## PRIMETALS TECHNOLOGIES PROGRAM SCHEDULE
### AISTECH 2020 - BOOTH #1859

### MONDAY

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<thead>
<tr>
<th>Title</th>
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<tr>
<td>Comprehensive Process Optimization for Electric Steelmaking Route</td>
<td>9:30AM</td>
<td>6</td>
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<td>Artificial Intelligence and Data-Driven Modeling in Ironmaking – Potential and Limitations</td>
<td>10:00AM</td>
<td>25C</td>
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<td>Assessment of the Peritectic Behavior in the Continuous Casting Mold</td>
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<td>10:00AM</td>
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<td>Full Hydraulic Solution – The Advanced Fourth-Generation Pair Cross Mill</td>
<td>11:30AM</td>
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<td>Mastering Fully Automated Steelmaking</td>
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<td>2:00PM</td>
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<td>3:00PM</td>
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<td>In-Line Direct Quench: Widening the Process Window</td>
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https://meta.ls/aistech-2020 including authors and abstracts.
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<td>9:00AM</td>
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Session: Electric Steelmaking

**Comprehensive Process Optimization for Electric Steelmaking Route**

This paper figures out major benefits for installation of comprehensive upstream process optimization automation for mini-mills. The level 2 automation system covers applied optimization tools for raw material calculation and advanced scrap processing, dynamic model-based electric arc furnace melting and computer-assisted refining in ladle secondary furnace metallurgy followed by state-of-the-art level 2 automation for continuous casting machines. A fully automated tracking and identification system with high-temperature-resistant radio frequency identification ICE tag solution allows reliable product tracking and maintenance planning for teeming ladles and casting equipment. Furthermore, actual results of a recent implementation of process optimization systems at a U.S.-based meltshop are outlined.

**Time:** 9:30AM - 10:00AM  
**Location:** 6

Session: Ironmaking

**Artificial Intelligence and Data-Driven Modeling in Ironmaking – Potential and Limitations**

The revival of artificial intelligence (AI) promises to offer solutions in particular for complex systems that are difficult to model with classical methods. An overview of AI solutions in ironmaking is provided, and their strengths and weaknesses are discussed. Topics include the applicability for typical problem groups, pre-conditions regarding required data quality and completeness of data sets, reliability, combination with classical approaches. Further, the deployment and integration of black box models into control systems and related stability are discussed.

**Time:** 10:00AM - 10:30AM  
**Location:** 25C

Session: Continuous Casting/Metallurgy-Steelmaking & Casting

**Assessment of the Peritectic Behavior in the Continuous Casting Mold**

Knowing the intensity of peritectic behavior of steel grades during solidification in the mold is essential for adjusting casting parameters in order to cast peritectic steel grades defect-free under stable casting conditions. The peritectic behavior of various steel grades from the whole production spectrum was measured using the Peritectic Expert of the MoldExpert system, which determines the peritectic behavior based on temperature measurements in the mold copper plates and expresses it as a dimensionless peritectic index. Based on these measurements, an analytic correlation between chemical composition and peritectic index for characterizing steel grades could be found.

**Time:** 10:00AM - 10:30AM  
**Location:** 1
**Evaluation of the System Dynamics and the Compliance Standards for Large Industrial Motor Starting**

Large motors are ubiquitous in a steel plant. Many of these motors require direct on-line (DOL) starting without speed or torque control. DOL applications create dynamic transients during starting. Using an example of a 10,000 hp motor from a recently executed project, this paper presents the study of the standard power quality compliance requirements, evaluation of the dynamic transients for various system initial states and the effects of these transients on the system. The paper also presents the procedure used for evaluation. Examples of compensation solutions evaluated and the final solution selected is presented along with the criteria used for selection.

Time: 10:00AM - 10:30AM
Location: 15

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**Power Cooling – Advanced Strip Cooling for Hot Strip Mills**

Primetals Technologies introduced a new strip cooling technology for hot strip mills with increased impact pressure to achieve higher strip cooling rates. The automation system with its advanced models is an important and integral part of the solution. With this type of equipment, steel producers are capable of producing new steel grades with higher strength at lower operation costs. The lower operation costs mainly arise from saving of alloys by applicable high cooling rates. This paper describes this technology and explains different locations of power cooling on a hot strip mill, supporting different production strategies and benefits.

Time: 10:00AM - 10:30AM
Location: 20

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**Full Hydraulic Solution – The Advanced Fourth-Generation Pair Cross Mill**

Pair Cross (PC) technology was developed by Primetals Technologies for hot-rolled strip profile control. Since operation of the world's first PC mill in 1984, more than 150 stands have been supplied worldwide and contributing to high-quality strips. The PC mill kept evolving since it was born to correspond to the constantly developing needs of steel market. Lately, the fourth-generation PC mill was launched with full hydraulic control system for better maintainability, meanwhile keeping the high performance of profile control consistent. This paper will introduce the structure and new advanced functions, such as automatic chock position zeroing and automatic leveling compensation.

Time: 11:30AM - 12:00PM
Location: 20
Mastering Fully Automated Steelmaking

Today dynamic ladle degasser/basic oxygen furnace/electric arc furnace process control with assisted secondary refining and autonomous steel casting is state-of-the-art upstream technology. The idea of fully automated steelmaking extends the meltshop automation to a level that enables the operator to act primarily as supervisor to execute steel production in a safe manner. Since there is no unified approach to close the gap between current plant-specific operation and the mid-term target of fully automated steelmaking, a digitalization road map draws a structured picture of required measures accompanied by an implementation order considering process development, IT and data infrastructure, meltshop logistic topics, and maintenance aspects as one.

Time: 11:30AM - 12:00PM
Location: 6

Electrometallurgical steelmaking by Molten Oxide Electrolysis

To achieve the Paris Climate Agreement goal of reducing CO2 emissions 80% by 2050, substantial changes to iron and steel production technologies are required. One visionary innovation is based on carbon-free direct steelmaking with Molten Oxide Electrolysis (MOE). Developed by Boston Metal in cooperation with Primetals Technologies, the goal is to reduce the fed iron oxide, using “green” electrons instead of carbon-based fuels. The only products from the process are liquid metal and the by-products electrolyte (slag) and oxygen. This paper describes the process of the MOE technology, the current development status and an outlook of the first industrial demonstrations.

Time: 11:30AM - 12:00PM
Location: 9

An Accelerated Installation and Commissioning Plan to Upgrade an Aging Static VAR Compensator for an Electric Arc Furnace

Static VAR Compensators play a vital role in providing power quality compliance and network stability to electric arc furnaces. Considering a typical life cycle of 20 years, upgrading aging SVC equipment ensures maximum meltshop production. Recent increase in production demand from meltshops has challenged maintenance supervisors with fewer and shorter downtimes available for equipment upgrades and servicing. This paper presents an executed plan where a conventional SVC installation and commissioning schedule was compressed from two months to just 11 days. This paper details the execution plan, risk analysis, challenges encountered and remedial measures taken to ensure on-time start-up.

Time: 2:00PM - 2:30PM
Location: 15
JFE Fukuyama’s Modern Greenfield Sinter Plant With Waste Gas Recirculation, Gas Cleaning and Leaching Plant

The greenfield 387 m² sinter plant for JFE's Fukuyama site comprises a modern sinter plant including a waste gas recirculation system, circular cooler, material handling, MEROS® gas cleaning system and a byproduct leaching plant. The design ensures minimum environmental impact. Part of the waste gas is recirculated to minimize its flow and to reduce coke consumption. The excess waste gas is treated by a MEROS gas cleaning plant to reduce SOx by 97% and dioxins to <0.1 ng/Nm³. The leaching system, the first of its kind, treats the solid byproduct to minimize operation and landfill cost. Valuable components are recycled while the cleaned wastewater is discharged to the sea.

Time: 2:00PM - 2:30PM
Location: 11

Smart Products, Assistance Tools and Service Solutions for Digital Production in EAF-Based Meltshops

Digital electric arc furnace (EAF) production means the seamless interaction of the installed equipment and any new feature and digital assistance system, which are added during a continuous plant modernization and step-by-step upgrade activities. Digital EAF steelmaking starts with automated scrap handling and preparation, followed by a fully automated melting process. Autonomous transport systems for ladles and materials guarantee a safe handling and the precise execution of the defined process logistics. Powerful tools for the process analysis and business intelligence systems allow a deep insight into the physical production and provide required information for important decisions and life cycle measures at a glance.

Time: 2:00PM - 2:30PM
Location: 6

Challenges and Opportunities for Smart Tools in Digitalized Rolling Mills

The ever-increasing necessity of digitalizing work processes and the availability of ever-larger amounts of data are changing the working requirements in the steel industry. Innovative software tools are used in order to meet this development and to facilitate the work of today and tomorrow. The visualization of data plays a key role here. This presentation will show different requirements, challenges and application possibilities for these tools. Furthermore, examples will be shown of how existing tools for rolling mill automation support the development, commissioning and maintenance of automation software. Moreover, the tools enable state-of-the-art data analysis techniques, visualization and optimization of processes.

Time: 2:30PM - 3:00PM
Location: 13
Session: Hot Sheet Rolling

Decoupled In-Bar Flatness and Contour Control in the Last Stands of a Hot Strip Mill

Flatness and contour errors (profile/wedge) during the rolling of hot slabs are closely connected but are conventionally treated as different problems and independent controls are designed. Flatness is controlled in the last and profile in the first stands to reduce flatness problems, leading to very slow control speed. This problem is solved with a newly designed decoupling controller considering several stands. This allows contour and flatness to be set independently of each other in the last stands, enabling a very high control speed due to the proximity to the measuring device. Measurements will be presented showing control results.

Time: 2:30PM - 3:00PM
Location: 20

Session: Electrical Applications

Digital Substations and Process Bus for Steel Mills – Overview and Quantitative Assessment

While digital substations have seen an increase in popularity in the past few years, their adoption has been restricted only to the utilities. This paper explores the finer details of digital substations and provides a comprehensive evaluation of process bus technology for steel mills. A cost benefit analysis is presented along with lessons learned and future applications. A centralized protection design is introduced and modern protection designs are explored. Safety, cost, scalability and integration into Industry 4.0 systems are evaluated for small-, medium- and large-scale substations.

Time: 2:30PM - 3:00PM
Location: 15

Session: Environmental

State-of-the-Art Eco Solutions for Integrated and Mini-Mills — Advanced Gas Cleaning and Waste Heat Recovery Solutions

Today, steel mills are forced to comply with the most stringent environmental regulations. Two practical examples for achieving ultralow emission levels and best-in-class energy efficiency are presented. The installation of a new electric arc furnace at a steel plant in Italy, including a state-of-the-art gas cleaning system and a novel type of waste heat recovery solution with record execution time, is discussed. The latest innovations for wet- and dry-type ultralow emission gas cleaning for basic oxygen furnace shops are introduced. A novel concept for top-gas recovery turbine arrangement for a blast furnace as well as operational achievements are presented.

Time: 3:00PM - 3:30PM
Location: 11
Session: Plate Rolling

In-Line Direct Quench: Widening the Process Window

In the production of steel plate, powerful in-line cooling machines with direct quench (DQ) capability offer the steel producer great flexibility. A wide range of final structure property relationships can be targeted in the as-rolled product. A key feature is the potential reduction in processing stages; however, final performance levels must still be achieved. This paper considers the pertinent process parameters that can limit the in-line DQ process window, such as temperature, geometry and capacity. The current performance and challenges in widening the process window compared to traditional process routes are reviewed.

Time: 3:30PM - 4:00PM
Location: 23

Session: Electrical Applications

Investigation of Grounding Failures in Transformers and Evaluation of Best Practices

Typical industrial transformer grounding design includes grounding of the tank, neutral and the control cabinet. The transformer core acts as a magnetic medium to channel the flux and is also grounded. Core grounding may not be seen as a requirement by process or safety. Improper grounding may lead to increased dielectric stresses, leading to internal transformer failures or line-to-ground faults. Investigations of transformer failures due to improper grounding are presented along with solutions to such problems. This paper also presents aspects of transformer grounding, focused on the core ground in order to improve the insulation system, protective relaying and safety.

Time: 3:30PM - 4:00PM
Location: 15

Session: Digitalization Applications

Software as a Service in the Metals Industry — Challenges, Requirements and Opportunities

The idea of software as a service is becoming more widely accepted throughout all industries. The benefits of IT systems that are always up to date, continuously supported by experts and providing functional extensions to the newest developments and technologies, are invaluable. Now the first full-featured process optimization system “as-a-service” subscription license model is available, taking the idea one step further and ensuring that higher-level automation systems will never be outdated anymore. This paper describes the challenges and requirements to engineer and implement modern process optimization systems ready for agile software-as-a-service business models and the opportunities this transition brings for both customers and suppliers.

Time: 3:30PM - 4:00PM
Location: 13
Artificial Intelligence Services in Steel Production — On Premise and in the Cloud

Physics-based metallurgical models have been used for decades in the steel industry. Advanced methods of machine learning and data sciences allow combining the strength of pure data models and proven physics models and exploiting their benefits. Expert know-how in steel is being integrated with data science expertise to provide the next level of digital services for the metals industry. This paper focuses on practical examples how to use artificial intelligence in steel production to gain deeper insight, develop new control schemes, find root causes, improve deviation forecasting, and to optimize operations, quality results and predictive maintenance.

Time: 4:30PM - 5:00PM
Location: 13

Journey Toward Improvement: 6-High Rolling Mill — A Major Upgrade Project

This paper describes the journey of improvement by completion of a major upgrade project of 6-high cold rolling mill at Tata Steel-BSL. The paper discusses the existing technological demerits, unique challenges faced during upgrade of equipment, and benefits that have arisen from the upgrade project. The project was completed in two phases: complete hydraulics pipe line change and automation (level 1 and level 2 upgrade). The presentation outlines the introduction of the 6-high cold rolling mill, reasons behind the upgrades, detailing the work done and benefits realized from these upgrades. These benefits include increased equipment availability, reduction in breakdowns, increased life cycle of equipment and high quality compliance for skin panels for the automotive industry.

Time: 4:30PM - 5:00PM
Location: 22

Tuesday

Reduction of Metallurgical Property Transition for In-Line Heat Treatment of Long Products

A new design solution for a system to supply water to in-line cooling boxes in high-speed wire rod mills has been developed. Using variable-frequency pumps and a series of isolation valves, the lag time needed to achieve setpoint temperatures is significantly reduced, thereby minimizing the transition length at the head end of each billet. The reduction in lag time is particularly important for small-diameter products at high speeds in order to minimize the transition length needed to achieve desired metallurgical properties. Results of trials on a prototype system are presented to demonstrate the capabilities of the design.

Time: 10:00AM - 10:30AM
Location: 23
A Forecasting Model-Based Discovery of Causal Links of Key Influencing Performance Quality Indicators for Sinter Production Improvement

Sintering is a complex production process where the process stability and product quality depend on various parameters. Building a forecasting model improves this process. Artificial intelligence (AI) approaches show promising results in comparison to current physical models. They are mostly considered black box models because of their hidden layers. Due to their complexity and limited traceability, it is difficult to draw conclusions for real sinter processes and improving the physical models in a running plant. This challenge is addressed by focusing on detecting causal links from AI-based forecasting models in order to improve the understanding of sintering and optimizing existing physical models.

Time: 10:30AM - 11:00AM
Location: 14

Efficient Electrical System Design for a Steel Plant: A Technical and Economical Discussion

During the design of an electrical system, the general focus is on capital costs, reliability and maintenance. The operational cost of the electrical system also needs equal attention. This paper evaluates the design aspects of major electrical components at steel plants, such as reactive power compensation, transformers, voltage stability and their operational benefits. Comparison of different types of electrical system configurations and their effect on the operation of the plant along with economic impacts are presented.

Time: 10:30AM - 11:00AM
Location: 15

How to Reach Maximum Steel Quality Through Mold Level Control in Continuous Casting

Robustness and performance are the key criteria for high-quality mold level control. Physical effects such as surface waves, unsteady bulging, steel flow variations, etc., or non-physical like component breakdown are the difficulties that need to be addressed. A state-of-the-art model-based control yields a robust solution for those requirements. This paper presents process modeling and mold level control of the future to reach maximum performance results in mold level accuracy and steel quality.

Time: 10:30AM - 11:00AM
Location: 5
Key Challenges for Efficient Descaling

Whenever hot steel is exposed to oxygen-bearing gases, it reacts to form scale. During high-temperature steel production, its influence on the surface state extends throughout processing. The dynamic local environment creates transient conditions that result in complex cycles of scale growth, deformation and removal. This presents a considerable challenge to the steel producer when aiming for process consistency. This paper focuses on key challenges that require an appreciation of the interaction of complex variables across different length scales. These will include the scale metal interface metallurgy and the setup of the descaling system.

Time: 10:30AM - 11:00AM
Location: 20

Microstructure Measurement for the Production of High-Strength Steels

As the duty of steels increases, the available process routes, a combination of alloying strategies and temperature-strain path, that can result in the final required mechanical properties decreases. A high level of process control and accuracy is needed to produce the most advanced grades. State-of-the-art steel manufacturing facilities have sophisticated process models and control systems to deliver the right products and performance from the supplied material. Up to now, no measurement with a on-line gauge has been possible. With the use of electromagnetic measurement and software modeling, microstructure transformation can be measured for increased process control.

Time: 10:30AM - 11:00AM
Location: 25A

Reducing Corner Cracks with a New Strategy for Secondary Cooling

Secondary cooling is typically equipped with air-mist nozzles to achieve a wide turndown ratio, without jeopardizing the spray pattern uniformity. To prevent corner cracks, center and margin zones are used. A new cooling system takes the discretization of cooling zones to the next level and makes it possible to increase the turndown ratio compared to air-mist systems and significantly by using water-only nozzles, which are driven with a pulse-width modulated signal. Operating costs are reduced through lower air consumption. This paper describes the DynaJet Flex system, the installation at Hyundai Steel and the operational results achieved.

Time: 10:30AM - 11:00AM
Location: 1
Session: Oxygen Steelmaking

Revamp and Upgrade of Converters at CAP Acero, Chile

The two 100-ton basic oxygen furnace (BOF) converters operated at CAP Acero, Chile, were coming to the end for life and a revamp was required. The new converters are equipped with Vaicon Link 2.0 vessel suspension system and, in addition, slag retention systems - the Vaicon Stopper - were installed. For optimization of the vessel shape and arrangement of bottom stirring, modern computational fluid dynamics tools have been used. Finally, an update of the process model has been done as well as an adjustment to the new conditions. The paper focuses on the technical features of the equipment, highlights from project execution and results achieved.

Time: 2:30PM - 3:00PM
Location: 7

Session: Electrical Applications/Digitalization Applications

The Widest ESP line for U. S. Steel — Full Digitalization Possibilities With TPO

U. S. Steel combines its integrated steelmaking process with the widest Endless Strip Production (ESP) line ever built to produce advanced high-strength steel grades that assist automotive customers in meeting fuel efficiency standards and Primetals Technologies offers newest digitalization possibilities. Through-Process Optimization (TPO) enables the control and optimization of production and product quality across the entire process chain. By collecting the right data with Through-Process Quality Control out of all automation systems, measurement systems, smart sensors and even from operators, data are transformed into valuable information, key performance indicators, decisions, advice and actions enabling a higher level of production and product quality.

Time: 2:30PM - 3:00PM
Location: 13

Session: Lubrication & Hydraulics

Increasing Hydrostatic Capacity of Oil Film Bearings in a Tandem Cold Mill - A Case Study

This paper details a case study of a North American tandem cold mill where roll force was successfully increased without the need to upgrade the existing backup roll bearing hydrostatic system. This cost-effective solution can be applied to any similarly equipped tandem cold mill.

Time: 3:00PM - 3:30PM
Location: 15
Pulverized Coal Conversion in Blast Furnaces — Analysis of Involved Scales

Pulverized coal conversion is a process involving length scales ranging from nanometers for the particle pores to meters for the blast furnace. For an ideal coke replacement ratio, the coal has to be converted within the oxygen-rich zone in the vicinity of the tuyeres. The residence time before leaving this zone is 20–40 ms. Analysis of involved scales gives valuable information for optimization. After introducing theoretical concepts, a reference case of blast furnace pulverized coal injection is presented. The scale analysis is then used to derive optimization strategies for the coal conversion process in the raceway zone.

Time: 3:00PM - 3:30PM
Location: 25C

Revamp of BOF Converters at AK Steel - Middletown Works Using Vaicon Link 2.0 Converter Vessel Suspension System

AK Steel - Middletown Works determined to change one of their two 225-ton basic oxygen furnace (BOF) vessels. The BOF vessel and trunnion ring were previously fabricated with a bracket support system. After a thorough technical analysis, AK Steel chose to revamp the vessel and trunnion ring to accommodate the Vaicon Link 2.0 suspension system. The vessel was installed in 2017. The paper describes the principles of the suspension system, the project execution and results from an inspection after 17 months of operation.

Time: 3:00PM - 3:30PM
Location: 7

Low Consumption Figures, High Productivity, Best Raw Material Flexibility, Environmentally Friendly, Safe and With a Perfect Level of Automation - One Furnace Fits the Needs

A high-powered EAF Ultimate is designed for all kinds of possible raw material scenarios. One-bucket charging even for 100% scrap, low electrical energy consumption, improved chemical power input and safety improvements are its key features. Modern and smart automation tools like an automated sand-filling system, automated charging system, T+S manipulator, offgas measurement or an automated taphole opener ensure safe and delay-reduced productivity. Additionally, current performance figures including maintenance costs and lifetime information of all major equipment parts will be shown, together with mechanical solutions to make brownfield implementations possible and workable.

Time: 3:30PM - 4:00PM
Location: 6
Session: Oxygen Steelmaking

Installation of Vaicon Slag Stopper at U. S. Steel Great Lakes Works

To improve efficiency and reduce conversion costs, U. S. Steel installed the pneumatic slag retention system from Primetals Technologies on the two 200t BOFs operated in the melt shop at Great Lakes Works. Expected benefits from this project include reduced slag carryover, improved alloy yield and increased steel quality. The Vaicon stopper went into operation in the Summer of 2018. The paper describes the equipment, operational results and benefits achieved. In the last part of the paper, an outlook on a new generation of slag stopper is presented.

Time: 4:30PM - 5:00PM
Location: 7

Wednesday

Session: Cold Sheet Rolling

Cold Rolling Mill Technologies for Electrical Steel

Climate change requires urgent attention and corrective actions from the international community. Electric vehicles are expected to be one solution to reduce carbon dioxide emissions. In order for electric vehicles to travel long distances, highly efficient electric motors are required. For this reason, electrical steel sheet production is increasing and market demands have evolved into thinner and harder materials. In response, key technologies such as edge drop control with work roll shift, small work roll application, etc., have been introduced for producing harder electrical steel sheet. This paper focuses on the application of such technologies within a tandem cold mill.

Time: 8:30AM - 9:00AM
Location: 22

Session: Digitalization Applications

Application of Data-Driven Models for Sinter Process Optimization

Product and process quality is playing an increasingly important role in the competitive success of ironmaking companies. Currently, a new sinter raw mix analyzer was installed to allow for fully automatic sample preparation and measurement of material properties of granulated sinter feed. Based on this measurement data and actual process data, data-driven models can be built and applied for optimizing parameter settings. This paper presents an approach for selecting data, building and evaluating models, and optimizing process parameters. The models are trained, tested and validated on operational data of a sinter plant.

Time: 9:00AM - 9:30AM
Location: 14
Use of Machine Learning to Improve Condition Monitoring and Vibration Analysis

Sophisticated condition monitoring and analysis is a cornerstone of any digitalization strategy. On-line monitoring of machine feature data is state of the art. For a full analysis of complex machinery (e.g., variable load, speed, product), however, a human expert is still needed to determine whether there is a problem, its severity, its root cause and, most importantly, what shall be done about it. More than 35 years of data allowed for the application of machine-learning (ML) techniques to extend what is possible automatically. This paper focuses on several examples of successful ML applications and the resulting benefits for steel producers.

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