

Eldorado
Celulose

SELF-DRIVING MILL



There is a lot of news available about Google, Uber, and the automobile manufacturers' efforts to develop autonomous automobiles (i.e., unattended and self-driving vehicles capable of sensing their environment and navigating without human input). On the other hand, there has not been much news about efforts to develop an Autonomous Pulp Mill. Until now.

The development of the Autonomous Mill is following the same path as that of the autonomous auto. First, smart sensors and instruments were required to reliably collect data. Next came secure and robust communications methods to move the data from the mill floor to a control computer, and back. And now comes the software and human expertise to combine equipment data with data pulled from process computers (DCS) and data mined from a mill's enterprise-wide computer (ERP) to "navigate" the best path for production and profits. That software/service is called Optimization of Process Performance (OPP) and is offered by ANDRITZ.

OPP has been around for over a decade, and is being implemented in various forms at about 50 mills around the world. However, the most ambitious – and arguably the most impressive – work just completed its

first year of testing as the Autonomous Mill project at Eldorado Celulose's mill near Três Lagoas (MS), Brazil.

AUTOMATED – AUTONOMOUS

Autonomous means self-governance: satisfactory performance despite uncertainties in the environment – with the ability to compensate for system failures without external intervention.

"Autonomous implies acting independently," explains Leonardo Soares Figueiredo, ANDRITZ's OPP Project Manager at Eldorado. Figueiredo is a member of a new group within ANDRITZ called ANDRITZ Process Optimization (APO). "Most of our work at Eldorado to date still has an operator in the driver's seat, so perhaps 'automated mill' more accurately describes what we are doing today – with an eye toward autonomy in the future."

Carlos Monteiro, Eldorado's Industrial Director, does not care whether it is autonomous or automated. Monteiro is focused on results. "I can tell you this," he says, "the results in the first year have been impressive."

Bottom line: an increase in operational efficiency from 89.2% to 93%; variable cost reduction of 5%; 38,000 admt production over the budgeted amount; controls in automatic mode 95% of the time.

OPP A "BIG DIFFERENCE"

A 3.8% boost in operational efficiency may not sound like much. But in a mill designed to produce 1.5 million t/a – and currently producing 1.7 million t/a – that amounts to millions of Brazilian Reals. That Eldorado operates sustainably at 13% above design without any additional capital investments is testament to the efficiency.

Why does a mill operating in the top-tier globally choose a service such as OPP?

"We are single-line mill," says Leonardo Pimenta, Technical Control Manager at Eldorado and the leader of the OPP project. "We are well-managed and have tight cost controls. But we can always improve our position. We focus on every detail to stay ahead of our competition. OPP is a tool for helping us stay ahead."

AUTOMATIC MODE IS CRITICAL

"Central to achieving results is the knowledge that processes are better controlled by automatic advanced process control strategies compared to operator intervention," says Pimenta. "Stability is a key issue in a mill. The fewer surprises, the better the performance. Every loop in auto makes us money."

When ANDRITZ proposed a pilot project on the Eldorado fiberline, the main targets were: 1) that all main processes would be controlled by Advanced Process Control (APC) strategies; 2) that over 95% of the control loops would be available in automatic mode; and 3) that the APC routines would be turned on at least 90% of the time.

"We believed that if we could achieve those targets, our operational stability would be

over 90% and our variable costs could be reduced between 5-10%," Pimenta says.

"They were pretty high targets, especially for a well-run mill," Figueiredo admits. "But, Eldorado and ANDRITZ were both committed to achieving them. We signed an agreement in August 2016 with the idea that we would have all the front-end work done by the end of the year so we could start measuring results in January 2017."

"PUT ALL OUR EFFORT INTO THIS"

There are various "flavors" of OPP in various mills, according to Arthur Santos, OPP Technical Specialist at ANDRITZ, ranging from evaluation and tuning of control loops to more complex data mining and integration of separate mill databases. The one thing in common is that

the work is done in collaboration with mill personnel – operators, technical resources, and management.

"However, Eldorado is unique in that from the very beginning we formed a joint team that works together daily," Santos says. "In the same room you can find Eldorado process engineers and maintenance reliability engineers and ANDRITZ OPP analysts. We interact constantly, collaborating and solving problems together."

According to Pimenta, when Eldorado decided to go with OPP, it did so in a big way. "We chose to apply all the concepts and all the technologies that OPP offers at the same time," he says. "We didn't want to do it in pieces, but all at the same time and as fast as possible. That's the Eldorado way."

Leonardo Pimenta, Technical Control Manager, meets with the OPP team to discuss progress. The team consists of Eldorado process engineers, reliability engineers, and ANDRITZ OPP analysts working side-by-side.





Eldorado Celulose's senior management team (left to right): Luiz Roberto Araujo, Maintenance; Marcos Steyer, Woodyard and Chip Preparation; Murilo Sanches, Recovery, Utilities and Energy; Leonardo Pimenta, Technical Control Manager; and Marcelo Martins, Production Manager.



(Left to right): Luiz Roberto Araujo, Maintenance Manager; Fabio Castro Soares, Instrument Technician; and Rafael da Silva Teodor, Electrical Maintenance Specialist, look on as Reliability Engineer Uliam Mazzardo Veloso shows the asset risk profile that is updated in real time in the OPP system.



Daniel Scigo of Eldorado, demonstrates a new smart sensor (an online shive measurement device) that is a new input to the APC strategy for Eldorado's fiberline. This ability to easily add new variables into existing controls is part of the OPP software strategy leading to an Autonomous Mill.



Ernandes Silva, Fiberline Operator (left), with Ederson Reis, Technical Assistant for Fiberline. After implementing OPP's advanced control, the digester has run with excellent stability and purges of the third screen have been eliminated. Several production records have been broken in 2017 after the implementation of OPP.

FRONT-END WORK PAYING OFF

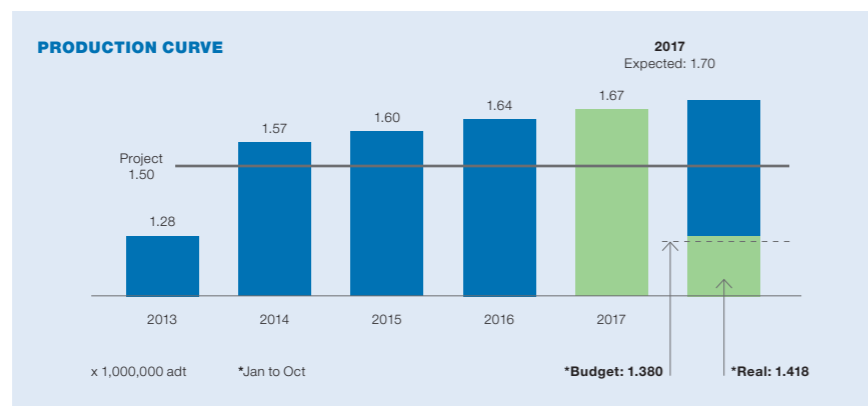
Santos believes that the front-end work of analyzing control loops and then "tuning" each loop is responsible for helping achieve the results Eldorado is seeing today. "It all starts with reliable data, which comes from reliable instruments and sensors," Santos says. "We completed over 40 projects using combinations of smart sensors, APC, loop tuning, data mining, etc., that that created the infrastructure and a standardized way of operating."

The OPP team started the development of APC modules for the fiberline processes. Causticizing and the drying machines were added later. By January 2017, 25 APC routines were completed developed and more than 50 loops tuned, progressing the fiberline from basic control to "hands off" and even "eyes off" operation so that operators could safely turn their attention away from mundane control tasks.

Was there ever a moment when operators resisted the Autonomous Mill project or feared for losing their jobs?

"Not really," says Pimenta. "This is not about replacing an operator; it's about re-assigning an operator to have time for more highly leveraged tasks. If you think about it,

even the best operator in the world can't be alert and on duty 24/7/365. An automatic control loop can. However, it is very important to have a high-performing team, strong leadership, and the right culture for this mindset to work well. People are our focus and our competitive advantage. So, changing the management model of a modern industry is a challenge and this must be taken into account."



FIBERLINE STABILIZED

Ederson Reis, Eldorado Technical Assistant for Fiberline, was active in seeking the input from operators and explaining the benefits to them. "We involve operators in every phase," he says. "They quickly began to see how automatic control makes their jobs easier."

An example is a problem that Eldorado was having with the hydraulic balances inside their massive digester. "We used to have to backwash the third screen in the digester every three days, which cost us time and production," Reis says. "After implement-

ing digester APC about one year ago, the digester has run with excellent stability. We have not had to purge the screen, so operators can work on preventative actions and more valuable things."

SUPPORT FOR RISK-BASED MAINTENANCE

Luiz Roberto Araujo is Maintenance Manager for Eldorado. He has three Reliability Engineers from his group working on the OPP team in a project to support the mill's culture of Risk-Based Maintenance by centralizing information from the process and the equipment in the same database.

Sounds easy enough, but the volume of work is quite challenging. ANDRITZ OPP analysts have tapped into the mill's SAP maintenance planning software to get vital information about Eldorado's 23,000 assets in the database and combine this with process information from the DCS. The team is working to make this a two-way communication between the databases.

"This gives us a new level of knowledge about our assets," Araujo says. "Understanding the process is fundamental to understanding the health of our mill. Identifying the risks early avoids unplanned stops."

The team has categorized each asset A, B, C, or D depending upon the critical importance of the equipment to the mill's operations. "We monitor the risks for each asset, and focus our attention on the highest priority risks to our most critical assets," Araujo explains. "One glance at a computer screen shows us where to focus our efforts to avoid unnecessary shutdowns."

The result? "We're operating at 95% overall equipment availability," Araujo says. "That is an excellent result."

KPIs MET

Early in the project, Eldorado and ANDRITZ set clear goals against which to measure success. These goals, known as Key Performance Indicators (KPIs), form the basis for 30% of ANDRITZ's compensation, so are important. What gets measured gets done.

"Setting the correct KPIs requires very open discussions between a mill and us," says Luis Binotto, Senior Vice President of ANDRITZ's APO group. "Their targets are our targets. There is only one team here."

The three KPIs selected most critical are: 1) operational stability in the 90-93% range; 2) a reduction in variable costs vs. budget; and 3) all the APC routines will be turned on at least 90% of the time.

There is a very definite correlation between OPP and operational stability – which leads to higher throughput. In less than one year, some important milestones were achieved:

a new record for quarterly production from January to March; a new monthly production record (average 5,045 admt/d) in May; a new quarterly production record from April to June; and in August a new average production record of 5,105 admt/d was set.

ALWAYS MORE TO DO

Underway now is an OPP project to determine the best Production Mill Balance at any given time. "Think of it as level control for the entire mill," says Santos. "We are writing software to monitor all the tank levels in the mill and combine this information with key process variables. This will guide us in knowing when to increase or decrease production of specific processes. At first, this will be a decision-support tool. But as supervisors gain confidence in it, it will run autonomously, precisely ramping processes up or down to keep Eldorado at optimum production."

In addition to Mill Balance, there are projects involving the lime kiln, recovery boiler, bleach plant, and drying machines.

"We are also working on an Augmented Reality (AR) project to help maintenance people get instant information in the field simply by looking at a piece of equipment with AR glasses," Pimenta says. "And we are quite far along with making checklists for operators and maintenance people available on their mobile devices."

"A BIG DIFFERENCE"

According to Monteiro, OPP has made a "big difference" in Eldorado's performance.

"In a short time, we have achieved excellent results," he says. "Every loop in APC makes us money. Selfishly, I would prefer if no other pulp mills would investigate OPP. But even for those who do, we intend to keep pushing, and to stay ahead."

"I suppose there are some people who believe that the Industrial Internet of Things (IIoT) is just a marketing gimmick," says Daniel Schuck, Vice President of Technology for ANDRITZ APO. "Maybe they said the same thing about transmitters and early distributed control systems. But what we are doing is not pie-in-the-sky fantasy. We are using new tools to do traditional things – saving mills millions of dollars a year."

"The commitment of our operational team was fundamental to this project," Pimenta says. "We might have tried to do some of this alone, but we chose to bring in an experienced partner with ANDRITZ. They have the tools and the experience to help us reach a much higher level of performance faster. I don't see any good reason to wait. Our results show that there is a lot to be gained by extracting the hidden capacity from our assets before having to make additional capital investments."

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