GE VERNOVA

MACHINE LEARNING AND PREDICTIVE ANALYTICS GUIDEBOOK FOR ENGINEERS

Leverage Domain Expertise to Drive Optimization – Without Needing a Data Scientist

Today, staying competitive means progressing on a digital transformation journey, including machine learning and predictive analytics. Not only can industrial organizations capitalize on the IoT opportunity, optimize operations and generate greater profitability, but engaging in the latest technologies also helps to attract and retain the best talent.

Fortunately, the journey to success with machine learning and analytics doesn't mean that process engineers need to be data scientists. Proven processes and software technologies make analytics do-able for every industrial organization.

Engineers Are the Process Experts

Process engineers have exceptional domain expertise to put together process models – or Process Digital Twins – and be able to interpret the models. This is the foundation for improving competitive advantage and success with analytics.

Visual representation of OEE optimization

Figure 1: *Engineers can use analytics to optimize OEE for a product on a line/machine/plant and gain new improvement insights in just hours.*

To drive analytics and improve processes, process engineers can align domain expertise to five capabilities:

1. **Analysis** - automatic root cause identification accelerates continuous improvement
2. **Monitoring** – early warnings reduce downtime and waste
3. **Prediction** – proactive actions improve quality, stability, and reliability
4. **Simulation** – what-if simulations accelerate accurate decisions at a lower cost
5. **Optimization** – optimal process setpoints improve throughput at acceptable quality by up to 10%

Advanced analytics techniques are available to industrial process engineers to align their domain expertise to these five capabilities. To support the journey to machine learning and analytics, GE Vernova provides analytics technology training in the form of self-serve detailed demo videos and application advice.

Additionally, while today's software features enhanced ease of use and no-code implementation extensible with Python, process engineers can still lean on product experts in combination with their own domain expertise to mine data and leverage analytics to improve operations.

Success with Predictive Analytics

As an example, a leading food manufacturer was able to drive down customer complaints by more than 33% through analytics. The manufacturer had struggled with weight control on a cube-shaped product. Make the cubes too heavy, and the manufacturer was giving away product or producing watery product if the excess weight was due to too much water. When the cubes were too light, the company was in regulatory jeopardy as well as having trouble compacting the product into a stable cube shape.

The team used _ to get a complete, correlated-by-lot and period picture of: ingredient specs, process variables as run, and lab data – using the software to look for controllable factors that correlated to excess giveaway and then comparing periods with better weight control to the factors that were true then. Now, when the team sees how a raw material variance was successfully corrected for or a process disturbance was overcome, that understanding is embedded into a new material spec, recipe or SOP. The smart analysis with Proficy CSense yielded other benefits as well.

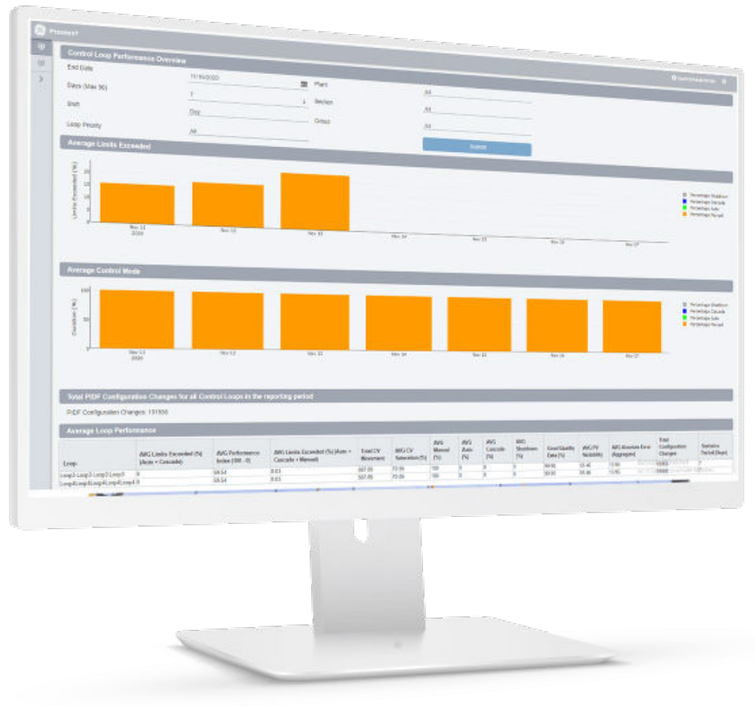
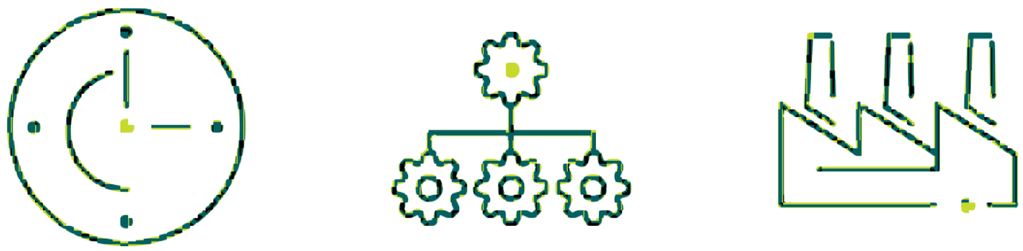


Figure 2: *A leading food manufacturer was able to drive down customer complaints by more than 33% through analytics, using Proficy CSense.*



Another example involves applying a smart predict project at a pulp and paper manufacturer to predict Critical to Quality (CTQ) KPIs to improve productivity and eliminate wastewater regulatory issues. As a final example, a partner in mining delivered an Advanced Process Control solution that increases throughput by 10% using smart optimization technology.

What is a control loop?

A simple form of a process controller is the thermostat which maintains the temperature of a room according to a given setpoint. It operates as a closed loop control device, trying to minimize the difference between the room temperature and the desired one.

The industrial version is the PID (Proportional-Integral-Derivative) control loop - an essential part of every process applications. PID loops have been around for a very long time. The first pneumatic instruments featuring a proportional controller were developed by Taylor Instrument Companies at the beginning of the 20th century,

Nowadays, loop controllers are available as standalone devices called single loop controllers, but the most common version is a piece of code that resides in a PLC (Programmable Logic Controller) or a DCS (Distributed Control System). It makes it easier to combine them to create advanced control diagrams like cascade or feed-forward control, or split range required for the complex control of food and beverage, chemical, oil and gas operations, and more.

PREDICT PRODUCT QUALITY WITH ANALYTICS

See how a process engineer can create a machine learning model to predict product quality that will help reduce laboratory testing.

ANALYTICS AND CONTROL LOOP OPTIMIZATION

As a use case example, process optimization is key in manufacturing, and control loops are the critical components. “Out of tune” loops can affect the quality of the product, the material and energy consumption, and ultimately increase the risk of contamination in regulated industries. AI and machine learning can be used to improve and optimize control loops to generate big savings and reduce risks.

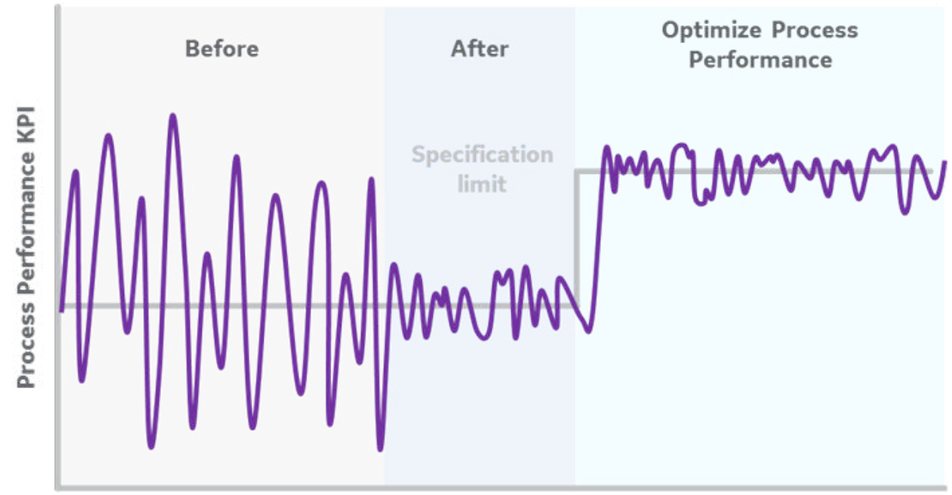


Figure 3: *AI and machine learning can be used to analyze and improve control loops to optimize performance KPIs, generate big savings and reduce risks.*

CONTROL LOOPS: SMALL TWEAKS, BIG IMPACT

A lot of literature exists that describe the behavior of PID loops and how to tune them. However, it still represents a challenge for many as all the processes are different.

The complexity of the process is obviously one of the criteria. Heat jacketed devices such as kettles, dryers, reactors or pasteurization units can be hard to control. Using steam, the heat transfer is not uniform which might result in an overshoot during uptimes, making the control loops difficult to tune. Note that this is less prevalent using water. Traditional cascaded loops will only solve part of the problem. An advanced analytics system such as GE Vernova's Proficy CSense can help by looking at historical data to create a model of the actual profile and recommend new settings accordingly. The model will take into account the change of parameters such as viscosity and steam pressure which affect the heat transfer coefficient and the flow pattern.

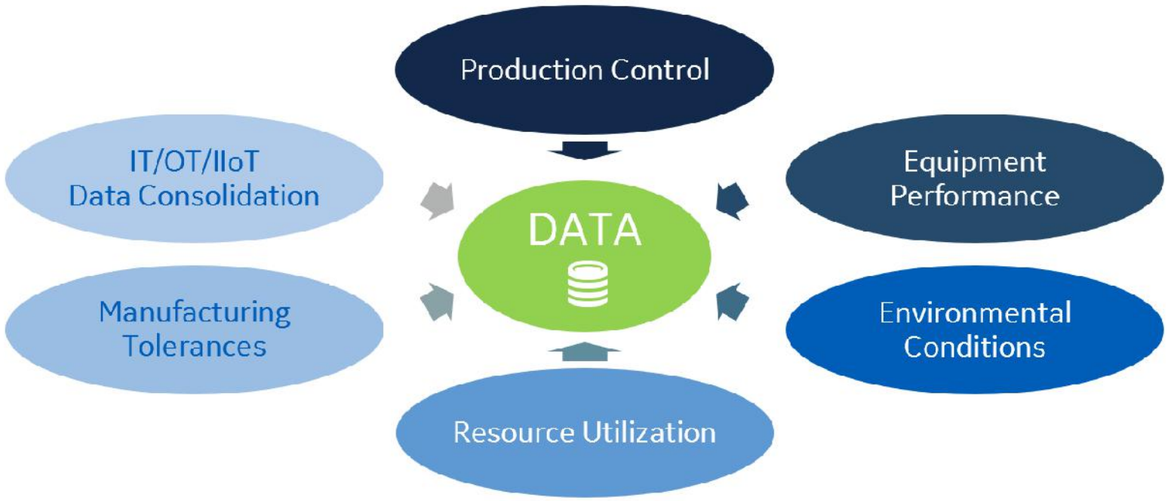


Figure 4: *An advanced analytics system can solve problems by looking at historical data – including from multiple sources – to create a model of the actual profile and recommend new settings accordingly.*

Two apparently similar machines might require different settings as they are equipped with sensors that will react to change in a slightly different way. This might be because they use different technologies – a glass vessel vs a steel vessel, which by nature have different inertia - or simply because their characteristics vary over time: aging valves, deviating sensors, etc.

Loop tuning therefore doesn't happen once. It must take place on a regular basis if done manually and customized for each asset. Another option is real time monitoring using AI and machine learning. Analytics make use of a suite of components to determine and understand the causes of process deviation in industrial environments. Engineers and data scientists can analyze, monitor, predict, simulate, and optimize and control set points in real time.

For process optimization, analytics solutions need to provide multiple capabilities: process modelling and troubleshooting as well as online deployment and real time monitoring.

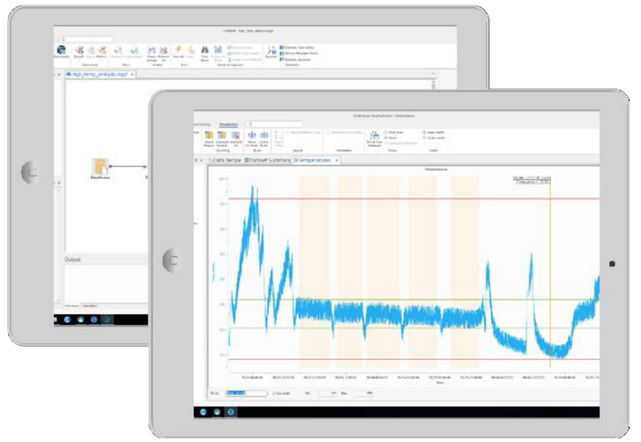


Figure 5: *Analytics solutions need to provide multiple capabilities: process modelling and troubleshooting as well as online deployment and real time monitoring.*

Data is prepared, visualized, and rules-based, data driven process models can be constructed. Using these models, root causes of process deviations are identified, so processes can be optimized.

PREDICTIVE ANALYTICS AND SENSOR HEALTH

Applications for predictive analytics are endless, but a possible first step: engineers can use analytics to monitor sensor health.

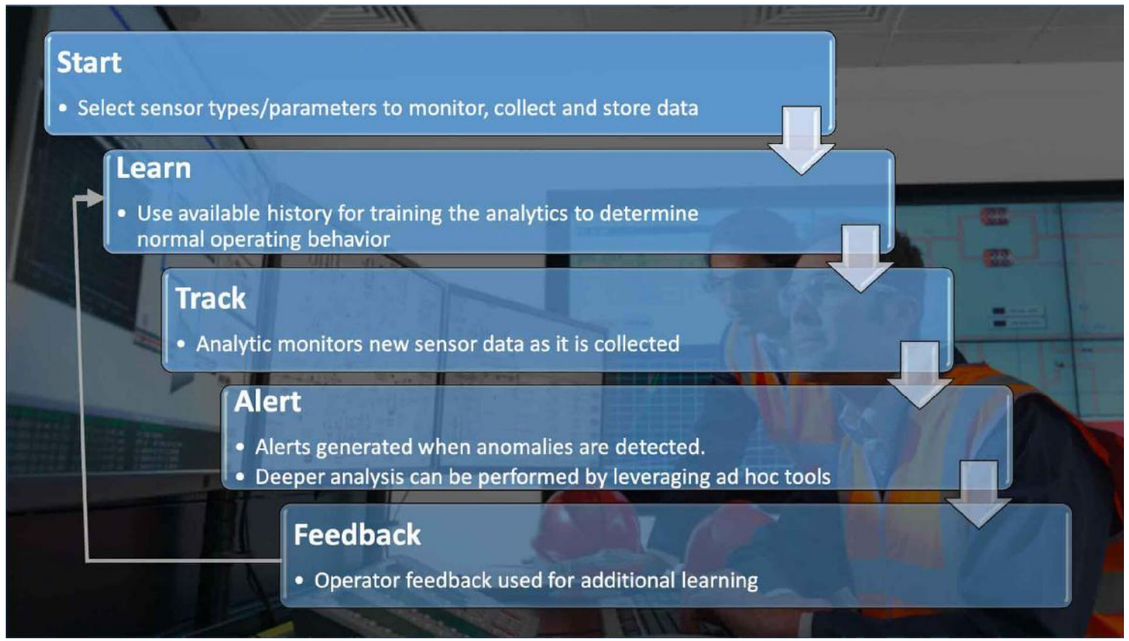


Figure 6: *Follow these strategy steps to good sensor health, leveraging predictive analytics and machine learning.*

Bad sensor data can mean lost product, downtime, compliance issues, and safety risks as well as a dirty data foundation for digital transformation and continuous improvement programs. Industrial organizations need to have good data that can be leveraged for operations, ad hoc analysis, and enterprise analytics.

Over time, sensors tend to deviate, impacting processes and operations. But, it's time consuming – and impossible for most organizations – to manually determine if and why sensors are working or failing ahead of increasing risk.

Predictive Analytics and Sensors

Engineers can employ a predictive analytics app such as Sensor Health to continuously monitor and analyze sensor data. Users can target anomalies and minimize their potential impact. The analytics app provides an easy way to automate the detection of bad sensors, where data is deviating from normal conditions.

When an anomaly is detected, the app can generate alarms to speed repairs, replacements, and recalibrations.

By using predictive analytics to monitor sensor health, engineers can:

- **Reduce downtime:** Sensors are often used to provide indications that equipment is running correctly. Incorrect readings can lead to equipment failure or damage. Early detection of a sensor that is no longer giving accurate or consistent results can provide advance warning that enables maintenance to replace or recalibrate the sensor before the worst happens.
- **Improve product quality and compliance:** Sensors are often used for measuring the results of a product or to ensure the ambient surroundings of a process are within specification. If the sensors used to measure the product or environment are not accurate or functioning correctly, it can lead to a product being out of specification. Providing early warnings can reduce costs related product recalls or scrapped product.
- **Ensure sensor data quality:** Ensuring data quality in downstream analytics is part of IoT-fueled improvements. If the intent is more advanced use of analytics for a process, the need for ensuring data quality is critical.

HOW TO SELECT THE RIGHT PREDICTIVE ANALYTICS SOLUTION

Every industrial organization knows that it's imperative to move ahead at light speed with predictive analytics. Consequently, new analytics startups and consulting companies are showing up every week.

How does an engineer select the right predictive analytics solution?

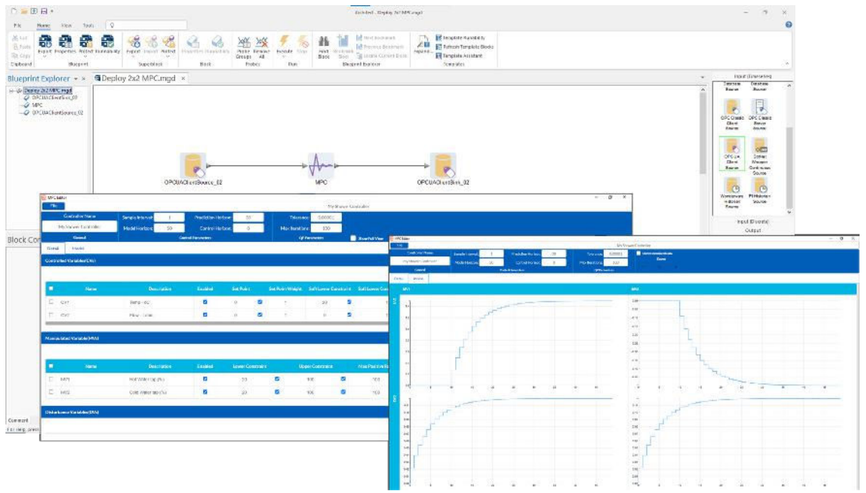


Figure 7: *To support the full IoT value journey, look for capabilities from simple calculations to predictive machine-learning models to real-time optimization and advanced-control algorithms.*

The following advice provides guidance for engineers.

1 **Make sure that "predictive analytics" isn't buzz hiding risky, unproven software and newbie "experts."**

For example, GE Vernova has offered and implemented analytics solutions for more than 15 years, serving industrial organizations around the world across a diverse set of industries.

Work with a partner that you can trust and know will support you for the long term.

2 **Select industrial advanced analytics with a troubleshooting component that enables engineers to rapidly troubleshoot continuous, discrete, or batch manufacturing process performance by mining insight from available sensor and production data.**

Seamless connectivity, rich visualization, and predictive analytics enable engineers to analyze operating scenarios, quantifying the impact that operational changes will have on key performance metrics and identifying causes for performance variation.

Additionally, to support the full IoT value journey, look for capabilities from simple calculations to predictive machine-learning models to real-time optimization and advanced-control algorithms.

3 **Be sure that the analytics package enables engineers to rapidly develop analytic solutions – supporting improvements in production throughput, yield, quality, and efficiency with significant margins.**

A comprehensive analytic solution-development environment provides visual analytic building blocks to build and test calculations, predictive analytics, and real-time optimization and control solutions with connectivity to real-time and historical data sources and drag-and-drop access to rich functional libraries.

Plug-and-play connectivity to historical and real-time data sources and automation systems make for faster configuration. Built-in support for data quality makes real-time data cleaning and validation easy.

4 **Confirm that the analytics package can speed deployment with templates for greater efficiency.**

Engineers should be able to save analytics solutions as reusable templates for easy deployment to similar assets or process units. Additionally, while the analytics troubleshooting component should enable engineers to find answers faster with analytics-guided data mining and process-performance troubleshooting, the development/configuration capabilities should allow them to more easily capture expert knowledge and best practices into high-value analytic templates for rapid enterprise-wide deployment.

5 **Focus on analytics solutions developed with engineers – not just data scientists – in mind.**

With an analytics package that is accessible to engineers, teams can create a Process Digital Twin for smarter operations. Visual drag-and-drop analytics accelerate time to value and reduce dependence on data scientists and programmers. Online demos enable rapid mastery of the software with easy-to-follow demonstrations and guided simulations.

As previously mentioned, a rapid development environment is critical. The best solutions provide rapid wizard-driven data mining for engineers for fast time-to-insight, an easy visual drag-and-drop environment for subject matter experts and engineers, and analytic solution templates without programming for simple calculations, data cleaning, maths, statistics, machine-learning models, real-time optimization, and advanced process control.

FROM SMALL PROJECTS TO MULTI-PLANT OPTIMIZATION

All automation and process engineers can and need to develop capabilities in analytics and machine learning to remain competitive – both at an individual professional level as well as to help their industrial organization – in our world of digital transformation.

Over time, engineers can go from small projects to pilots to multi-plant optimization with deep application of analytics. Engineers' deep domain expertise provides a foundation for modelling processes and developing the analytics that are game changers in very specific applications. The combination of applied analytics technology with those Process Twin models uncovers hidden opportunities for improvement over-and-over again.

If you're ready to optimize with analytics, GE Vernova's Proficy CSense turns raw data into real-time value with a Process Digital Twin. The software uses AI and machine learning to enable process engineers to combine data across industrial data sources and rapidly identify problems, discover root causes, and automate actions to continuously improve quality, utilization, productivity, and delivery of production operations.

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ADVANCED ANALYTICS CASE STUDIES

Global References for Proficy CSense

Major Food Company uses analytics to reduce waste, improve quality, save on raw materials, and optimize OEE

The Problem

The company was looking to apply analytics to MES data to optimize OEE, reduce waste and improve product quality.

What was done?

Proficy CSense was used to analyze combined Proficy Plant Applications data (Raw Materials, Production Context, Final Product Quality) and Proficy Historian data (Process/Sensor) to identify best operating settings and raw material properties to ensure good quality product, avoid waste, maximize OEE & minimize cost.

Conditions to AIM for to avoid waste and ensure quality

Value to customer?

- Reduced product waste by 75% with $240K per year savings
- Improved Quality reducing Customer complaints by 38%
- Reduced Raw Materials cost with $65K per year savings
- Improved OEE by 9%

FIBO Wall Panels Manufacturer gains insight in hours about how to improve quality

The Problem

The company was looking to apply analytics to MES data to optimize process OEE performance, throughput and product quality.

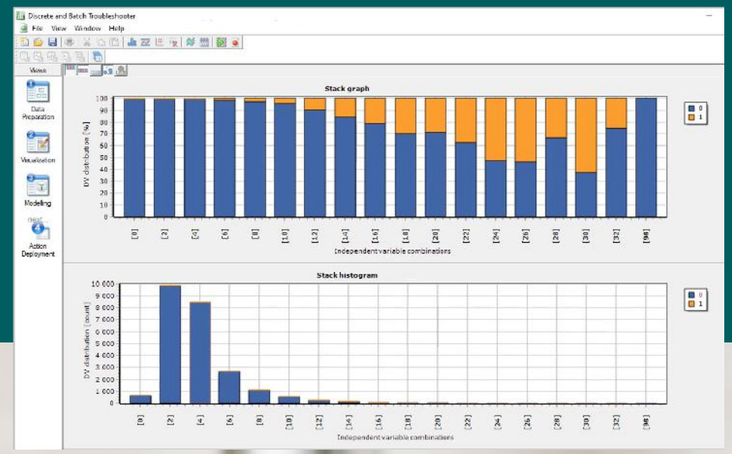
What was done?

Proficy CSense was used to analyze combined Proficy Plant Applications MES and Proficy Historian data in hours identifying and confirming critical process variables and thresholds, and raw material properties and highlighting or confirming multiple potential improvement insights.

Insights like which combinations of raw material vendors work best for them, or what are the optimal raw material quality thresholds, beyond which their risk of defects increase significantly, or what are the critical process variables and their thresholds to produce best final product quality.

Value to customer?

Improvement insights in hours by combining proven analytics and MES software.



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SKJERN PAPER USES AI TO IMPROVE PRODUCT QUALITY AND REDUCE WASTE

SKJERN PAPER, LOCATED IN SKJERN, DENMARK, HAS ALWAYS BEEN AHEAD OF ITS TIME.

The only paper mill in Denmark, Skjern Paper started production in 1967 with the idea of manufacturing paper exclusively from old newspaper, becoming an innovative leader in sustainability.

Today, Skjern Paper is owned by Buur Invest A/S and manufactures 75,000 tons of paper and board products each year from 100% recycled fiber.

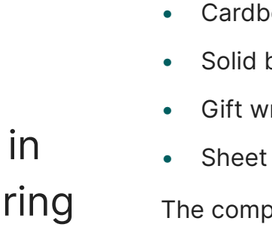
The majority of its products serve end customers as:

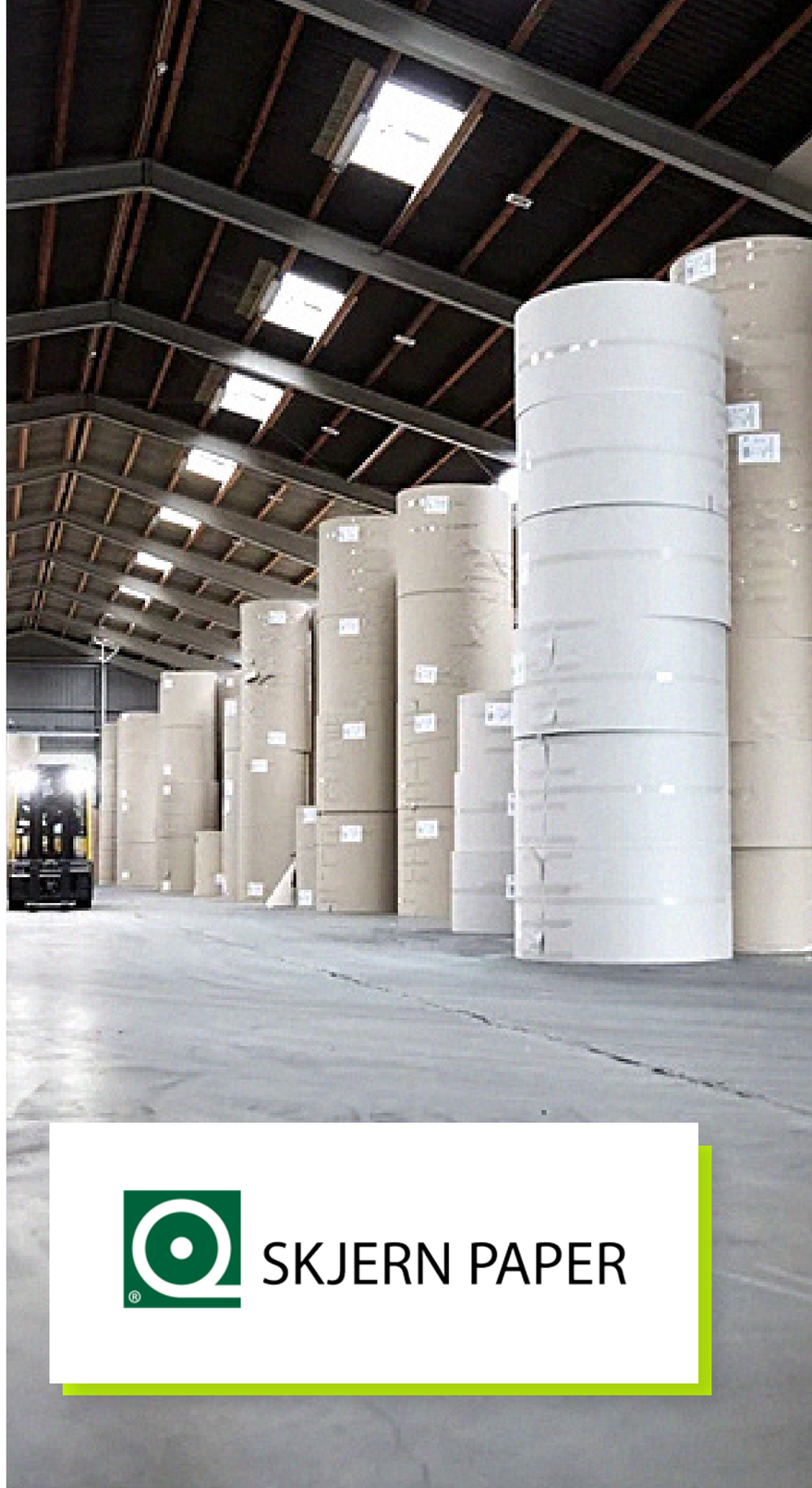
- Cardboard cores in toilet rolls and kitchen towels
- Composite cans
- Cardboard in binders
- Solid board boxes
- Gift wrap paper rolls
- Sheet interlayers for pallet goods

The company's environmental and societal commitments extend to Circular Economy and membership in the UN Global Compact and its Nordic network.

Supporting its commitments to the environment and customers, Skjern Paper relies on innovation in its production. Using the latest technologies and processes, the company provides high quality, flexibility and just-in-time delivery to its customers – with delivery within 24 hours to most of Europe.

Recently, the plant manager at Skjern Paper looked to Artificial Intelligence (AI) and Machine Learning (ML) to take production to the next level.



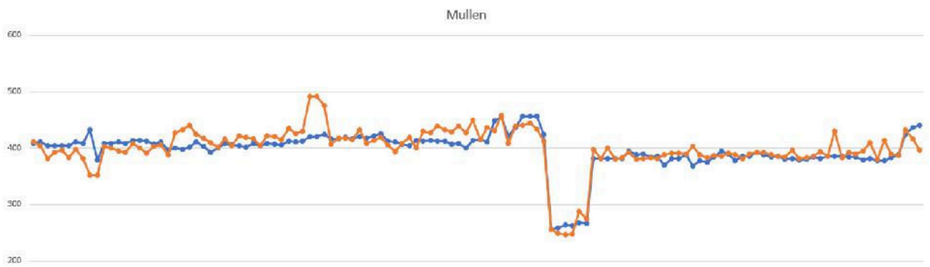


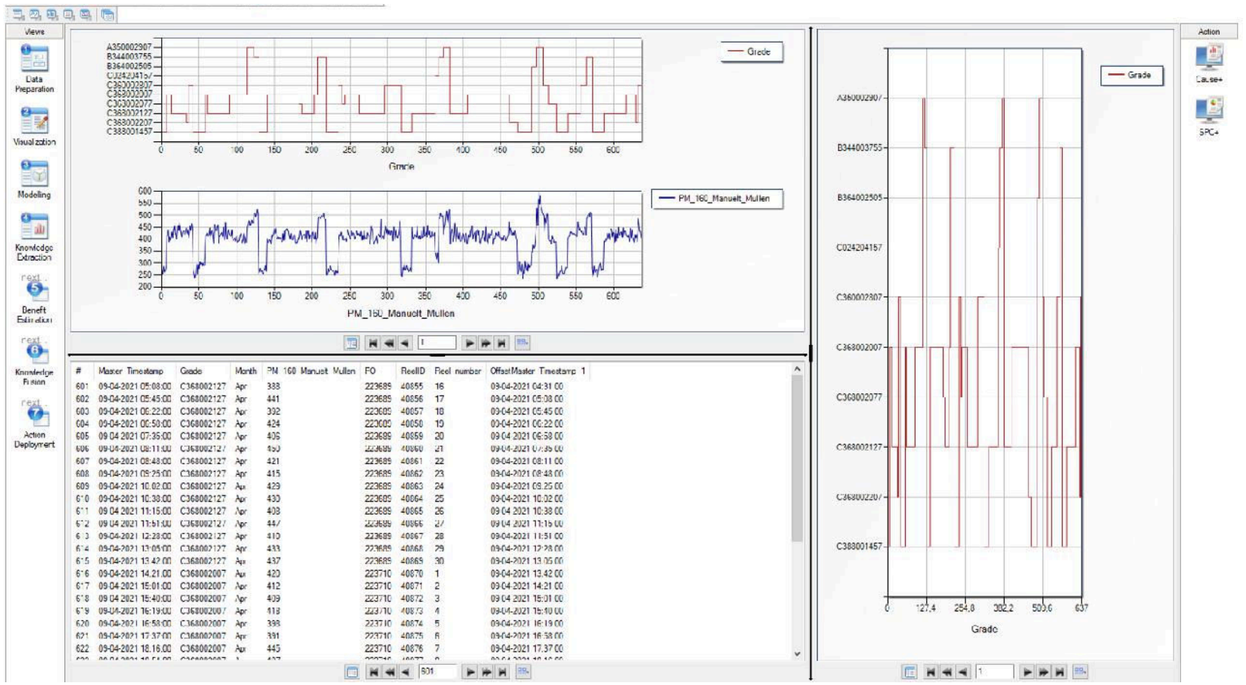
A STRATEGY TO LEVERAGE AI IN PRODUCTION

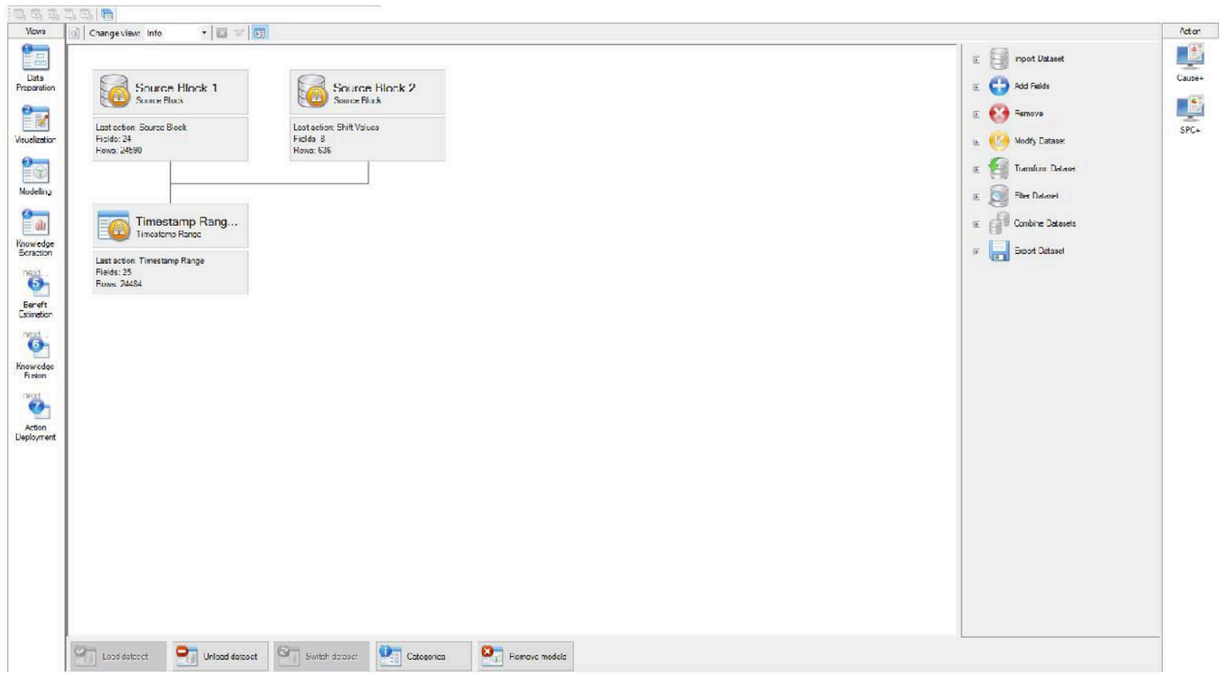
“I’ve been looking at the area of AI for some time,” explains Skjern Paper’s Technical Manager Erik Møller. “The industry has gained insight into improved efficiency using AI and ML. We decided to make digitization and production improvements through AI and ML part of our strategy.”

GE Vernova partner, Novotek, introduced Møller to Proficy CSense, an industrial advanced analytics software package that predicts future asset and process performance. Møller was able to easily explore CSense’s technical capabilities through a series of YouTube videos and demos.

“Proficy CSense looked very user friendly,” Møller says. “I saw that it has the capabilities that we needed; the price was right, and [GE Vernova] was willing to provide six hours of free consulting to help us get started. I was interested to see what possible production issues we could identify when using the CSense product.”





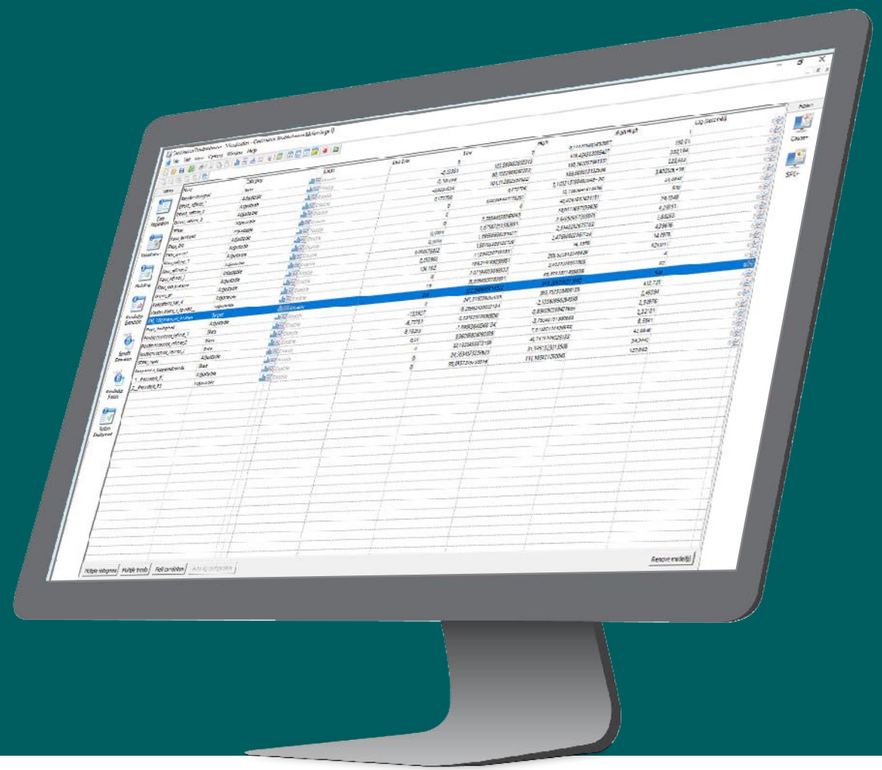


ACCELERATING AN INITIAL AI PROJECT

Paper plants have hundreds of PID control loops that can cause process variation and contribute to quality issues, if not maintained in a healthy condition.

At the same time, while Skjern Paper has extensive quality assurance systems, the team does not have many real-time ways to measure paper quality, making real-time quality control difficult. Operators would check quality samples for a whole reel of paper at the end of a production run, which involved a delayed lab analysis and the inability to adjust production earlier in the process.

With a goal of avoiding or reducing 5% of quality rejects, especially when switching between different products, Møller took advantage of free consulting with a GE Vernova AI and ML expert to jump start the analytics project.



In six hours of consulting, Skjern Paper captured insights from the initial project. The team used Proficy CSense to:

1. **Analyze:** Used available data to discover causes of quality variation and rejects
2. **Monitor:** Monitored the health of PID control loops to reduce process variation
3. **Predict:** Created a predictive model from available data to predict product quality in real time, enabling real-time quality control to reduce quality rejects

Quality Prediction and Analysis: Paper Burst Strength

The team built a model in CSense around a quality parameter related to the Mullen burst strength of the paper. The Mullen Burst Test is an industry standard to measure the paper's physical strength and fiber bond. Skjern Paper has 20 data points inputting to the CSense model, which predicts the burst strength parameter.

Burst strength is a sensitive measurement, according to Møller, and a hard one to start with – however, even with that challenge, the team saw early predictive success.

"We built a rather fine model and compared data from the model with actual quality data later," Møller explains. "It is not completely aligned but showing good results. I'm quite pleased with it."

By examining data and applying the capabilities of CSense, Møller was able to discover possible causes of errors in the production line. When producing paper, manufacturers add dewatering chemicals. Møller discovered in the production process that they are producing scrap due to adding too much chemical to the pulp mix.

"The model provides instant feedback on the differences in the level of the chemical," Møller says. "It was the error in the production. When we had problems with dewatering, we would add more chemical, but in this case, we can add less. We had thought that more chemical was better in the production, but we have new insight with CSense. Now, we can reduce the amount of chemical used and reduce scrap – which decreases our costs. It is a great capability that gave us benefit straight away."

QUICK INSIGHT AND RESULTS

As the company moves from these initial insights and into production, operators will benefit from the real-time AI optimization.

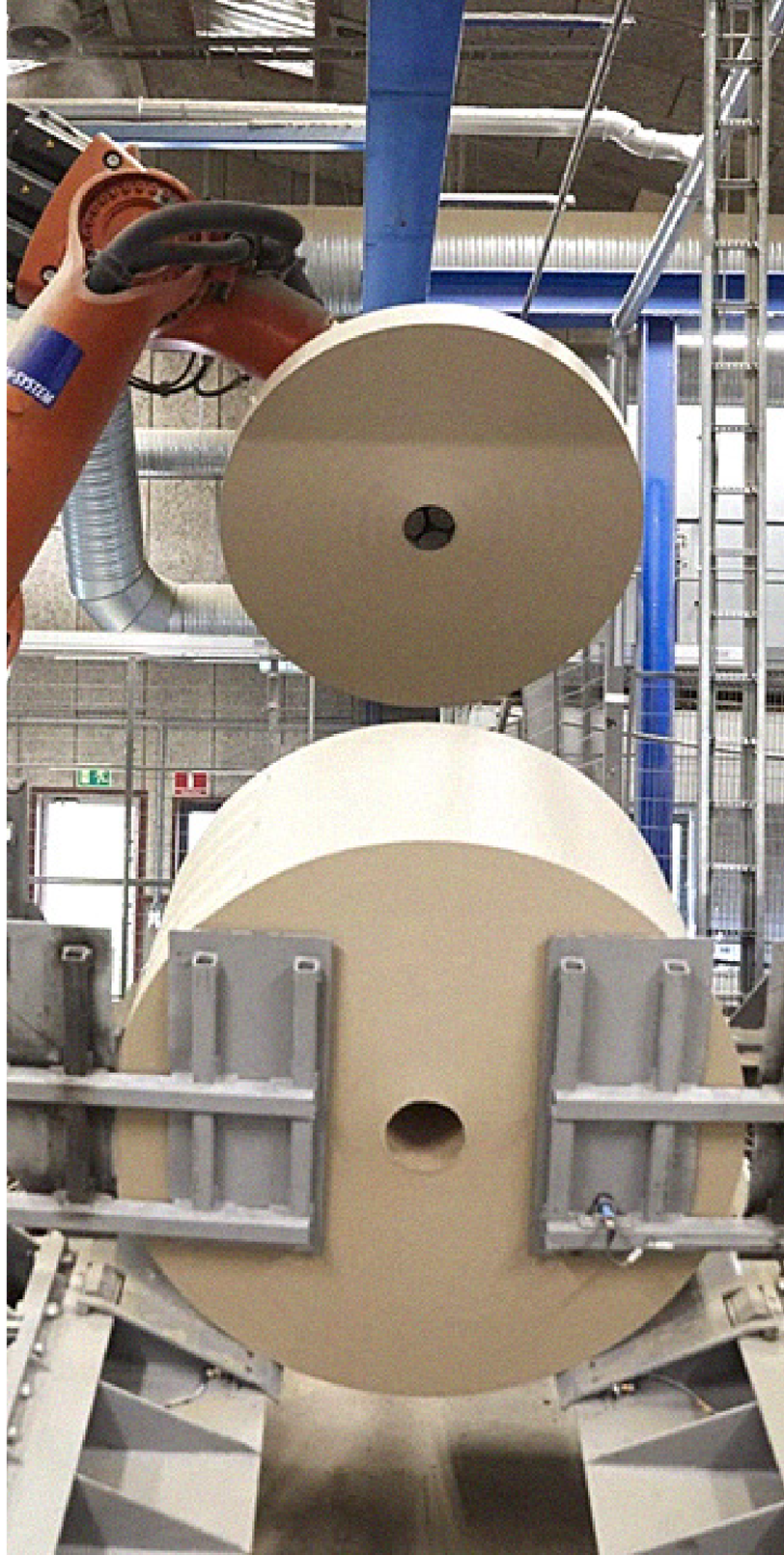
This new insight from AI also supports the company's commitment to Circular Economy.

"When we finish implementing and adjusting the model, we will see a reduction in the scrap that we are producing," Møller notes.
"We will get an early warning when quality is changing, and the operator will get an early indication. The master plan is to have the indicators in the SCADA system. We will be able to solve the reasons for issues by using the CSense visualization."

"Decreasing scrap and chemical usage and increasing production capacity through CSense are all ways that we are helping the environment," Møller explains. "Also, as we use CSense more, we can gather data from the supply chain and optimize that way too. The capabilities are there, so it is just a matter of structuring the data and the model correctly."

In summary, after just six hours of consulting, Skjern Paper was able to realize:

1. **Analyze:** New insight was gained about how dewatering chemicals can affect product quality
2. **Monitor:** It was then shown how Proficy CSense can be configured to monitor PID control loop health to detect suboptimal PID control loops early to avoid process variation
3. **Predict:** It was shown how a predictive model can be created from available data and can be deployed to predict product quality in real time, enabling real-time quality control to reduce quality rejects and waste



NEXT STEPS

While the initial project was about gaining some quick wins with a small model and realizing the potential of AI, Møller has a plan for next steps.

These include:

Taking the insights already learned and driving the realized process changes into production

- Constructing data that will lead to more insights
- Tackling downtime – starting with locking the data related to downtime, doing some manual manipulation of the data, then investigating how CSense can use that data
- Training additional team members on using CSense and having them take over from Møller's foundation of work
- Build a model to gain insight into increasing capacity

Skjern Paper will also be implementing Proficy Operations Hub for main PID loop monitoring and visualization.

AI Recommendations and Insights

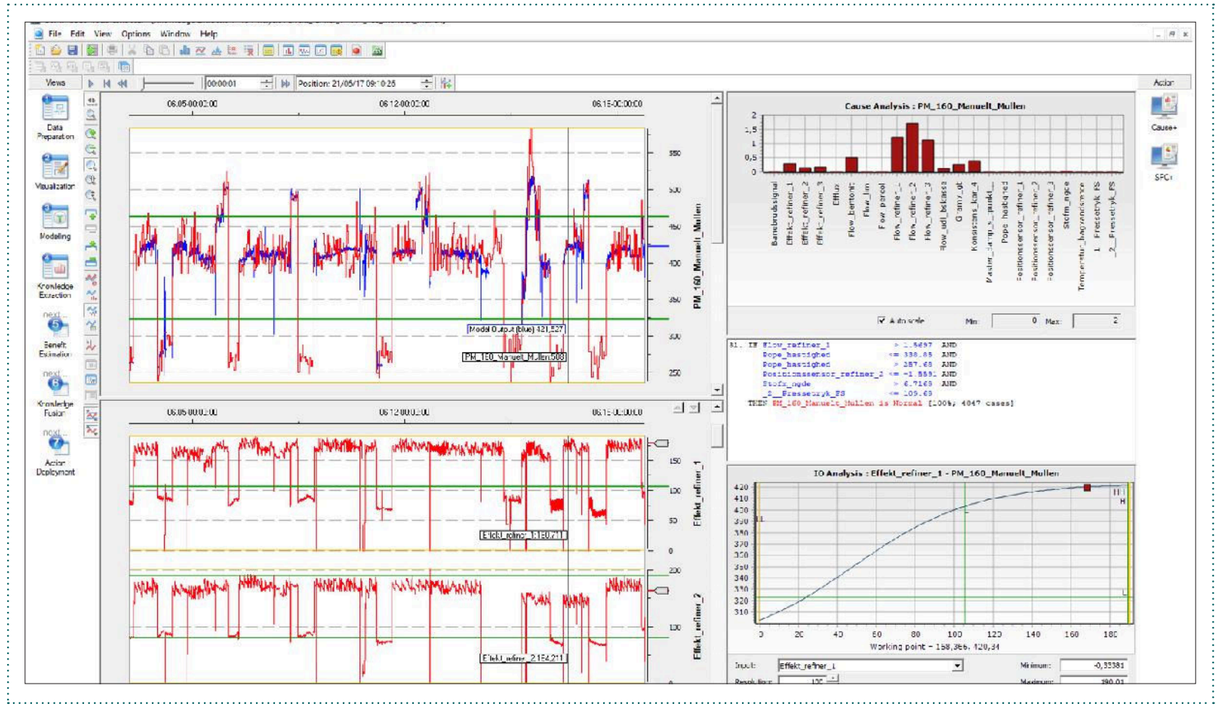
With its journey into AI, Skjern Paper is continuing its tradition of being at the forefront and ahead of its time.

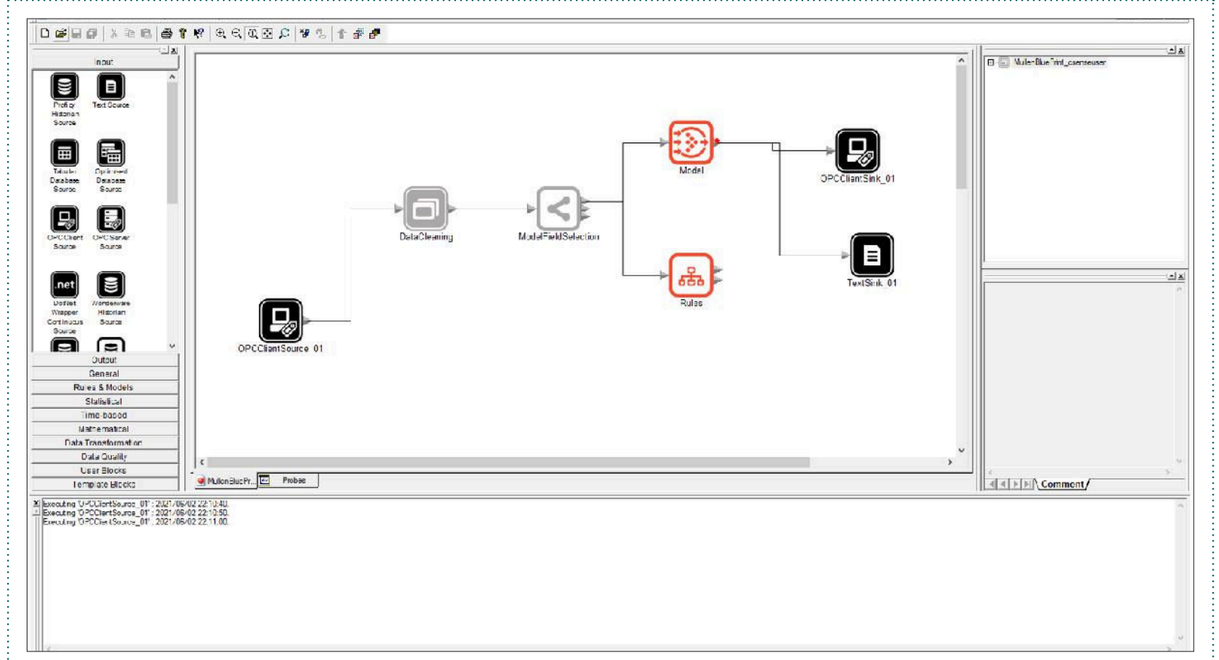
What does the team recommend to other companies?

"I would recommend Proficy CSense to other companies," Møller says. "Also, to proceed with AI, my advice is to start looking at how to get the dataset. We were quite lucky that I have been working with the data in the mill. The dataset that I have been producing is very compatible with CSense."

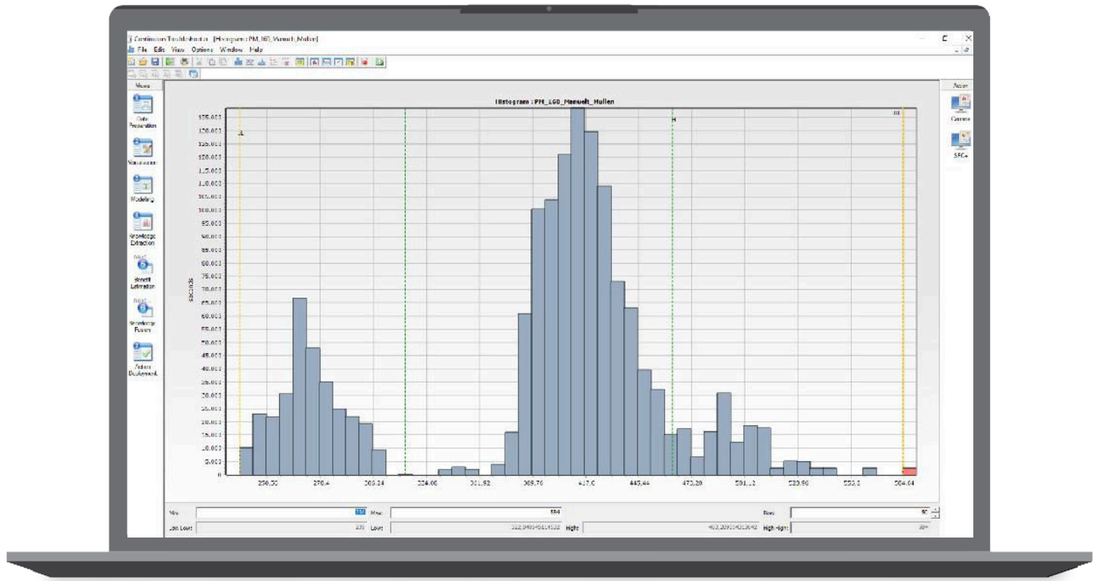
Lastly, Møller foresees quick return on investment related to Proficy CSense. The team has already gotten valuable insights so far in a short time.

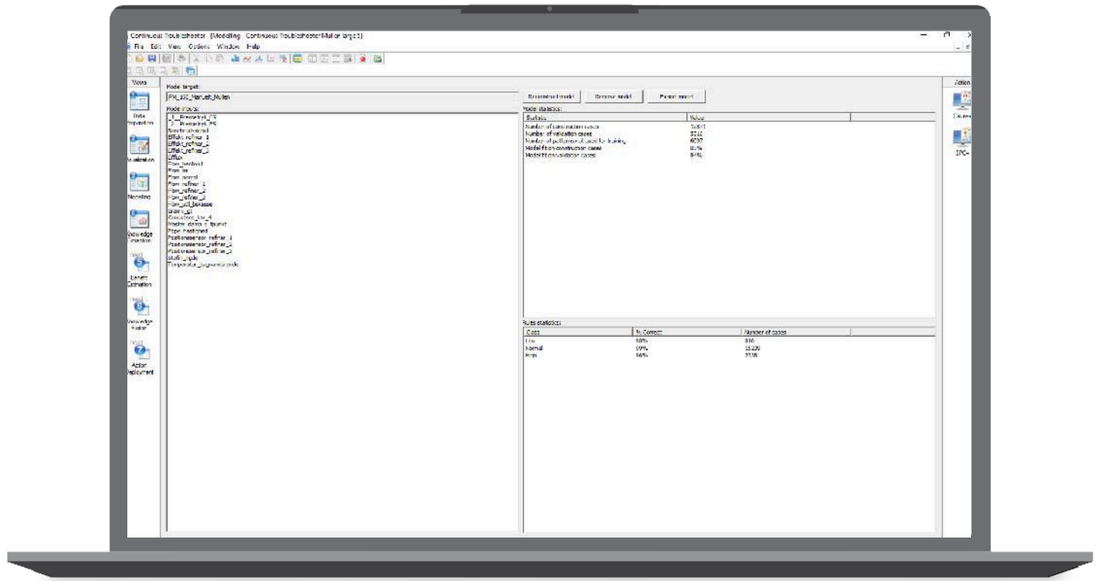
"The more we use the Proficy CSense software," Møller concludes, "the more ways we keep finding to apply it. With AI, we can take production to the next level."

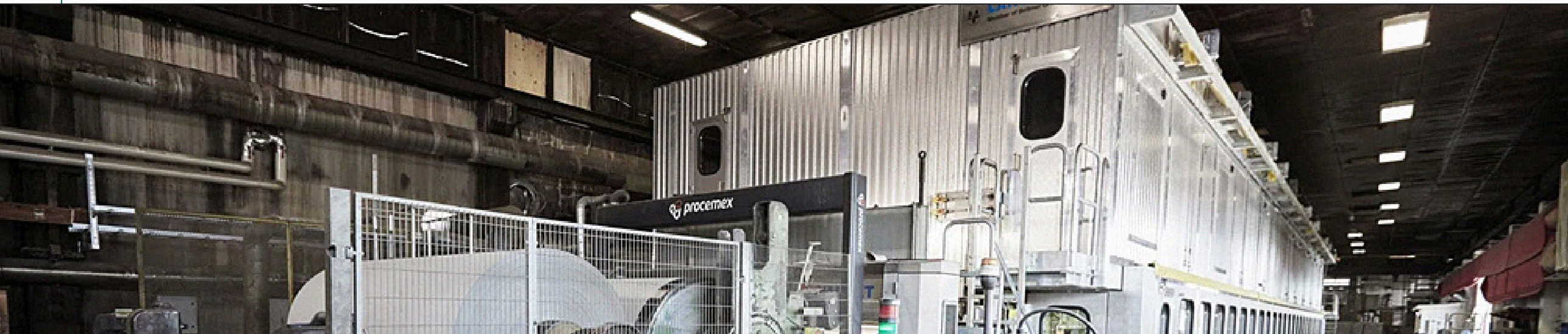




ADDITIONAL EXAMPLES







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EXXARO AND WABTEC BUMP UP THROUGHPUT AT COAL OPERATION

10%

Increase in throughput

+98%

Utilization since commissioning

6 MONTH BUDGETED CYCLE

Successful POC

ABOUT EXXARO RESOURCES LIMITED

Since formation in 2006, Exxaro Resources Limited has grown to become one of the largest and foremost black-empowered coal and heavy mineral companies in South Africa, with other business interests around the world in Europe, the United States of America, and Australia. The company's asset portfolio includes coal operations and investments in iron ore, pigment manufacturing, renewable energy (wind), and residual base metals. Recently, Exxaro produced 45.6 million tonnes (Mt) a year, reflecting contributions from its expanded flagship Grootegeluk mine. The group had recent year-end assets of R68.8 billion and a market capitalization of R47 billion (US$3.3 billion).

Exxaro's vision is to make a positive impact on the world. The company aims to power better lives in Africa and beyond by responsibly investing in commodities that will sustain life on the continent. advantages.

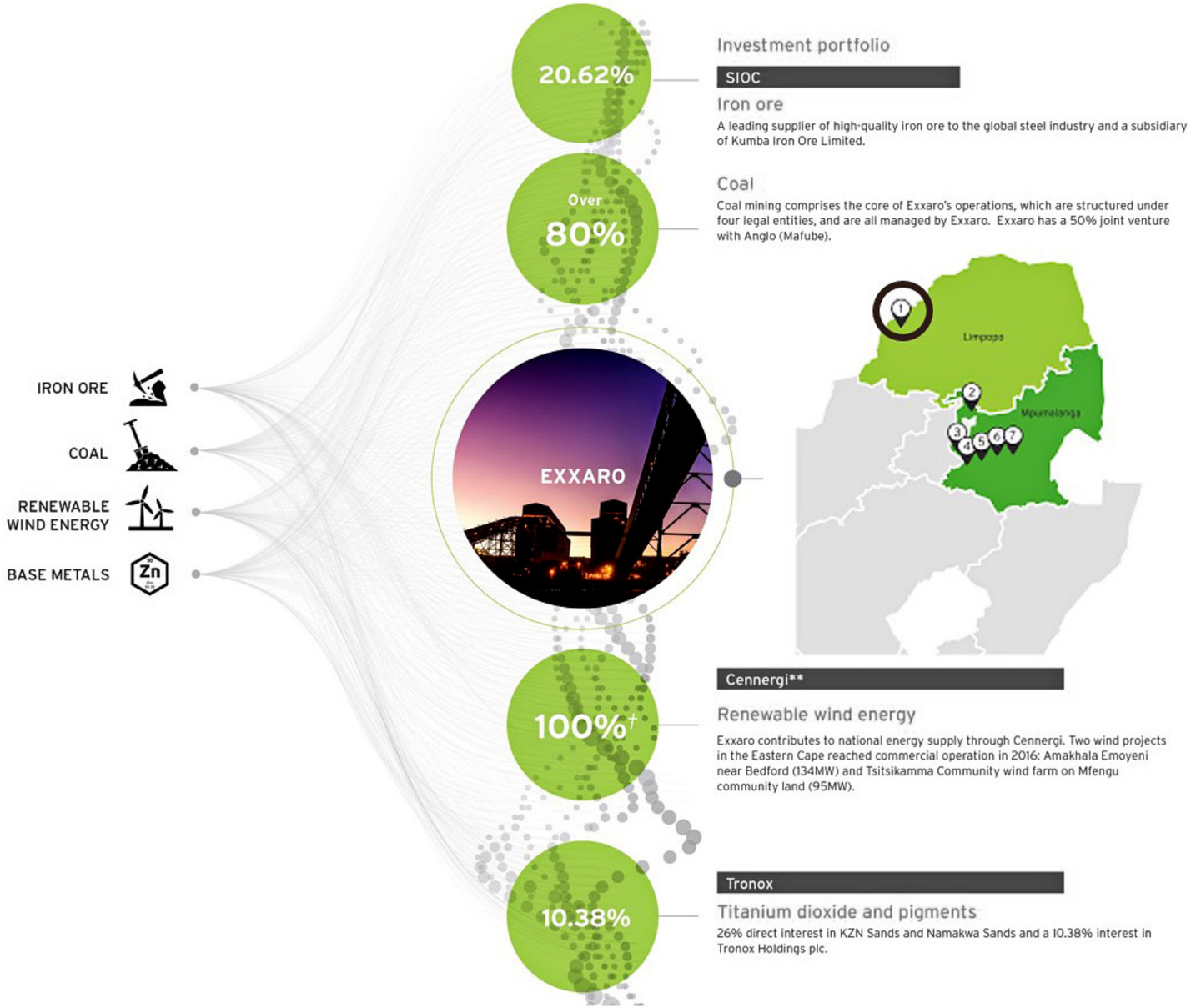


Figure 1: This map shows the northern part of South Africa where Exxaro is involved in seven coal operations. The project with Wabtec and Proficy CSense is at Exxaro's flagship Grootegeluk coal mine, approximately 280 kilometers from the capital, Pretoria, in the northwest on the Botswana border.

JOURNEY TO DIGITAL TRANSFORMATION

Like many industries, coal processing is complex, and digital transformation provides an opportunity for improvement. The absence of advanced process controllers (APCs) in the coal processing industry led Exxaro to explore research into opportunities for improvement, particularly in the area of throughput.

The journey for APC started with Exxaro's Jonathan Mayer, who was interested in the process control environment and pursued academically. The academic interest led to throughput improvement, and the journey continues.

As Hennie Engelbrecht, Principal Engineering for Process Improvement and Performance, Metallurgy, at Exxaro Resources, explains, a few years ago, Exxaro approved a proof of concept project to implement model predictive control at the Grootegeluk GG45 comminution plant. The business case was a simulation that showed the potential for a 5% throughput increase. Wabtec's Digital Mine team executed the control system with Proficy CSense from GE Vernova. Exxaro used a third-party performance evaluation by Professor Ian Craig from the University of Pretoria to validate the resulting throughput increases to be between 8.2 — 9.6% well beyond the simulation projection!

The team selected Proficy CSense for the following reasons:

- One software interface that enables the full lifecycle from data analysis up to the real-time deployment of APC applications
- Competent data manipulation and data analytic tools to explore control relationships
- Intuitive, user-friendly interface that allows drag-and-drop development of plant model and controller blueprints
- Very competent Wabtec APC engineering team to implement
- Lower licensing cost compared to six other vendors evaluated in the APC program
- Site software license does not limit the amount of applications that are allowed to be deployed

Advanced Process Control at GG45

GG45 is one of the processing plants at Grootegeluk. As shown in Figure 2, there's an open-air mining supply stockpile with a set of vibrating feeders feeding into a tunnel conveyor that leads into a closer compression screen plant, which in turn feeds an intermediate bin. From this bin, the team feeds the GG4 and 5 plant over a set of two classification screens that splits it in a fine feed to GG4 and GG5. This is the environment where the APC was developed and implemented.

The objective of this APC is to maintain maximum plant feed throughput, which is measured as the tempo of the inclined conveyor out of the tunnel. This needs to be done without violating plant constraints. These various constraints include the incline conveyor toward a closed-circuit crush and screen plant and bin level, as well as the feed inputs to the classification screens, and the feed input to the processing plant. The APC reevaluates plant capacity every two seconds. In order to overcome the plant constraints, optimal control settings are determined and affected to 13 feeders that sit in the panel. This process is repeated on a two second-by-second calculation cycle.

PROJECT IMPLEMENTATION LIFECYCLE

As shown in Figure 3, the project implementation lifecycle involved six phases:

1. Project scoping
2. Develop plant Digital Twin
3. Simulate APC and optimize Digital Twin
4. Integration with OT infrastructure
5. Commissioning, stabilization, and optimization
6. Monitoring and performance evaluation

When we look at project implementation life cycle and how a project like this is developed and implemented, it's important that we started with great project scoping, which includes site visits, scoping the solution by interacting with subject matter experts as well as on-site people," says Marnus Olivier, Lead APC and Data Science Engineer, Digital Mine, Wabtec. "Collecting a lot of data helps to make sense of the process environment. It continues to system identification where the systems behavior is modeled."

Engelbrecht explains, "You effectively enable yourself to develop a plant digital twin. This is where the Proficy CSense software starts to do its magic in the hands of an APC control engineer."

Proficy CSense and its graphical interface allow Exxaro to do process modeling as well as development of the controllers. In the third step, Exxaro simulated the plant and verified the controllers before deploying onto the actual plant. Then, in order for the controller to interface with the plant, the team integrated the PLCs and SCADA and developed a SCADA interface screen that allows operators to switch the APC on and off, and also adjust some of the operating parameters for the APC. Next, during the commissioning, the team noted where all of the parameters were performing, followed by stabilization and then the optimization phase for the APC application. The process of the lifecycle is concluded with the monitoring and performance evaluation phases, ensuring that Exxaro sustains the benefits of the APC application continuously.

WATCH NOW

Figure 2

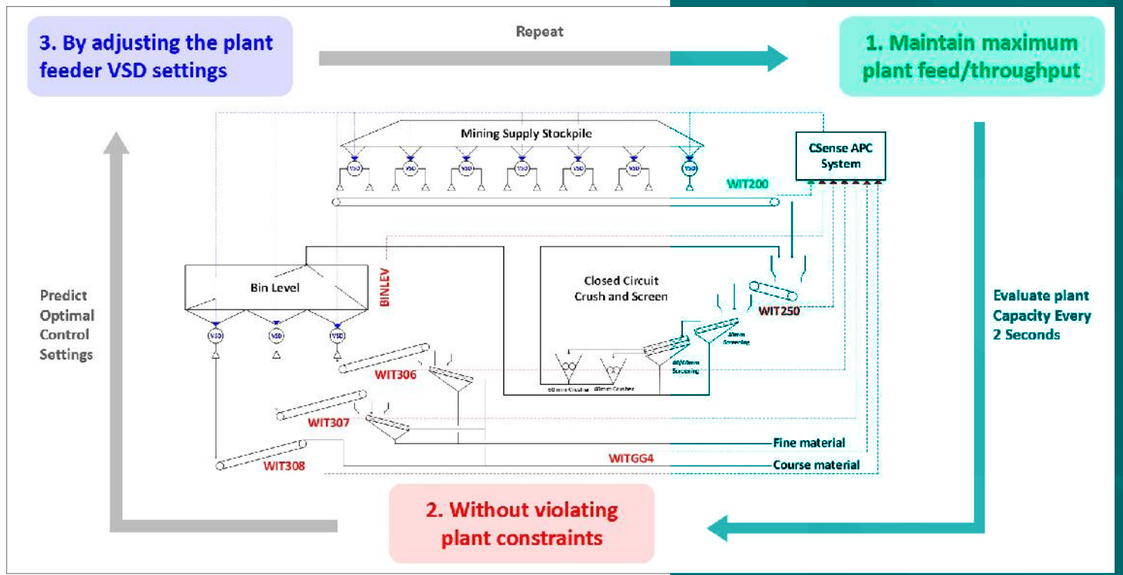
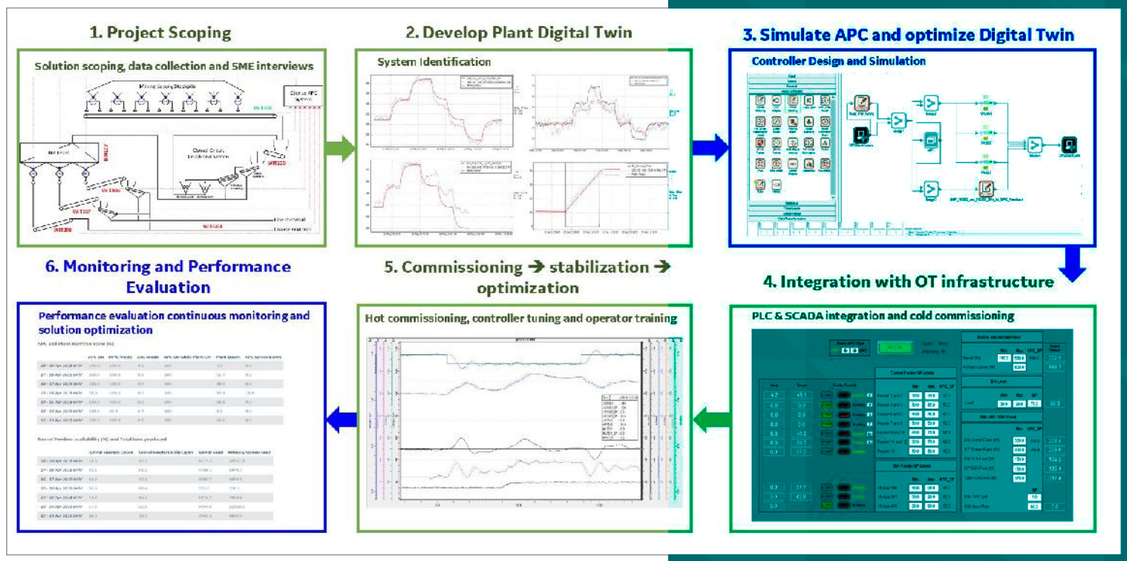


Figure 3 - Project Implementation Lifecycle



Positive Impact on Operations

In evaluating the impact of the APC on operations, the team first looked at stabilization, constraints, and performance before finally examining throughput performance. Figure 4 shows before-and-after illustrations of performance on the areas of the constraints that Exxaro monitors.

“You can see that before we had the APC, we had quite a lot of variation in our plant,” Engelbrecht explains.

“This is due to manual stop start of feeders by operators as well as the manual response to some of the violations in the process by operators, which cannot make decisions every two seconds on other plant statuses.”

With the analysis, Exxaro could see the stabilization of the switching on of the primary screen feed from a reactive situation before APC to a very stable APC plant. The tempo of the tunnel feed conveyor and product flow into the final processing plant, as well as the operations around the bin, have a great stabilization impact on the bin level, as well as the feed tempo to different processing models.

“The APC application implemented through the Proficy CSense software was able to really stabilize our operations,” Engelbrecht says.

The team also needs to ensure that the solution does not violate constraints in the plant and exceed safe plant limits. As shown in Figure 5, the histograms’ light pink coloration indicates where the team had violated some of the constraints on the plant prior to the APC. Violating specified constraints on the plant can cause spillages on the conveyors and blocked pressures, as well as feeding the plant at rates where the beneficiation of the coal is not done as the standard, and the plant starts to lose efficiencies in processing.

Olivier explained, “It’s very clear that after we switched on the APC during the stabilization phase, the APC controlled the process away from these constraints. Even when we had the APC optimized, we moved a little bit closer, but the APC was effectively controlling the plant process away from constraint violations, as quite a competent solution.”

Figure 4 - PAPC ON-OFF Stabilization Comparision

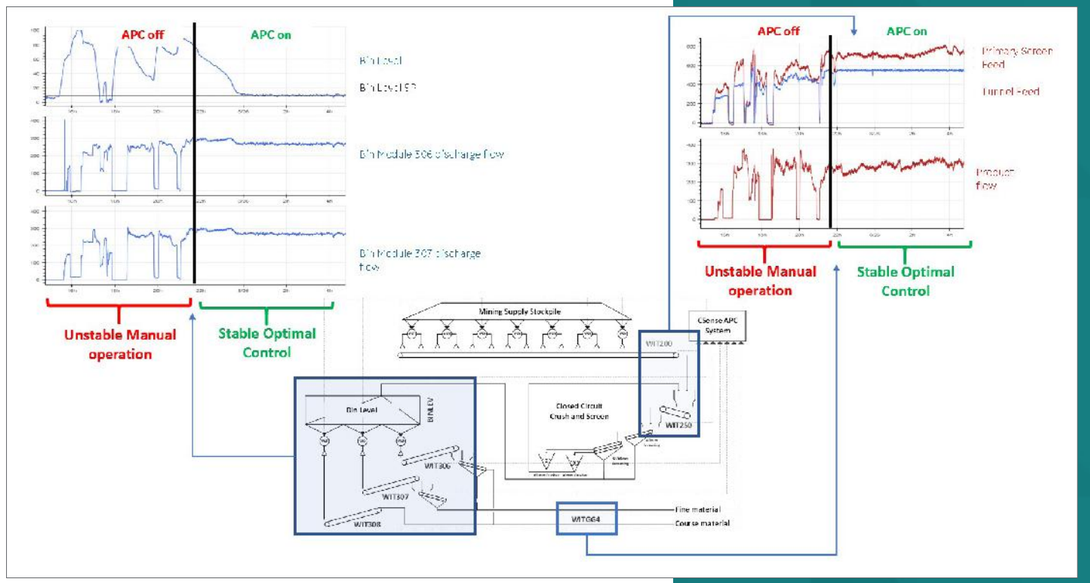


Figure 5 - APC ON-OFF Constraint Comparision
Are we violating the safe plant limits?

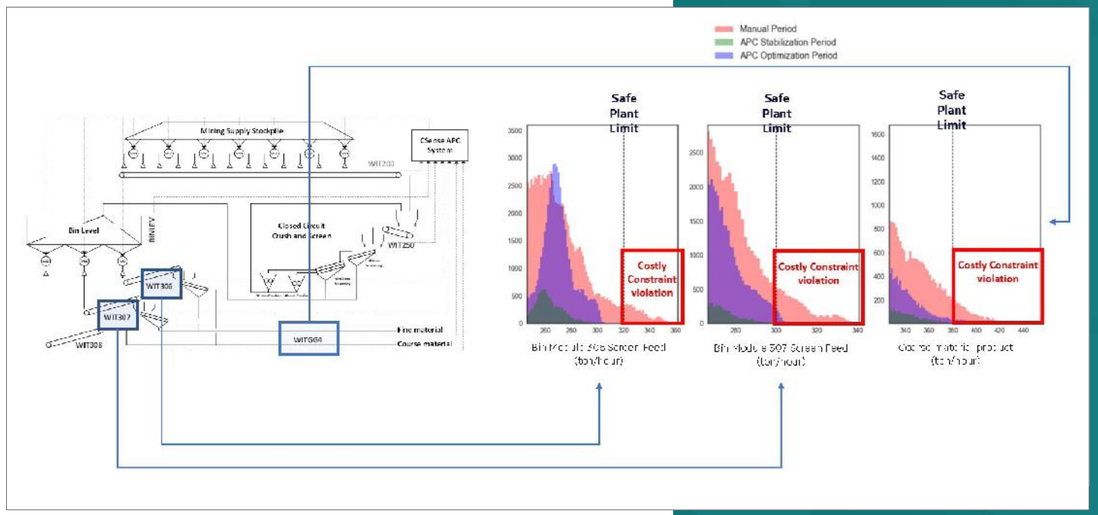
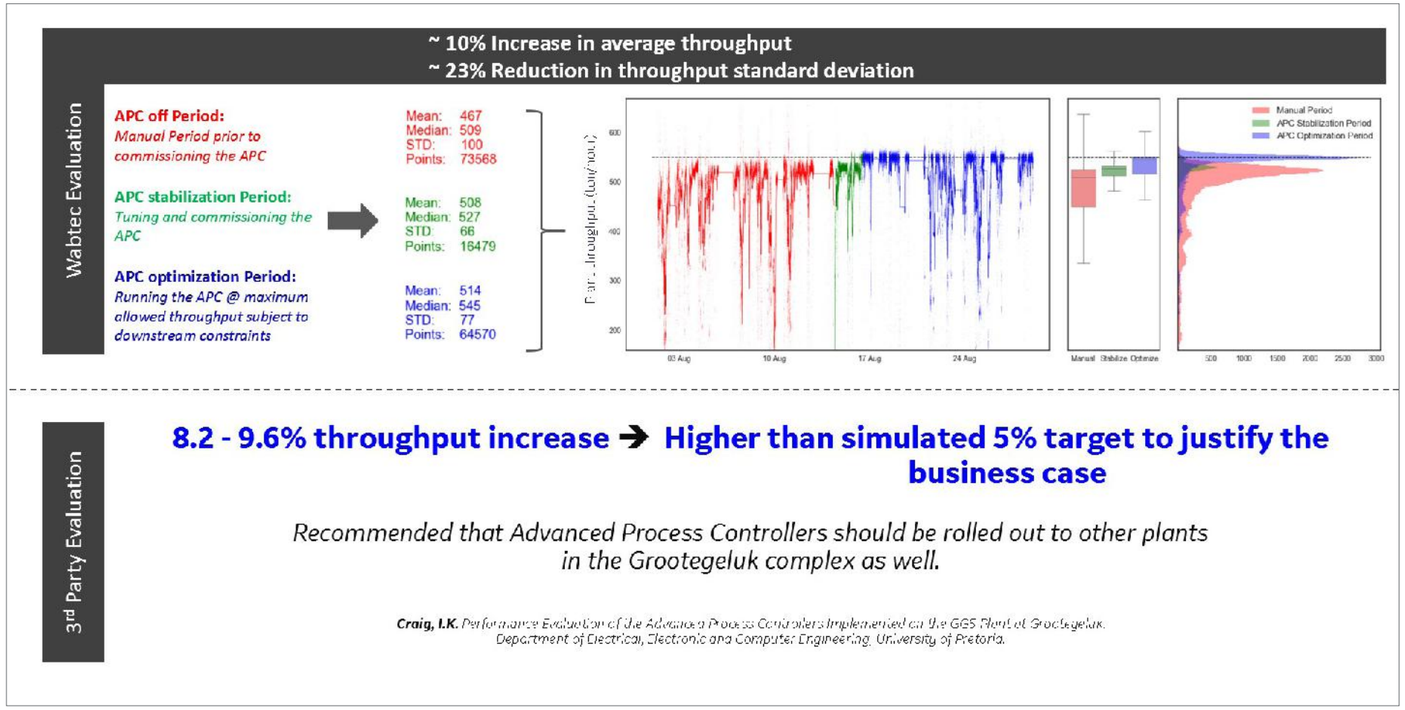


Figure 6

APC ON-OFF Throughput Comparision



COMPARING THROUGHPUT: BEFORE AND AFTER

In comparing throughput, the time-series graph in Figure 6 shows that before the APC was switched on, Exxaro had quite variable throughput rates, not running very close, and some light dots indicating how the process was violated. Once the team switched on the APC, immediately there's a stabilization. Furthermore, as the team optimized the APC, the graph shows how the APC is able to run very close to the constraint. Note, some of the data indicates when the plant has an empty stockpile not controlled by the APC, resulting in lower throughput.

When looking at some of the basic statistics, the data shows the mean throughput from 467 going up to 508 and 514, with about a 10% increase in mean throughput. The standard deviation went down 23% just in this basic evaluation done by the Wabtec team.

"We used third-party evaluation to confirm the throughput improvement above the simulated target," Engelbrecht says. "With these confirmed improvements, the resulting recommendation from the third party was to roll out the advanced process controllers to the other plants at Grootegeluk as well."

In addition to throughput, the team considers the following KPIs as priorities for the APC applications:

- Reduction in unplanned stop-starts
- Reduced energy consumption
- Reduced reagent consumption
- Increased recovery through improved process stability
- Increased resource utilization (yield increase) through improved quality control
- Reduction in maintenance expenses by avoiding overloading and possible damage of equipment

Sustaining Optimal Performance: Operators Are Key

According to Engelbrecht, APC monitoring and maintenance is very important, and continuous monitoring coupled with stakeholder engagement is crucial to ensure sustainable optimal performance.

“There are times when the process environment changes, and operators have an intimate knowledge of this, and therefore you need to engage with them all of the time,” Engelbrecht explains.

In the end, the operator is the ultimate end user of the APC, and a goal is to keep the APC switched on. Therefore, APC utilization becomes a primary indicator also of the buy-in and the change adoption for the application.

Additionally, the automation infrastructure needs to be monitored to make sure that all communication between the APC and PLC systems are healthy. Otherwise, the APC is not functioning and not controlling the plant optimally.

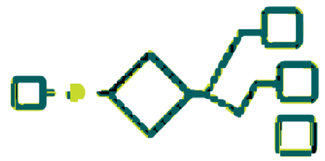
Performance metrics are also very important, and the team continually looks to whether the target objective is sustainably being achieved. Daily emailed reports help the team monitor the performance of the APC solution.

In summary, the team takes the following steps to ensure continued benefit from the APC:

- Monitor KPIs
- Periodic performance reviews
- APC solution enhancement
- Engage operations teams – feedback & training

Successful Implementation and Next Steps

- Proof of Concept completed within the 6-month budgeted cycle
- Wabtec and third-party performance evaluation showed outcome was higher than simulated target of 5% to justify the business case
- Actual throughput increase 8-10%
- Utilization from commissioning to date is higher than 98%, which demonstrates the adoption of the solution by plant operations
- The APC is now solely utilized to control the GG5 plant – used for start-up, shut-down and steady state conditions
- Solution monitoring paramount with regard to collaboration, continuous improvement and sustaining
the solution performance



“In this picture (Figure 7), you see at least the largest coal beneficiation complex in the southern hemisphere. We have our GG1 plant, the dual-stage coal beneficiation plant. Next to it, GG45 where we did our first APC application. The GG3 plant next to it. The GG2 coal beneficiation plant, and integrated into that, the GG6, and the most recent expansion with Grootegeluk is the GG7 and 8 processing complex. This all forms quite a significant coal processing environment. This is where our journey started and where our journey continues.

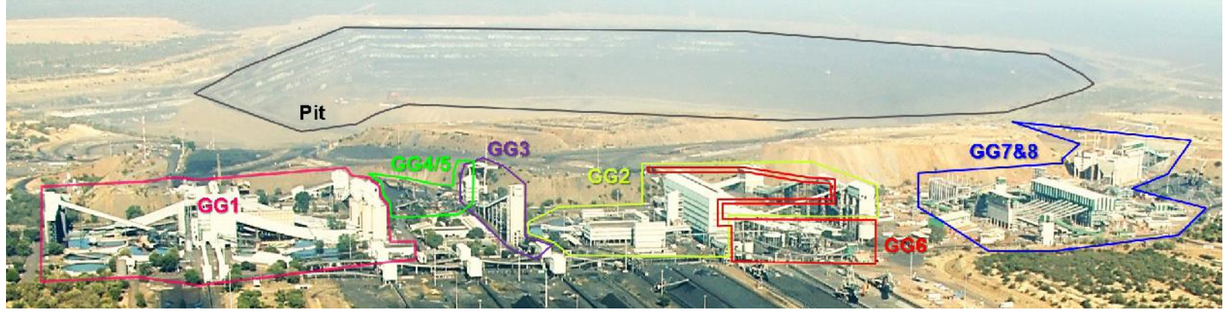
Our plan for the future: Grootegeluk plans to obtain a site-wide Proficy CSense license, so we can expand our APC footprint across the whole of the site. We’re very excited and will definitely continue the journey of implementing more APCs, but also skill our own engineers to get a better understanding and be able to more competently participate in the future of APC. The site is excited about the potential of advanced process control and also the future journey with Wabtec and the Proficy CSense software.”

*– **Hennie Engelbrecht**, Principal Engineer, Process Improvement & Performance, Metallurgy, Exxaro Resources*

COMPANY:

Exxaro Resources Limited

Figure 7



Solution:

- Advanced Process Control
- Digital Twin

Product:

- Proficy CSense

Results:

- 10% increase in throughput
- 23% decrease in throughput standard deviation
- 98% and higher utilization since commissioning
- 6-month budgeted cycle with successful POC
- Approximately double the throughput increase estimated in the original business case simulation that justified the POC project
- Equipment protection from overloading and damage
- Reduced spillage clean-up cost and associated downtime
- Improved efficiency on processing plants when avoiding processing beyond violation ranges

Time-to-Value Factors

- Time to value depends on the complexity of the APC to be installed, the readiness of the process to support the APC development, and the maturity of sensors and control elements.
- The recent two applications were developed and deployed in about 3 to 4 months each.
- Time to full value is also impacted by the adoption from the operations teams. Training and 1:1 coaching open doors for APC adoption.

Framework for Success

1. Leadership support
2. Investing in the right enabling technology
3. Implementing use cases that have been studied and ranked for implementation priority
4. Operating team participation
5. Well-established APC methodology, guidelines and standards to effectively integrate different functions and ensure uniformity in approach
6. OT architecture
7. Stable basic control layer
8. Working with the right industry partners and vendors
9. Developing the required skills to participate in and lead APC application development and deployment

GE VERNOVA

HERNING VAND GATHERS VALUABLE KNOWLEDGE WITH THEIR HISTORICAL DATA

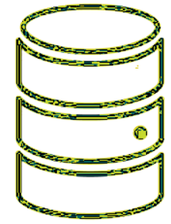
Based in Denmark, Herning Vand strives to efficiently deliver clean water to its customers

GOING BEYOND BIG DATA

”Big Data” has become a buzzword and everyone agrees that it is worthwhile to explore the large volumes of data. Herning Vand has invested in an advanced calculator that can help to interpret their process data and already in the first project they came across particularly valuable knowledge.

“We have achieved some excellent results with our first project and we see a great future optimization potential with the tool.”

*—**Jan Ravn**, Chief Operating Officer at Herning Vand*



For years, Herning Vand has recorded and saved a large amount of process data that is collected online from Herning Vand’s 14 purification plants.

The data is logged with the clear intention to make Herning Vand wiser and therefore better equipped to optimize processes and the overall operations. However, for that to happen the large volumes of data must first be sorted, analyzed, processed, evaluated and thoroughly compared so that the important correlations and trends can be localized.

However, Proficy CSense shall, just like other simulation tools, be used shrewdly and Herning Vand, together with process consultants from COWI who were responsible for the initial consultancy, gained some valuable experience. COWI assists Novotek, a GE Vernova partner, with process technical advice in connection with the use of Proficy CSense.

“A spreadsheet can be used to handle relatively large amounts of data, but it will not work when there are too many parameters in play simultaneously. Therefore, last spring we invested in Proficy CSense software solution, which is dedicated to finding and using mathematical correlations of large amounts of data,”

— Jan Ravn

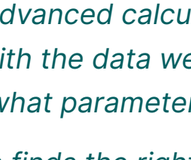
IS THERE A CONNECTION?

“I see Proficy CSense as a closed box that is filled to the brim with advanced calculation routines. We just feed the box with the data we want it to compute and then we tell it what parameters we want to observe.

Proficy CSense finds the right mathematical description of the data stream and can then show two curves of the same data stream. One curve contains the actual data and illustrates the process as it was in reality. The other curve is generated by the mathematical model that Proficy CSense has set and therefore shows a simulated process.

When the program is fed with multiple data streams at once, it automatically locates the possible relationship that exist between the different data and that is exactly what we are after.”

*— **John Sorensen,** Senior Project Manager for water and wastewater at COWI.*



When CSense has found the mathematical models and correlations, the user can then determine which parameters to focus on and what to look out for. Just like when you insert different values into an equation. Here it is just an automated solution to an almost unlimited number of equations.

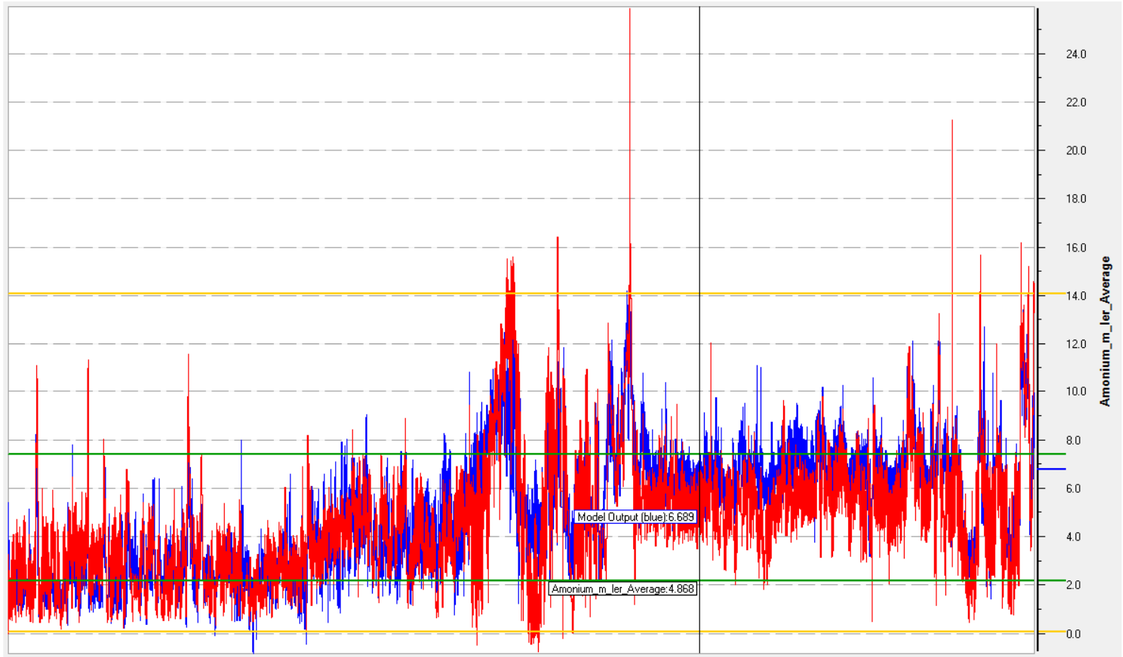


Figure 1: Modeling of variations in ammonium concentration. Proficy CSense has generated a model where the result is shown by the blue line. The red line is the measured values.

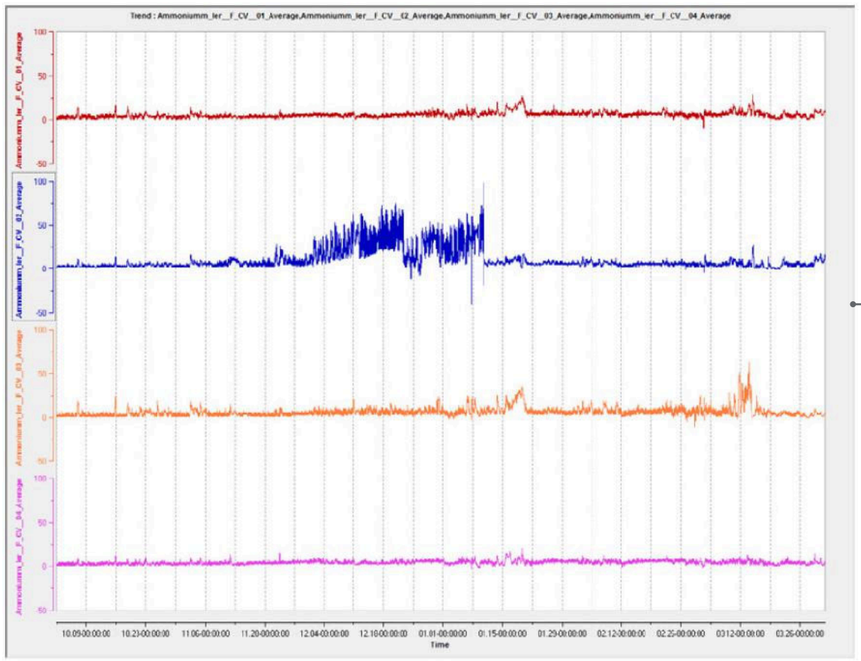


Figure 2: Simple comparison of trend curves to get a quick overview of the situation. The figure shows the ammonium concentration in four process lines.values.

”We can find correlations that we did not know existed and our theories can be confirmed or dismissed. Once we have located the significant correlations, we can begin to optimize the process based on this new knowledge,”

“If, for example, I want to have output A as high as possible, how should I then set inputs B, C and D?”

— ***Jan Ravn***

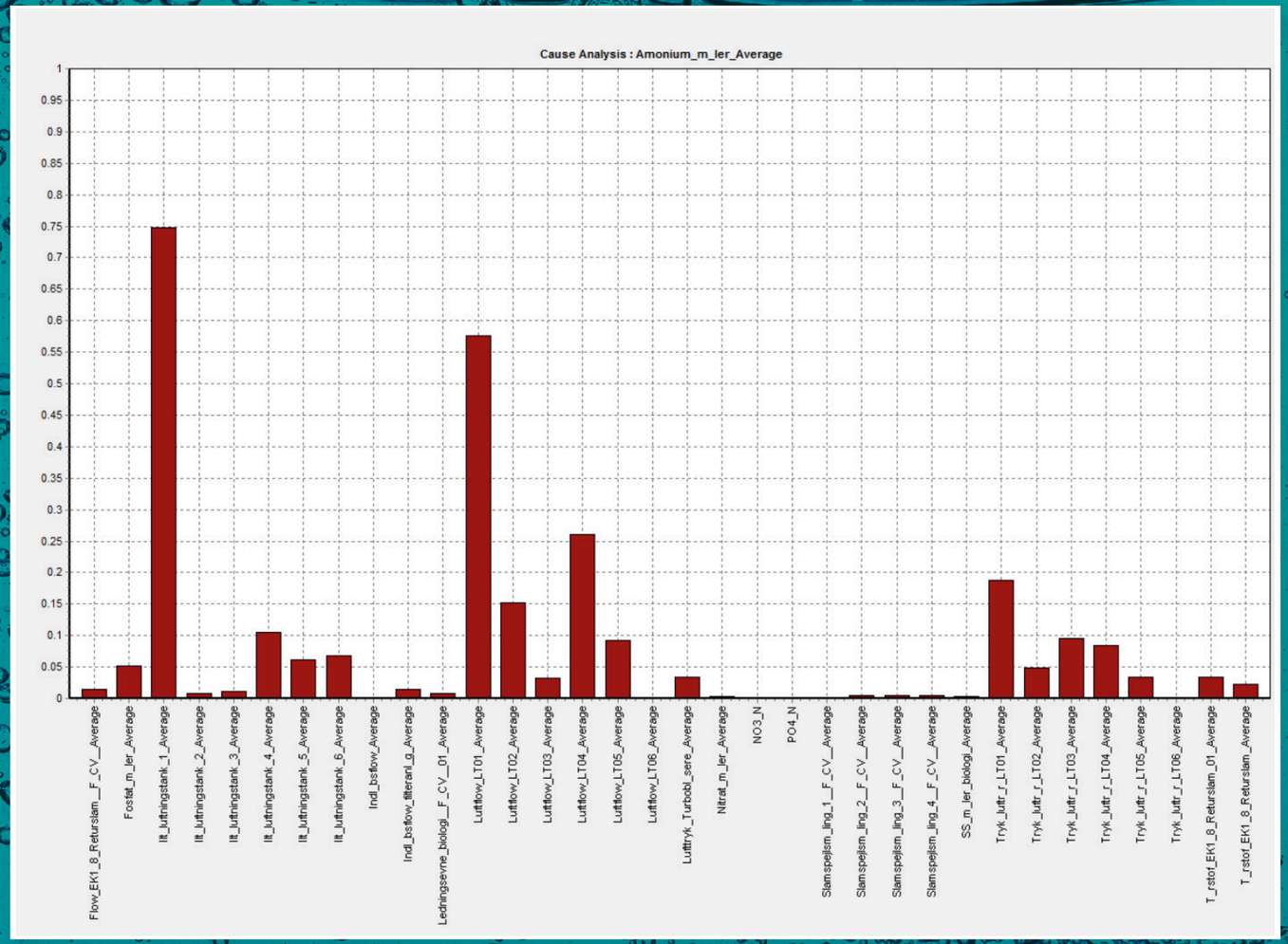


Figure 3: *Proficy CSense has identified the parameters that have the greatest influence on a given run-off result.*

A SAVINGS OF DKK 500,000

The first project, which was the optimization of the gas production that is based on sludge from the purification plants, gave an output improvement of as much as 20%.

The gas is used for electricity production and according to Jan Ravn the increase corresponds to an annual additional production of approximately 400,000 kilowatt hours, which earns Herning Vand approximately DKK 500,000.

Herning Vand is now engaged specifically in a series of small defined projects that will ultimately achieve the goal of making Herning Vand energy neutral.

“We knew roughly which buttons we had to press to achieve this gain and so CSense should not take all the glory. However, the tool makes it much easier for us to check the accuracy of our assumptions and it can also show us the way to the process-related correlations that we cannot find ourselves.
— Jan Ravn

The Art of Definition

The advice from Jan Ravn and John Sorensen is that you have to be good at defining the amount of different data that CSense works with and you get the best and fastest results if you have relatively robust process knowledge.

The more data you put in means you get more answers out at the other end. However, there is of course an upper limit, and too many parameters in play can make it difficult to understand the results.

As Jan Ravn explained, "Our advice to new users is that you start simple and carefully consider both what it is you want to have answers to and also what parameters are likely to affect these answers. If you do not know exactly which parameters affect your focus area, you can gradually reduce the number using Proficy CSense as you test each one. When the data streams are recorded and analyzed they fit together mathematically, so when you adjust each parameter up and down with the mouse, you see how the other parameters are affected to either go up, down or remain unchanged. When you have isolated the relevant parameters there is the option to activate the tool to simulate towards an optimum process within a given framework."

Jan Ravn and John Sorensen assess the collected information.

The first project is only the tip of the iceberg in relation to what we expect to achieve with Proficy CSense. We have an ambition that the tool will be used regularly for small and large projects, and therefore assist us to pick all the low-hanging fruit that would otherwise be missed during a busy working day,”

The findings are instantaneous and the application potential is great.”
— Jan Ravn

GE VERNOVA

IMPALA PLATINUM REDUCES PROCESS VARIATION BY 40% WITH PROFICY CSENSE

BACKGROUND

Impala Platinum's Base Metals Refinery (BMR) in Springs, South Africa, receives its raw material from the company's mining, concentrating, smelting, and converting facilities in nearby Rustenburg.

The BMR then removes as much of the base metals as possible and sends the Platinum Group Metals (PGM) concentrate to the Precious Metals Refinery (PMR) plant for further processing. The base metals are refined and sold separately to maximize the conversion of raw material into revenue.

THE CHALLENGES

Poor pH control, complex, multi-variable environment

Impala Platinum identified difficulties in controlling the pH in the first stage autoclaves, and poor pH control has a serious and negative impact on the PMR processes. It had to decrease the base metals content (thereby increasing the precious metal content in the concentrate), which could be done by controlling the pH and consequently improving the nickel and iron extraction efficiencies.

Up to this point, the pH had been controlled through a cumbersome process of manual sampling and operator intervention. Responses to changes were delayed and future values could not be predicted automatically.

As shown in Figure 1, the first stage leaching process involved operators having to deal with numerous interdependent variables (pH, temperature, levels, pressures, etc.).

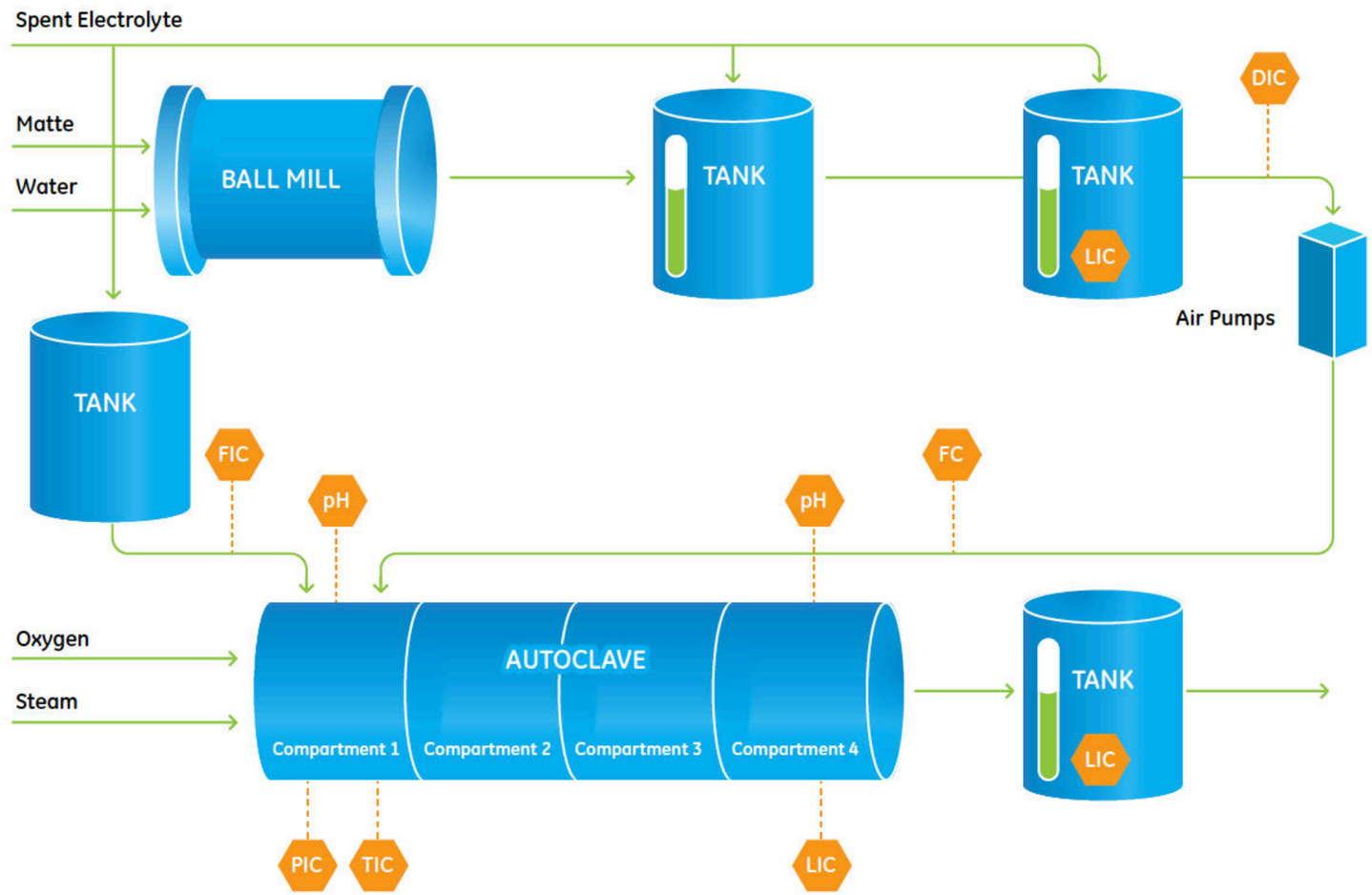


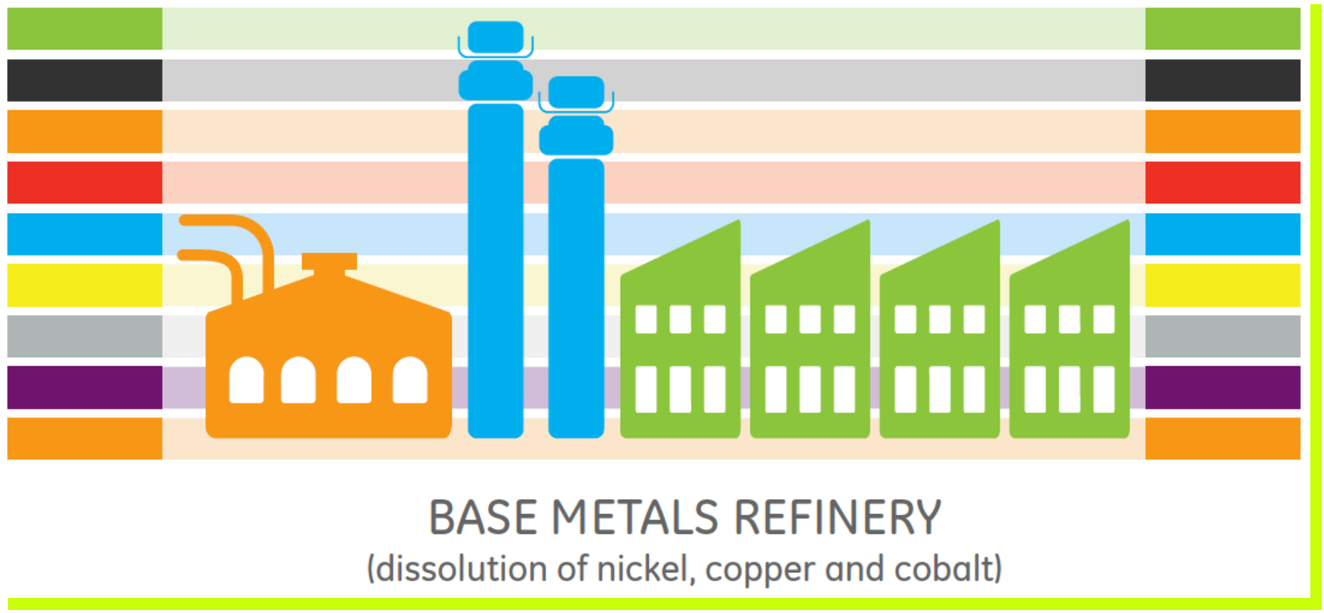
Figure 1:
An overview of the process

THE PROCESSING OF PLATINUM IS A COMPLEX AND COSTLY AFFAIR. THE QUALITY OF THE UPSTREAM PROCESS KNOWN AS BASE METAL REFINING (BMR) CAN HAVE SERIOUS FINANCIAL CONSEQUENCES ON THE PROFITABILITY OF THE DOWNSTREAM PRECIOUS METALS REFINING (PMR) PROCESS.

With operators having to juggle all these variables, it was easy for temperature and pH profiles, for example, to go beyond their set limits. This affected Impala's ability to remove as much as possible of the nickel from the solids, and it degraded the quality of all products downstream.

Another important metal to remove (leach) in this process was iron, which had to be kept in solution. To do that, active pH control needed to be applied to the autoclave. Iron should be discarded with the nickel solution otherwise it would contaminate the PGM solids, which would impact downstream processes negatively and can even lead to costly reworking of the concentrate.

In addition, ore grade is gradually dropping and there are large variations in concentrations in the matte supplied by the smelter. All of this contributes to an environment where manual process optimization is extremely challenging.



THE SOLUTION

Advanced pH controller provides real-time optimization

Impala Platinum turned to GE Vernova to help address its challenges. Over a period of six weeks, GE Vernova installed its Proficy CSense solution, providing Impala BMR with control and optimization of its nickel-leaching process. The software relieved operators of many decisions that were previously difficult given the complex, variable, and real-time nature of the processes in their charge.

An advanced controller based on a hybrid of analytics technology and fundamental principles was implemented to provide:

- Stabilization of the pH to improve the leaching efficiency of iron and nickel. This provides a better quality of PGM concentrate for PMR and other processes.
- On-line and real-time pH sampling. This provides the degree of control required to help optimize the process. Another consideration was that pH cannot be measured inside the autoclave, so a special sampling pot was designed by GE Vernova to address this sampling problem.
- Simplification of the control approach by manipulating acid addition to compensate for pulp density and product feed rate changes, as well as changes in pH measurements, while taking into account that high-pressure acid leach has complex reaction dynamics.

“Some systems are just too complex and have too many variables for operators to run optimally. That’s when we need the help of predictive solutions that can deal with the complexities of our unique problems.”

— Tim Spandiel,
Impala BMR Manager

GE VERNOVA'S PROFICY CSENSE SOLUTION HELPS TO INCREASE PROCESS EFFICIENCY

Since the solution was implemented, it has greatly reduced the level of impurities in the product from the BMR, thus increasing the concentration of PGMs. This ultimately leads to more platinum being extracted in the PMR downstream.

Sello Semosa, Impala's BMR Manager, said that operators have embraced the solution, which has led to increased productivity. She explained, "With Proficy CSense, I know I have a dedicated solution that is running real time with no disruptions. It has freed up time for me and my staff, and time is important in terms of production." Enabling effective information sharing across the company, the solution automatically provides performance reports. This enables management to have a near real-time view of the efficiency of the BMR nickel leaching process on which so many other processes rely.

Solution results:

40%
improvement
in pH stability whereby variation was reduced from 1.2 to 0.7

0.5%
increase
in nickel extraction efficiency

3.3%
increase
in iron extraction efficiency

1.4%
increase
increase in the PGM grade (concentration)

Other benefits included:

- Reduction in pH peaks in the autoclave, which can lead to certain elements becoming very difficult to leach. These elements go right through the process and end up contaminating the PGM solids, with the result that the entire batch has to be recycled through a lengthy and costly processing pipeline.
- Acceptance of the system by operating staff
- Stable process control in spite of variations
- Indirectly limits environmental emissions

"Although these numbers may seem small, they are extremely significant to the financial benefit of all our refining processes."

— Tim Spandiel,
Impala BMR Manager

GE VERNOVA

POSITIVE CHANGES IN ROCKWOOL

Proficy CSense's Troubleshooter advances Rockwool's capacity for process analysis

ABOUT ROCKWELL

The ROCKWOOL Group is the world’s leading supplier of innovative products and systems based on stone wool, improving the environment and the quality of life for millions of people.

“A year ago, one of my employees enthusiastically told me about a software system for process analysis, Proficy CSense's Troubleshooter, which he discovered at a seminar. It was his opinion that it was exactly something like that, we needed in our department.”

— ***Mogens Heine Larsen, Section Manager, Process & Quality Service, Rockwool International A/S***

Our division is called Process & Quality Service, POP, and consists of eleven highly experienced process experts, all working for Rockwool International in Hedehusene. Half of them are based at our factories around Europe, travelling to our various production lines in the world. The experts’ tasks include helping our subsidiaries to solve problems with raw materials, processes and quality controls. Our consultants are all highly experienced, almost as if they have a built-in Proficy CSense, which decreases the daily needs. However, there is a need for new analytical tools that can provide new insights and help to “adjust myths”. The tool should not require deeper mathematical insights or to be difficult to use. We have now found all that we look for in Proficy CSense's Troubleshooter, working with GE Vernova partner, Novotek.

New Usage

We expect to make a great use of Troubleshooter to a whole new production process in our new factories, while at same use it in our existing environments. We also have a large ongoing project for automatic control of a complex production process, including environmental facilities.
An unexpected and very interesting use, currently being investigated together with Novotek, of Proficy is the possibility to simulate a production process in a simulator. This can be used for training our operators before they control the actual process. The “proof of concept” has been completed and we will continue by presenting the idea to the Directors who have the overall responsibility for training in correlation to introduction of new factories and production lines.

“There is no doubt that this software has a quick return on investment due to better analysis and optimization of processes.”

— *Mogens Heine Larsen*

Solutions:
Process optimization

Benefits: *Better analysis and optimization of processes*

Rockwool, A Global Leader

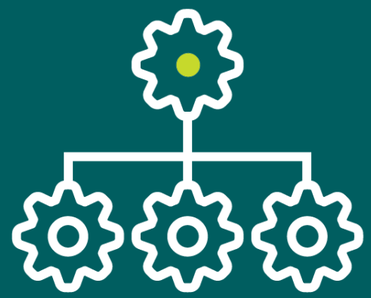
The Group is amongst the global leaders within the insulation industry. Together with other building-related products such as acoustic ceilings, cladding boards and consultancy business, the Group ensures energy efficient and fire-safe buildings with good acoustics and a comfortable indoor climate. We create green solutions for the horticultural industry, inventive special fibres for industrial use, effective insulation for the process industry and marine and offshore as well as noise and vibration systems for modern infrastructure.

THE SOFTWARE HAS PAID FOR ITSELF

We have chosen a setting where Proficy CSense's Troubleshooter is on a server, accessible to all consultants. However, only one user at a time can access the information, on the one license available. Getting all data was challenging at first, but once we got everything in order; it was easy to transfer between our systems. There is no doubt that the software has paid for itself as we got better analysis and optimization from our processes.

The possibility to analyze data from production has evolved from simple trending to a complete overview of the significance and correlation of these data. Proficy CSense is a tool that through the application of advanced mathematical algorithms, at the same time being easy for the user to use, gives an insight into the process that previously has not been available.

Mogens Heine Larsen,
Section Manager, Process & Quality Service,
Rockwool International A/S



USE YOUR INDUSTRIAL DATA IN AN EASY WAY

Proficy CSense enables engineers and operators to use the data from production to avoid mistakes and create simulations.

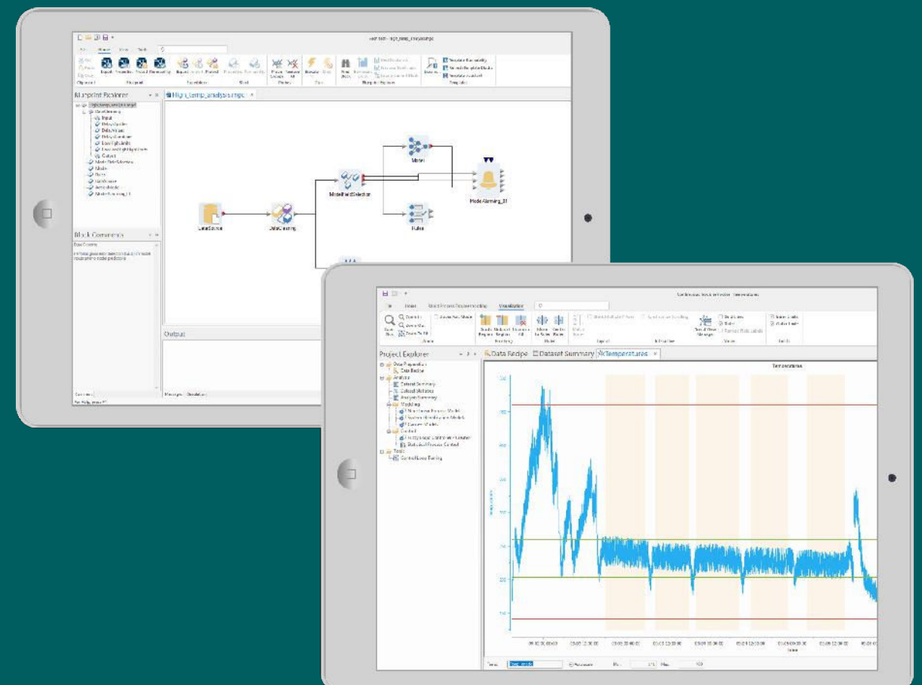
The result is knowledge of how and what is needed to improve the quality and yield of the production process, by using historical data, hence knowledge, intelligently to make it possible to identify the causes of the problems and variations in the process.

Prevent Recurring Problems

With Proficy CSense, you can now prevent future problems from happening by using modeling and thereby the ability to predict how the process will be developed. Proficy CSense can be used in wholesale, manufacturing and continuous process.

Numerous Usages

With the use of Proficy CSense and Troubleshooter, you can visualize process problems and their causes through modeling and simulation based on historical data. Proficy CSense becomes a digital Process Twin facilitating process intelligence and optimization. It requires knowledge of the actual process, but no knowledge about modeling, PCA etc., as this is not visible to the user.



Proficy CSense works with most historians on the market. Even data from relational databases and text files can be used. This gives the users more data to work with in the multivariate analysis of historical data.

With Proficy Troubleshooter you can:

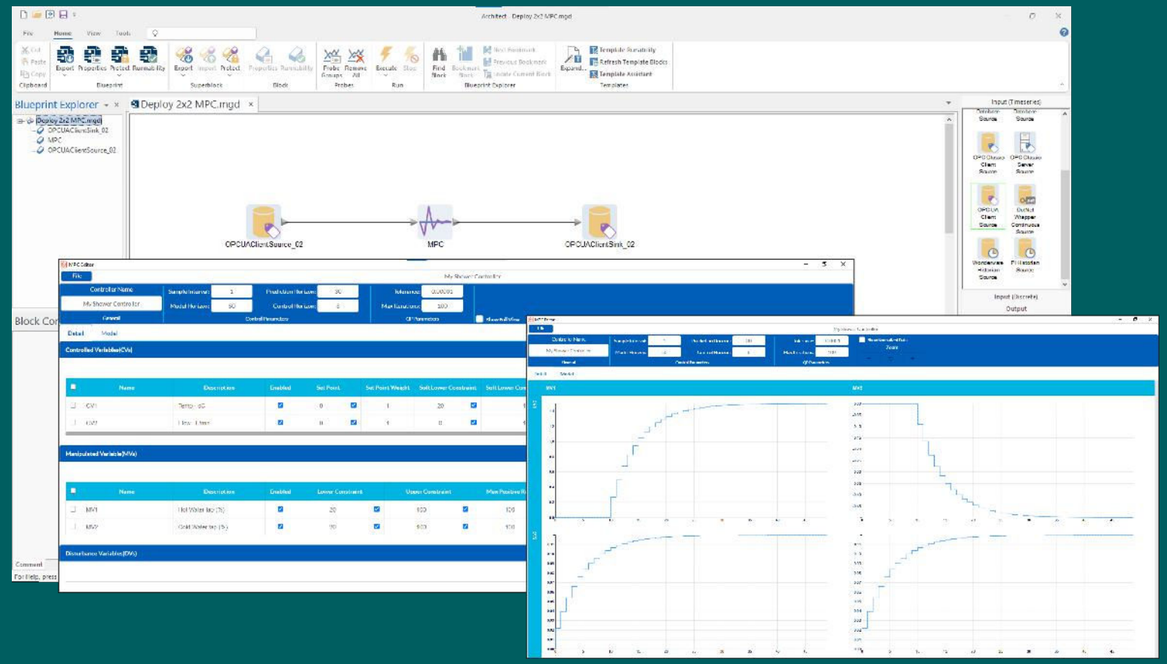
- Identify the likely causes of process problems and variations
- Identify process rules automatically based on historical data
- Identify correlations between variables
- Estimate the benefits of an online real-time solution
- Build and simulate the real-time solution

After the collected data is transformed into intelligent knowledge, it is used to find causes of process problems and variations, and to take real time corrective actions.

DECISION SUPPORT FOR OPERATORS

Profice CSense can, by using the models, provide feedback in real time on process events and thereby avoid discrepancies and errors. You can, step by step, expand the decision support for operators—directly integrated in the iFIX and CIMPLICITY HMI/SCADA screens or other HMI/SCADA software. As these decisions and guidance have proven its value, you can continue to expand with real-time control.

With Proficy CSense, we can ensure that operators and process engineers get immediate insight into the process status, the rules that drives the process in its current status, as well as identifying the process values that have the greatest impact right now. This is possible through a specially developed real-time component and provides a unique opportunity for operators and process engineers to constantly be alert and to avoid errors. The loop has been closed and we have now enhanced the intelligent HMI/SCADA system.



GE VERNOVA

LONMIN INCREASES SMELTER THROUGHPUT BY 10% WHILE IMPROVING RECOVERY

When platinum prices were at an all-time high, Lonmin wanted to maximize efficiency and unlock any hidden capacity in its process. GE Vernova previously helped the Lonmin concentrating section to solve some tough challenges, so GE Vernova was called in again to help with a bottleneck in the smelter area. This would prove to be the start of a new partnership in which GE Vernova would help Lonmin with its continuous-improvement journey through optimization and operational transparency.

Lonmin is the third-largest producer of PGM (Platinum Group Metals) in the world. The company's operations are located in the Bushveld Complex near Rustenberg in South Africa.

↑ **10%** increase in throughput in the filter and drying section

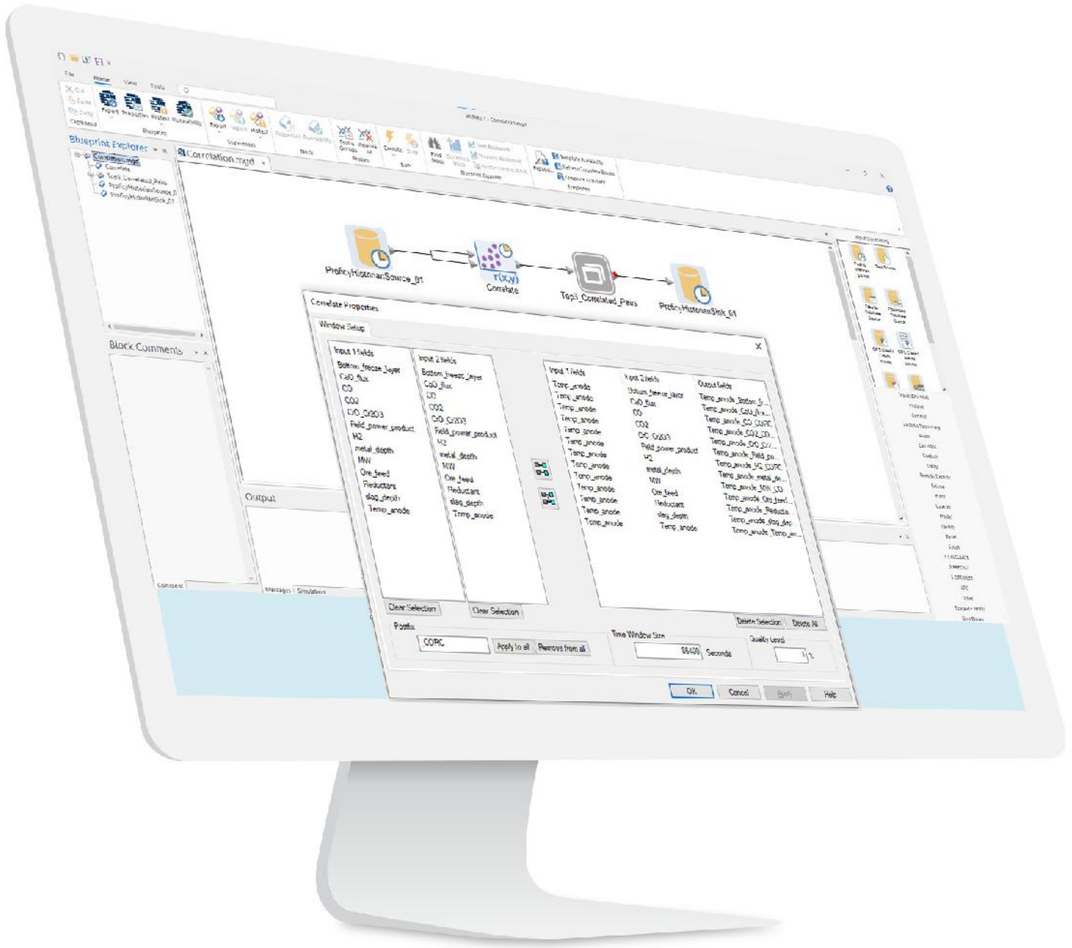
↓ **25%** decrease in variation in feed into the slag mill

↓ **45%** decrease in variation in cyclone feed pressure

SOLUTION OVERVIEW

The mine performance solution using GE Vernova's Proficy CSense analytics software was initially implemented at the filter and drying section of the Lonmin smelter operation to help remove bottlenecks and increase efficiency. Results were so positive that the solution was expanded to include several other sections in the smelter, and it was further expanded to include monitoring of the control systems.

As a next step, Lonmin plans to utilize the predictive analytic capabilities of Proficy CSense to increase uptime and decrease maintenance costs on its fans and blowers.



FILTER AND DRYING SECTION

The first section where the Proficy CSense solution was implemented was the filter and drying process.

At the time, concentrate could not be dried fast enough to meet demand from the furnaces.

Operators struggled to juggle the multiple interacting process variables. Excessive process instability due to varying filter cake feed and moisture content in the feed, as well as frequent trips were encountered, increasing the wear-and tear on the equipment. A holistic process control and optimization approach was needed that could not be provided by normal regulatory control.

After GE Vernova implemented the process optimization solution on this circuit, **throughput increased by more than 10%, consistently reaching maximum design capacity.**

Temperatures stabilized and costly trips were eliminated. Even in recent times with depressed metal prices, when throughput is not the main priority, Lonmin continuously uses the solution to ensure that equipment damage and costly inefficiencies do not occur.

SLAG CONCENTRATOR

Another problem area in the smelter was the slag plant, where material from the furnaces are concentrated and recycled back into the process.

Design limitations in this circuit caused major instabilities in the milling section, which impacted the whole concentrator.

Spillages were frequent events, which further wasted production time.

GE Vernova's Proficy CSense stabilized the in-mill density and float feed rate and ensured optimal cyclone operation. A performance evaluation post-implementation showed a 25% decrease in variation in the feed and a 45% decrease in variation in the cyclone feed pressure. Overflows are now a thing of the past.

The overall impact on the stability of the concentrator ultimately led to greater recovery, which is up 1.5%.

Although other factors also played a role, the process-optimization module was a major contributor. Every percent extra recovery in the smelter area has a direct impact on Lonmin's bottom line—saving millions of dollars in metal that would otherwise have been lost.

OFF-GAS HANDLING PLANT

The third area where process optimization was applied was the gas cleaning plant, where the offgas from the furnaces and converters is treated.

At this stage, Lonmin had some issues with sulfur dioxide emissions, which exceeded the allowable limit.

The process dynamics were complicated, and there was large variability in the sulfur dioxide concentrations in the feed that the conventional controllers could not handle. This caused large disturbances in the process, which led to high emissions.

The advanced controller stabilized the pH control in the absorber, which brought the emissions back into range. The GE Vernova process experts also made some recommendations during the investigation phase that improved overall stability of the plant.

PROCESS MONITORING

Lonmin's smelter also uses the monitoring tools and services to optimize the performance of its base-layer (PID) control. The automation manager and his staff can immediately see where the control inefficiencies lie and apply resources where it matters most. They are managing the process proactively, receiving early warnings of changing process and asset conditions. GE Vernova process experts also have weekly calls with Lonmin control experts, augmenting the team onsite with GE Vernova expertise developed by monitoring a multitude of plants and processes.

The Lonmin plant has seen unprecedented stability in the years since monitoring began.

“WITHOUT THE [GE VERNOVA] SOLUTION, WE WOULD INCUR ADDITIONAL COST FOR INEFFICIENCIES AND WE WILL DEFINITELY HAVE EQUIPMENT DAMAGE DUE TO OUR INABILITY TO CONTROL THE PROCESS IN THE SAME WAY AS AN ANALYTICALLY-DRIVEN SYSTEM.”

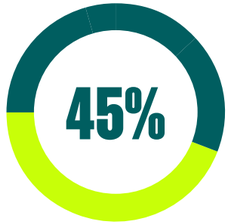
— **Percy French**
Automation Manager, Smelter, Lonmin

SUCCESS ON MANY LEVELS

Although there were some normal change-management challenges with the real-time optimization modules, the software now is an integral part of the Lonmin smelter operation, with operators being heavily reliant on the solution to run the process optimally. The solution has been able to provide significant value throughout the Lonmin smelter:

increase in throughput in the filter and drying section

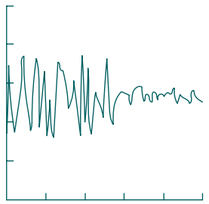
decrease in variation in feed in the slag mill



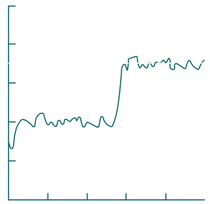
decrease in variation in cyclone feed pressure

1.5%

Geater recovery in the slag plant



Stabilization of pH control in the absorber in the gas cleaning plant

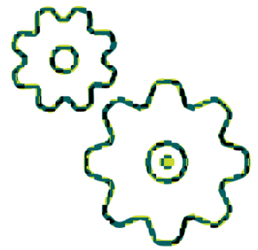


Optimization of performance of baselayer (PID) control

PLANS FOR CONTINUED IMPROVEMENT

According to Percy French, Automation Manager at the smelter at Lonmin, Proficy CSense has helped him to “highlight more and more potential areas for improvement.” As a next step, he plans to implement the predictive monitoring capability of the solution on some of the smelter’s critical equipment, including fans and blowers, to help reduce failures and prioritize maintenance.

> *“The software is running and the people are used to it, it’s very difficult to manage without it.”*
>
> — ***Percy French***
> *Automation Manager, Smelter, Lonmin*



GE VERNOVA

ABOUT GE VERNOVA'S PROFICY® SOFTWARE & SERVICES

GE Vernova's Proficy® Software & Services empowers teams, illuminating the path to a greener, more profitable future. Our proven industrial software accelerates innovation, enables connected workers, and operationalizes sustainability. We're driving measurable progress for over 20,000 diverse customers around the world.
The Proficy portfolio includes cloud-based and on-prem HMI/SCADA, MES, industrial data management, and analytics. Our software solves the toughest industrial challenges and is used in applications such as discrete, hybrid, and continuous manufacturing; utilities automation; metro transit; and much more. Proficy offers architecture flexibility including single machines, remote substations, and complex, distributed networks that span multiple factories and geographies.

Explore Proficy Software & Services