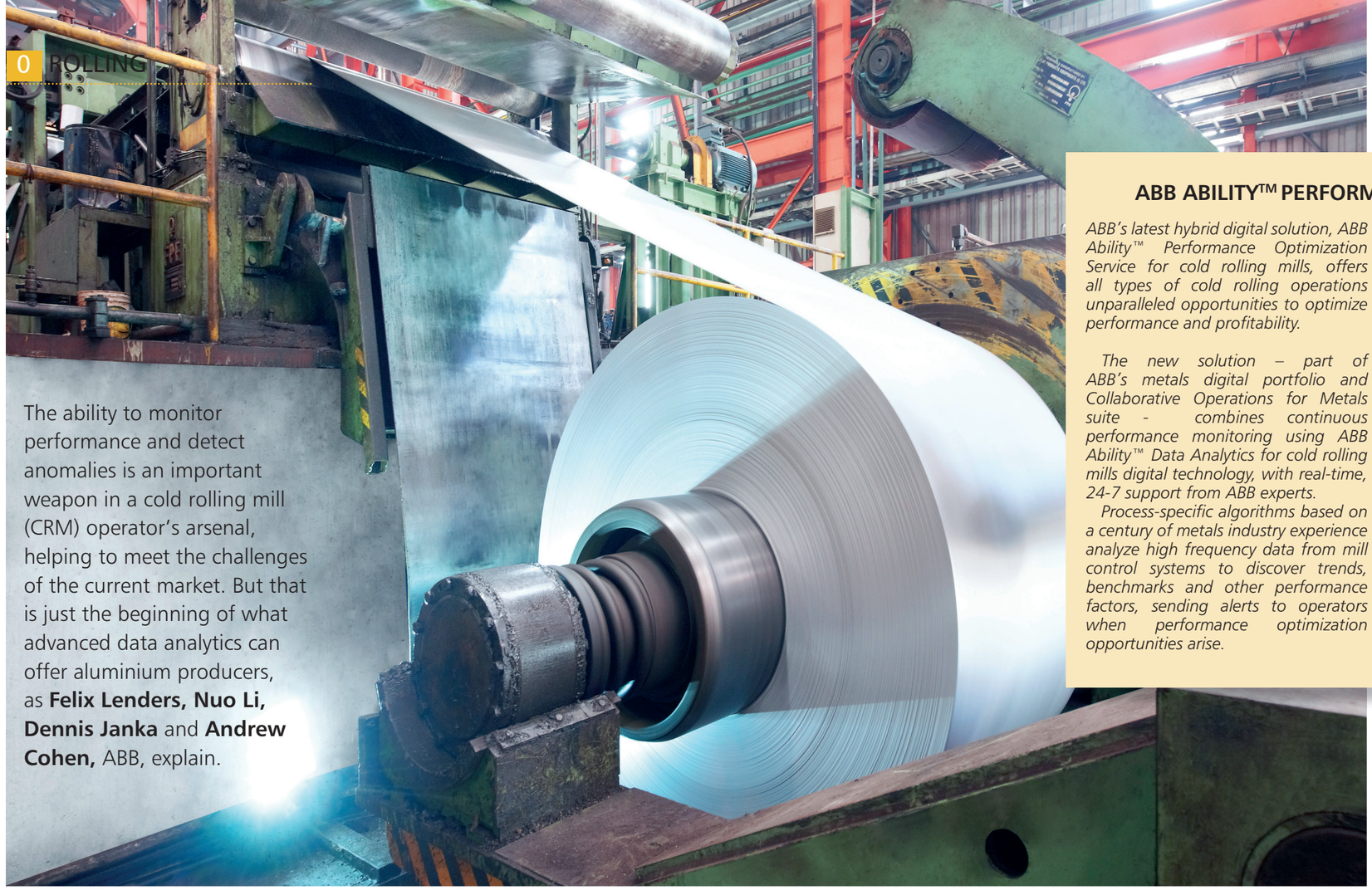


The ability to monitor performance and detect anomalies is an important weapon in a cold rolling mill (CRM) operator's arsenal, helping to meet the challenges of the current market. But that is just the beginning of what advanced data analytics can offer aluminium producers, as **Felix Lenders, Nuo Li, Dennis Janka** and **Andrew Cohen,** ABB, explain.

Improving cold rolling mill performance with advanced data analytics

Cold rolling mills play an important part in aluminium production, but with producers increasingly faced with challenges to stay competitive, meet customer demand for increased product quality, and cope with a widening variety of materials, how can they ensure that at the practical level, acceptable thickness and flatness tolerances decrease, while improving throughput and yield?

One response to these business and technical challenges is through greater use of digital technologies, such as advanced data analytics. The idea is simple: if CRM operators were able to observe the status of equipment and processes in near real time, they would gain crucial insight into performance – and particularly into deviations in product quality or problems with the process. This insight would allow operators to actively manage production to better meet the various demands on them.

But achieving this is more easily said than done. Despite the conceptual simplicity of the rolling process, in reality it is a complicated operation that depends on a multitude of factors. To fully exploit the full production potential of the CRM in today's market therefore requires a connected and integrated approach to automation optimization, control, and decision-support tools.

The good news is that CRMs are often already equipped with modern control systems that include multiple sensors to monitor and record vast amounts of data. And with sampling times in the range of milliseconds, hundreds of sensor values are recorded – more than 3GB worth a day, during mill operation. This includes measurements of flatness, tension, speed, and strip thickness.

This data is routinely exploited by service engineers for commissioning and maintenance of rolling mill devices. But this valuable resource is rarely analyzed for performance purposes due to the difficulties of manual analysis and data pattern screening – a tedious and costly endeavour by any measure.

A lost opportunity?

To help CRM operators and maintenance engineers release the potential of their raw data and efficiently analyze the performance of their systems, a technology partner is required with deep domain knowledge and the ability to draw on the latest advances in neural networks and advanced data analytics applications for operational data. This combination of practical and digital expertise helps to create a digital service solution that addresses real-world challenges.

Digital Solutions for Industrial Processes (SODA) from ABB aims to do just that. Key concepts from SODA have now been integrated into the ABB Ability™ Data Analytics for cold rolling mills solution, which forms the basis for the new-released ABB Ability™ Performance Optimization Service for cold rolling mills. Notably, this includes the ability to detect and monitor problem signatures, as well as undertake basic root cause analysis of the issue. In this way, this new digital tool provides operators with the data they need to keep track of the status of their CRM, while assessing productivity and product quality.

It does this by quickly guiding users to the relevant information and providing interactive diagrams and plots. Engineers area therefore easily able to focus on the information they need to make smarter and speedier decisions.

Monitoring CRM operation…

In the first step on the road to digital awareness, a 'golden coil' is synthesized from available historical data: this is a fictional coil that consists of time segments of varying lengths at points when product quality and mill productivity were at their peak. The golden coil thus represents the operating modes in which the highest quality and productivity values were attained.

With the golden coil as reference, deviations within the historical data can then be analyzed, effectively teaching the system the range of functional behaviours, which are classified from poor to excellent. Currently, up to 100 different performance indicators are extracted from sensor measurements to compute the productivity and quality key performance indicators (KPI).

Once the KPIs have been calculated, the user may assess the performance of the coil currently in production by comparing it with the calculated golden coil and with examples of historical coils from the specific device being evaluated. Coils can then be clustered according to performance and the information explored in depth via the graphical user interface.

Poor quality coils can then be assessed, and any patterns or deviations recognised, making future troubleshooting easier. For example, the velocity profile of a poor-quality coil could be superficially compared to the golden coil. In fact, the operator is able to compare the selected coil with the golden coil for any KPI – and consequently ascertain the reasons for poor performance.

Another example would be roll geometry problems, which are particularly challenging to detect. But roll eccentricity can cause periodic variations in the roll gaps, leading to undesirable variations in the thickness of the rolled product. Using spectral analysis, however, ABB's digital solution for CRMs is able detect roll eccentricity in near real time.

… and detecting problems

SODA uses algorithms to detect various characteristics and common problem signatures in time series data: changing properties of incoming materials or measurement mismatches due to improper tuning of control loops. While some of these algorithms are based on conventional signal processing, others rely on an approach based on machine learning. This approach is especially suited to time series data analysis, due to its ability to model discrete time dynamic behaviour.

The process follows a conventional machine-learning approach. Firstly,

ABB ABILITY™ PERFORMANCE OPTIMIZATION SERVICE FOR COLD ROLLING MILLS

ABB's latest hybrid digital solution, ABB Ability™ Performance Optimization Service for cold rolling mills, offers all types of cold rolling operations unparalleled opportunities to optimize performance and profitability.

The new solution – part of ABB's metals digital portfolio and Collaborative Operations for Metals suite - combines continuous performance monitoring using ABB Ability™ Data Analytics for cold rolling mills digital technology, with real-time, 24-7 support from ABB experts.

Process-specific algorithms based on a century of metals industry experience analyze high frequency data from mill control systems to discover trends, benchmarks and other performance factors, sending alerts to operators when performance optimization opportunities arise.

Alongside this, ABB experts are always on hand to recommend corrective actions, ensuring that mills maintain KPIs for productivity, thickness quality and thickness yield. At launch, the solution offers KPIs for thickness only, with KPIs for flatness quality to follow and additional KPIs to be developed in line with customer demand.

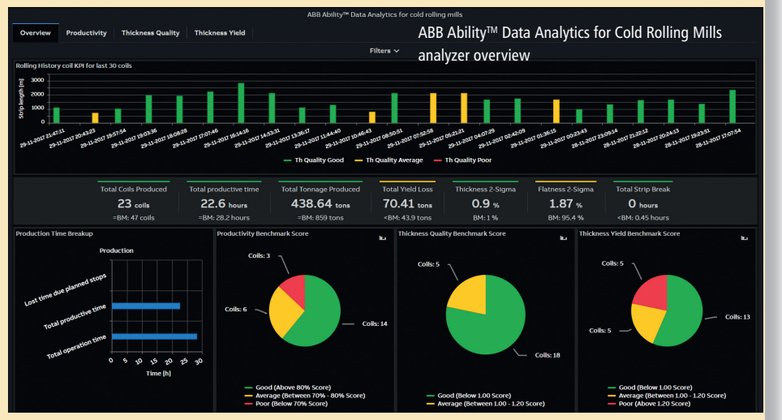


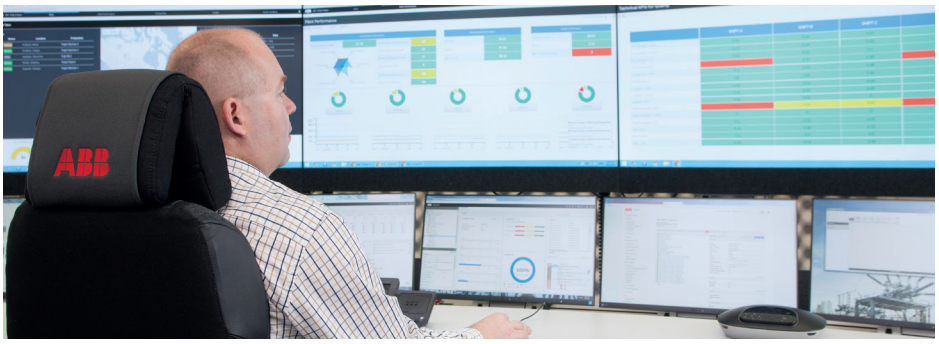
ABB Ability™ Data Analytics for Cold Rolling Mills analyzer overview

a model is created during a training phase, when the pattern of interest is characterized by examples as determined by a domain expert, which are then used to teach the model. The model can then locate patterns within the time series data that are similar to the examples it has previously learned.

Maintenance and process experts are also able to use the system to swiftly detect improperly-tuned control loops – an undesirable state that leads to productivity losses. By detecting such problem signatures, any decline in performance or productivity can be explained and service engineers dispatched to resolve the issue.

Going forward, artificial intelligence (AI) is another concept with radical potential for CRMs. Although conventional signal processing is effective and efficient for certain use cases, they are not able to detect many relevant problems encountered by CRM operators.

For example, overshoot is an important characteristic of a control system that relates to step change. Common in CRMs, measured overshoots all have similar visual appearances, but their shapes, waveforms, and duration vary, making them hard to detect with classical signal processing methods. To counter this, ABB has developed an approach that can learn arbitrary patterns in time series data. During the analysis, the engineer tags patterns of interest, such as overshoots, which are then used to train a classifier, based on recurrent neural networks.



Conclusion

The ability to track and analyze deviations in the performance of CRMs with ABB Ability™ Data Analytics for cold rolling mills is an important step in equipping CRM operators for the challenging market conditions they face, and is the basis for collaborative solutions, such as ABB Ability™ Performance Optimization Service for cold rolling mills, combining continuous remote monitoring with process-specific data analytics and remote, expert support from ABB.

These advanced digital solutions and services are only made possible through the combination of deep domain experience and digital expertise that partners, such as ABB, can bring to the table. It is the operational knowledge that empowers digital change, making sure the insights gained from digital solutions are meaningful and applicable to real-world situations in a way that informs decisions and provides real value in the form of improved mill uptime, production speed, and yield. ■