

The way towards the learning steel plant

The steel industry now finds itself in the age of digitalisation. High plant availability, consistent plant conditions, and maximum product quality are key factors when it comes to optimum plant operation. Today, it is increasingly important not only to produce efficiently but also in a resource-saving and sustainable manner. The demand for digital products that also address the subjects of artificial intelligence and machine learning is on the rise. SMS group and its digital entity SMS digital are the ideal partners when it comes to opening up the full potential of a plant and, thanks to their modular software solutions, are able to provide all the tools for full plant connectivity and capacity utilisation.

Author: Bernhard Steenken
SMS group GmbH

SOFTWARE FOR INDUSTRY 4.0 – DIGITAL APPLICATIONS FOR EXCELLENT PLANT EFFICIENCY

A modern steel mill with a highly flexible process chain and state-of-the-art technologies for ensuring high-quality steel products, as installed at Big River Steel (BRS) in Arkansas, USA, consists of a large number of highly specialised systems generating an enormous amount of data. These data contain information about almost everything that is going on in the mill. When these data are integrated in the right way, they are able to provide answers to questions relating to plant status, process accuracy and the way in which it determines the product quality or operational cost drivers. Therefore, these data are of great importance for various types of performance evaluation and system adaptations.

SMS group and SMS digital have already realised their vision of the learning steel plant at BRS, the world's first learning steel plant. Here, SMS has succeeded in digitalising a complex steel mill in such a way that stable and resource-saving production is optimally controlled. In order to concentrate digitalisation competence in the best possible way and to activate the full potential of digital solutions, SMS digital relies on strong partnerships. In this way, SMS digital, in cooperation with noodle.ai, a leading provider of Enterprise Artificial Intelligence®, is further optimising the learning steel plant at BRS by developing digital applications using state-of-the-art data analysis technologies such as artificial intelligence and machine learning. The goal is to operate the mill in the most resource-friendly and energy-saving manner possible.

In order to meet the challenges of digital transformation, companies in the metals industry need software that processes large volumes of data and analyses them to identify important interrelationships. The age of

digitalisation and Industry 4.0 calls for getting maximum performance out of plants and processes. High-end technology and intelligent digitalisation solutions help to generate more added value. If plant expertise, experience in process modelling and state-of-the-art data science are cleverly combined, improvements in production efficiency, product quality and plant condition can be achieved.

Many companies are already collecting and storing data along their entire process chain. Therefore, the data volume is increasing, but the companies do not use the data efficiently. Storing large volumes of data, however, should always be associated with added value. Otherwise, it does not make sense to store unorganised data – they simply cannot be used. SMS digital uses a data-oriented approach to find out, together with the customers, which data are available and how they can be best used. The goal is to add value to the plants and their processes by achieving a faster return on investment.

A plant is designed in such a way that it uses advanced automation in all production phases. The production systems of the plant monitor and control each process step and the large data volumes that are generated in the process. These data are used to verify the correct procedures used for production and to ensure that the product meets the customer's requirements. These data are also important for monitoring the condition of the various units within the plant. Each of the production units maintains its own data storage and generates its own reports. Combining data from several sources and the generating reports across several production units can be a difficult and time-consuming process.

In order to prepare a steel mill for digitalisation, certain measures must be taken to extract the data and make them usable for applications, digital products and services. These data can usually be extracted through the

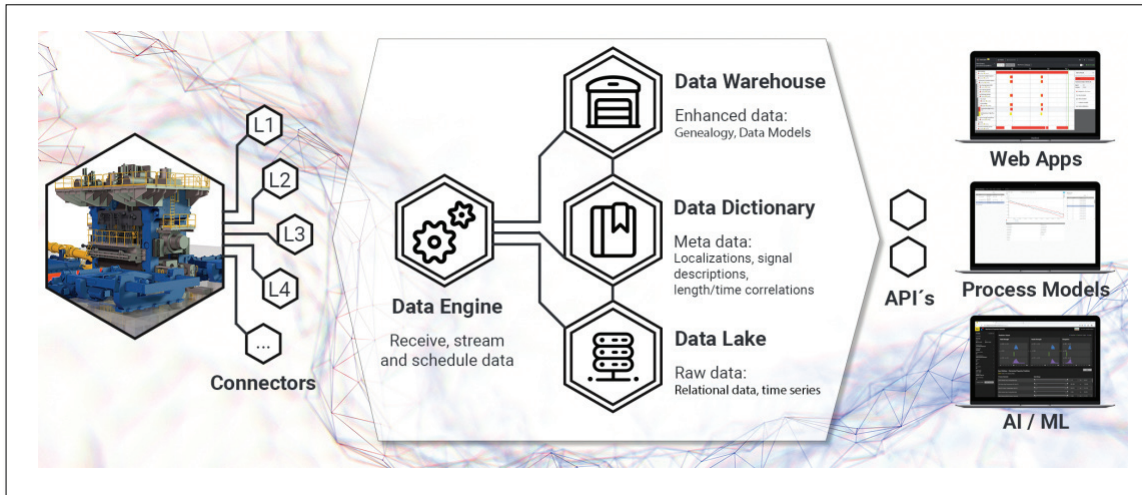


Fig 1 The SMS Data Factory concept

various automation levels, such as sensors, process models, etc. and are mainly used by systems and solutions that concentrate on a certain process stage.

SMS DIGITAL'S VISION OF THE LEARNING STEEL PLANT

For SMS digital, the learning steel plant is one that permanently controls and optimises itself autonomously with regard to its essential performance parameters such as product quality, lead time, adherence to deadlines and yield. This can be achieved by interlinking all involved persons and systems to form a network. The plant uses artificial intelligence algorithms to determine and evaluate suitable scenarios, ie, it trains them, monitors itself with learning algorithms and draws appropriate conclusions from real events. To achieve optimal results along the entire production chain, it is necessary to model the processes from material provision through production to distribution and to fully master the relevant machine, process and product data.

Although the majority of SMS group's business is in the steel industry, digital technologies are of course also being used in many other sectors, such as aluminum or copper. However, the digital technologies and methods developed by SMS group are so universal that they can be used in other industries such as paper and glass manufacture.

The term 'plant' is scalable with regard to the scope of the project. Digital solutions can be made available for individual parts, for example in the form of an innovative platform for ordering spare parts, for a specific machine type by providing first-class automation systems, for an entire plant complex which enables efficient production planning, quality or logistics processes, right through to solutions connecting several locations, for example in

the form of business intelligence solutions that allow for company-wide transparency.

The main task of the learning steel plant is to turn data into value. It makes use of all the advantages of innovative technologies to increase its productivity and user-friendliness and has an enormous positive effect on sustainable green steel production. Being part of a multinational company, SMS digital has access to specialised domain knowledge from around the world regarding every production route in the steel industry. Under the umbrella of the three main pillars of planning, quality and plant condition, the solutions provided by SMS digital cover digital products and consulting services with regard to operational competence, platform services, customer-specific development solutions as well as data analysis and preventative maintenance.

With the aid of modern agile methods of working such as design thinking, new products can be developed right from the start in close cooperation with the customer, the end user and the experts of SMS group. In this way, the best possible solutions can be achieved, as the solutions are perfectly tailored to the individual needs of the customer – with immediate added value and maximum profit.

EXTRACTING ADDED VALUE FROM DATA

In order to create a basis for all digitalisation applications and to finally obtain added value from data, the plant data must be available in a structured and well-organised form. For this purpose, SMS digital offers the 'SMS Data Factory' which is used to convert raw data such as relational data, process data, time codes or files into usable data. Figure 1 shows a general overview of the concept. The Data Factory collects data from the existing plant automation system and makes them available to other applications. It consists >

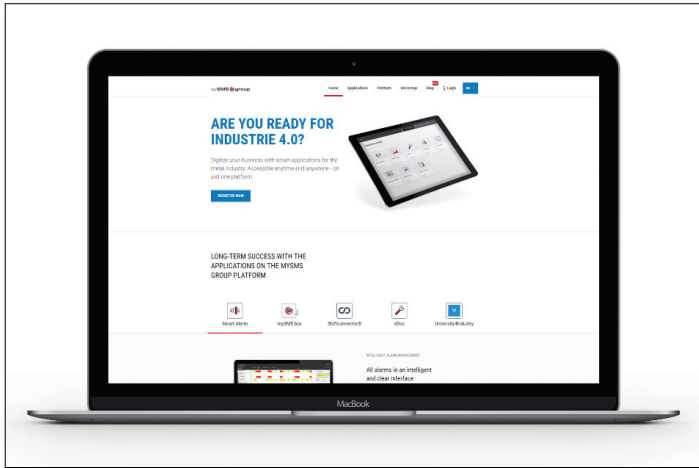


Fig 2 Applications available on the mySMS platform



Fig 3 Production planning using the Manufacturing Execution System X-Pact MES 4.0

of a local component and a cloud component, with one or the other components being in the foreground depending on the application and the specific requirements of the respective plant.

The Data Factory is a scalable product, which can be used for a specific plant or machine as well as for a complete plant complex or for an entire company. In this way, a specific plant section can be used for starting small and the application can later be extended to further plant components.

In a first step, data have been enriched with added value. Now, to make these data visible, SMS digital uses the mySMS platform (see Figure 2). With this industry-specific software-as-a-service (SAAS) platform for the metals industry, SMS digital hosts and combines the most important applications for the fast and direct digitalisation of a company and guides the customers step by step on their way to the learning steel plant. Users benefit from a single sign-on for all applications in one interface.

This feature is supported by simple and intelligent user and role management. All data is hosted in highly secure data centers, data transmission takes place using end-to-end encryption and is secured by encrypted drives. SMS group and SMS digital are constantly expanding the portfolio by adding new and innovative applications to the mySMS platform. In this way, customers will be able to test new developments early on and can add real added value to applications with their feedback.

EFFICIENT PRODUCTION PLANNING

Digital solutions for production planning include all products and services that serve to optimise production planning and control. They focus on KPIs such as output, finance, delivery performance or warehouse management. One of the key products offered by SMS digital in this context is the production planning system X-Pact MES 4.0 (Manufacturing Execution System) as illustrated in Figure 3. Like all modular software solutions from SMS digital, MES 4.0 uses the methods of machine learning, artificial intelligence and big data analysis to monitor all production steps along the entire process chain. Thanks to the modular structure, MES 4.0 can be supplemented by further applications and integrates smoothly with an existing IT landscape. The entire process can be tracked, from receipt of the customer order to the product leaving the plant.

For MES 4.0, one of the most attractive areas of application is the field of production planning, when it comes to achieving improvements through digitalisation. Seamless vertical and horizontal connectivity, optimisation algorithms and data-controlled models, in particular, improve the flexibility of production planning without adversely impacting operational productivity or stability.

Nevertheless, the technological knowledge in the field of metallurgy continues to be a decisive factor. Today it is more important than ever that this specialist knowledge can be easily and intuitively integrated into dynamically growing MES functions. After all, the dynamic changes in market demands, triggered by the Internet of Things, require considerably shorter cycles of automation modernisation as we head towards Industry 4.0. Rising volumes of data and new means of exchanging information are resulting in closer collaboration between full-line suppliers of plants and automation systems, and plant owners and operators. The flexible adaptation of products at consistently high product quality must be ensured. The production lead times must be minimised and a high level of adherence to delivery deadlines must be achieved. At the same time, resources must be optimally utilised with reduced stock, and maximum yield must be attained to ensure profitability.

Around 15,000 signals are available in a modern compact strip production (CSP)[®] plant. Knowing the origin of the signals and the way they are created is of vital importance for the analysis, and is thus a crucial factor for long-term production optimisation. AI algorithms have been integrated to enable the best possible dynamic re-planning.

Thanks to the integration of MES 4.0 at Big River Steel, SMS group and SMS digital have jointly been able to contribute to achieving maximum plant performance with minimum maintenance as well as high product quality and yield. Therefore, MES 4.0 is an essential component in the successful change to the Smart Factory in the spirit of Industry 4.0.

SOLUTIONS FOR QUALITY OPTIMISATION

Even today, quality management is not an automated process in most rolling mills. A great deal of time and effort is invested in quality monitoring by humans, for example to determine the exact cause of defects. Deviating quality data require decisions and measures by the monitoring staff, such as redirecting or, in the worst case, scrapping a coil, which results in losses. In the past, IT implementation of quality assurance was almost impossible, due partly to the broad variety of products manufactured and small batch sizes for customer-specific steel products. Another critical factor is that quality and process data are usually stored on several local systems, so that a large part of them cannot be accessed directly. The user-friendly approach of the Quality Execution System (QES) enables the systematic introduction of an automatic coil release system for all production lines.

The QES data integration supports digital connections between different departments, sectors and supply chains, thus enabling users to improve cooperation, coordination

and transparency. This enables both horizontal integration, eg, between processing lines, and vertical integration by making data from the field and process levels usable for higher control levels, eg, through communication with MES 4.0.

CONDITION MONITORING FOR OPTIMAL PRODUCT LIFECYCLE MANAGEMENT

Many plant processes in companies have already been digitalised. However, the evaluation of the generated data is very time-consuming. Intelligent maintenance solutions make it possible to carry out automatic system-wide analyses, thus improving quality and efficiency. These products and solutions focus on aspects such as plant availability, inventory management or maintenance planning. Here, SMS digital offers just the right tools that can be easily integrated into existing system environments and are seamlessly integrated with each other: Problems in the plant are first detected by Genius CM and forwarded to Smart Alarm (*see Figure 4*) to inform the maintenance personnel. Using eDoc, suitable spare parts can be identified and ordered so that a visual plant inspection can be planned using the production planning software MES 4.0. IMMS coordinates the personnel, tools and materials required for this task – precisely and on schedule.

Let us have a closer look at the application. Genius CM[®] enables permanent monitoring of the plant components, which facilitates early detection of critical situations and prevention of unplanned shutdowns. The monitoring functions include diagnostic vibration analysis, temperature monitoring, monitoring of dirt particles, oil flow, water level and hydraulic fluids, a torque analysis system and process monitoring using the mill diagnosis system. The installed sensors on all important plant components along the process chain constantly transmit measured data to Genius CM[®], which, unlike other systems, compares the measured values with the process data. The software then compares these findings with the tolerances and triggers an alarm if limit values are exceeded. In this way, considerable damage from overstressing and unforeseeable consequential damage can be prevented.

The production processes are monitored by means of PCA[®] (Process Condition Analyser). The software evaluates all types of data, such as data from surface inspection systems, technological measuring systems, basic automation systems, process models and from the Level 3 system with regard to production and plant conditions along the entire process chain. It visualises where the production conditions are not within the limits and where the corresponding equipment can be found in the plant. This information, together with the complete documentation, starting with data sheets for sensors and functional descriptions, circuit and hydraulic diagrams, up ▶



Fig 4 Smart Alarm visualises all the relevant alarms on a dashboard

to expert recommendations and mechanical drawings, is made available to the personnel as a web application on mobile devices. For this purpose, eDoc is connected to PCA® or can be used separately. eDoc is a digital solution that makes technical documentation available in a modern and easy-to-use manner. In this way, the shift personnel can react more quickly and effectively to any defects that occur and assume more responsibility.

The detection of changes in the long-term behaviour may trigger maintenance activities in the regular maintenance shifts. That is why PCA is linked to the integrated maintenance management system (IMMS). As a result, the maintenance approach is shifted from a mainly cyclical to a mainly predictive one, thus enabling a more cost-efficient operation. Suitable maintenance measures allow individual parts to be serviced in such a manner that the optimum strategy for the respective plant is obtained. The focus lies on prioritised measures with the right amount of documentation – achieving more efficient results than with conventional methods.

Through mutual harmonisation, all software functions work perfectly together. Maintenance management is practice-oriented and is based on the principles of reliability-oriented maintenance and an ideal mix of repair strategies, supported by the rules for failure mode and effect analysis (FMEA) and critical analysis.

If deviations are detected by means of the applications, the plant personnel are informed via Smart Alarm. Smart Alarm is an intelligent alarm and maintenance management system that helps to increase plant availability, optimise maintenance activities and make available expert knowledge for all employees. A major

advantage is that the plants can extract data from a large number of systems and aggregate and evaluate these data using a central software. The visualisation option on the dashboard provides a sorted overview of all processes as well as necessary maintenance activities and can be called up in real time from any mobile device.

The interaction between the individual digital solutions enables comprehensive monitoring and control of the entire plant and of all production steps in order to achieve overall transparency of the plant. In conjunction with artificial intelligence and machine learning, the plant is able to optimise itself – the learning steel plant has become reality.

SUMMARY: ADVANTAGES OF THE APPLICATION OF DIGITAL SOLUTIONS

Steelmaking in the age of digitalisation calls for new approaches. The demands for more efficient and sustainable production processes are growing all the time, and the higher level of automation calls for modular solutions that create connectivity. The interaction of all modular solutions from SMS digital is bringing plants a step closer to becoming a learning steel plant.

Industry 4.0 needs to come up with an answer to a very simple question: How can digitalisation help steel producers to improve the efficiency and profitability of the entire value chain? In the face of economic competition, only sustainable digital solutions will survive. SMS digital is able to meet the challenging market conditions within the scope of digitalisation. Digitalisation is not hype, it is a multi-stage process for optimising the overall efficiency of the plant. **MS**

Bernhard Steenken is CEO SMS digital GmbH with SMS group GmbH, Düsseldorf, Germany.

CONTACT: thilo.sagermann@sms-group.com