HONEYWELL FORGE

BEYOND TRADITIONAL PLANT OPTIMIZATION USING AI/ML

The first Artificial Intelligence/Machine Learning driven Advanced Process Control optimization

Case Study

MINING FOR EFFICIENCY

A large-scale mining operation located in Chile, owned by a top 5 Base Metals global leader, wanted to increase its productivity.

This particular operation had been running a long term improvement plan, one that achieved a high level of productivity and automation and was recognized as leader among peers in these areas.

FINE COPPER AND CRUSHING PEBBLES

Trying to further improve an already-optimized plant is a difficult task.

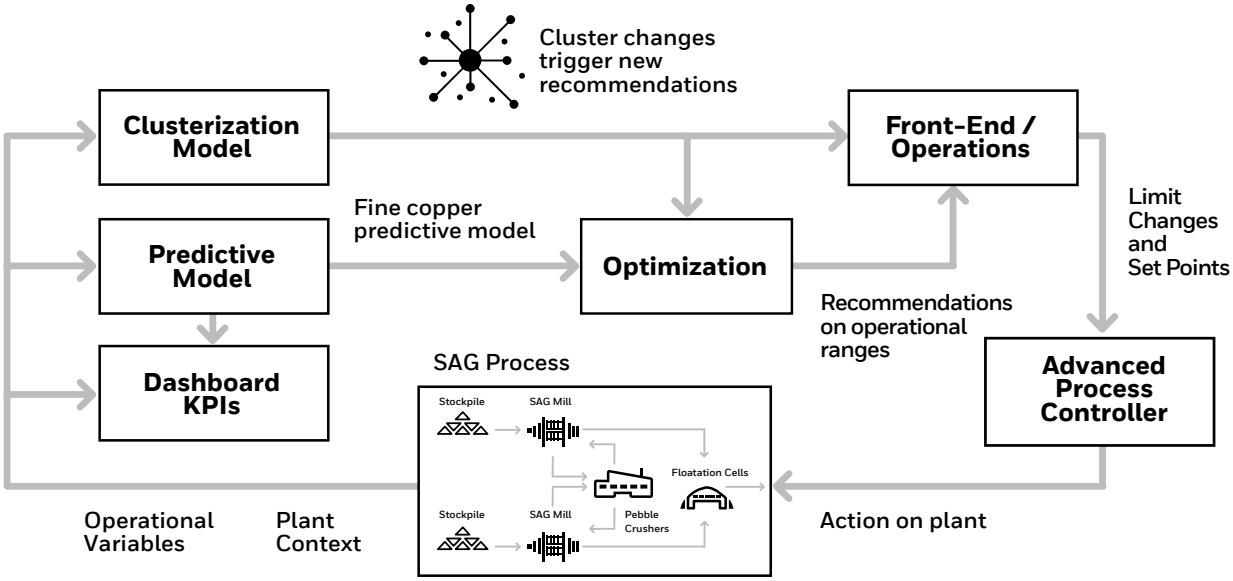
The plant already had a highly tuned and utilized Advanced Process Control (APC), as well as other high-end control systems and tuning applications, so improvements needed to come from truly innovative, disruptive ideas and technologies

The Honeywell Mining team had been working on several initiatives exploring Artificial Intelligence and Machine Learning, so they believed these leading-edge technologies could be the solution for increasing plant performance.

The team set up to build an application based on machine learning models, one that delivers actionable recommendations to increase fine copper production.

For this, supervised and unsupervised machine learning models were developed that received as variable inputs of control and plant context, and then, through an optimization algorithm, generate a list of recommendations for grinding and flotation that maximized production fine copper. The great added value was that the system was aware of the existence of the advanced process control layer that the equipment possessed, and therefore it was designed to be a bridge between advanced analytics and advanced process control.

The initial phase was the Semi-Autonomous Grinding 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 (upon which the teams can recommend and act) and those of plant context, including upstream or downstream information, and feed them to predictive machine learning models.



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

A SUCCESSFUL PILOT

A pilot was carried out to implement the recommendations of the flotation model, showing an increase of 0.9% in recovery during the month of the piloting compared to the previous month. This was achieved through the stabilization of the recovery in the different ranges of mineral treatment, which was previously inversely related 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.

Honeywell Connected Enterprise
715 Peachtree Street NE
Atlanta, Georgia 30308
www.honeywell.com

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THE FUTURE IS WHAT WE MAKE IT

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