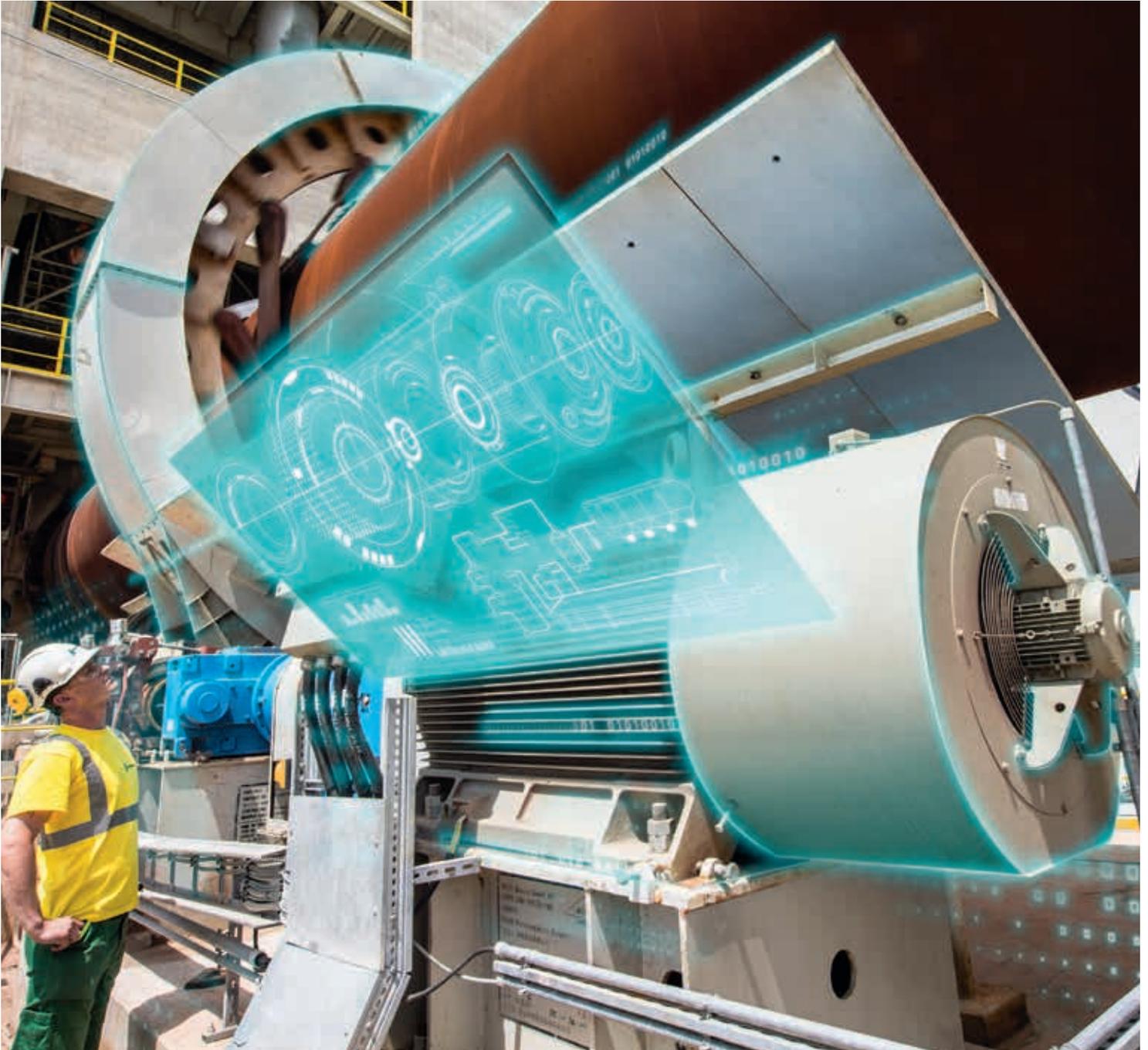


The Magazine

for the mining and cement industries

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**The future of mining is
autonomous and digitalized**

Streamlined operations
A single MES for
Vale in Brazil

Increased safety
Underground operations
at the Grasberg mine

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Dear Reader,



Everybody's talking about digitalization and the power it has to improve business in a whole range of sectors. However, the scenarios that are being painted are often in the future. It's easy to get the impression that digitalization is about what's to come. At Siemens Minerals, though, digitalization is already a reality. And by embracing digitalization now, businesses become better equipped to deal with the future. In this issue of "The Magazine for the mining and cement industries," we show what is possible now with Siemens digitalization solutions.

Digitalization saves money. At Vale, improvements are now being made at operations around Belo Horizonte and São Paulo in Brazil. In short, 38 sites are being equipped with a highly tailor-made manufacturing execution system (MES) from Siemens. By 2020, the project is expected to generate savings of more than \$70 million.

Digitalization drives performance. The coal stockpiles at the Boxberg power plant in Germany feature unmanned operation. The staff in the control center just has to enter the order details and the rest happens automatically. Not only is performance higher compared with manned operation, orders are filled more accurately, utilization of the stockpile is better and energy consumption is lower.

Digitalization makes operations safer. The Grasberg mine in Indonesia and the Kiruna mine in Sweden may be far apart from one another, but they do have something essential in common: their underground operations are driven remotely from a control room on the surface. That means fewer people in the hazardous underground environment.

Of course, that's just a sampling of benefits digitalization brings. An essential ingredient is strong and dependable automation. Our answer for the cement industry is Cemat, which was a frontrunner when it was introduced over 40 years ago – and it still is today.

Aside from digitalization, we also track progress of our projects all over the world. One example is the modernization and expansion of St Marys Cement in the United States to supply growing demand. Another is Siemens' participation to create the world's most climate-friendly, energy-efficient smelting plant for Norsk Hydro.

I hope you enjoy this issue of "The Magazine for the mining and cement industries." We look forward to your feedback – and to accompanying you on your digitalization journey.

Best regards,

A handwritten signature in black ink that reads "Roland Ehrl".

Roland Ehrl
Minerals Executive Vice President
Siemens AG

Credits

Published by:
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Communications
Wittelsbacherplatz 2
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magazine@siemens.com

Responsible for content:
Winfried Wittmann
(in accordance with the German press law)
Roland Ehrl
Thomas Walther

Concept, coordination:
Daniela Michel-Fracchi

Editorial committee:
Thomas Walther
Karen Chong

Concept, editing, design:
Agentur Feedback, Matthias Weiner,
Munich, Germany
www.agentur-feedback.de

Editorial staff: Alexander Chavez

Art direction: Monika Gollasch

Layout: Clarissa Jochum

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Nobsa

Upgrade completed at LafargeHolcim site in Colombia

After a three-year project duration, a new process control system has recently been commissioned at the Nobsa, Colombia, cement factory operated by LafargeHolcim Ltd. The hardware and software modernization project entailed converting the previous control system to Cemat 8.1 from Siemens.

For LafargeHolcim, the project goal was to ensure fail-safe plant performance and process reliability. The Cemat process control system from Siemens is a clear answer, as it supports the building materials industry when it comes to optimizing production potential along the entire value chain. Its convenient user interface design allows employees to access all the relevant production data in real time. Operating and integrated diagnostics functions detect possible faults

at an early stage and act to reduce unforeseeable downtime.

The migration was implemented smoothly within the three-year period by adapting to planned maintenance schedules. The solution package comprising hardware and software was tested before and after commissioning by experts from LafargeHolcim. In particular, rigorous testing before commissioning avoided downtime outside the planned schedule.

Producing 3,600 tons of clinker a day, Nobsa is the biggest LafargeHolcim factory in Colombia. By migrating to the new high-powered process control system, LafargeHolcim has optimized its production potential and so secured the competitive edge of the location.

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SIMULEX®

Cemat now offers cement process simulation

SIMULEX®, the cement process simulator from KHD, can now be integrated into Cemat V8.2. The result is realistic training on a plant's process control system. The trainee sees a one-to-one representation of the plant, including

all operating elements, faceplates, alarms and messages. A special feature is the possibility to train critical situations, such as motor and signal malfunctions as well as process malfunctions. By covering critical

situations like these, safety is increased for the entire cement plant, and damage and repairs can be avoided. For the operator that spells lower costs and higher efficiency.

➤ www.siemens.com/cemat

Cemat

Additional features for the latest Cemat version

Correctly functioning processes are vital to ensure the economical operation of plants in the cement, mining and building materials industries. Expensive equipment standstills have to be avoided at all costs. The Siemens Minerals portfolio is designed to keep everything ticking smoothly and includes the Cemat automation standard, a control system based on Simatic PCS 7.

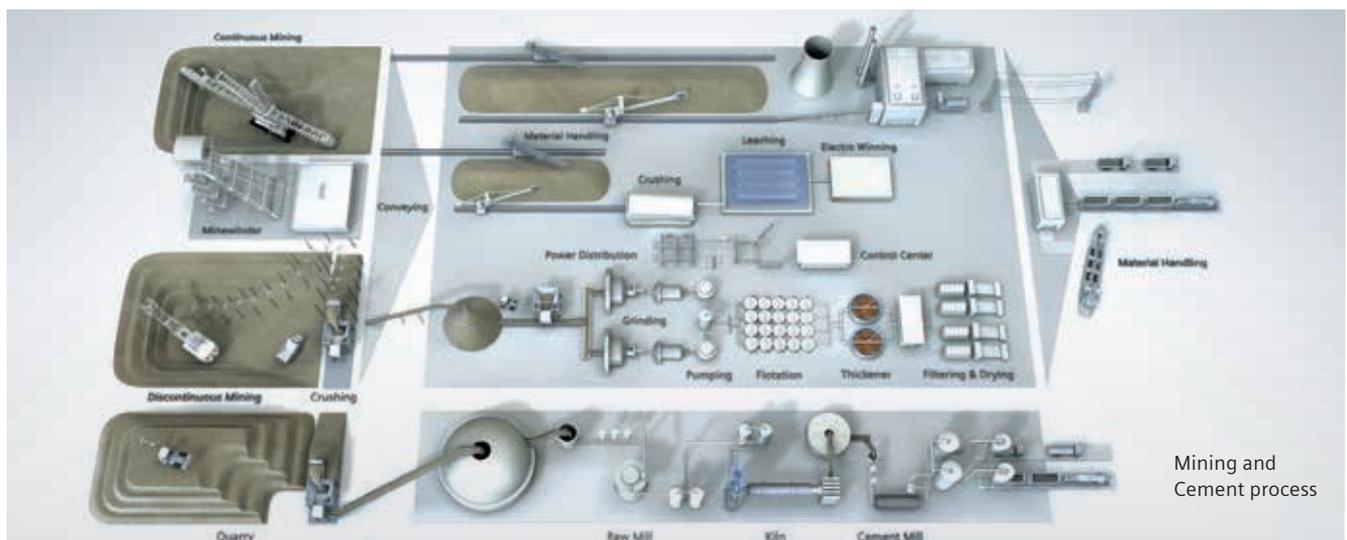
Cemat depicts the complete steps within the production chain – from the extraction of raw materials through to packaging of the end products – and also offers supplementary modules for mill optimization using advanced process control functions. Cemat version V8.2 comes with a series of additional features as an update for versions V6.1 to V8.1.

The extended sequence test mode allows all hardware-relevant inputs

of an object to be simulated in OS runtime operation following a switch-over to “sequence test” in the system plan. Additional symbols, which can now be scaled proportionally and displayed on an instance-specific basis, are designed to simplify one-step operation. Using new evaluation options it is possible, for instance, to define maintenance intervals for analog and binary signal modules, and to log and evaluate completed maintenance processes. Extended warning or fault information on motor start-up, set-point value setting for bi-directional drives, additional user-configurable messages over EventTS, a new module for displaying the status of subordinate small controllers, and scalable production control (SPC) modules for recipe-specific processes round off the update.

The SPC modules allow parameters to be saved, imported, exported and/or switched over, if required. The parameter characteristics are depicted in each case by different SPC module types, which can be freely connected to each other depending on the quantity structure and requirements. A central SPC manager module forms the interface for the plant operator. It is also possible to include the flexible assignment of materials to different storage locations in the project engineering process.

Coming soon, the Cemat version V9.0 is going to be introduced and will include additional SPC features, new interlock modules and many more enhancements. Considerations for work in a virtual environment have been a strong focal area in the development process for V9.0.



Mining and
Cement process

Tomorrow's vision is today's reality

Autonomous and digitalized: these two words are used to describe the future of mining. Yet in many respects, the technologies that are expected to drive tomorrow's mine are already being implemented today.



What will the mine of 2030 look like? In December 2016, a steering committee at Siemens tried to answer this question. “One thing is certain: it will be autonomous and digitalized,” says Yun Zeng, director of Digitalization at Siemens Mining.

First and foremost, the major challenge for the industry will be handling lower ore grades. In fact, that is already reality for traditional open-pit mining operators today as they go deeper into the earth’s surface to obtain ore and in some cases transition to underground mining. Efficient operations in these remote locations will increase in importance. The key is expected to lie in highly automated

modular equipment to enhance cost and operating flexibility. Resource depletion will also push mining to new frontiers – to extreme mining. In this regard, mining companies will start to look in areas that are not easily accessible but potentially contain promising mineral deposits, even the seafloor.

In the face of these hazardous and hard-to-reach environments, digitalization is seen as a major tool to increase cost efficiency and the automation of operations and processes in the mining industry. What is more, digitalization will drive the integration of suppliers and partners along the value chain. “That carries with it new levers to unlock potential for operational

excellence and new business and operation models,” points out Zeng.

Welcome to the future digital mine

In short, digitalization tools are expected to be integrated at all mining stages, from exploration, engineering and simulation to advance process control.

Some of the attributes of the digital mine: The whole up-front mine-engineering process, from mine planning to process planning, will be completely digitalized and paperless. Strategic and real-time planning and scheduling will be aligned, and mine operations will be run fully remotely by real-time KPIs and decision-support systems. Furthermore, forecasts and quality management will be based on real-time data, which will allow for fast reactions to market volatility. Self-learning algorithms will identify optimized operation models to lower CAPEX and OPEX – independent from employees’ skills. And artificial intelligence will continue to develop, thereby giving way to self-maintaining robots and systems.

Two constant companions will be the extensive use of digital twins and cyber security. Digital twins will be used for simulations of sequential scenarios, for forecasts, and for quality management and control. Furthermore, digital twins will be the go-to tool for plant optimization, trainings and services. In regard to cyber security, prevention strategies will be an integral part of daily business operations, allowing for risk-free data exchange and operations.

Already reality

The digital mine sounds good, doesn’t it? “For many, it might seem like something that is really far off,” Zeng says. “But the fact is, many of these technologies are already available today at Siemens.” In the following pages, digitalization solutions of the future are presented in real-life examples from today. The vision isn’t just on paper – it’s becoming reality. ■

The mine-engineering process will be digitalized and paperless.

Digital twins will be used for simulations of sequential scenarios, for forecasts, and for quality management and control. Furthermore, digital twins will be the go-to tool for plant optimization, trainings and services.

➔ www.siemens.com/mining-digitalization
yun.zeng@siemens.com



Streamlined operations

Vale, the world's third-biggest mining company, is implementing a single manufacturing execution system to replace 17 production management systems used at its operations in Brazil. The solution is expected to generate savings of more than \$70 million by 2020.

Vale has grown in recent years primarily through acquisitions, taking on more and more mines and processing facilities for different minerals, such as iron, copper, nickel, coal, manganese and phosphate. Today, Vale is the global leader in the iron ore business with 38 sites operating in Brazil alone – that includes 22 mines, 11 pelletizing plants as well as a railroad network and ports. The result of these acquisitions has been different cultures, concepts, processes, KPIs and systems – with 17 applications running to oversee production. That made it difficult to manage and compare operations, and a great deal of effort was needed to maintain and evolve solutions. Getting timely and reliable information also proved to be a challenge. Naturally, with all these systems in place, technology costs were high.

Standardization, it was decided, was the way to go. But which solution? “Ahead of the project we compared different concepts and even piloted them,” explains Jonas Ruis Chagas, Mining Systems Project Manager at Vale. “After careful consideration, we opted to go with the Chemtech concept,” Chagas continues. The fully owned Siemens subsidiary Chemtech was contracted to develop and commission a manufacturing execution system (MES) for Vale's sites in Brazil.

GPV-M is one of the foundations Vale's digital strategy.

Development was kicked off in 2014, with implementation starting in 2016.

Called Vale Production Management-Mining (GPV-M), the MES is a highly tailor-made solution aligned with Vale's specific needs. The system guarantees comprehensive transparency along the entire value chain and at all facilities, from the mines to the railway and port facilities. GPV-M implementation is in line with Vale's policy to cut costs and optimize the margin from the productivity increase. “GPV-M is one of the foundations of our digital strategy, which aims to establish a platform that will allow Vale to reach new heights of productivity through the combination of new technologies and processes,” says Janio Souza, IT Innovation Manager from Vale.

Results already apparent

Since work commenced in October 2016, implementation has been completed in some 20 units of the planned 38. The remaining facilities are set to follow during the course of 2017. To date, more than 20 million tons of iron ore have already been shipped using the newly commissioned GPV-M. “Chemtech has been a truly competent partner. The success of the project has been down in large part to the close cooperation between customer and supplier,” sums up Chagas. “Now we can compare more easily the performance of our units, thus identifying process improvement points to enable increased productivity,” adds Marcelo Baltar, Ferrous Information Manager at Vale.

In concrete terms, operating performance indicators from across all sites can be compared to one another. To ensure simpler, more flexible operation, all communication interfaces as well as user interfaces have been standardized. The system is capable of processing up to 1.2 terabytes of real-time data and serving a thousand users simultaneously.

Compared to older systems, GPV-M boasts shorter downtime as a consequence of the more modern and robust technology. The increased agility and the reduction of unproductive hours are obtained by the higher level of integration with automation systems that provide immediate and reliable data, besides



requiring less manual work (for example, typing) and being more intuitive for operators.

Another great advantage of the single system is that it allows the standardization of concepts and indicators in different units of the company. All operational expertise of these units will be gathered in a digital database, facilitating the replication of the best practices and internal benchmarking. The decision process becomes more dynamic and competitive. If that isn't enough, the expected cost savings are particularly impressive.

Significant savings

The change to GPV-M brings three major financial gains. One is the IT cost reduction with the maintenance and evolution of different systems and platforms. By 2020, these cost savings are expected to reach \$19 million. The second gain is the avoided cost to business due to the

The system can process up to 1.2 terabytes of real-time data.

reduction of operational impacts caused by system downtime. And lastly, relevant gains are expected with more labor productivity and a reduction of unproductive hours of

the assets, supported by improved usability of the system and greater availability of information for decision-making. These two operational gains are estimated to have a value of \$53 million, also by 2020.

Though it will take a few years to know the exact cost savings, they are significant. As GPV-M is the intellectual property of Vale, in the future it will be possible to keep extending the solution and develop new functions from the analysis of generated data and of other technologies. And that will bring further savings. Another great aspect of the open structure is that it will allow GPV-M to expand in step with Vale's growing requirements, making it a truly future-proof solution. ■

➤ www.siemens.com/mining-digitalization

Authors: Yun Zeng, Breno Bregunci
yun.zeng@siemens.com
breno.bregunci@chemtech.com.br

A boost for safety – and speed

When operators of the Grasberg mine in Papua, Indonesia, decided it was time to transition to underground mining, they found inspiration for their operations in Sweden. The result is a better working environment for their staff.



The atmosphere in underground mines is anything but pleasant: — hot and noisy, tight quarters. No matter how vigilant workers are about safety, risks abound. For example, operators can easily be struck by a stray stone when working around crushers. So when planning the underground mining operations at the Grasberg mine in Papua, Indonesia, owners Freeport-McMoRan Copper & Gold Inc. wanted an alternative that involved as few people in this hostile environment as possible. Their search brought them to the Kiruna mine in Sweden.

In Kiruna, underground mining has been carried out remotely since 2012. Operators work in an air-conditioned control room – their connection to the underground mine is via a screen and

a joystick to control the machinery. In the end, Siemens' automation solution partner and mining industry expert Midroc – the company that implemented the underground mining solution for the Kiruna mine – was contracted in 2015 to install a similar setup in Indonesia. At the heart of the solution is Simatic PCS 7 for the distributed control system (DCS). Incidentally, Grasberg was no stranger to Siemens technology, as the company had previously delivered the gearless mill drives and the level instrumentation for the flotation cell.

Time to go underground

Since 1973, Grasberg has been operated as an open-pit mine. However, the open-pit mine cannot be made any deeper and operations must now go

underground. The effort is well worth it: Grasberg contains the world's largest gold deposit and the third-largest copper deposit. "The underground operations are currently in different stages of implementation, yet the DCS from Siemens is vital for three areas," says Mark Yseboodt, sales development manager for mine automation.

The first is the block cave mine. Block cave mining is a highly efficient form of underground mining. Large ore blocks are cut from beneath, allowing the ore to collapse under its own weight. After collapsing, the ore is brought to loading points and conveyed to a crusher. The crushed ore is then loaded onto driverless trains and transported to an unloading station, from where it is brought up to the surface.

All communication networks have been extensively system tested.

Grasberg contains the world's largest gold deposit and the third-largest copper deposit. For the underground operations, a CCTV system is being installed with 220 cameras for real-time monitoring.

Installation in the block cave mine is still ongoing, with completion planned for the end of the year. To put the extent of the operations into perspective, there will be 20 chute galleries with a total of 121 loading points and nearly just as many crushers, plus three unloading stations. Eleven production trains and five service locomotives will travel the 28 km of electrified rail – which happen to feature a Siemens catenary system. A CCTV system with 220 cameras will allow operators in the control center to monitor all activities in real time. At peak production, the mine will produce 160,000 tons of ore per day.

The automation system based on Simatic PCS 7 will connect the underground equipment to the operators in the control room – the chute galleries, unloading stations and the

service area including the motor control center (MCC), variable frequency controllers (VFC), the uninterruptible power supply (UPS) and CCTV. As in Sweden, the operators will be able to monitor and control a range of activities in a comfortable and, most important, safe environment. For example, the chutes and crushers will be driven from the control room, as well as the train movements.

“A special aspect about Simatic PCS 7 is that it has interfaces to all equipment, even equipment from third parties,” comments Yseboodt. A case in point is the Bombardier train system being installed in the mine. From their screens in the control center, operators will have direct access to the train automation system without having to change screens or even the user interface.

Dependability a must

As mentioned previously, creating a safe environment was a key concern for Grasberg's operators. The communication system delivered by Siemens is a key component. While some of the communication between the control center and the devices is wired, for the most part wireless networks are employed from the Siemens Scalance portfolio, which has been developed to withstand harsh industrial environments. “In an operation like a mine, you can't afford any mistakes or errors. The communication system has to work at all times,” says Yseboodt. For that reason, all systems feature double redundancy. For wireless communication, iPCF (industrial Point Coordination Function), also known as rapid roaming, is employed. It allows the mobile devices to roam between access points within 50 milliseconds, which is required to maintain Profinet communication under all conditions. In addition, before even being introduced to the market, all communication networks are extensively system tested with all possible components to ensure 100 percent compatibility and availability.

The communication system is highly secure: Safety Matrix software built into Simatic PCS 7 is responsible for secure connections between the equipment and the DCS. Furthermore,

Siemens has obtained cyber security certification from TÜV SÜD (an international technical services provider active in the testing, inspection and certification (TIC) market) for Simatic PCS 7.

The next area controlled by Simatic PCS 7 is the deep mine lower zone, which has already commenced operations. The mine is half as large as the block cave mine, but in many ways similar in its setup. As many processes as possible are controlled from the control center using the same technology as in the block cave mine. However, instead of unmanned trains, conventional trucks are employed for ore transport within the mine.

Simatic PCS 7 is not only being put into service for mining operations: the third area is for a common infrastructure project. The focus is on traffic control and ensuring safety for truck and bus movements and for two tunnels. “Particularly at shift changes there is a great deal of traffic as employees are bussed in and out,” notes Yseboodt. The control room is small and boasts an excellent use of space and high redundancy. CCTV is also installed for this solution so operators can observe movements on the road. Parts of the common infrastructure are already operational.

More data than ever

In line with Grasberg's wishes, the delivered solution is basically the same as the one in Sweden, over 11,000 kilometers away. The biggest difference is in the communications networks. “In the five years since operations started in the Kiruna underground mine, the amount of data that has to be transferred has grown exponentially. The rapid roaming access points in the wireless communication network have been adjusted accordingly,” says Yseboodt.

Grasberg is getting a solution that fits the bill in more than one way. Not only is worker safety improved because fewer people are exposed to unsafe situations, the solution also brings more speed. And that's good for the bottom line. ■

➔ www.siemens.com/mining
mark.yseboodt@siemens.com

Proven reliability

Since 2009, stockpiles at Germany's Boxberg power plant have been running fully automatically. In fact, the technology has matured to such an extent that secondary controls are no longer necessary.

Cutting-edge technology can reduce the amount of CO₂ emitted by coal-burning power plants. A necessary element, however, is lignite of a consistent quality. At the Boxberg power plant in the German state of Saxony, a fully automated stockpile management system ensures uniform lignite quality. In addition, the system also features unmanned operation of the stockyard machines.

First and foremost, the focus is on the delivery of the requested amount of lignite in the specified quality. The lignite at Boxberg is stored in four stockpiles adjacent to one another, with a storage capacity of 80,000 to 100,000 tons each. In turn, each stockpile can be divided into several stockpile sections. The machinery at the site consists of two combined stacker/reclaimers travelling on one outer rail each, and two stackers travelling on a joint rail in the middle of the four stockpiles.

The core element of the management system is the 3D model of the stockpiles with a record of both the quantity and quality of lignite. The model is updated regularly with data delivered by the stackers and reclaimers. Over the years, the quality of data has increased considerably. "Initially, control laser scanning was needed to ensure that measurements were accurate. However, in recent years and in certain cases, we see this step being performed less and less, because the information provided



“The collision protection system creates virtual zones around the machinery and ‘knows’ where the other elements are at all times.”

Yun Zeng, director of Digitalization at Siemens Mining

by the machinery during running operations is sufficient to keep records up to date,” says Yun Zeng, director of Digitalization at Siemens Mining.

Safety a priority

With unmanned operation of the equipment, it is not necessary to have personnel working among the stockpiles, as all work is performed from the safe atmosphere of the control room. After the working area and parameters for each job are specified, the details are calculated automatically and, after approval through the operator, the job is transferred to the equipment. The rest is automatic, and during execution of the work no additional support from the control room is necessary.

As important as staff safety is, safe operation of equipment is also a priority. After all, any equipment outages can result in unplanned downtime. The stockpile equipment is therefore outfitted with a protection system that uses data delivered by sensors to avoid collisions. “The collision protection system creates virtual zones around the machinery and ‘knows’ where the other elements are at all times,” explains Zeng. Thanks to the system, there have been no incidents whatsoever in the eight years of operation. Best of all, machine reliability as a whole is upward of 99 percent.

Higher performance

In sum, experience gathered with the unmanned stockpile system has proven one thing: higher performance compared to manned operation. Additional plus points are increased accuracy, full utilization of the stockpile area, and optimized energy consumption. Of course, the stockpile management system is not just limited to lignite – it can be employed for any bulk material stockpiles. For many operators, automated stockpile management can be a first step into the world of digitalization. ■

➤ www.siemens.com/mining
yun.zeng@siemens.com

A spitting image

Today's fast cycles leave even less time for important steps like development and commissioning. Digital twins – a digital representation of a system or machine – are being used for equipment across the industry, such as for gearless mill drives.

Mining has become more and more complicated. Just consider the technical requirements involved in developing systems and system components: mechanical and electrical engineers have to increasingly take completely dissimilar topics into account, such as machine, drives and component automation, or the provision of production data. Plus, network communication issues also have to be considered. At the same time, they are expected to combine increasingly complex mechatronic solutions with various automation tasks.

To tackle these challenges it takes more than designing systems on CAD screens, says Helmut Liepold, a sales representative for gearless mill drives at Siemens. Today work is done using digital twins, which are digital models of systems or components that either already exist or still need to be built.

"It's simply the competitive pressure," says Liepold, explaining the background of this development. "Product lifecycles for the machines are growing ever shorter worldwide, and the machines must be more and more variable and flexible in manufacturing processes. The pressure on engineers to get a system ready for market within a short period is rising."

So starting with the earliest production stages, engineers are using digital twins to deliver a level of quality and efficiency so high that readjustments later can be kept to a minimum. "The time for commissioning in particular is extremely expensive," Liepold emphasizes. "We barely have time anymore for testing the individual components of the drive systems at the construction site. The machine has to be delivered,

assembled and commissioned, and then it must immediately operate in the client's production process."

From start to finish

Therefore, Siemens offers its Digital Enterprise Suite, a comprehensive portfolio of software- and hardware-based systems that provide a solid foundation for integrated engineering. Siemens' comprehensive approach offers engineers mechanical, thermal and drive engineering as well as the integration of automation solutions, all on a single platform. It is based on the creation of a digital representation – the digital twin – of a system or machine. Mechanical engineers can design, simulate, test and optimize their products in a purely virtual world, even before any resources are used in the real world.

Above all, the software allows engineers to work with the time factor in system simulation. For one, they can test system behavior in virtual operation and in various fault scenarios. Doing so saves time and money, because the entire machine design and dimensioning can already be tested without the need to build a prototype.

A case in point is the trend toward larger mills with higher output requirements. For a long time, it looked as though SAG mills at 40 ft. (inner diameter) and 28 MW would meet demand. Today, ore-grinding mills at 42 ft. and up to 35 MW are a normal discussion. Systems of this size cannot be tested in a laboratory, yet nevertheless must function faultlessly from the start. Simulation and stress analysis with verified motor models as well as function tests are the only way to know what will work – and protect customers' investments. Similarly, simulation can

Digital twins protect customers' investments.

serve as proof that the foundation, mill and ring motor meet special requirements, such as those set down in the Chilean seismic standard to ensure that equipment can withstand even extreme earthquakes.

Perfect memory

Engineering in a virtual world leads to greater flexibility and improved quality and efficiency of the machines. Moreover, the digital twin is a memory of the installed system. If changes are made along the way, they are recorded in the digital twin. Furthermore, measurements from the condition monitoring system can be run against simulations in the digital twin for an indication of changed system behavior and required maintenance activities.

The bottom line is that a digital twin – whether employed for a gearless mill drive, a mine winder or a conveyor system – saves time and money. And that means operators can become profitable more quickly. ■

➤ www.siemens.com/mining-digitalization
helmut.liepold@siemens.com

The flying giant

Compañía Minera Doña Inés de Collahuasi SCM, one of the largest copper producers in Chile, has improved the reliability and throughput of its mine in Northern Chile with new drive systems in four of its ore mills. Getting the required equipment to the site was a challenge in planning and logistics.



Compañía Minera Doña Inés de Collahuasi SCM (Collahuasi) was looking to boost the reliability and throughput of its copper ore operations in northern Chile. The mine's operators, therefore, commissioned Siemens to modernize the drive system of four ore mills at the site – two 8 MW semi-autogenous (SAG) mills and two 9.7 MW ball mills. In addition to delivering four complete state-of-the-art dual-pinion drive systems for the mills, Siemens also provided six 4,000 kW and six 4,850 kW synchronous motors, Flender couplings with torque limiting, Sinamics SL150 converters with thyristor columns, and a transformer. In addition, the Siemens team upgraded all software and hardware systems and was responsible for the installation.

A large, delicate undertaking

This project wasn't without its challenges. Everything had to be online

within nine months – a relatively short time period for a project of this dimension. Furthermore, a window of just 13 days had been reserved for installation. If that wasn't enough, Collahuasi's open-pit mine is remote, located 180 kilometers southeast the port of Iquique at an altitude of 4,200 meters. Because of the high altitude, parts and components required special electrical and thermal dimensioning – per se not a problem for Siemens, as the company has equipped many mines in remote locations like this. The bigger problem was getting the four dual-pinion drives to site quickly for installation.

Transporting the first four giant machines – each weighing 42 tons – from the factory in Berlin, Germany, to the high-altitude site in northern Chile, normally takes time. And time was the one thing the team didn't have. The only viable solution for was

to forgo sea transport and use air-freight instead. But which machine can handle such loads? One freight plane – the Antonov An-225 – was built especially to handle giant cargo. At 84 meters long, with a wingspan of 88 meters, the An-225 itself weighs 285 tons. It needs 32 wheels to handle its own weight as well as that of its cargo. In fact, the An-225 is not only the largest cargo plane, it is the biggest airplane in the world.

Once completed, the dual-pinion drives made their way from Siemens' Dynamowerk motor factory in Berlin to the nearby Leipzig/Halle Airport, where they were then loaded onto an An-225 and flown to an airport near Iquique. Back on the ground, the drives continued on by special transport up the Chilean mountains to the mine and arrived on time for the installation phase. The remaining components embarked on their journey to Chile by ship.



To transport four machines each weighing 42 tons from the factory in Germany to the site in northern Chile, the Antonov An-225 was employed. At 84 meters long, with a wingspan of 88 meters, the An-225 itself weighs 285 tons. In fact, the An-225 is not only the largest cargo plane, it is the biggest airplane in the world.

Online within nine months

Part of this project's challenge was for the Siemens engineers to design the new systems to fit the existing foundations, which were used by the predecessor equipment from a different manufacturer. Doing so prevented costly downtimes. Also, to minimize any risks associated with the conversion, Siemens replaced the entire mill automation system with modern technology rather than take the laborious task of adapting the hardware and software.

Installing the new automation systems and the direct converter in new, pre-assembled E-Houses was also crucial to keeping within the deadline. The E-Houses were fully developed, produced and pre-tested in the Siemens plant in Santiago, Chile. This simplified the process of connecting and commissioning on site and made it possible for the system to be installed within an

extremely short standstill period of just 13 days – and for everything to be online within nine months.

The first six operational months of the four motors already proved the increase in reliability and consequently the step up in mill throughput. And that means a significantly higher availability of Chilean copper in the market – and higher profits for Collahuasi. ■

➤ <https://blogs.siemens.com/en/mediaservice-industries-blog.entry.html/2017/02/14/40147-giants-take-to-the-air-the-world-s-biggest-cargo-plane-transport-motors-for-ore-mills-in-chile.html>

Authors: Felipe Contreras, Werner Kitz
 contreras.felipe@siemens.com
 werner.kitz@siemens.com

A benchmark in the making

Norsk Hydro is currently building the world's most climate-friendly, energy-efficient smelting plant on Norway's Karmøy island. Siemens is delivering among others its VB1 high-current vacuum switchgear, which underwent exhaustive testing to check for its dielectric strength, as well as the high DC current supply system. Aside from dimensioning, production and delivery, Siemens is also responsible for integration and commissioning.



For a number of applications, aluminum is the metal of choice: it is strong and light, and has a high potential for recycling. However, aluminum production is energy intensive, with a global average of 14 kWh per kilo produced. As the biggest mainland investment in Norway in over a decade, Hydro is constructing a pilot plant on Karmøy island that promises to become the world's most energy-efficient, climate-friendly aluminum production facility. Hydro's goal to be exact: reduce energy consumption in aluminum production by about 15 percent compared to the world average.

Technology supplied by Siemens for the project will include among others VBI high-current switchgear with vacuum switching technology and a high DC current power supply for production. This is a project on a superlative scale: with a length of 34 meters and 26 switch panels, this will be the longest high-current and generator switchgear ever built by Siemens. This type of system protects equipment such as generators and transformers from overvoltage and short-circuits. To ensure a secure supply of electrical energy for the production process, Siemens is also providing six large converter units – each designed for more than 100 kA DC current – including the associated control and protection systems and the requisite cooling systems. The converters transform alternating current into direct current to operate the power-intensive smelting furnaces. Beside other electrotechnical infrastructure, the scope of supply also includes the automation technology with the Simatic PCS 7 process control system and distributed I/O system, as well as the operator control and monitoring systems. In addition to dimensioning, production and delivery, Siemens is also responsible for integration and commissioning.

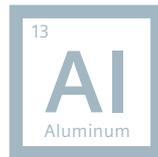
A pilot plant is being constructed at the Hydro site on Karmøy island to reduce energy consumption in aluminum production by about 15 percent compared to the world average.

Norsk Hydro

Hydro is a global aluminum company with production, sales and trading activities throughout the value chain, from bauxite, alumina and energy generation to the production of primary aluminum and rolled products as well as recycling. Based in Norway, the company has 13,000 employees in more than 40 countries on all continents. Hydro's plant on Karmøy island, which opened in 1967, was the company's first smelter.



15%
less energy



75,000
tons of aluminum per year

Extensive testing

To ensure that the switchgear fulfills Hydro's needs, a panel for the new pilot plant was subjected to two weeks of exhaustive testing. In mid-July 2016, working with production partner FEAG, Siemens pre-assembled the high current and generator switchgear in St. Ingbert in Germany. The insulating materials and intermediate spaces between the sections of the unit were checked during testing for their dielectric strength – in other words, to see whether they were capable of withstanding a certain overvoltage for a defined period of time without sparkover or disruptive discharge. After testing, the remaining 25 panels were constructed, and by the end of 2016 they had all been dispatched individually to Norway for installation. In addition, a rectifier-transformer combination was assembled and tested in the workshops to ensure the combined functionality and performance of the systems before delivery to the site. The high DC current supply units will be delivered by mid-2017.

Savings ahead

Once the pilot plant on Karmøy island is completed, it will produce 75,000 tons of aluminum per year and consume about 1 terawatt hour (TWh) of electricity – which roughly corresponds to the annual electricity consumption of 50,000 Norwegians households. Indeed, a lot of energy, but the balance at the end is impressive: the new technology is expected to require just 11.8 kWh per kilogram, or around 15 percent less energy than the worldwide average of 14 kWh per kilo. With a lower energy balance, aluminum may become even more attractive for several new applications. The combination of low energy consumption, low emissions and high productivity will make the smelter plant at Hydro Karmøy unique. ■

➤ <https://www.industry.siemens.com/verticals/global/en/mining-industry/heavy-duty-rectifier-applications/pages/default.aspx>

Author: Oliver Schein
oliver.schein@siemens.com



Full charge ahead

Specialists at Siemens are working on developing a modular electric drive portfolio for underground mining operations. The first product will be a haul truck. Testing began in mid-2017 and commercial release is slated for 2018.

Underground (UG) mining has become more and more challenging as a result of lower mineral grades and minable ore bodies, which are found only in greater depths of the earth's crust. In order to extract the same amount of mineral concentrate or to even increase mineral output, much more bulk material has to be blasted, dug and hauled to the surface. Yet increasing the number of diesel trucks in operation or using trucks with a higher payload capacity and therefore bigger diesel engines isn't the answer. "The number of trucks per mine as well as the maximum power of the diesel engines is

limited due to mine layout and the necessary ventilation and cooling," says Dr. Philipp Reupold, head of Global Sales for Mobile Mining at Siemens. It quickly becomes apparent that a new approach is needed in regard to mining equipment and technologies.

Electrification as a starting point

Machinery electrification is part of a strategy Siemens specialists have come up with to heighten productivity in UG mines – as well as to improve conditions in the UG mines themselves. To this end, Siemens engineers are currently working on developing a

highly efficient electric drive system portfolio for UG mining vehicles. At the heart of these systems are electric components that have been successfully applied for many years in a number of applications in the mining industry.

The solution will first be applied to an articulated UG haul truck with a payload of 60 metric tons. In this particular application, four motors are used, each one driving one wheel. With this drive architecture, the speed and torque of each wheel can be controlled precisely. As a consequence, additional features are available like advanced slip/slide control and

electrically supported steering, which enables more precise turns and reduced tire wear.

Testing commenced in mid-2017 at a mine in Western Australia. Initially the solution will be tested for one month above ground and then for six months in an UG mine. “After the testing phase, we will move right into series production,” comments Reupold. All the while, the focus will be on a solution that can transport more tons per dollar, is safe for mine personnel, and contributes to overall mine productivity. Thus, the benefits for mine operators are significant.

Improvements on many fronts

Trucks with diesel-electric drive systems are faster than diesel-mechanical trucks because the total efficiency of the diesel-electric drive system is higher. More power from the diesel engine is therefore used for propelling the vehicle uphill, leading to higher speeds on grade. And with

these higher speeds, cycle times are shorter, which means that more material can be transported in a given time.

A further point is that diesel-electric drive systems require less maintenance – that makes more operating hours possible between scheduled downtimes. Availability is greater as a result. In total, Siemens engineers expect maintenance expenditures to be approximately 15 percent lower with diesel-electric haul trucks than with conventional diesel haul trucks. Together, the higher productivity and operating times will lead to reduced cost per ton for a productivity gain of about 10 percent.

The electric drive system allows the diesel engines to be operated at constant speed. As a result, particulate and noise emissions are lower. Also, there are no bursts of noise coming from the engines. Furthermore, breaking energy can be harnessed and stored for electric

propulsion. An upshot of using diesel-electric drive systems is that operators can gain access to ore bodies that can't be mined economically with conventional diesel-mechanical trucks.

Operation is enhanced: electric power allows easy and smooth start/stop operations with less operator strain due to precise torque control. Electric drivetrains feature a single-speed transmission, so there are no gear-shifting shocks. Softer/smooth driving also means less maintenance expenditures for the vehicle and road, thus a longer lifetime is possible with overall lower operating costs.

If these attributes are not enough, the use of diesel-electric drives has the potential to create a better atmosphere for mine personnel. Staff can work more efficiently because the UG environment is improved as a result of less heat and exhaust from diesel engines.

Promising market situation

Requirements for replacement machinery in UG mines are viewed as the primary market driver for diesel-electric systems. “As machinery ages, it requires more and more maintenance and repair. At some point, it simply becomes uneconomical to keep operating it,” explains Reupold. While at the moment the focus of diesel-electric solutions for UG mines is on haul trucks, Reupold says the plan is to extend the portfolio to also include LHDs (load haul dump vehicles) and other UG vehicles like drilling machines.

“The integration of diesel-electric drives into UG mining equipment is seen as the first step to complete electrification of UG mines,” says Reupold. By taking steps toward electrification now, operators can start benefiting from increased productivity and lower maintenance costs, as well as adhere to environmental standards and – most importantly – create a safer work environment for UG mine employees. ■

Haul trucks

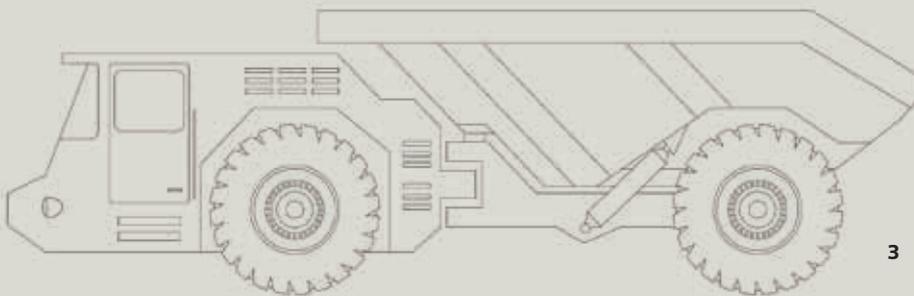
1 The number of haul trucks that can fit into an underground mine is limited not only in regard to space, but as a result of ventilation and cooling needs.

2 Drawing on experiences with reliable components that Siemens has provided to the industry over many years, a new 160 kW traction motor has been developed for the new drive system.

3 Testing on the diesel-electric haul truck began in mid-2017.



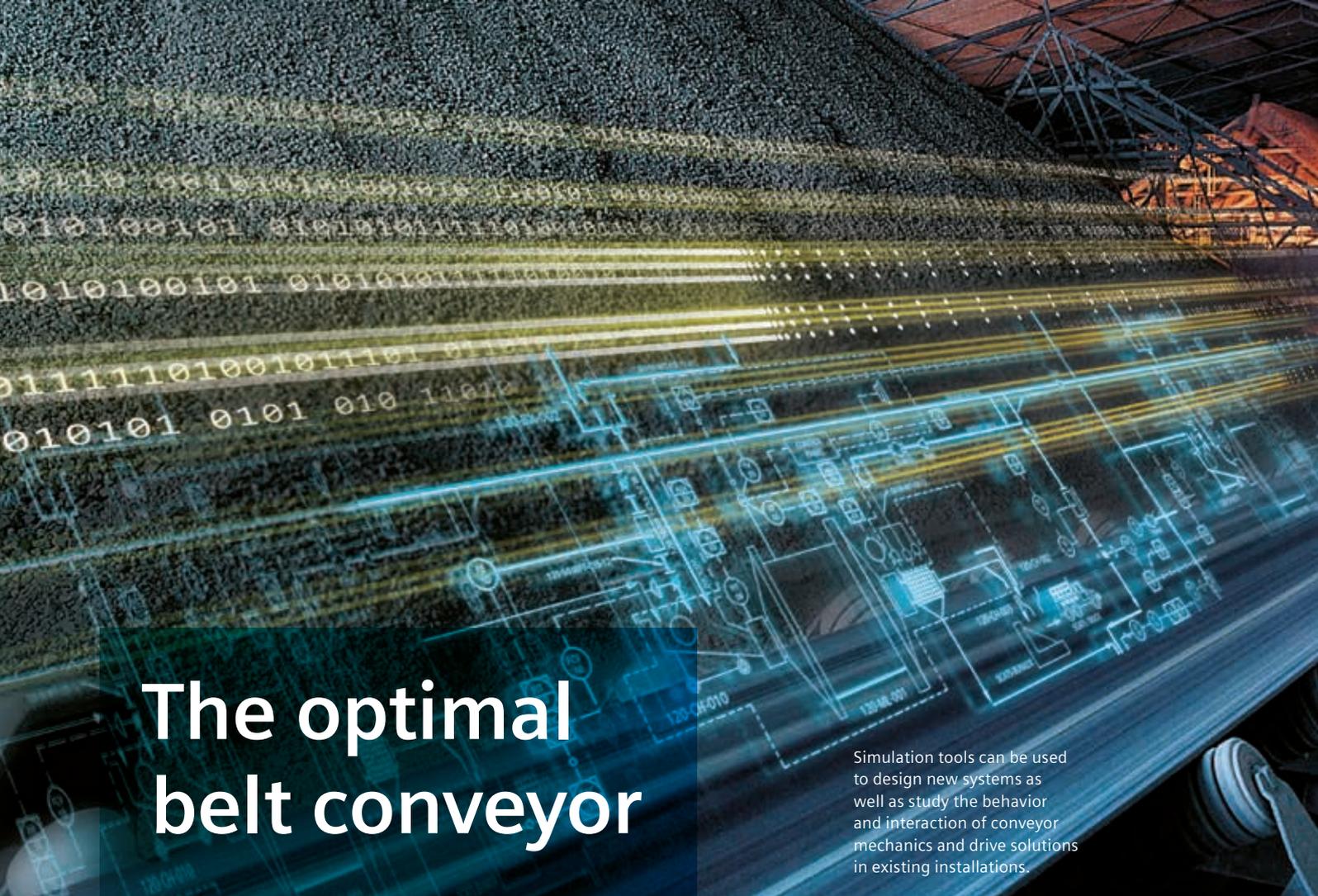
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Author: Dr. Roland Grafe
roland.grafe@siemens.com



The optimal belt conveyor

Simulation tools can be used to design new systems as well as study the behavior and interaction of conveyor mechanics and drive solutions in existing installations.

Whether for changes to existing systems or for new installations, simulation helps engineers come up with optimum solutions.

With shorter and shorter erection phases, there is less time remaining for the construction and design of open-pit mines – particularly when it comes to belt conveyor systems. Plenty of calculation methods are available today for dimensioning belt conveyor systems – they normally determine the maximum load for components, the motor rating, the belt tension, or the bearing load. But what these methods do not reveal is the dynamic behavior of the whole system – mechanical as well as electrical parts – nor do they allow engineers

the possibility to explore and improve how the individual components work together.

For these tasks, Torsten Hellmuth and his colleagues use simulation tools – not only to develop new systems, but also in order to study the behavior and interaction of the belt conveyor mechanics and drive solutions in existing systems. Hellmuth is a product manager in bulk material handling at Siemens responsible for belt conveyor systems used in open-pit as well as underground mines. By means of simulation, he

and his team investigate changes, influences and consequences in the system performance during modernization, for example if capacity is increased, the topology is changed or components are replaced.

“Simulation provides us with the answers to important questions,” says Hellmuth. Examples include: Which drive solution produces the lowest stress on the mechanical elements of the belt conveyor? How does drive performance change if the conveying capacity is increased? Which control algorithms are suitable for minimizing the translational oscillations when the belt conveyor is started? What are the maximum stresses that occur for mechanical and electrical components if the power fails? Do varying operating conditions cause the drive to work in generator mode? Hellmuth notes that without simulation, answering these



In greenfield projects, simulation provides engineers with the information they need to decide on which motors, converters and control concepts to employ.

questions is not possible or can only be done with disproportional expense and effort.

The simulation results are used internally for planning and commissioning the drive solutions, or provided to potential operators or system builders. With simulation, it becomes easier to select the suitable drive solution and controller in order to optimize the operational and productivity ratios. In greenfield projects, engineers have the information they need to decide, for example, whether a drive solution with a hydraulic coupling is sufficient, or whether drive solution with a frequency converter is more suitable. Simulation also allows improvements to be made in system operation and to minimize idle time.

How it's done

The first step in developing a simulation model is the creation of the mechanical model. The belt conveyor mechanics are constructed with basic models using the appropriate elements of a model library. These elements correspond to the individual components of a belt conveyor, such as upper and lower belt sections or loading, tensioning, discharge and drive stations. These elements are put together according to the belt conveyor's topology. With the ability to set belt conveyor parameters, the mechanical properties such as belt width, elasticity module, pulley diameter, idler geometry, mass inertia, conveying capacity and belt speed can be implemented in the simulation model. Drive element models (simulated on a different platform, i.e. from another library) are combined into a suitable drive solution and linked with the mechanical model. The simulation model is completed by adding controller signals and control algorithms.

The next important step is model validation. This means that the simulation results are compared with measured values from the real system or with the available calculation results. If a satisfactory error tolerance is achieved, then it can be assumed that the subsequent simulation analyses of extreme situations or changed operating conditions will

lead to realistic results. The model is now tuned to the real belt conveyor and can be used for further tests, simulations, etc.

All-around benefit

"For us as a provider of solutions for belt conveyor systems based on electrification, automation and digitalization components, the drive unit and the corresponding control system always have priority," Hellmuth emphasizes. "Our expertise allows us to map the mechanical part of the belt conveyor, which is either delivered by third parties or already available, in the model and to analyze the interaction with the drive solution," he continues.

The results from simulating how the mechanical and electrical part of a belt conveyor work together are then internally fed back and serve as a basis for further development of motors, converters and control concepts. In addition, linking together the digital models of a belt conveyor's mechanical and electrical components produces a digital twin and enables virtual commissioning of the belt conveyor. "Complex controllers as well as the parameters for converters and motors can be tested and decided upon in advance, thereby saving on-site time and tests for faster and safer commissioning of the system," says Hellmuth.

The use of digital tools does not stop once the real conveyor is in service. Data is collected from drives, motors and other elements of the system. This data provides valuable information about the status of the different components as well as information related to the system as a whole. An emerging issue can be recognized early and rectified before it becomes or creates a problem. While today data collection components are generally added on to new and existing components, in the future these components will be integrated during the manufacture of the solution components. Digital every step of the way, from design through to operation. ■

➔ www.siemens.com/mining
torsten.hellmuth@siemens.com

Improved extraction

The fossil-energy sector is striking a new path for cleaner, more efficient and productive extraction. The sector's goal is to modernize and transform itself into a high-tech industry. Premogovnik Velenje in Slovenia is taking on the challenge.



The coal industry is making efforts to become cleaner, more efficient and successful. And naturally, Premogovnik Velenje (Velenje coal mine) doesn't want to be left behind. For over 140 years, the technologically advanced Slovenian company has been engaged in underground lignite mining. Today coal mining is a supporting pillar of Slovenia's energy supply system, and an important contributor to the raw material security of the country.

Premogovnik Velenje has been continually optimizing the coal production process through development projects in areas such as clean technologies for coal production, electric power, roadways, transport and logistics. Siemens has supported Premogovnik Velenje with many projects over the years, such as the electrical modernization of its mine winder hoist.

No interruptions

The scope of the modernization project included the mine winder DC drive, the low-voltage distribution, the data recorder, two control desks, the brake control, the automation and pulse generators, and the human-machine interface (HMI). "The biggest challenge, however, was to carry out the work with minimum production disruption," recalls Roland Gebhard, product manager for Mine Winder. The Siemens team pulled it off and carried out the project in a record time of just three weeks.

The key component of the modernization project was the implementation of the Simatic S7-based Winder Technology Control Unit (WTC). The WTC hardware consists of a fail-safe, dual-channel system to assure maximum safety and reliability by using approved features for critical functions and supervision tasks, combined with the flexibility and well-proven reliability of a redundant Simatic PLC. The basic function of the WTC is to control and monitor the movement of the cage in the shaft. The WTC consists of an ultramodern data registration and visualization system, together with a mathematical model to calculate the operational characteristics of the hoist cycle. With the WTC, smoother cage movements can be ensured. The

The WTC contributes to increased hoist utilization and productivity.

result is a more comfortable, safer and time-optimized hoisting cycle. Additionally, rope oscillations can be avoided, thereby contributing to a reduction in mechanical stress and preventing damage to the rope and other machine components. These WTC features guarantee longevity, operational efficiency and safety of the mine hoist.

A boost in productivity

The WTC also makes a contribution to increased hoist utilization and productivity. It provides data about the operation of the mine hoist system, such as the number of conveyance cage movements or the transported weight during any given time period. A correction model is implemented in the WTC that facilitates smooth cage motion. If the correction factor exceeds a defined threshold value, a message is displayed on the control system requesting maintenance work to be carried out at the hoist system. All operational data can be extracted from the WTC in the CSV format, which allows the information to be used by other applications to analyze operational conditions.

"For ten years now, the revised hoist system has been performing its services with a high degree of reliability and dependability – both of which were crucial for Premogovnik Velenje," Gebhard reports. With Siemens' help, Premogovnik Velenje has made a further step to making coal into a high-tech industry. ■

➤ <http://www.industry.siemens.com/verticals/global/en/mining-industry/transport/mine-winder/Pages/mine-winder.aspx>
roland.gebhard@siemens.com



The Premogovnik Velenje lignite power plant is a supporting pillar of Slovenia's energy supply system. The key component of the modernization project was the implementation of the Winder Technology Control Unit (WTC) that increases hoist utilization and productivity.



A step change for better profitability

In 2018, the two SAG mills at Ok Tedi copper and gold mine in Papua New Guinea will be equipped with new drive train infrastructure. Also part of the delivery scope: a cloud-based condition-monitoring system combined with remote access, a two-year contract for the mechanical mill drive system, and a further two-year contract for drive train analytics.

Siemens has been working with Ok Tedi Mining Limited since 2005 to improve operational performance, for example in 2015 with the delivery of two Planurex P2KB20 planetary gear units. The latest project targets improvements in the drive train infrastructure.

In the island state of Papua New Guinea, Ok Tedi Mining Limited (OTML) runs the copper and gold mine Ok Tedi. Like many mines in Papua New Guinea, the drive train infrastructure on the grinding mills there is in excess of 30 years old, and OTML were aware of the potential problems with the aging equipment. They also knew that in order to ensure long-term profitability, a move to industry standard variable-speed control of the SAG mills was required and therefore invited solutions from a number of suppliers.

Siemens has a longstanding relationship with OTML that started in 2005. Since then, Siemens has been committed to improving operational performance in many areas on site – most recently through the supply of two Planurex P2KB20 planetary gear units in 2015.

On the basis of the trust and mutual respect gained over the years, Siemens and OTML conducted a mill drive train audit in 2014 and identified areas for potential improvements. Both parties agreed that the biggest potential would be in changing the operational concept from fixed speed to variable speed on both SAG mills, since the benefits to process efficiency and liner life alone would make the project viable.

Over the next two years, Siemens developed several modernization scenarios for the existing mill drive train, ranging from a partial modernization (keeping the existing motors and adding variable-speed drives only) to a complete modernization (installing new motors and variable speed drives). Initially, OTML was leaning toward the partial

The mill modernization will enable OTML to improve uptime and throughput.

modernization that would have re-used the existing motors to the maximum extent possible. In the end Siemens was able to convince OTML that by removing the air-clutch on SAG 1 and removing the slip-ring motor with its brushes on SAG 2, maintenance activities on the mills could be reduced. Adding an online condition-monitoring system would continue that strategy even further and allow OTML to better manage its new infrastructure, track mechanical wear, assist with proactive maintenance and increase overall productivity.

Furthermore, Siemens showed that by increasing drive power capacity by 15 percent to 20 percent, it would be possible to eliminate momentary power limitations and throughput restrictions on the mill as a result of changing ore hardness.

In December 2016, OTML decided to go ahead with the complete modernization and tasked Siemens with the supply and installation of new motors and couplings, variable-speed drives and a cloud-based condition-monitoring system to track mechanical wear as well as electrical performance of the supplied equipment.

Advantages on many levels

As a result of the modernization, the SAG mills will benefit in many ways. For example, by using variable-speed drives to start the new induction motors on both mills, starting currents will be reduced to less than 100 percent of nominal current. That ensures smooth starting and minimal mechanical stress on reducers, pinions and girth gear. “On-the-fly” frozen charge detection is performed automatically during every start-up, which saves precious process time.

Variable-speed mill control also has an impact on grinding efficiency. A common issue is that the lifting capacity of liners deteriorates over time as they wear on the edges. Subsequently, material cascades earlier, which reduces grinding performance. Variable-speed mill control compensates for liner wear through an increase or decrease in mill speed. Grinding performance thereby remains constant over the life of the liner.

The mill modernization will enable OTML to improve uptime and throughput, which will increase overall productivity. The drives are scheduled to go into operation in spring 2018. After that, two further two-year contracts will go into effect: one for full service and support for the complete electrical and mechanical mill drive system, and another for drive train analytics. ■

➤ www.siemens.com/mining

Author: Matthias C. Neurohr
matt.neurohr@siemens.com

Frozen charge

Frozen charge is a condition that can occur when a mill has not been operated for a while. The slurry inside the mill solidifies and when the mill is turned, rather than sliding off the inner shell, it sticks to the mill shell. The worst-case scenario is that the solid or frozen charge is carried all the way to the top of the mill (180° rotation from start) and then falls down. The massive impact will cause the mill shell to crack and mill bearings to be damaged. “On-the-fly” frozen charge detection monitors the mill angle and the load torque demanded from the mill – the load torque is an indication of whether the charge inside the mill is cascading or not. If the charge hasn’t cascaded past a certain point (usually about 50° or 60° rotation from start), frozen charge is present and the mill is stopped immediately.

Fresh energy for an old mine

Buenavista del Cobre copper mine in Mexico has reduced downtime by 60 percent and costs by 50 percent. At the same time, safety and security have increased. Customized control technology to manage and administer the mine's power supply networks have made these achievements possible.

Buenavista del Cobre S.A. de C.V., a subsidiary of Grupo México, runs one of the largest open-pit copper operations in the world. The mine – Buenavista del Cobre – was established in 1899, making it the oldest active copper mine in North America. Located 40 kilometers south of Mexico's border with the United States, and southwest of the city of Cananea in the state of Sonora, the mine is almost a city in itself: its 9,000-plus workers produce over 200,000 tons of copper a year.

Like all mines, Buenavista del Cobre is a huge consumer of energy. And even more so as it grows. After a recent extension of the mine, electrical demand runs around 500 MW. Seven substations, including one switching substation, were constructed to receive energy from the grid and distribute it at 230 KV. Control of the system is through a distributed control center (DCC) from Siemens.

Specific wishes

When Grupo México looked to Siemens for the DCC, the order was quite specific: a smarter grid that would allow operators to automate data acquisition and create a more proactive maintenance approach without having to halt running operations for any reason. Naturally, any errors during construction, point-to-point testing or commissioning of the system had to be avoided. Other key priorities were adherence to Buenavista del

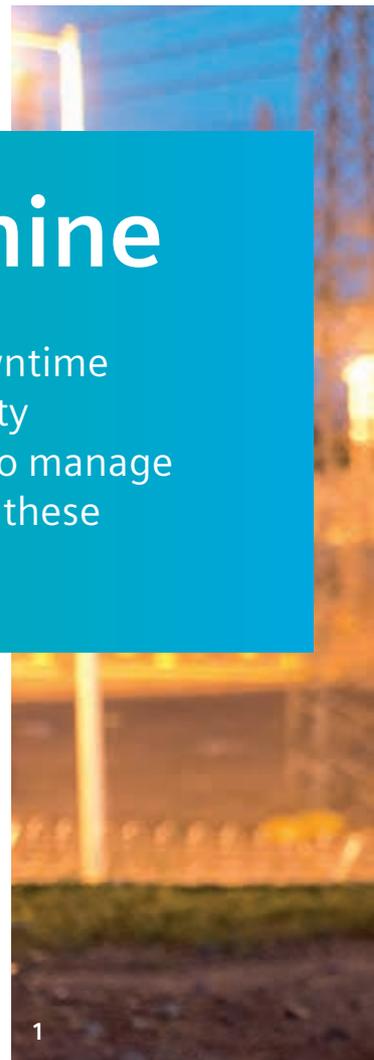
Cobre's high safety standards and to a strict timeline.

The solution Siemens came up with was a custom-designed, state-of-the-art DCC that fits perfectly within the designated space. It included the energy backup, a data network (with four compact Sicam RTUs combined with Ruggedcom 1500 APC communication devices), installation of Spectrum Power™ 5, and the configuration of Buenavista del Cobre's substation control systems using Sicam PAS technology.

The Siemens team had just seven months to execute all construction and monitoring activities. Installation was completed within the scope of the annual major maintenance shutdown in October 2015, with final monitoring of production-related energy consumption implemented by December 2015.

Complete panorama

The benefits of the overhaul have been manifold. Simply by automating network monitoring, Buenavista del Cobre has reduced its downtime by 60 percent and running costs by 50 percent – radical results for a project that took just months to complete. “This project has put us in a better technological position, and we have a lot of flexibility for operating the system too,” states project manager Alberto Arriaga from Grupo México. Maintenance scheduling has improved, while operating errors and major maintenance outages have come down.



1 The visual system provides a clear overview of the status of the electrical network.

2 The benefits of the overhaul have been manifold. Simply by automating network monitoring, Buenavista del Cobre has reduced its downtime by 60 percent and running costs by 50 percent. For operators, one of the biggest advantages is increased transparency.

3 Established in 1899, Buenavista del Cobre in Mexico is not only North America's oldest active copper mine, with a yearly output of 200,000 tons it is also one of the largest open-pit copper mines in the world.



Transparency has increased too. “I now have a complete panorama of how all the electric substations are doing,” says Doris Salomón, supervisor at Buenavista del Cobre’s DCC. Salomón and her colleagues can easily assess the quality of the energy delivered by Mexico’s Federal Electricity Commission and adjust energy models accordingly. This frees them up to focus on more value-added tasks and on activities that help boost productivity and energy efficiency.

Safe, smart, scalable

“The system’s most important benefit for the mine is the safe and secure administration of electricity,” says Tomás Reyes Sánchez, business unit manager at Siemens Mexico. As such, Siemens was able to fulfill the high-level priority of decreasing risks for personnel.

Continuing the mine’s 115-plus years of operations with a solid and

dependable power management system in place gives everyone piece of mind. It also provides Buenavista del Cobre with a solid foundation from which to further expand. And expand it can. Spectrum Power™ is based on international guidelines that are globally applicable as key standards for viable smart grid solutions. Its medium-voltage capacity is also scalable. With a safe, smart and scalable power control system, Buenavista del Cobre can adapt anew when the time for more radical changes comes its way. What’s more, with intelligent electricity management in place, Buenavista del Cobre has made a significant step on the path to intelligent mining. ■

www.youtube.com/watch?v=0B7fFEoMBZ8

Author: Heike Onken

heike.onken@siemens.com



Speed and precision

Tried-and-tested technology is behind the fast start-up and today's easy operation of Africa's largest copper smelter.

Back in 2012, First Quantum Minerals decided to expand its Kansanshi mine operations in Zambia with the construction of a copper smelter. Integral to their success, the Kansanshi operators knew, would be a highly reliable plant-wide control system engineered to incorporate all control functions, including many cutting-edge functions unique to copper smelters. Simatic PCS 7 was selected as the control system, and MIPAC, an

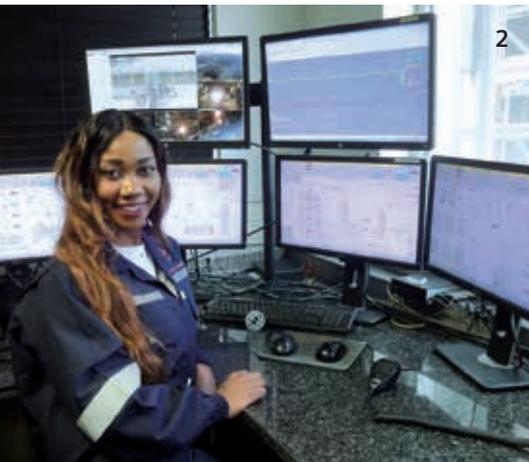
Australian Siemens Solution Partner, was contracted to program, install and commission the high-end solution.

Planning of the control system for the smelter commenced during the fourth quarter of 2012. Detailed control system engineering, plant simulation and factory acceptance tests (FATs) were completed early in the third quarter of 2014. Following this, smelter commissioning commenced and was completed in the

first quarter of 2015. The plant started operations on March 7, 2015, and achieved commercial production status by the end of the second quarter, ahead of expectations. "This compact time frame for planning, engineering and commissioning a smelter of this size and capacity is unprecedented for similar smelter projects," notes Philip Pascall, First Quantum's chairman and CEO. A large factor for the early start-up was the control system.



1



2

1 The new control system also integrates cutting-edge functions unique to copper smelters.

2 Simpler operations: manual operator intervention has been minimized with the new control system.

MIPAC

MIPAC provides engineering services and solutions in electrical and instrumentation, automation, process control, operational technology, data management and process optimization. The company has worked extensively in industries that rely on complex and efficient process control, including minerals processing, oil and gas, energy, water and wastewater, chemicals and manufacturing.

➤ www.mipac.com.au

Details on a selection of features:

Smooth engineering

MIPAC was able to leverage the Simatic PCS 7 configuration tools. The standard library cut down the time needed for engineering. For example, the engineering hours to build the communication tables between the human-machine interface (HMI) and the controllers could be eliminated, thereby saving time and money. The embedded simulation tools could be easily implemented for the FATs and operator training.

Interface with external systems

The smelter consists of several plant areas, such as materials handling, primary smelting, secondary smelting, off-gas handling, services and the oxygen plant. The control of all these plant areas was integrated into one homogeneous control system, thereby achieving a seamless interface from the plant equipment to the operators.

Remote access

Ten web navigator clients are available for plant managers, superintendents and supervisors to access Simatic PCS 7 both on-site and remotely, if required. Remote access to the plant is also provided through secure VPNs and KVM sharing software. This allowed MIPAC commissioning engineers to quickly react to support calls during the early stage of commissioning. Once commissioning was completed, remote access was handed to the maintenance engineers.

The remote access solution allows supervisors to remotely access a view-only version of the HMI, or superintendents and plant managers to access the process integration interface remotely. Engineers can also access the Simatic PCS 7 for control modifications via a secure access link, including MIPAC supporting the plant from Australia.

Simpler operations

MIPAC's design intent for the project was to minimize manual operator intervention in all instances where the control could be handled by the control system. This aspect allows the operators to focus on operating and managing the processes, rather than acting as process controllers themselves. In addition, a custom faceplate was developed to simplify the Simatic PCS 7 interface. The operator is now able to quickly visualize the overall interlocks for the sequence and, if required, drill down into the sequencer itself to see the step actions and interlocks.

The system capabilities of the Simatic PCS 7 system combined with the sound engineering work applied to the project has resulted in one of the fastest and the most successful project start-ups for comparable copper smelters in recent times. The inherent functionality of the system and engineering provided has led to the site's ability to respond to failures quickly as well as determine the true cause of faults. For ongoing operations, the resolution and optimization of the plant and processes continue to be successful.

In any case, First Quantum Minerals is quite satisfied with the Simatic PCS 7 solution at the Kansanshi smelter – so much, in fact, that Simatic PCS 7 and equipment from Siemens are currently being implemented at the Cobre Panama green-field copper project. And with this project too, MIPAC is taking care of engineering. ■

➤ www.siemens.com/mining

Author: Marek Lisik
marek.lisik@siemens.com

Go West

Declining markets in China are giving the country's heavy-load machinery suppliers occasion to increasingly look abroad for business opportunities. Could this be perceived as a threat for Western companies?

East meets West. The heavy-load machinery arm of century-old Dalian Huarui Heavy Industry Group Co., Ltd (DHHI) was selected in 2013 to supply Australia's Roy Hill iron mine with a range of equipment. With the contract signing, DHHI's management was very pleased to have broken in to the international market with a project of this caliber. As the fourth-largest mine in Australia, Roy Hill is designed to yield up to 55 million tons of high-grade iron ores every year. The volume of ore stacking, reclaiming and transportation at the mine and the port made the project one of the largest of its kind around the world.

To tackle the project, DHHI needed support. For example, the required rated capacity of the port reclaimer

used for bulk cargo transportation in the Roy Hill project was 14,400 tons per hour, more than two times higher than the service capacity of a common stacker-reclaimer used at Chinese large bulk cargo ports. A trusted partner had to be found for drive systems and equipment – and in the end that partner was Siemens with its Flender drive portfolio.

Lightweight and reliable

In February 2015, for the Roy Hill iron mine project Siemens provided the master drive systems for DHHI's two bucket-wheel stacker-reclaimers (14,400 tons per hour), one ship loader (12,500 tons per hour), five other types of stacker-reclaimers, and one double-cabin tippler system.

Facts and figures

Bucket wheel reclaimers for Roy Hill iron mine in Australia

Length: **120 meters**

Height: **36 meters**

Weight: **2,000 tons**

Hourly service capacity: **14,000 tons**



In addition, Siemens also supplied drive systems for the bulk cargo transportation equipment. Engineering services were also part of the Siemens package.

The equipment and products manufactured for high-end peak applications are significantly different from other products of the same type. The reduction gear unit is a typical example with its requirements for a light dead weight and high reliability. In both cases, the Flender drives from Siemens fit the bill.

Among all the reduction gear unit solutions considered in the bidding, the Siemens Flender gear unit had the largest output torque of up to 2,600 kNM and the least dead weight. The application-specific gear unit for a bucket-wheel machine is installed on the cantilever of the bucket wheel. Lower-weight reduction gear units not only mean less counterweight at the other end of the cantilever and therefore less energy consumption, but also lower risks of the cantilever being deformed under load. Lower engineering costs are the direct result, as is higher system reliability.

High reliability is a special concern for the Roy Hill iron mine. First and

foremost, in Australia the labor costs for maintenance are very high. Furthermore, as defined by Standards Australia the drives had to boast an availability of 95 percent. The remaining 5 percent is reserved for maintenance, which in the case of the Siemens Flender drives can be performed by the end customer during use. Finally, the drives are designed for a long service life: the equipment can remain in good running condition even after a normal service period of 30 years.

Just the beginning

Wang Peng, the director of DHHI Design Institute for Bulk Cargo Machinery, is very satisfied with the partnership with Siemens. "By cooperating with Siemens," he says, "DHHI was able to

win the big order." During project implementation, the Siemens staff provided on-site services and responded quickly when issues came up, which took a burden off the shoulders of the DHHI installation team. Operators at the Roy Hill mine are also pleased with the equipment.

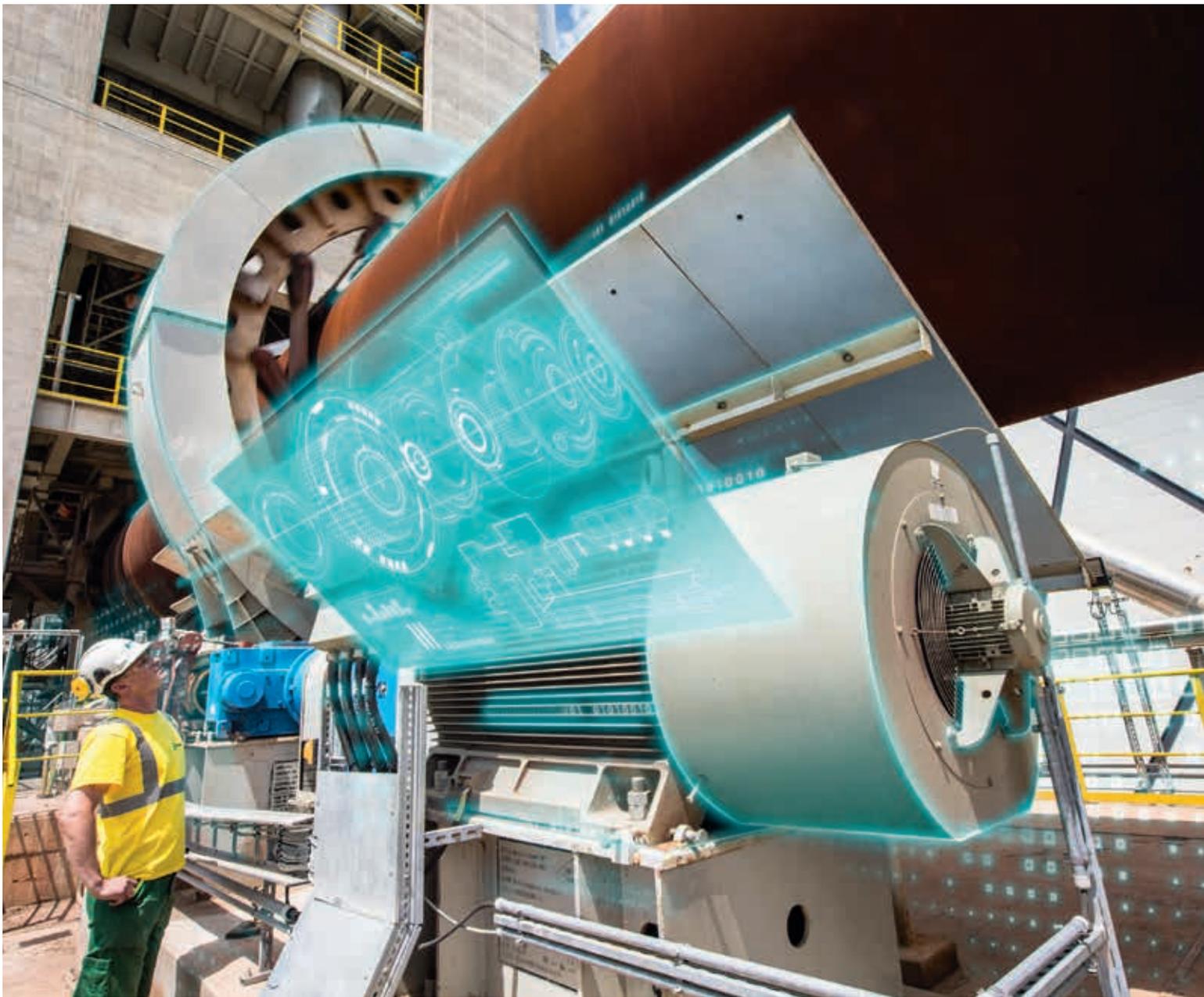
The foundation has been laid for further collaboration between Siemens and DHHI. Aside from machinery, DHHI representatives see possibilities with their business activities involving metallurgy, wind power and crane manufacturing. East meets West isn't a threat, but a recipe for winners all around. ■

Author: Liu Chang Qing
changqing.liu@siemens.com
➤ www.siemens.com/flenderapplications

DHHI

Dalian Huarui Heavy Industry Group Co., Ltd. (DHHI) has a history that stretches back more than 100 years with the foundation of Dalian Iron Works. Today DHHI has about 10,000 employees. The company operates a technical center in China consisting of a vast design and research institute as well as a research and development center in Germany. With over 500 patents, DHHI has achieved a number of firsts in China, and has exported its technologies to many parts of the world.

The two stacker-reclaimers supplied by DHHI and outfitted with Flender drives from Siemens each have a capacity of 14,400 tons per hour.



New features for a trusted tool

Growth prognoses based on a number of what-ifs as well as the need to adhere to stricter and stricter regulations: the cement industry is again at a crossroad. The introduction of Cemat V9.0 is a good omen for a stable future.

It's basically everywhere and almost always under our feet: concrete. In the last 20 years, the market has been chugging along quite well with a growth rate of close to 6 percent per year. Most of that growth came from China. However, as the Chinese market slows down, it is unclear where growth will be coming from going forward. India and Turkey show potential, as do a number of countries in Africa and South-East Asia. The United States may also be another growth market, provided that the much-talked-about infrastructure renewal program takes off.

In any case, global cement production is set to fall back with expected annual growth rates of 2 to 4 percent. The new "normal" for quite some time to come, say analysts. At the same time, cement producers are being called on to lower their CO₂ emissions. Just these two developments alone have cement producers looking for higher productivity and greater flexibility, improved resource and asset utilization, lower costs and simpler processes, enhanced safety and security, and improved decision support. Can answers be found in digitalization?

"Yes, definitely," is the answer from Thomas Walther, vice president of Siemens Minerals. At the heart of all digitalization tools for the cement industry is end-to-end automation, as supplied by Siemens' process automation system Cemat. Yet Cemat, which is based on Simatic PCS 7, has a long history of making life easier for cement operators. "For over 40 years, Cemat has been helping the cement industry deal with its challenges," says Walther. What is special about the automation platform is that it covers horizontal needs, from the crusher to dispatch, as well as vertical needs, from field devices to the management level. Since its inception, Cemat has been a frontrunner – and with the newest update, it is holding on to that status.

Update for Cemat

Cemat V9.0 is the latest version, and it includes an array of new functions across the entire cement production

chain. "A highlight is definitely scalable recipe and storage location management," says Walther. This highly sophisticated functionality has been integrated into the base process control system. No further hardware or software components are necessary, which makes asset management much easier. Processes are more efficient as a result.

Other new features include an expansion of the sequence test mode: After switching to "Sequence test" in the system plan, all field signals of an object can be simulated in the operating system runtime mode. Operators also benefit from new pictograms, which support one-step operation. Plus, the pictograms can be scaled proportionally and displayed on an instance-specific basis. Cemat V9.0 now includes a definition of maintenance intervals for analog and binary signal modules. Furthermore, performed maintenance work can be logged and evaluated. The list continues with extended warning or fault information on motor start-up, as well as integrated scalable production control (SPC).

SPC allows parameters to be saved, imported, exported and/or switched over, if required. The parameter characteristics are depicted in each case by different SPC module types, which can be freely connected to each other depending on the quality structure and requirements. A central SPC manager module forms the interface for the plant operator. A possibility, for example, is to include the flexible assignment of material to different storage locations in the project engineering process.

A new step for digitalization in cement

A hallmark of digitalization is interconnectedness – from components in a single cement plant all the way to connections between different plants. Cemat V9.0 can naturally manage all that. With the new version, it is taking a further step with integration of the cement process simulation and training simulator SIMULEX® from KHD. This training simulator was developed together

with the association of German cement manufacturers (Verein Deutscher Zementwerke – VDZ) about 20 years ago. Today SIMULEX offers a realistic emulation of process behavior of a cement plant from raw material preparation via the pyro-process to cement grinding. A portfolio of customer-specific cement applications is available, for example, for the roller-press, or for vertical and ball mills.

The advantage of the interconnection between SIMULEX and Cemat is that the client can benefit from realistic cement process training with the existing plant configuration, and a full simulation of the controller level and operator faceplates. In short, simulated plant operation is an exact reflection of a real control center. The trainee has the same operation elements as the operator, including faceplates, alarms and messages. No relearning is necessary after training. And most important, there is no risk to product quality, equipment, personnel or production.

Ready for the future

The improvements to Cemat are helping the proven solution from Siemens to answer challenges facing cement operators. No matter which direction growth takes or how strict regulations become, Cemat is an essential tool to improve resource and asset utilization, and for better decisions. Come what may: plants equipped with Cemat are in line to profit from digitalization. ■

➤ www.siemens.com/ceamat
www.siemens.com/cement
 thomas.walther@siemens.com



St Marys Cement has been
in operation for more than

100 years

St Marys Cement will
increase annual production
capacity at the plant to

2 million tons

The Brazilian Votorantim Group
is active in over

20 countries

Expansion kicks up production

Demand for cement in the United States is growing again – so much so that St Marys Cement has decided to extend and modernize its operations in Charlevoix, Michigan. In fact, the project will expand capacity by 40 percent.

Whether for buildings, bridges or roads, cement is all around us. In the United States, all indicators point to growing demand after a six-year slump. To satisfy this demand, St Marys Cement – a Canadian company owned by Brazilian building materials supplier Votorantim

Cimentos – is currently expanding and modernizing its operations at its site in Charlevoix, Michigan, with a \$130 million investment project. St Marys Cement will benefit with a 40 percent rise in production capacity at the plant, from 1.4 million tons annually to 2 million tons annually. For owner Votorantim Cimentos, the project is contributing to increasing cement production in the Great Lakes region.

Siemens is providing a complete engineering and electrical equipment solution for the Charlevoix project. The Siemens scope of delivery covers medium-voltage drives and the entire process automation and instrumentation, from the Cemat PCS 7 process control system through to medium-voltage switchgear type GM-SG-AR (5 to 15 kV) and modular, pre-produced E-House substations for a fast, reliable energy supply. The Siemens solution will enable St Marys Cement to not only reduce the costs of project completion, but also minimize the risk of a power outage.

Trusted partners

The project in Charlevoix is just one in a line of projects Siemens has completed for St Marys Cement. One of the more notable projects of late was an update of the weighing technology at the production facility in Bowmanville, Ontario, Canada. For the weighfeeders, which had been in service since the 1980s, Siemens installed new technology based on its award-winning MSI solution. Going back to the 1990s, Siemens also installed most of the solids flow meters and the belt scales during an expansion.

For Siemens, the projects with St Marys are a chance to contribute to the North American cement business. And for St Marys, a chance to tap the reviving market. ■



Votorantim Cimentos

Headquartered in São Paulo, Brazil, Votorantim Cimentos is one of the world's largest cement producers, with sister companies active in the metal, steel and power sectors. The company is a part of the Brazilian Votorantim Group, which is active in over 20 countries around the world. Part of Votorantim Cimentos, St Marys Cement has been in operation for more than 100 years.

➤ www.siemens.com/cement

Authors: Joe Holmes, Rubin Boyd

joe.holmes@siemens.com

rubin.boyd@siemens.com

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