carried out. In combination with the DynaGap SoftReduction® technology package, dynamic soft reduction is also possible to improve internal strand quality. More than 1,000 SmartSegment units have been sold worldwide to date.



Smart Solutions for fast slab-thickness changes

SmartMold

SmartBender

SmartSegments

## First industrial application

The Brazilian flat-steel producer Companhia Siderúrgica Paulista (Cosipa) will be the first company to apply the combined SmartMold, SmartBender and SmartSegment solution for flexible slab-thickness adjustments. This will be implemented in a new single-strand slab caster with a nominal capacity of 1.2 million tons per annum. Following the start-up of this caster scheduled for early 2008, the company will be able to flexibly and quickly respond to the demands of the highly profitable slab market. ■

## Main Benefits

- Proven and industrially applied individual solutions
- Remote slab-thickness changes in less than 30 minutes
- Thus, high caster availability and productivity
- Increased flexibility to slab-market or rolling mill demands

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Implementation of DynaGap SoftReduction technology in bloom and billet casters

# Quality to the Core

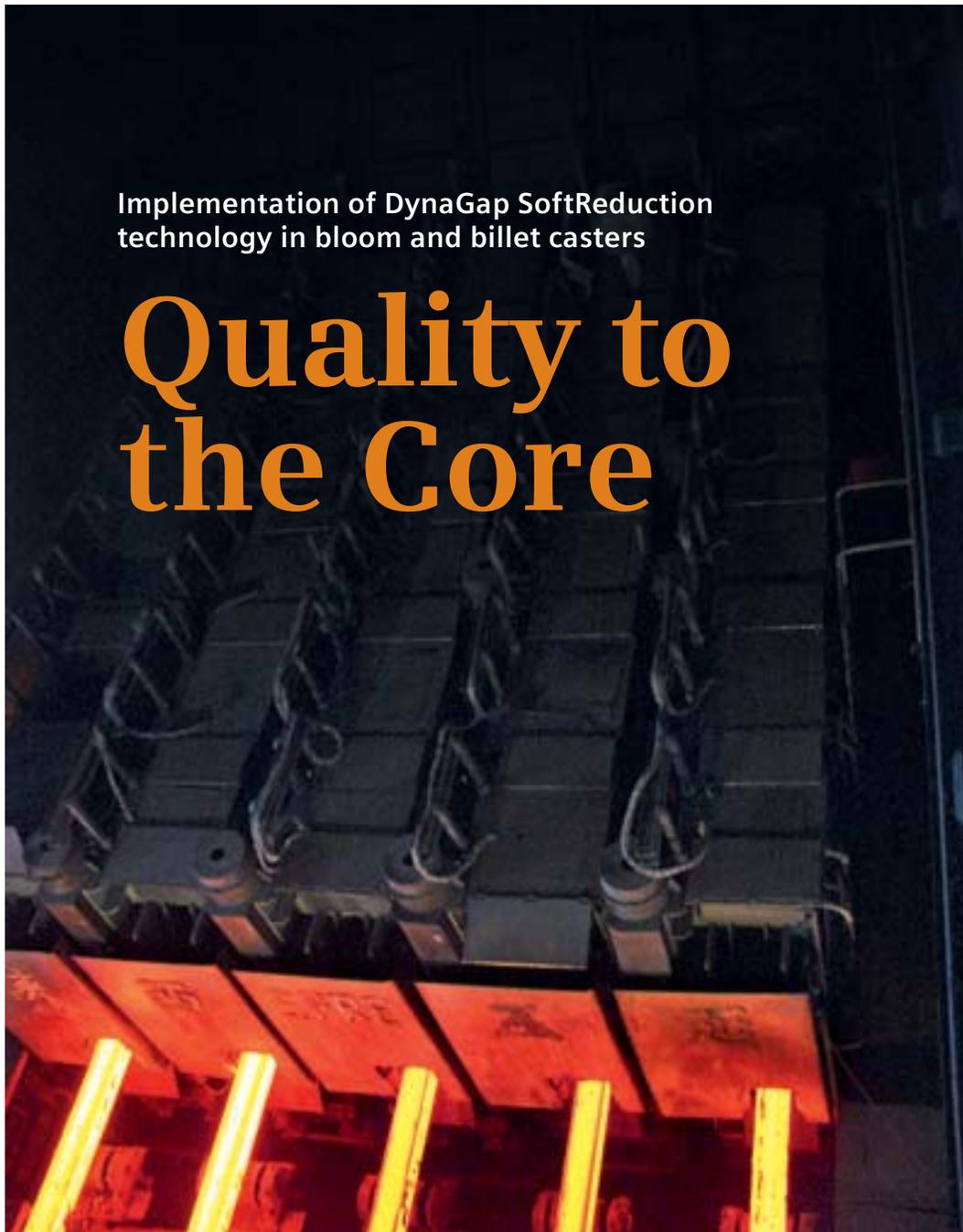


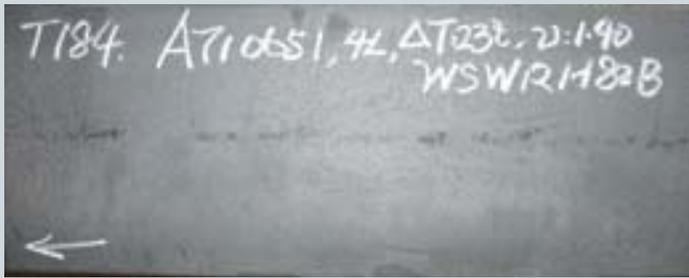
Figure 1:  
View of DynaGap  
SoftReduction  
stands in bloom  
caster of WISCO,  
China

Mechanical soft reduction, applied in the final zone of strand solidification, reduces centerline segregation and center porosity in continuously cast strands. Previously applied in slab casters, Siemens VAI extended its DynaGap SoftReduction technology for use in bloom and billet casters. This article describes the results of the installation of this technological package in a 5-strand bloom caster of the Chinese steel producer Wuhan Iron & Steel Co. Ltd.

**T**he principle behind mechanical soft reduction is to press the chemically highly segregated, remnant liquid steel which collects in the core of a solidifying strand in an upstream direction to im-

prove the chemical homogenization of the steel, to avoid center segregation, as well as to compensate for thermal shrinkage of the steel. This is achieved by applying small strand-thickness reductions in the final

**Figure 2:**  
Longitudinal macro-etches of a 200-mm square bloom (tire-cord grade)



**(a) DynaGap SoftReduction sample.**  
Casting speed: 1.4 m/min, superheat: 23 °C  
DynaGap SoftReduction applied



**(b) Reference sample without soft reduction.**  
Casting speed: 1.1 m/min, superheat: 26 °C  
DynaGap SoftReduction not applied (hot-strand pressure only)

zone of strand solidification. The result is a significant improvement in the internal quality of cast strands, which is particularly important for the production of critical steel grades such as rail steel and tire-cord steel. The DynaGap SoftReduction system of Siemens VAI incorporates a 3-D thermal tracking system which calculates online the temperature profile in the strand. This dynamic process tool also determines the optimum set points for pinch-roll-stand reductions even during unstable casting conditions, taking into account changes in the superheat, steel grade, casting speed, and water flow of the secondary-cooling system.

#### Industrial application

DynaGap SoftReduction technology was implemented in a Siemens VAI bloom caster for the first time in 2003 at Panzhihua Iron and Steel (Group) Co. (Pangang), Sichuan Province, China. This was followed by the start-up of this technology package in March 2006 in the previously supplied Siemens VAI 5-strand Bloom Caster No. 1 of Steel Plant No. 1 at Wuhan Iron & Steel Co. Ltd. (WISCO), China. The WISCO caster mainly casts high-carbon steel grades, such as tire-cord grades, in small square bloom formats of 200x200 mm. For the implementation of DynaGap SoftReduction technology, it was necessary to revamp the casting machine. The four existing pinch-roll stands for each strand of the caster were complimented by two additional pinch-roll stands and repositioned (Figure 1). The automation package for DynaGap SoftReduction was also installed.

Macro-etches of samples of a tire-cord grade were taken and compared from strands where DynaGap SoftReduction was applied during casting and where it was

not (Figure 2). The sample where DynaGap SoftReduction was applied shows almost no segregation lines and only minor center porosity. An optimum reduction per pinch-roll stand, as calculated by the integrated dynamic process model, assures that no internal cracks occur.

#### Concluding remarks

It could thus be shown that the application of DynaGap SoftReduction technology, even when applied on small, square blooms cast at relatively high casting speeds, leads to significant internal quality improvements. On the basis of the excellent results achieved with this technology package at both Pangang and WISCO, Siemens VAI has since received orders for the installation of DynaGap SoftReduction in March 2006 for the new 5-strand No. 3 Bloom Caster in Steel Plant No.1 of WISCO, as well as in May 2007 for the new 3-strand No. 2 Bloom Caster in Steel Plant No. 1 of Nanjing Iron & Steel Co, China. Both bloom casters will be supplied by Siemens VAI. ■

#### Main Benefits

- Reduction of centerline segregation and the center porosity
- Uniformly high internal strand quality achieved even during unstable casting conditions
- Improved quality of rolled products, higher yields and less product downgrading

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A new billet-welding process for uninterrupted long-product rolling

# Endless Rolling Technology

The endless rolling process from Siemens VAI is a major technology step forward for the production of long products. Billets are welded together before entering the first rolling stand, resulting in the advantages of a higher metallic yield and increased productivity. Larger coil weights can also be produced, as increasingly called for by the market. With this solution a smooth and stable rolling operation can be achieved, along with lower processing costs.

In a conventional rolling mill for long products, billets are individually fed to the rolling mill after having been preheated in the furnace to the desired temperature. A gap time of a few seconds separates two subsequent billets, causing a loss in productivity. Along the rolling train, the required cropping cuts for the head and tail ends need to be repeated for each billet, leading to a significant loss in the metallic yield. Also, individual billets have to enter each of the rolling stands in sequence, meaning a repeated danger of generating a cobble.

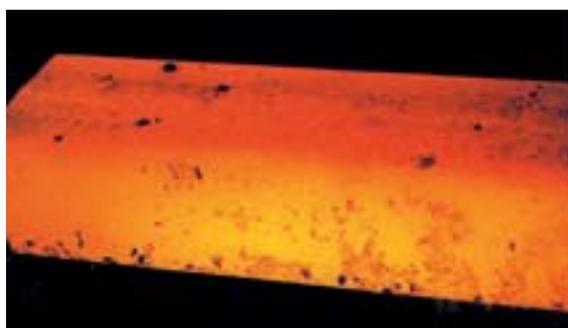
## Principle of ERT

Endless Rolling Technology (ERT) overcomes these disadvantages by flash welding the tail of each billet to the head of the next one before entering the first rolling stand. The welding machine travels synchronously with the two moving billets. After welding, the burr is

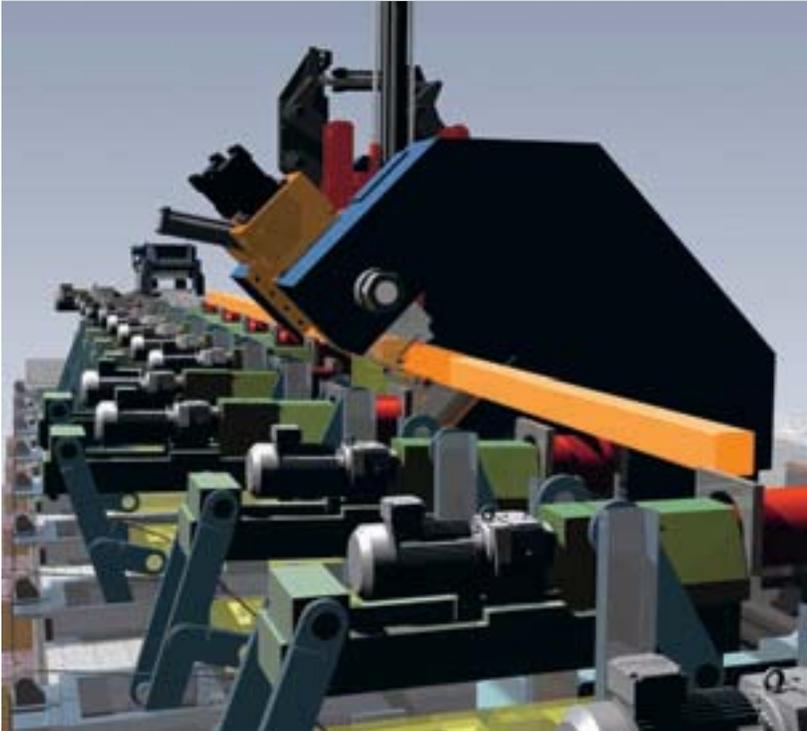
removed by rotary disk cutters to avoid potential defects during rolling. The welded joint has salable quality, as all of its properties are identical to the rest of the bar (see figure). A short welding-cycle time makes the system applicable in high-productivity installations. The result is one endless billet undergoing rolling. In wire production it is possible to increase the coil weight independent of the individual billet weight.

## Process and main components

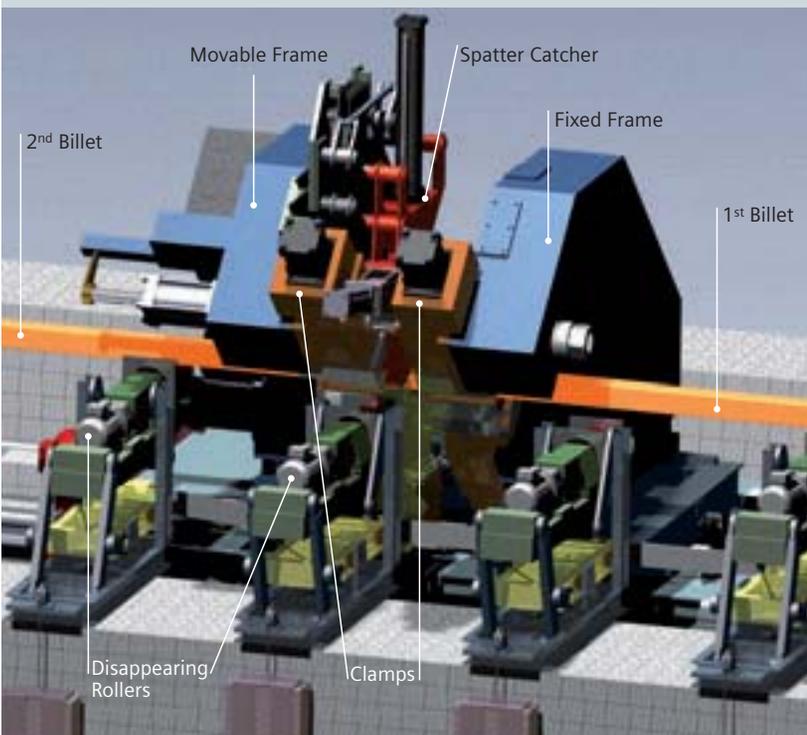
Welding machine; the welding machine employs a flash-welding process, operates with low-voltage and high-current electricity and without the need for any filler material. After both billets have been clamped, the head of the trailing billet approaches the end of leading billet, while the automation system controls the appropriate gap distance during flashing. In the first flashing phase the two ends of the adjacent billets are heated up to the melting temperature. The heating is very intense and rapid, causing most of the melted metal to be ejected from the joint area. During the following upsetting phase, a force is applied to both ends which forces the remaining molten metal out of the joint forming a burr around the joint line. The flash-welding process is applicable also for rough and oxidized surfaces, as the upsetting action pushes all the impurities out to the burrs. Martensite formation and residual stresses are avoided by the high temperature, while microstructure, physical properties and chemical composition are perfectly homogenized during rolling with conventional reduction ratios. During the rolling process the joint area is spread over a long bar distance, and the final result is a negligible difference of properties between the welded area and the rest of the bar.



Appearance of welded joint area after 1st rolling stand



General view of welder with retractable rollers



Welder components and assembly

### ERT Benefits for straight-bar lines

- No inter-billet time losses
- Virtual elimination of head- and tail-end croppings
- Full utilization of cooling bed capacity with no short bars entering cooling bed
- Constantly high rolling speeds due to continuous rolling, stable rolling operations and fewer disruptions
- Reduced chance of cobbling
- Stable process conditions, hence improved product quality and uniformity
- Longer life of rolling and guiding equipment
- Less maintenance, spare parts and consumables

### ERT Benefits for coiled bar lines

- Similar advantages as in straight-bar lines, additionally –
- No need for trimming of coil head and tail
- Possibility to produce larger and customized weights
- Practical integration with Siemens VAI bar-spooling process
- Production of larger coils without the need for costly modifications to other equipment (e.g., billet caster, billet-reheating furnace, rolling train)

Disappearing rollers; traveling of the welding machine along the roller table is enabled by disappearing rollers, which move laterally. This prevents metal droppings produced during welding from clogging the area, making maintenance easier and faster.

Burr-cutting machine; this unit removes burrs in both the horizontal and vertical directions and also trims the corners of the welded joint. Deburring is performed by rotary disk cutters, offering a long tool life and excellent quality and appearance of the cut.

### Concluding remarks

With the continuous billet welding and endless rolling process offered by Siemens VAI, much more stable and reliable rolling operation can be achieved at a constantly high rolling speed. Fewer cobbles are likely to occur and a considerably higher metallic yield results from the elimination of head- and tail-end croppings of the rolled bars. These factors, in combination with a reduced specific energy consumption, can lead to an up to 10% productivity increase and cost savings in the range of several euros per ton of rolled steel. ■

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PANORAMA >



Richard Serra

# Steel as a Form of Art

Since Richard Serra started experimenting with steel, his works of art have gradually grown in size. However, his work is not always given a warm reception. The Museum of Modern Art displayed some of his pieces throughout the summer of this year.

**B**orn in 1939 in San Francisco, the American sculptor and graphic artist Richard Serra first took up English Literature, and then went on to study Fine Art at Yale University in New Haven, Connecticut. During his studies, he earned money as a steel worker, which may have influenced his future decision to use steel as a medium.

## New ways of seeing things

Even with his early works, Serra already belonged to the generation of American post-minimalists whose principle is a radical demand for reality and who view works of art not as bearers of preconceived ideas, but as an expression of oneself. Serra used these ideas in his work in the 1960s, in which the specific properties of the materials used – rubber and molten lead – determined the form of the art and its presentation in the room. The works of art, particularly governed by material and material-specific shapes, also always interacted with the environment in which they were installed, be that a museum, city or countryside setting. This leads to new relationships between the piece of art and its surroundings and opens up “new meanings, new ways of seeing things,” which directly affect the observer. There is an interaction of the works of art, defined by their material, form and surroundings, and the observers, whose normal way of looking at things is challenged.

## Walk-in art: fantastic plastic

An artistic concept that has become increasingly evident since Serra began his career around 1968 is his use of steel and the subsequent trend toward creating increasingly larger pieces. The first large walk-in pieces, where artistic perception is accompanied by immediate, physical experiences, were presented to the public at the start of the 1970s and have, for the most part, been received by the local population with anything from controversial discussions to mass protests. In particular, “Tilted Arc” (1981) on the Federal Plaza in New York triggered fierce reactions, which lead to

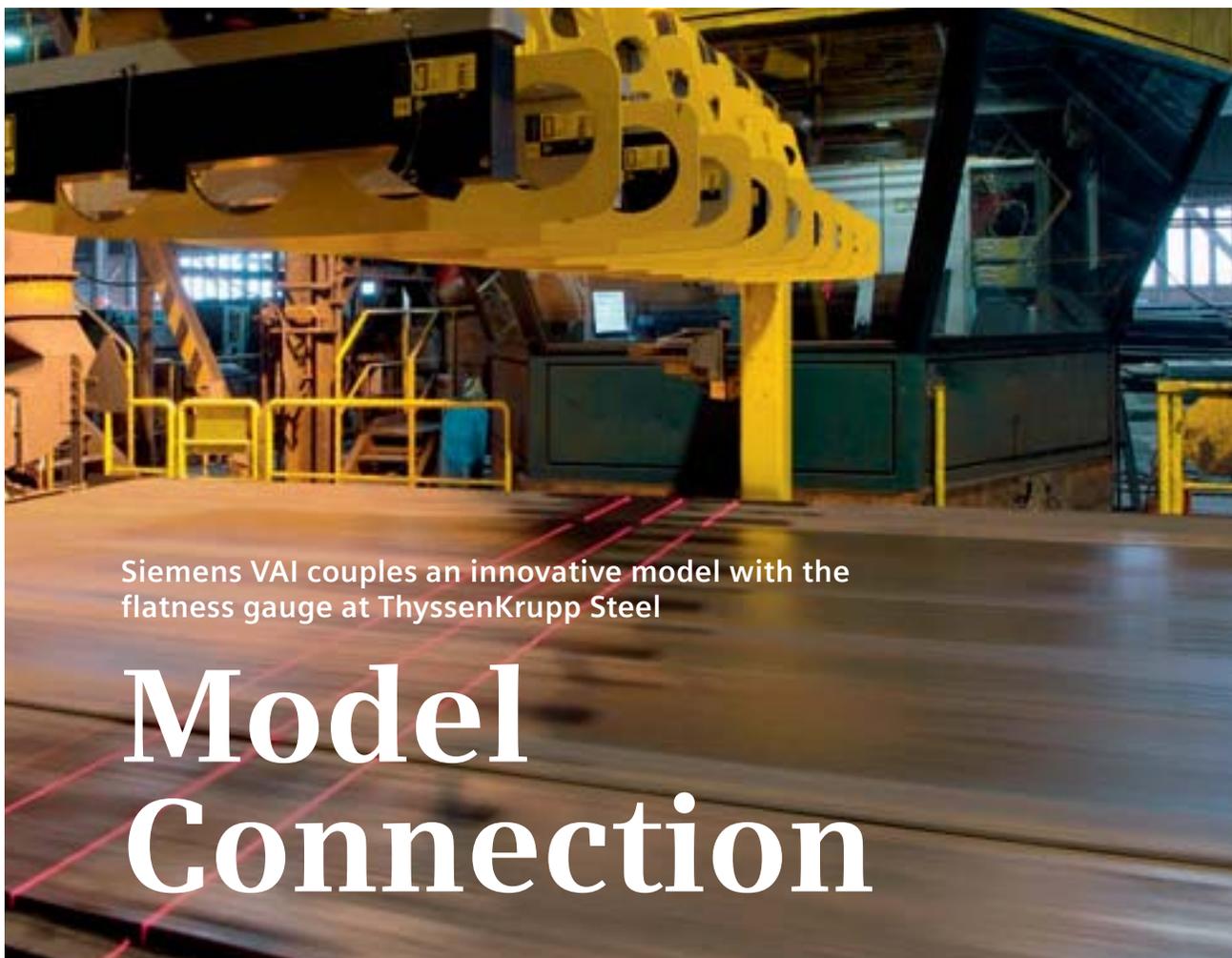


Intersection II (1992); Richard Serra

the plastic art having to be removed in 1989. His series of “Torqued Ellipses” (1996–99), which comprise gigantic plates of towering steel, bent and curved, leaning in and out, carve very private spaces from the necessarily large public sites in which they have been erected. Serra’s most recent public work includes the 60-foot-tall “Charlie Brown,” which has been erected in the courtyard of an office building in San Francisco.

## Richard Serra Sculpture: Forty Years

The exhibition “Richard Serra Sculpture: Forty Years” in The Museum of Modern Art in New York presents the artist’s forty-year career, from his early experiments to monumental late-career pieces, including Intersection II (1992) and Torqued Ellipse IV (1999), along with three new works that have never been exhibited before. With works on view throughout the Museum and in The Abby Aldrich Rockefeller Sculpture Garden, “Richard Serra Sculpture: Forty Years” displays the extraordinary vision of this formidable artist, who has radicalized and extended the definition of sculpture. ■



Siemens VAI couples an innovative model with the flatness gauge at ThyssenKrupp Steel

# Model Connection

ThyssenKrupp Steel Heavy Plate Profit Center decided to revamp their existing cold plate leveler to include the modernization of the main hydraulic gauge control and bending cylinders with new internal position transducers, a new Level 1 control, the leveling model of Siroll<sup>CIS</sup> PM, and a flatness gauge. A configuration involving an online mathematical leveler model coupled to a flatness gauge was selected to improve the quality of the products, increase the productivity, and reduce reworking effort.

In the field of oil and pipeline, shipbuilding, and construction, end plate users fuel a growing demand for higher plate quality with better flatness characteristics. Flatness challenges in these fields are being met by solutions such as the Siroll<sup>CIS</sup> PM setup model developed by Siemens VAI. To achieve maximum knowledge of the material characteristics, Siemens has developed a neural network capable of adapting yield stress after each pass.

## Leveling principles

Best known among steel plate flatness defects are the wavy edges, center buckle, quarter buckle, positive or negative ski, and the cross bow. Despite a good flatness before downstream processing, the cut pieces from the

plates might feature flatness defects. If these defects are not created by the cutting process itself, then they are the result of the internal residual stresses remaining in the original flat plate. These internal residual stresses cannot be detected online, neither by the operator nor by a flatness gauge.

As the plate is processed through the leveler, it undergoes alternate decreasing bends. At each bend, the fibers facing the roll are compressed while the fibers on the other side of the plate are stretched. The heavy bends (Zone 1 of Fig. 1) used to remove heavy flatness defects also create some internal stresses, which cause flatness defects, such as the cross bow effect. These newly created defects and others are removed by the later bends of the leveling process (Zone 2 of Fig. 1).

When a plate is bent as shown in the Figure 2, the fibers next to the surface of the plate are compressed and stretched to a greater extent than the fibers at the center (thickness-wise). During leveling, the fibers close to the plate surface go into a state of plastification (i.e. beyond yield point), and the fibers close to the center do not. The heavier the bends, the higher the number of plasticized fibers, and therefore the effectiveness of the leveling.

### Coupling the leveling model and flatness gauge

Given the thickness, the width, and the yield stress of the incoming plate, the Siemens VAI leveling model computes the gaps required to reach a target plastification ratio. It also calculates the expected forces per roll, the torques per roll, and the ending necessary to compensate for the stretch of the leveler. A typical target plastification ratio is around 60 percent to 70 percent. Once the target plastification ratio is chosen, the model automatically computes the presets, even if the plate format changes.

If the measured flatness is exceeding specified tolerances, a warning is sent to the operator, who can then choose to do a new pass, bypass the warning by validating, or downgrade the plate to a lower quality. Because the flatness gauge is located at the exit of the leveler, the model must use the operator's inputs for a preset computation for the first pass. After the first pass, the model takes the flatness data given by the flatness gauge as an input for the second and third pass, if the

plate is below is exceeding specified tolerances. With this information, the model selects the optimal plastification ratio and calculates the most adapted roll bending setup for the next pass and the subsequent pass. Flatness pattern is automatically included in the production data report.

### Siemens VAI – the right connection

Siemens VAI leveling model has helped operators at ThyssenKrupp to better understand the leveling process and to make better use of the leveler itself. The flatness gauge eases the screening of the products at the end of the production line. Moreover, the flatness data delivered to the model reduces operator responsibilities because the model computes a preset for the second and third passes. Thanks to the installed model running on the automation system and coupled with a flatness gauge, ThyssenKrupp has established a more stable and reliable leveling process, inducing less internal reworks along with achieving better overall flatness performance.

### Main Benefits

Provides operators with maximum knowledge of material leveling characteristics

Automatically computes leveling presets from the target plastification ratio, even if the plate format changes

Improves the quality of products, increases productivity, and reduces reworking effort

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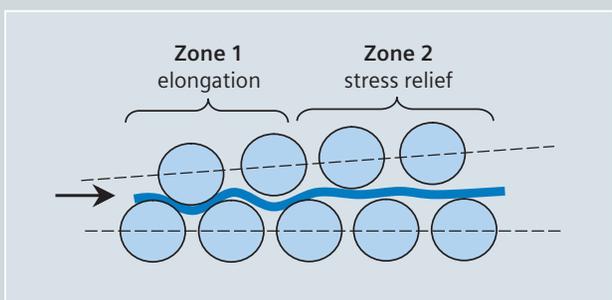


Figure 1: Two zones inside the leveler

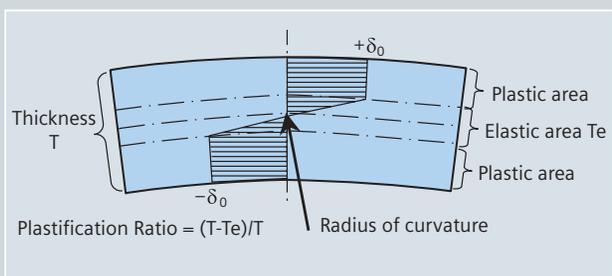


Figure 2: Inside the plate thickness

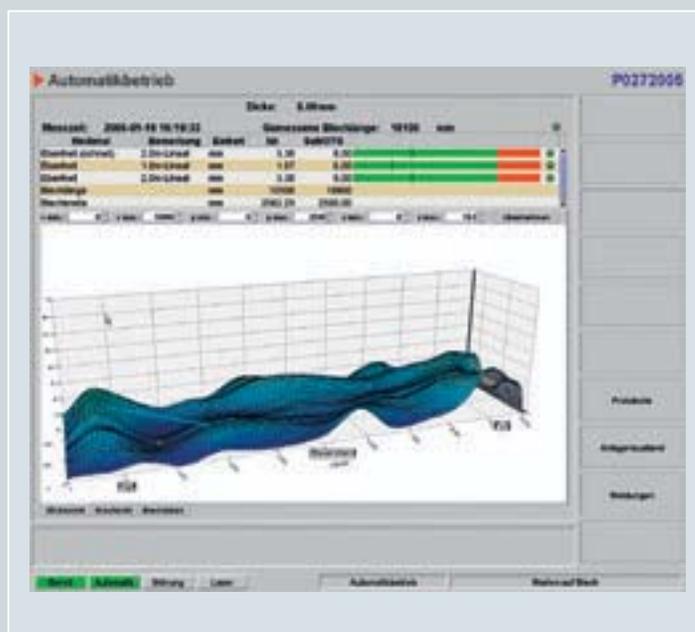


Figure 3: 3D-view of the topography of a measured heavy plate as displayed at the control stand

## HOT ROLLING



Finishing mill

Second extension step enhances flexibility and performance at Shagang

## Next Step to Success

The relocation of ThyssenKrupp's integrated "Westfalenhütte" steel plant from Dortmund, Germany to Jinangsu Shagang Steel Corporation near Shanghai has been one of the most challenging logistical and technological projects ever attempted in the steel industry. Now that the plant has been re-installed and recommissioned in China, Siemens VAI equipment and systems are helping Shagang to take the next step to success by enhancing plant flexibility and performance.

**A** total of 250,000 tons of plant structure and equipment was dismantled and shipped from Dortmund to China. Siemens VAI had complete process responsibility for the restart and performance of the plant, including specification of equipment upgrades, implementation of the automation system, and commissioning of three blast furnaces, an LD (BOF) converter plant, a twin stand ladle furnace, a two strand slab caster, a new plate mill, and the relocation of the hot-strip mill.

The layout of the modernized plant essentially corresponds to the layout prior to disassembly of the plant in Dortmund, with the roughing-mill area shortened from three-stand to two-stand design. Two of the three roughing stands were reused. This makes the rolling mill more compact and leads to advantages in temperature management.

### Siemens VAI leads modernization effort

Modernization of the 1600mm wide hot-strip mill was carried out by Siemens VAI, with the goal of its being able to produce 4.5 million tpy of state-of-the-art steel products. The relocated mill went into operation with the reworked design in June 2005. On schedule, in Spring 2007, the mill was equipped with additional

technical features to include a new hydraulic automatic gauge control (HAGC) and work-roll bending system on Stand 0 of the finishing mill; a SmartCrown work-roll bending system and roll shifting on Stands F1, F2, and F3 of the finishing mill; a hydraulic station and hydraulic control of Roughing Stand V2; an automatic roll-changing system on Roughing Stand V2; new drive systems in the rolling area of the roughing mill; and new binding and labeling machines in the coil dispatch area.

Scheduled to extend over a period of 40 days, shutdown for the adjustments started on April 11, 2007. Thanks to the excellent preparation and the highly motivated staff of both the customer and Siemens VAI, the first strip was rolled on April 29, 2007, after just a 19-day shutdown period. The start-up curve was also exceeded, with the mill achieving the pre-shutdown production level just 3 days after recommissioning of the hot-strip mill. Most importantly, Jiangsu Shagang was immediately able to sell all products into the market, due to excellent product quality. ■

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## Successful start-up of hot-rolling mill at Mittal Steel Poland in Cracow

# Most Modern Mill

In the hot-rolling mill supplied by Siemens VAI to the Arcelor Mittal Group as a turnkey installation in Cracow, Poland, the first coil was produced at the end of June – 23 months after signing the contract – which is one month before the contractually agreed date.

**A**rcelor Mittal now has the most modern hot-strip rolling mill in Europe. It is the first completely new facility of this kind in Europe for more than ten years and is scheduled for an annual production capacity of 2.4 million metric tons of steel.

The new hot-rolling mill in Cracow was supplied by Siemens VAI as a turnkey installation. Apart from the technological parts of the facility and the complete elec-

trical, drive and automation systems, the project included construction, the roll-shop and auxiliary installations – including water treatment equipment. Siemens also trained the operating and maintenance personnel and carried out commissioning.

### Scope of supply

The technological scope of supply of Siemens included a reheating furnace, a reversing quarto roughing stand with hydraulic upsetting devices, an “Encopanel” insulating tunnel and a crop shear. The six-stand finishing train is equipped with “SmartCrown” work-rolls, which enable a larger adjusting range for profile and flatness control. With the use of a sophisticated profile and flatness model, the SmartCrown work-rolls are shifted to match the roll contour to the crown of the incoming strip. The result is a final strip profile and flatness satisfying the tightest dimensional tolerances. Another major advantage is the avoidance of quarter buckles through local thickness reductions in quarter buckle sensitive areas of the strip. Rolling with SmartCrown work-rolls is normally carried out in combination with work-roll bending.

A laminar cooling section with quickly switchable “SmartCoolers” in the fine tuning zone enables precise control of the cooling process – an essential prerequisite for manufacturing special grades of steel. Two “PowerCoilers,” each with four wrapper rolls, ensure reliable winding of high-strength steel grades.

The plant produces steel strip in thicknesses from 25.4 millimeters down to 1.2 millimeters and has an annual capacity of 2.4 million metric tons. The maximum coil weight is 35 metric tons. With a maximum strip width of 2100 millimeters, the hot-rolling mill is one of the widest plants in Europe. ■

The new mill with one of the first steel strips



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Expanding into cold strip at Tangsteel

# Productive Relationship

On July 6, 2007, Tangshan Iron and Steel Corp. (Tangsteel) celebrated the first anniversary after final acceptance of its tandem mill coupled to a pickling line in the presence of senior officials from both Tangsteel and Siemens VAI. The motivation for this celebration was to express the deep satisfaction of Tangsteel with the investment made in 2004, and the productive relationship since maintained with Siemens VAI.

ROLLING &amp; PROCESSING &gt;



**T**angsteel is a fast-growing steel producer located in Tangshan city (Hebei Province, PR China). The industries in Tangshan city have been developing rapidly, and Tangshan has primarily become a production base for high-quality steel products, construction materials, energy, equipment manufacturing, and chemicals.

As part of its strategic development planning, Tangsteel purchased a 5-stand tandem cold mill from Siemens VAI to produce 1.5 million tpy of cold strip for

final application in cold rolled coils, galvanized coils, annealed, or skin passed coils for construction, household appliances, and hardened steel grades.

#### Making the most of advanced mill features

The Siroll<sup>CIS</sup> CM tandem cold mill has a number of advanced features. These include long stroke hydraulic cylinders positioned at the top and controlled by servo-valves to handle rolling force. Positive and negative work roll and intermediate roll bending are mounted



**Certificate signing ceremony.** From left to right:  
 Front: Philippe Gippet, Philippe Cruiziat, Wang Tianyi, Chairman of Tangsteel Group, Han Jizheng, Cold Mill Plant Manager.  
 Back: Mr Xue, Mr Grabner, Shi Dongri, Duan Guomin, Yu Shaoqing, Geng Jianxin, Zhang Hao



**Preview of the future 6-high tandem cold mill at CORUS, The Netherlands, currently under construction**

in Mae West-type blocks bolted to the mill housings. Intermediate roll shifting of the stand no. 5 enables increased flatness control. There is also a provision for work roll shifting on stands No. 1 to 4, enabling the implementation of edge drop control and increasing the efficiency of the flatness control on the last stand. Constant pass line adjustment is handled by wedge-type equipment. And roll spray cooling is done through spray heads incorporating remote controlled pneumatic valves able to control roll thermal deformation coordinated with Automatic Flatness Control (AFC).

Automatic work roll change is carried out at constant level compatible with coupled operation (high-speed strip-in-stand operation). The carrousel reel coiler has been equipped with strong-designed expandable mandrels for coiling and coil unloading in fixed position. The rotary shear operates at a maximum cutting speed of 300 mpm.

The automatic strip guiding system comprises a three-roll system on the entry side. The pickling line exit section was modified for coupled operation mode of the mill.

Medium voltage AC motors with vector control are used in the main drives. AGC/ AFC/ Flying Gauge Control/Mass Flow Control/Roll Eccentricity Compensation characterize state-of-the-art solutions for light gauges and tight tolerances. Finally, a Manufacturing Executing System (MES) has been installed to obtain the maximum throughput of the coupled Pickling Line – Tandem Cold Mill (PLTCM) without any compromise in quality.

### Long-term productivity and quality

Productivity levels achieved after a year of operation are outstanding, and daily production records are broken on a regular basis. In fact, the last record set was 6,800 tons per day, mostly with 0.35 mm thick product. This

is well above nominal mill capacity of 1.5 million tpy, and sets the benchmark for other PLTCMs in China.

Hitting – and even surpassing – these production records does not impact quality at all. Indeed, powerful actuators, such as 6-high shifting system and hydraulic gap control cylinders, together with the advanced technological controls for flatness and thickness, can handle any type of product, with extremely flexible scheduling capabilities. Auto-adaptive physical models cope with new materials and lubrication changes without the need of manual intervention.

Yet Siemens VAI will continue providing high-level services in order to improve the mill performance and capabilities. One area of investigation is the new Advanced High Strength Steel (AHSS), to allow penetration of the automotive market.

### Success breeds success

In June 2006, a delegation from CORUS Netherlands visited the Tangshan PLTCM as a Siemens VAI reference of 6-high tandem mill. The production and quality levels witnessed at the time played their role in helping CORUS to make their decision for their new PLTCM. ■

### Key mill data:

Steel Grade:	CQ, DQ, HSLA
Entry thickness:	1.5 to 4.0 mm
Exit thickness:	0.3 to 1.5 mm
Strip width (max):	1,650 mm
Capacity:	1,500,000 tpy
Exit mill speed:	1,200 m/min
Mill design:	4-high: stand No. 1–4 6-high: stand No. 5
Tension reel:	Carrousel-type

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Advanced evaluation of rollability

# Triple-A Rolling Model

Siemens VAI's Advanced Arbitrary Arc (Triple-A) model is based on a noncircular arc theory for the calculation of the elastic work-roll flattening. In addition to the radial displacements of the work-roll surface, it takes circumferential displacements, generated mainly by the acting shear stresses between work roll and strip, fully into account.

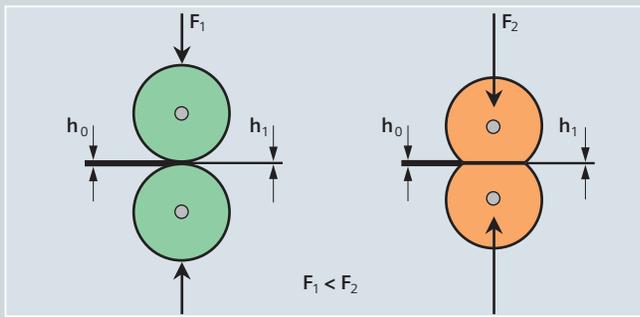
There is a distinction between practical and theoretical rollability. The “theoretical rollability limit” is reached if the strip thickness does not decrease, although the work rolls are adjusted against each other, resulting in extreme work roll flattening (Fig. 1). The rollability limit for certain products is frequently reached before the theoretical rollability limit, due to limitations regarding installed rolling forces and mill power, and technological constraints (e.g. maximum allowed draft to ensure that no slippage occurs between work roll and strip or limited rolling forces to prevent flatness defects). The latter limits are designated as “practical rollability limits” below.

## Siemens VAI's Triple-A rolling model

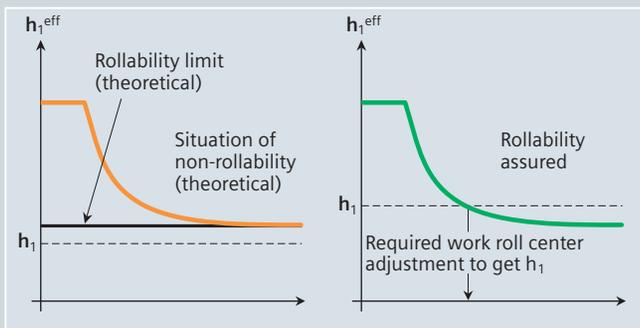
The algorithm for the determination of contact between work roll and strip is based on an iterative procedure. The contact stresses (compressive and shear stresses) are calculated for a given distribution of strip thickness and slip speed on the strip surface. The resulting contact stresses are applied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

In constructing the Triple-A model, the contact pressure was calculated keeping the strip thickness reduction constant. To ensure the prescribed draft, the work roll center had to be adjusted during the iteration scheme according to the resulting work roll deformation from the previous step. However, and especially for thin strips, this procedure led to severe oscillations of the contact area estimation. This problem was solved by fixing the work roll center during the iteration for the contact area and stresses, and by introducing an additional outer iteration for the work roll center in order to adjust the strip exit thickness to the prescribed value.

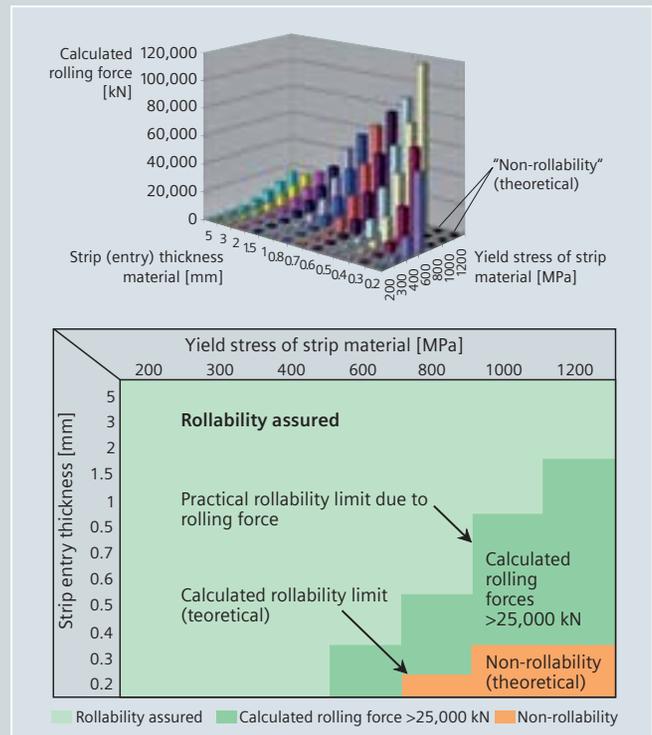
One advantage of this method is that rollability can be evaluated herefrom. If the strip exit thickness  $h_{1eff}$  does not decrease any further in the course of the iterations, although the work-roll center is adjusted more and more to the strip, then “non-rollability” respective-



**Fig. 1: Theoretical non-rollability ( $h_1$  indicates the strip exit thickness)**



**Fig. 2: Detection of (theoretical) non-rollability (left) and rollability (right)**



**Fig. 3: Calculated rolling forces for several rolling passes (top) with the corresponding predicted rollability limits (below) using Triple-A**

ly the theoretical rollability limit is detected. In Figure 2 designates  $h_1$  the target exit thickness of the strip.

Figure 3 (top) illustrates calculated rolling forces for several rolling passes with variable entry strip thickness and variable yield stress of the strip material. The corresponding prediction of the theoretical rollability limit as well as a suggestion for a possible practical rollability limit based on Triple-A is shown in

Figure 3 (below). Compared to existing rolling models the Triple-A model offers the capability to calculate rolling scenarios close to the rollability limits and even beyond them. This in turn is the basis to exactly evaluate the practical and theoretical rollability limits.

This makes Triple-A a unique tool for sizing cold and skin-pass rolling mills. Excellent correlation between measured and predicted rolling forces and rolling torques has demonstrated the validity and quality of the model.

### Main Benefits

- Very accurate prediction of rolling forces and rolling torques over a wide range of applications. Including very thin and hard strips
- Improved modeling of cold and skin-pass rolling
- Continuation of calculation beyond the rollability limits
- Sophisticated tool for sizing rolling mills

### Better modeling of cold and skin-pass rolling using Triple-A

As a noncircular arc rolling model, Triple-A was developed for offline calculations in order to predict rolling forces and rolling torques very accurately over a wide range of applications including very thin and hard strips. The approach improves modeling of cold and skin-pass rolling, as the circumferential work roll displacements allow for the existence of slip as well as no-slip zones inside the roll bite. The model automatically detects the appearance and includes the effects of contained plastic flow. A major advantage of Triple-A is that the calculation can be continued beyond the rollability limits, providing a sophisticated tool for sizing rolling mills. ■

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Effective collaboration drives project success in Shagang

# Solid Product Improvement

ROLLING & PROCESSING ^

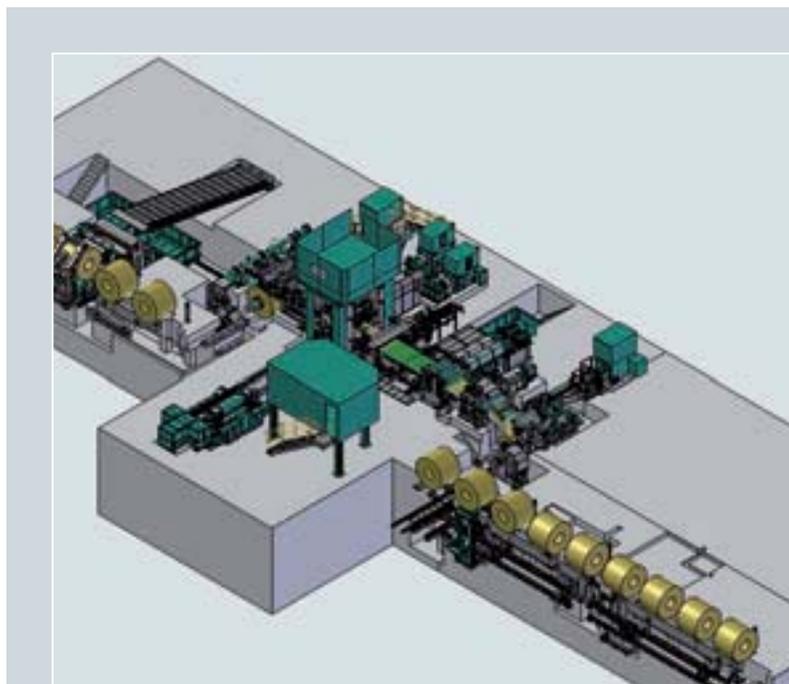
Continually increasing demands regarding strip flatness, elongation and roughness, especially for hard material grades, make the 4-high hot skin pass mill (HSPM) the preferred solution, particularly because of the much higher rolling forces and torques that can be achieved. In February 2006, the HSPM project between one of the Chinese iron and steel market leaders, Zhanjiagang Hongchang Plate Co. Ltd., and Siemens VAI MT Spain was signed, and the first coil is to be processed in October 2007.

**J**iangsu Shagang Group Co., Ltd is an iron and steel enterprise originally incorporated in 1975. At present, it employs more than 9,700 people. Current annual production capacity is 10 million tpy iron, 15 million tpy steel, 15 million tpy rolled products, 1.2 million tpy of stainless steel strip, and 0.15 million tpy of galvanized steel sheet.

In February 2006, Siemens VAI was awarded with the contract for the supply of a stand-alone hot skin pass mill and coil dividing line. Both lines will process the coils coming from the hot-strip mill (refers to article on page 48), allowing thickness range from 1.5 to 12.7 mm, width will be between 900 and 1550 mm. The project includes engineering of all the equipment and the manufacturing of the key-equipment.

## Challenging project requirements

The project is executed by the office of Siemens VAI in Bilbao, Spain. The manufacturing of the core equipment was done in the own workshops, while other parts were purchased from local suppliers under quality control of Siemens VAI. Final erection will be undertaken by the customer under the supervision of Siemens VAI MT Spain. Reliable and easy to maintain mill stand designs, in combination with advanced technological control processes, make the hot skin pass mills an ex-



Engineering drawing of the new hot skin pass mill

cellent tool for increasing the value added to final products from hot-strip producers or distributors.

## The value of cooperation and teamwork

Solid cooperation and teamwork between Siemens VAI and the customer has been a decisive factor for success of the project. At present, the equipment is at commissioning phase, SVAI team is now performing hot tests. First test coils were produced, on September 19 for Dividing Line and on October 16 for Hot Skin Pass Mill. The tests are successfully running according to the project plan agreed with the customer. This project shows how foresight and enthusiasm coupled with effective and open collaboration among suppliers and with the customer can lead to outstanding project success. ■

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Unbroken success of LW21 laser welder family

# Perfect Weld Every Time

Since the first laser welder of the LW21 family was introduced in 2004, the market has shown unbroken interest in the Siemens VAI technology. Laser welder applications now on order include finishing, continuous electrolytic cleaning, hot-dip galvanizing, and pickling lines. The move toward high-strength steel and need for flexibility is driving a growing number of customers to opt for Siemens VAI laser welder technology.

**L**aser welder developments at Siemens VAI started with the LW21L dedicated to lighter gauges. A total of seven of these welders has already been ordered, and two of them are already in industrial operation.

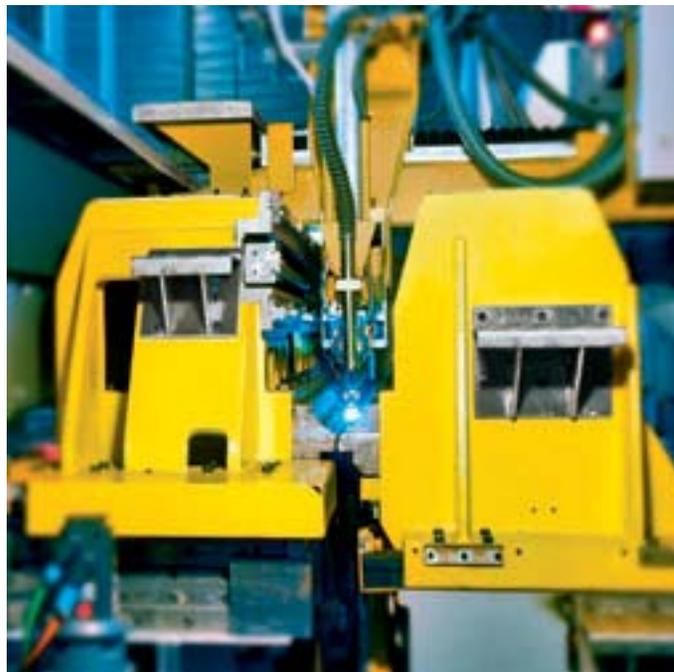
The latest order includes four LW21L laser welders for Tangshan Hengtong in China, where they will be used on new hot-dip galvanizing and will process a wide product mix involving CQ, DQ, DDQ, EDDQ, IFS, HSLA, HSS – including DR and TRIP – steels; 0.3 to 2.5 mm strip thicknesses; 1000 to 1250 mm strip widths; and tensile strengths up to 800 Mpa. The laser welders will be completely assembled and tested in the Siemens VAI workshop during summer 2007 for installation in China in early 2008.

The laser welders ensure a perfect cutting quality and strip preparation, leading to consistent welding quality while minimizing maintenance requirements. The laser beam path allows easy dismantling of the mirrors and welding heads in a very short time without losing the machine settings.

## LW21H welder for heavy gauges

Just three years after the LW21 development program began, the LW21H welder for heavier gauges was introduced to the market. Applications include continuous pickling lines and continuous rolling mills. Together with the LW21L, Siemens VAI now covers the whole range of applications, including those usually handled by mash lap and flash butt technology.

The LW21H welder is dedicated to wide product mixes including high-strength steels with tensile



Laser welder LW21H

strengths up to 1500 Mpa while featuring low maintenance, high reliability and consistent welding performance. A first LW21H welder will be installed on the new continuous pickling line now being supplied by Siemens VAI to Dunafer in Hungary to handle CQ, DQ, DDQ, EDDQ, IFS, HSLA, HSS – including DP and TRIP – steels; strip thicknesses between 0.8 and 7.0 mm; 600 to 1625 mm strip widths, and a maximum tensile strength of 1500 Mpa.

Other features of the LW21H welder are:

- Fixed shear with automatic adjustment
- Fixed resonator
- CO<sub>2</sub> SLAB laser source
- Direct cooling technology on the resonator group
- Easy dismantling and maintenance of bending mirrors in the beam path
- Convenient dismantling and maintenance of the shear blade
- Fully-automatic operation

The heavy-duty shear is fixed, which ensures consistent cutting of strip head and tail ends. After welding, a planishing wheel guarantees perfect weld geometry. The Dunafer welder will be delivered in November 2007. ■

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Success from start to finish with the new Masteel continuous annealing line

# From Cooperation to Integration

In February, 2005 Maanshan Iron & Steel (Masteel) awarded a contract for the process turnkey supply of a new continuous annealing line in Maanshan, PR China to a consortium comprising Siemens, VAI Clecim, and Stein Heurtey. The acquisition of VAI by Siemens provided an excellent opportunity to transform what started out as cooperation between the two independent companies into genuine integration involving both.

Originally, Masteel looked to a recognized supplier for a continuous annealing line capable of producing more than 930,000 tons of annealed strip for the automotive and household industries. This plant was planned as part of the first phase of the 2130 Cold Rolling Strip project, which is expected to increase Masteel's production by more than 2 million tons by the end of 2007.

The continuous annealing line is designed for soft low carbon steel, IF steel, BH steel, and high-strength steel having thicknesses between 0.25 and 2.5 mm and widths of 900 to 2000 mm. The line operates at up to

420 m/min. It comprises an automatic entry section having two pay-off reels, a mash lap welder, followed by a hot alkali and electrolytic dunk cleaning section. A double vertical entry looper precedes a vertical radiant tube annealing furnace that provides recrystallization annealing and temperature cycles for tuning the material properties. An intermediate double vertical looper decouples the surface treatment section consisting of a combination temper mill and tension leveler unit with flatness control. This is followed by an exit looper and the exit section containing a side trimmer, an inspection station, an electrostatic oiler, a flying shear, and two tension reels as well as the exit coil transport system.

The automation and drive concept features a matched Level 2, Level 1, drives, and HMI; very accurate tension control; highly-responsive drives; optimized sequences; and intuitive diagnostics. Automation is handled throughout the plant by Simatic S7 programmable controllers using standardized application modules as part of the integrated Siroll<sup>CIS</sup> PL solution. This facilitates commissioning as well as maintenance and service work.



Layout of the annealing line



**Exit section during installation phase**

### **Main Benefits**

Higher welding force, higher current, and better

Feedback control of welding parameters

Outstanding results regarding roughness transfer

Modification of metallurgical properties, and flatness improvement

Individual optimization of the mill performance parameters

### **Special features make the difference**

The core technology of the Siemens VAI solution is contained in the special packages, which are essential to the final product quality. First among those packages is a special duty welder, the ML21M. Masteel chose the ML21M mash lap welder because of its unrivaled ability to weld AHSS (advanced high-strength steel). It features higher welding force, higher current, and better feedback control of welding parameters.

Masteel was also looking for a solution to provide the best results for their products with respect to roughness transfer, modification of metallurgical properties, and flatness improvement. Based on Siemens VAI experience, and in line with the steel grades specified by Masteel, the solution proposed was a quarto temper mill combined with a tension leveler and permitting individual optimization of the performance parameters.

This was seen to be an advantage over a single 6-high temper mill where, because of actuator interaction, the best solution always leads to a compromise in the strip properties, and tuning is time-consuming. The in-line temper mill operates with the Siflat flatness control system that includes a neural network control model to produce excellent flatness for all strips.

The quality of the strip surface is determined by the SIAS automatic surface inspection system. This unit detects and classifies surface defects and issues strip-related reports which enable the customers to grade and sort their product in accordance with their clients' requirements. What is more, the surface inspection system used at Maanshan has a new width measurement

function with pixel accuracy (0.5 mm). This function detects holes, edge cracks and measures product width in order to optimize edge trimming and features location of edges with sub-pixel accuracy; geometric compensation of optics, CCD sensor, and camera positioning; compensation of strip vibrations and tension changes.

### **Moving toward integrated mechanical and electrical capabilities**

During the first phase of the contract, the relationship between the mechanical (VAI) and electrical (Siemens) consortium partners took the usual form of a marriage of convenience, whereby each partner had to respect the needs and tasks of the other, but also had the clear goal of maximizing individual gain. With the incorporation of VAI into Siemens, it became necessary to consider the project as a whole, with project problems being solved by taking both mechanical and electrical factors into account. The result is that the mechanical and electrical project engineers have become more aware of each other's requirements, and this new awareness has translated into genuine benefits in project realization. After all, first coil on the line was produced at beginning of June 2007, while the official inauguration took place on September 20th. ■

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Modernization of Novelis Korea  
YeongJu No. 2 cold mill

# Record Restart

Novelis Korea and Siemens VAI are pleased to announce the successful restart of the No. 2 cold mill at Novelis Korea YeongJu plant following recent retrofitting work. The mill restarted, four days ahead of schedule, on May 30, 2007, after a 10-day shutdown period and by June 1, 2007, was up and running at full output capacity 24 hours per day producing salable material.

**E**arly start-up was achieved as a result of detailed planning and the hard work and close working relationship of the site teams from Novelis, Siemens VAI, and a local Korean partner. Although each supplied a different part of the contract, it was their cooperation that generated the partnership needed to drive this comprehensive modernization project to completion in just 10 days and well ahead of the schedule written into the contract.

### Fast, but comprehensive

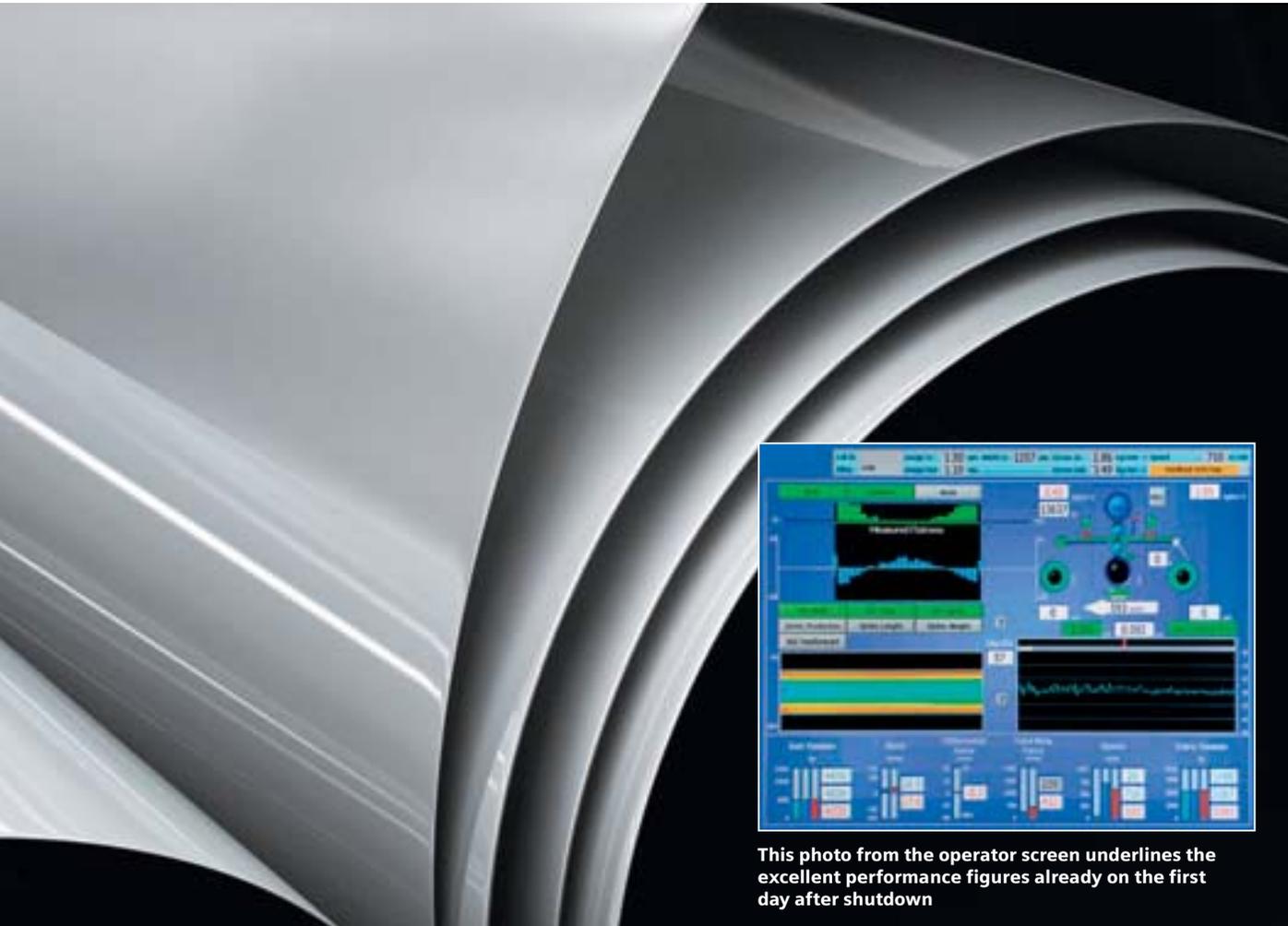
Although retrofitting work took place on a very tight schedule, it was nevertheless carefully planned and meticulously executed. The work comprised a new entry-side spool handling system designed to handle both empty spools and spools with scrap or pup coils. A replacement X-Ray Entry thickness measuring gauge system has also been fitted to the mill.

A new hydraulically-actuated cross-cut shear is fitted on the exit side of the mill. Modifications to the entry and exit fume exhaust hoods on the mill stand, to increase the air velocity. Improved work roll cooling by Siemens VAI spray bars incorporating the Integral

Solenoid Valve (ISV) was installed to match the sensor spacing of the existing shape measurement roll. Coil Car pit floor plates. New auxiliary hydraulic valves now support the additional functions of the new equipment. There is now a pneumatic panel for control of the new sleeve grab arm. A new, advanced Flatness (AFC) and Thickness (AGC) Process Control system has replaced obsolete existing mill systems. All new mechanical equipment for the mill was designed by Siemens VAI in Christchurch and manufactured in Korea. The new coil preparation station and associated equipment was designed and built by a Korean partner. The process control system, spray bars, thermo-thickness gauge, and hydraulic equipment were all designed and built by Siemens VAI. For added safety, traversing floor plates linked to the entry and exit coil cars are mounted between the walls of the coil car pits to provide covers to increase the safety in these areas. Additional fixed floor plating is also added in other areas above deep pits.

### Effective entry spool handling

The pivoting arm and existing sleeve discharger on the entry side of the mill and its associated ramp have been



**This photo from the operator screen underlines the excellent performance figures already on the first day after shutdown**

replaced with a new system designed to handle both clean sleeves and scrap coils. A pivoting and traversing grab arm equipped with a pair of pneumatically operated jaws securely clamp round a sleeve or scrap (pup) coil on the unwinder mandrel, traverse it off the mandrel, and release it onto a new sleeve discharge ramp to interface with the existing sleeve transfer system. The pup coil spools run from the ramp down into a basket, which is then taken away by fork lift for the scrap pup material removal.

#### **Exit cross-cut shear**

The cross-cut shear presented some design difficulties with respect to locating it in the limited space between the existing shape roll and exit thickness gauge while minimizing the installation effort. The exit gauge guard also had to be redesigned to enable it to be raised during in mill shape roll calibration.

#### **Taking advantage of modern process control**

Apart from the mechanical equipment, Novelis also benefits from the new, state-of-the-art process control solution. The new system interfaces to both new and

the existing mill equipment, such as drives, PLC, position and pressure transducers, the shapemeter and to the new spray bars. Network links are also provided to existing Novelis logging and information systems. The automatic gauge control includes features for entry thickness and tension feedforward as well as backup roll eccentricity compensation.

The process control system has lived up to its well-earned reputation of delivering full performance right out of the box: It produced salable material on its very first day of operation on May 30, 2007, and only one day later, entry thickness feedforward control was operating and most of the production output was well within contractual guarantees. Consequently, Novelis is very satisfied with the results of the retrofit and is already reaping the benefits of the investment. ■

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Weld cladding on strandguide roller

Improving the overlay welding of slab-caster rolls

## Tailor-made Solution from Brazil

Siemens VAI in Brazil has developed an innovative solution for the dressing of slab-caster rolls that increases the service life of caster rolls and roller jackets, reduces maintenance costs, and improves slab surface quality.

**T**he robust conditions prevailing during continuous casting operations make it essential that the surface of slab-caster rolls provide a high degree of corrosion resistance, be highly heat resistant, and be able to withstand extreme mechanical wear. Unfortunately, these properties are mutually contra-

dictory, making it necessary to overlay weld the surface of caster rolls. Adding to the challenge of servicing these rolls, the composition of the welding wire is a compromise that attempts to satisfy the requirements in a standard manner, but is not the optimum solution for each specific roll.

## Main Benefits

Longer service life-time of caster rolls and roller jackets

Reduced maintenance costs

Improved slab-surface quality

Siemens VAI Services Brazil has developed a special solution for improving the lifetime of caster rolls, based on the individual operating conditions for rolls on different casters. Because some rolls or roller jackets are more susceptible to corrosion, some more to heat stress and others more to mechanical wear, different welding wires

and welding procedures are now being used by Siemens VAI Services Brazil to improve the properties

of rolls or roller jackets, increasing the overall service life of caster segments. With this approach, the service life of the slab-caster rollers of a Siemens VAI-supplied bender segment has already been made to exceed 1.2 million tons of rolled product. ■

### Author

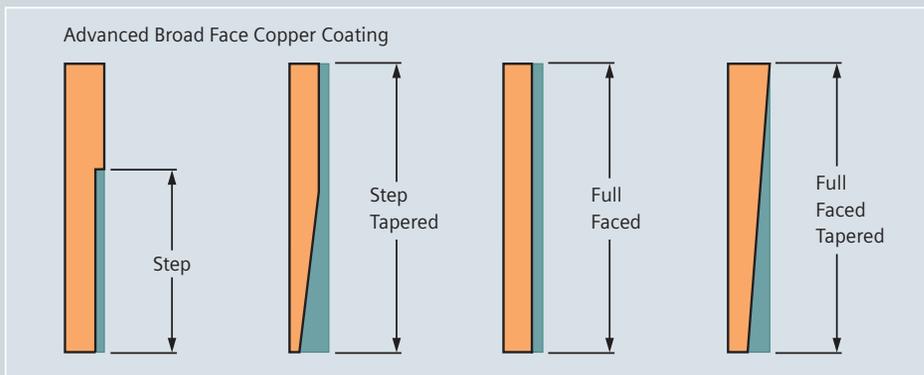
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## Siemens VAI improves broad face copper durability

# The New Face of Coating



**Fig. 1**  
Plating profiles  
used on broad  
face coppers

Siemens VAI Services is a primary vendor to the US and Canadian steel industry and specializes in the application of ultrahard alloyed nickel mold coatings (Variable Hardness Hiper Coat and Hiper Coat) to provide wear resistance over traditional broad face coating products.

**T**he applied hardness of Hiper Coat can be variable from 220 to 750 Hv. Coating performance and the desired control of the heat transfer of the copper can be achieved by modifying the plated profile on any broad face (Figure 1).

The key performance benefit of Hiper Coat is its maximum hardness, which results in an immediate increase in the service life of the plates. If excessive wear

is a primary reason for mold extraction, and the liners are plated with standard nickel, the next choice to extend mold life and improve ROI (Return of invest) should be a coating that is much harder.

The economic impact of using Hiper Coat over other hard products such as ceramic can be significant. Indeed, the application cost of ceramic to broad face copper can be 40–300% higher than Hiper Coat. What is more, Hiper Coat provides excellent bond adhesion to the copper hotface while inhibiting abnormal cracking, flaking, or peeling that is common with other brittle high-hardness coatings. ■

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This year the event, which takes place every four years, accommodated more than 360 exhibitors from 27 countries, who presented their products and solutions on a total exhibition area of 14,500 square meters.

A distinctive element of Siemens VAI's fair presentation was the so-called Vision Carousel, for which Siemens had prepared diverse hypotheses on the future of the world of steel production, inviting the visitors to comment and further develop the ideas. Some 560 visitors climbed to the top of the Vision Carousel and evaluated the hypotheses. When reviewed, the responses showed that over 90 percent of the visitors are confident that Siemens VAI will develop the right solutions for the future. The surveyed individuals indicated that they could well imagine that steel plants would be operated with hydrogen technologies from Siemens VAI in the future. They also agreed with the hypothesis that nanosteel, foamed steel and steel with shape memory would change the market – a development which will become a reality through the use of innovative technologies from Siemens VAI.

This fair concept was also reflected in the unusual design of the Division's fair stand: with its futuristic design, the two-section fair presentation provided a look at tomorrow's steel technology landscape. The eye catcher was a model of an ESP plant (Endless Strip Production), whose innovative operational concept provided the interested specialist visitors with extensive information on the underlying technologies. At the same time, the ESP model served as impressive proof of what SiemensVAI is already capable of today.

#### Leading technological solutions

The second section of the fair stand presented the current range of products, systems, and solutions – from the upstream process of mining to iron and steel-making through to strip finishing lines.

Siemens VAI's comprehensive portfolio is made possible by the integration of leading technological solutions in the areas of mechanics, automation, electrical engineering, and information technology into a seamless overall approach. The very positive customer

feedback after the event confirms that, thanks to its efficient stand concept, Siemens VAI has succeeded in creating a transparent and attractive presentation in spite of the limited space – in short: a steelstylish ambiance.

#### Successful business

The worldwide crude steel production is increasing by 4 percent per year, from 1.2 billion tons in 2006 to

### Siemens VAI at the METEC

# Shaping the Future Together

On June 12 to 16, the 7th METEC took place at the exhibition grounds in Düsseldorf, Germany. This leading trade fair for the metals industry centered on casting products, casting technologies, metallurgy, and thermo-processing technology.

an expected 1.4 billion tons in 2010. In China alone experts anticipate a growth rate of 9 percent. The strategy in response to these challenges is orientation toward the very top of the market and a comprehensive portfolio. However, steel producers will not necessarily react to the rising demand for steel products by investing in the construction of new plants – greenfield construction is expected to experience a downward trend until 2010. Capacity gaps will most likely be closed through the replacement of outdated technologies. Overall modernization is another key tactic: existing plants can be upgraded with new drives and automation systems that increase capacity. Accordingly, Siemens is expecting increased activities in these areas.



With its focused and future-oriented alignment, Siemens VAI is well positioned to meet these requirements. In fiscal 2006, Siemens VAI was able to further strengthen its global market leadership as proved by its extremely positive new order volume and well-filled order books. The regions Europe and Asia both account for about 30 percent of business each, while the remaining 40 percent is divided equally between the regions America and Near/Middle East. The expected

of existing plants – especially in the US and Europe. As a global player, Siemens VAI serves this trend with its Life Cycle Services offers.

With these services, Siemens VAI helps iron and steel producers all over the world tap the optimization potential of their plants along the entire value chain. For this purpose, Siemens is continually developing innovative processes and plant solutions. The Division's regional presence and worldwide network



### METEC 2007

More than 15,500 visitors from five continents – about 3,500 visitors more than in 2003 – attended METEC 2007 in Düsseldorf. The number of exhibitors also increased this year, from 320 in 2003 to a total of 368. The number of international visitors was very high at 51 percent, and has increased slightly compared to 2003. Nearly half of all visitors came from Europe, followed by Asian visitors, with a share of 29 percent.



general drop in the worldwide demand for greenfield projects will be compensated by the Life Cycle Services business, which is expected to amount to about one-third of Siemens VAI's business volume by 2010, double its current share.

#### Focus on service

All this points to growth service business, an area that is becoming more and more important. In fact, the maintenance business including services, spare parts logistics and E&A service (Electrics & Automation) will probably be the field with the strongest growth until 2010.

The trend is clear: productivity increases in steel production will be realized through the modernization

not only ensure optimum local customer service but also provide geographical proximity to customers and projects, which helps Siemens VAI enormously in expanding its knowledge of customer needs and requirements. Especially in view of the expected continuing growth in the service market, Siemens must demonstrate to its customers that they will greatly benefit from a partnership over the entire life cycle of their plants.

#### Conclusion

With the product and service portfolio Siemens VAI is thus the ideal life cycle partner for metals producers, capable of providing the optimum solution for the individual and specific needs. ■

## Service Day for Customers

Siemens VAI invited customers to Montbrison to visit its facilities on June 28, 2007. At Montbrison, located near the office of Siemens Metals Technologies SAS (Siemens VAI) in St. Chamond, a workshop is dedicated to the manufacture, assembly and testing of equipment and specialized components primarily for the steel rolling and processing industry. State-of-the-art machining equipment partly directly linked to the CAD tools.

Philippe Cruiziat, President & CEO of Siemens Metals Technologies SAS, and Gilles Bernolin, Director Services Division Siemens Metals Technologies SAS,

explained the complete portfolio of the services activities, the new services strategy and targets. In the plant the participants were invited to discover the four main strategic activity poles, core of the business of the Montbrison plant (Off-line maintenance for mechanical equipment, factory test expertise for technological devices, a pilot rolling mill for new control methods and manufacturing of special equipment). During the visit the Siemens experts have given additional technical information regarding the activity poles and the capacity of machine tools, cranes, and the assembly area. ■



Expert personnel at your service

## Shape Technology Fully Acquired by Siemens VAI

As of October 1, 2007, Shape Technology Ltd was fully acquired by Siemens VAI Metals Technologies Ltd. The company, with its headquarters in Bournemouth and a 100% subsidiary company located in Pittsburgh, Pennsylvania, USA, excels in developing and implementing shape- and profile-measurement systems for the metals industry. These are mainly mechatronic instruments required in the rolling and processing stages to provide shape and geometric-quality-control information.

Products include shape meters, coolant and hot-edge-spray systems, edge-wipe systems, width-gauge and crop-shear systems, wire rod, bar and section-profile gauges. More recently, the product range has been extended to include Schneider™ Filter Technology (Schneider filters are manufactured under license from JR Schneider Company) and Allegheny polypropylene tanks, both also used in the metals industry.

### Helping to shape the future of metals

The offered solutions ideally complement the larger plant-building activities of Siemens VAI, bringing added value and a new dimension of excellence to the portfolio of Siemens VAI products. With this business transaction the scope of products and support services available for customers will be improved and extended. ■

## More information

You can find further information and more press releases over our online portal at [www.siemens-vai.com](http://www.siemens-vai.com)

# Events: Upcoming Conferences and Fairs

- NOV 8 – 9** STAHL2007: „Wettbewerb um Zukunft – Competition for the future“, Düsseldorf, Abendveranstaltung  
[http://www.stahl-online.de/termine/Termine\\_2007\\_aktuell.htm](http://www.stahl-online.de/termine/Termine_2007_aktuell.htm)
- NOV 11 – 13** 23<sup>rd</sup> INT. FERRO-ALLOYS CONFERENCE, Monte Carlo, Fairmont Monte Carlo  
<http://www1.metalbulletin.com/events/conference.asp?id=171>
- NOV 11 – 14** CONAC 2007 – 3<sup>rd</sup> NATIONAL STEEL INDUSTRY CONFERENCE & EXPOSITION, Monterrey, Mexico, N.N.  
<http://www.aistmexico.org.mx>
- NOV 12 – 14** STAHL IM AUTO – Intelligenter Leichtbau mit Stahl, Wiesbaden, Dorint Pallas Wiesbaden  
<http://www.euroforum.com>
- NOV 12 – 14** NEW SCRAP CONFERENCE, Scottsdale, AZ, Hyatt Gainey Ranch  
<http://amm.com/events/2007>
- NOV 13 – 16** 13<sup>th</sup> INT. METAL-EXPO, Moscow, All-Russia Exhibition Center  
<http://www.metal-expo.ru/>
- NOV 13 – 14** MICROALLOYED STEELS, PRODUCTION, PROPERTIES, APPLICATIONS, London, 1 Carlton House Terrace
- NOV 14 – 16** NATIONAL METALLURGIST DAY, Mumbai, India
- NOV 14 – 17** CSM ANNUAL MEETING, Chengdu, Sichuan Prov.
- NOV 19 – 22** GALVATECH '07 – 7<sup>th</sup> INT. CONFERENCE ON ZINC & ZINC ALLOY COATED STEEL SHEET, Osaka, Osaka University Convention Center  
<http://www.ics-inc.co.jp/galvatech07/>
- NOV 21 – 23** INCAL 2007 – Int. Conference & Exhibition on Aluminium, Hyderabad, India, Hyderabad Int. Convention Center  
<http://www.aluminium-india.org>
- NOV 22 – 24** GLOBAL STEEL 2007 – 4<sup>th</sup> International Conference on Steel Making Raw Materials, Kolkata, Hyatt Regency  
<http://globalsteel.in>
- NOV 26 – 28** METALS INDIA 2007, Kolkata, Netaji Indore Stadium
- NOV 26 – 28** AUSTRALIAN IRON ORE CONFERENCE, Perth, Sheraton  
<http://www1.metalbulletin.com/events/conference.asp?id=190>
- NOV 26 – 28** 15<sup>th</sup> INT. RECYCLED ALUMINIUM, Munich, Arabella Sheraton Grand Hotel  
<http://www.metalbulletin.com/events/recal>
- NOV 26 – 30** 6<sup>th</sup> DIRECT REDUCTION SEMINAR, Belo Horizonte  
<http://www.metalbulletin.com/events/bmc>
- NOV 27 – 29** BASE METAL CONCENTRATES, Lima, Peru  
<http://metalbulletin.com/events/bmc>
- DEC 2 – 4** 5<sup>th</sup> STEEL SUCCESS STRATEGIES EUROPE CONFERENCE, Paris, Le Meridien Etoile  
<http://www.metalbulletin.com/events/ssse>
- DEC 3 – 4** 2<sup>nd</sup> ANNUAL MOVING METALS CONFERENCE, Atlanta, GA, Omni Hotel  
<http://amm.com/events/2007>
- DEC 9 – 11** 11<sup>th</sup> MIDDLE EAST IRON & STEEL CONFERENCE, Dubai, N.N.
- DEC 12 – 14** 28<sup>th</sup> ATS STEEL CONFERENCE “From Cokemaking to Steel Product”, Paris
- FEB 7 – 10** 68<sup>th</sup> WORLD FOUNDRY CONGRESS “Cast for Competitive Edge”, Chennai, India  
<http://www.wfcindia08.com/>
- FEB 14 – 15** DÜSSELDORFER EDELSTAHLTAGE, Düsseldorf, Rheinterrasse Infostelle  
[http://www.stahl-online.de/stahl\\_zentrum/Duesseldorfer\\_Stahltag\\_2008.pdf](http://www.stahl-online.de/stahl_zentrum/Duesseldorfer_Stahltag_2008.pdf)
- FEB 17 – 21** AIST's MODERN ELECTRIC FURNACE STEELMAKING SEMINAR, Jacksonville  
<http://www.aist.org>
- FEB 18 – 20** CIS METALS SUMMIT, Moscow, Marriott Grand Hotel  
<http://www.adamsmithconferences.com>
- FEB 22 – 24** ALUMINIUM INDIA, Mumbai, Bombay Exhibition Center, Hall V  
<http://www.aluminium-india.com>
- FEB 24 – 27** AIST's HOT ROLLING FUNDAMENTALS SEMINAR, Orlando, Hyatt Orlando Airport  
<http://www.aist.org>
- FEB 26 – 27** ISIS 2008 (International Surface Inspection Summit), Amsterdam, RAI  
<http://www.isis2008.de>
- FEB 28 – MAR 2** BORU 07 – 4<sup>th</sup> INTERN. TUBE & PIPE INDUSTRY FAIR, Istanbul, Expo Center  
<http://www.boru.com.tr>
- MAR 4 – 5** STAHLMARKT 2008, Düsseldorf, Euroforum  
<http://vhb.handelsblatt.com/stahlmarkt>
- MAR 9 – 13** TMS 2008 – 137<sup>th</sup> Annual Meeting & Exhibition, New Orleans, Ernest Morial Convention Center  
<http://www.tms.org/annualmeeting.html>
- MAR 12 – 14** 14<sup>th</sup> WORLD STEEL CONFERENCE, Rio de Janeiro, Copacabana Palace Hotel  
<mailto:cruevents@crugroup.com>
- MAR 17 – 19** 8<sup>th</sup> INT. ARAB IRON & STEEL CONFERENCE & EXHIBITION, Doha, Qatar
- MAR 25 – 28** SIBMETAL 2008 – International Industrial Exhibition for Metallurgy, Mechanical Engineering, Metal Processing, Welding, Cutting & Surfacing, Novosibirsk, Russia, The Siberian Fair International Pavilion

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