HONEYWELL FORGE

ACHIEVING PLANTWIDE OPTIMIZATION

LATAM's largest mining operator undertakes its first AI/ML-driven APC Optimization

Case Study

OVERVIEW

Located in central Chile, east of the city of Rancagua, the Teniente mine is the largest underground mine in the world.

Operated by the largest mining company in LATAM, the site boasts an enormous operation with an extensive underground labyrinth of tunnels.

Comprised of six main mining blocks, the world's largest underground mine has extensive infrastructure to support it. There are over 3,000km of tunnels, and around 1,500km of underground roads.

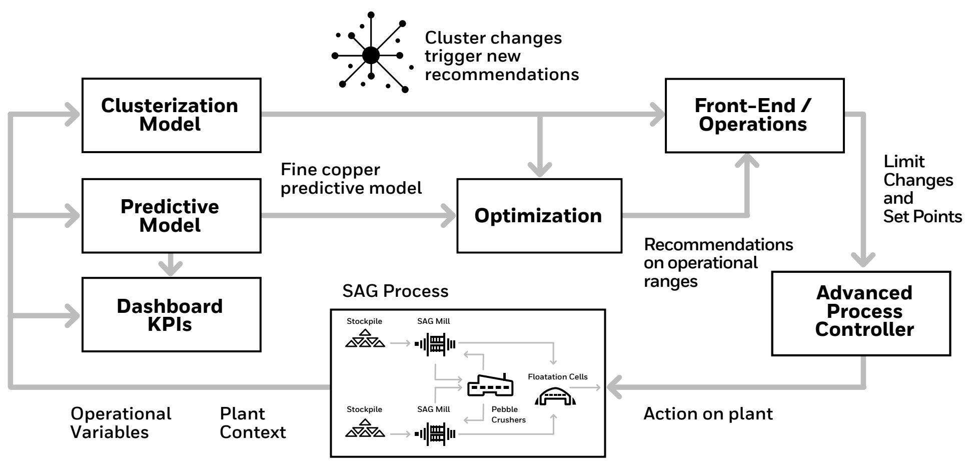
A 3.5km tunnel connects the mine itself with the outside world. A railway system delivers ore to the surface, where it is transported to crushing plants on a conveyor belt. Once processed, the copper concentrate is moved to a smelter.

El Teniente employs 4,000 full-time workers, with a further 11,000 on a contractual basis.

CHALLENGE

Trying to improve an optimized plant is difficult. The plant already had a highly tuned and utilized APC, as well as other high-end control systems and tuning applications. Improvements needed to come from disruptive ideas and technologies.

The Kairos team, with experts from the client and Honeywell, had already been working on exploring Artificial Intelligence and Machine Learning. They believed leading-edge technologies could increase performance.



The team set up to build an application based on machine learning models – delivering actionable recommendations to increase fine copper production.

First, supervised and unsupervised machine learning models were developed with variable inputs of control and plant context. Then, through an optimization algorithm, it generated recommendations for grinding and flotation that maximized fine copper production. The system was aware of the existence of the advanced process control (APC) layer that the equipment possessed; it became a bridge between advanced analytics and APC.

The initial phase was the SAG process, consisting of two SAG mills with two ball mills each, in addition to a pebble crushing plant, and then the flotation process contemplating rougher cells, scavenger cells and cleaning columns.

The objective was to maximize the production of fine copper by suggesting actions on the control variables of this equipment. It separated the variables into operational variables, on which we can recommend and act, and those of plant context, including upstream or downstream information, and fed them to predictive machine learning models.

The final output of the models was fine copper that was capable of being produced for the current plant context, given the operational variables at that time. The models were passed to an optimization stage based on Monte Carlo models with Markov chains. These looked for the operational variables that would maximize the fine copper predicted by the models.

This was translated into actionable recommendations that were reported to operations through an interactive front-end, where graphs of the plant context, time series of the variables of interest, operational limits, and suggestions for changes on those limits were displayed. These could be accepted or rejected through the interface. The accepted recommendations were written directly to the advanced control layer - to act on the plant.

A clustering model based on key context variables was added, that defined characteristic modes of operation. When a change in operating mode was detected, the optimization routine was triggered again to generate recommendations that were adapted to the new operational context.

Finally, a KPIs dashboard was developed to monitor the performance of the models, the use and adherence of the platform, and reports of productive impact.

BENEFITS & RESULTS

A pilot was launched to implement the recommendations of the flotation model, showing an increase of 0.9% in recovery during the pilot month vs. previous month. This was achieved through stabilization of the recovery in the different ranges of mineral treatment, which was previously inverse to recovery (decreasing with more mineral processed). On the grinding side, the processed mineral base increased by 3.5% during 2019, driven by the detection of bottlenecks and piloting that led to changes in operational standards, all based on the recommendation system.

The success of this initiative, as well as its ability to be replicated with minimal changes, due to the self-learning and adaptability of the underlying technologies led to the development of Smart APC, the first Artificial Intelligence standard application for Mining plant optimization in the market.

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