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HIGHER PRODUCTION PLAN REALIZATION THROUGH DYNAMIC SIMULATION

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ABSTRACT

Production plans are based on fair assumptions of process performance and all operation parameters are taken as averages. There are a number of events that happen in any manufacturing setup during the course of production like periodic delivery of raw materials or changeovers on a machine. The interaction between these events is non-linear and cannot be easily visualized. As a result of which most of the production plans in any company have only a limited realization. This paper provides an example of how simulation using Anylogic has been applied in one such plant scenario to visualize the plan outcome.

1 INTRODUCTION

The client is a leading manufacturer of gold and silver products in India. The plant receives raw material in the form of impure bars. This raw material then undergoes multiple processes such as melting, refining, graining and casting to be transformed into products. The production process is a mix of discrete and process manufacturing. In Figure 1 we have given a overview of the entire process.

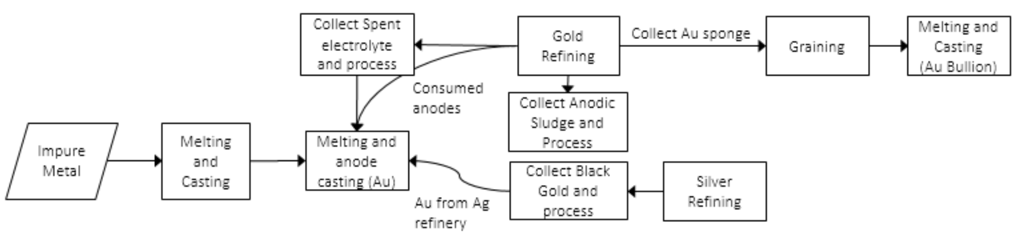

Figure 1: Overview of Production Process (Gold Refining).

2 PROBLEM DESCRIPTION

The company operates in a Make-To-Order (MTO) environment. This requires promising a delivery date to the customer. Hence creating a feasible plan and giving realistic delivery dates to customers is critical. The existing planned vs actual production variance was as high as 35% on some days. Following complexities in the production process had to be modelled

- The impure metal contains both gold and silver along with other impurities. As a result some gold is recovered from silver refinery and some silver is recovered from gold refinery. So the manufacturing routes are not unique by products
- Only about 70% of the input material in the form of impure anodes is dissolved. The leftover anodes from the electrolytic process needs to be periodically collected and recycled back into the process.
- The chemical composition of the electrolyte needs to be maintained. Hence we need to replenish the electrolyte for refining (min-max planning).

- The refining banks need to be near fully loaded to get the optimum output. If the quantity of input material in the refining bank is less than a threshold then the output of the bank falls exponentially.

Multi-method simulation was chosen as an approach to model the processes and accurately predict the daily refining bank output and bullion output. Simulation also provided opportunity to see the behavior of the system with time (like machine capacity utilization) and tweak the parameters to get the best results.

3 METHODOLOGY

The refining banks were modelled using system dynamics(SD) principles. This was done because the output rate of deposition depends on the quantity of gold in the bank which is continuously changing. We empirically determined the relation between the deposition rate and the quantity of residual gold in the bank. For the melting & anode casting process and for the melting & bullion casting process we used discrete event(DE) modeling as the parameters are stationary. The simulation model was created on Anylogic.

Figure 2 describes the different modeling approaches used, the SD and DE part are connected using events. Some events are periodic, such as collecting gold sponge from refinery every 8 hours. Other events are based on reaching a threshold quantity, such as min-max planning for replenishing electrolyte. The simulation model is run every Monday morning for next two weeks.

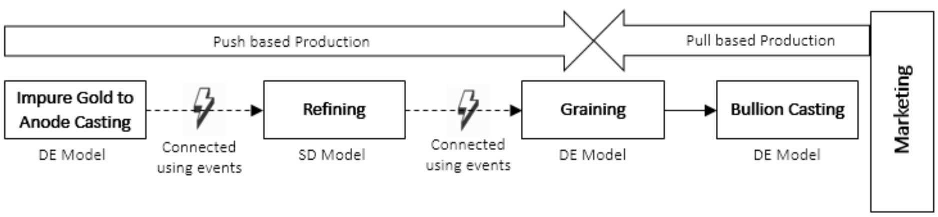

Figure 2: Modeling approach used.

4 RESULTS

The planning team is now able to create a feasible plan using the model. A comparison of the planned versus actual production is shown for a week in Figure 3. The mean absolute percentage error(MAPE) of planned versus actual production is down from between 20% to 35% to about 3% to 5% using the simulation model.

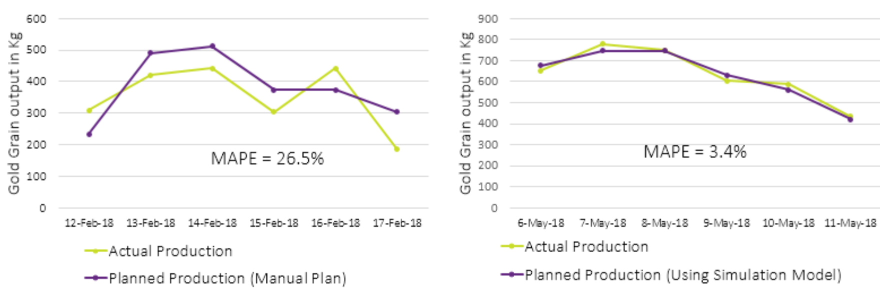

Figure 3: Comparison of Planned versus Actual before and after the project.