Decision Making for Downstream Processes in the Event of Upstream Delays

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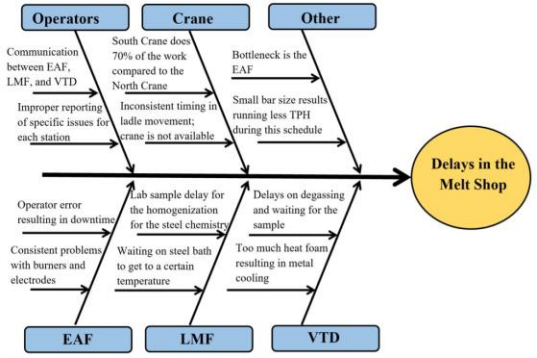
Gerdau Fort Smith Steel Making Process

Gerdau's Fort Smith Mill produces steel billets in a six-step steel making process, each with availability for two molten steel ladles. The steel scrap is first collected and sorted. Second, the scrap metal is charged into the electric arc furnace (EAF) to convert solid raw materials into liquid crude steel. Third, the molten metal is taken to the ladle metallurgy furnace (LMF) to further refine its chemistry and temperature.

Fourth, a vacuum tank degasser (VTD) is used to reduce the concentrations of dissolved gases in the molten steel. Fifth, the molten metal is delivered to a continuous rotary caster to make steel into billets. Finally, the hot rolling process raises the temperature of the metal over its recrystallization temperature which allows the steel to be molded into desired geometries and tolerances.

Upstream Delays Impacting Downstream Processes

Gerdau is interested in increasing the average tons per hour (TPH) output by the system, by increasing the efficiency of delay communication and caster speed. Through stakeholder analysis, we discovered that delays within the system show a large amount of variability. The biggest problem being the collection and usage delay data. With floor managers (GTFs) having 30+ years of knowledge, the impact of various delays are determined by experience rather than historical analysis.

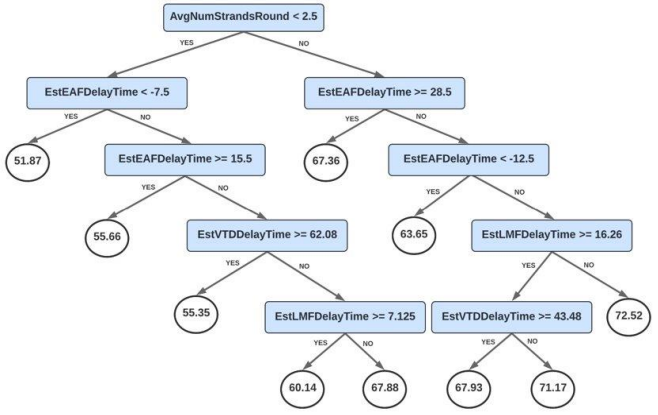


Our Plan for Achieving More Efficient Delays

Our goal for Gerdau is to create a tool that not only allows for a more efficient use of data to aid in decision making for caster speed, but to also aid in better data collection. The system design is comprised of four subsystems: data collection, data analysis, monitoring, and usability.

Decision Support Tool for Caster Speed

To create the decision support tool that uses historical data to recommend an operating TPH, we performed various types of regression models. We attempted to model expected operating TPH as a function of station delay time and number of casting strands being utilized. We did this through running multiple kinds of regression analyses such as multiple linear regression, decision tree, and random forest. Below is our decision tree.

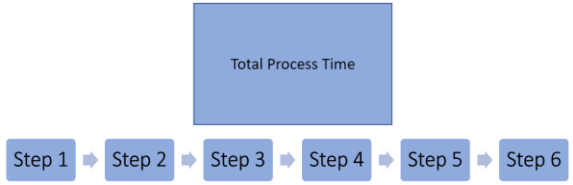


Through our analysis, we decided that using a multiple linear regression model will most accurately represent the current historical data being used. The information from this regression will be made into an equation for the operator to use upon delays at the EAF, LMF, and VTD.

$$Suggested\ TPH = (E \times -0.020) + (L \times -0.016) + (V \times -0.052) + (S \times 11.23) + 38.93$$

Data Collection Tool for Future Analysis

Our data collection tool will enable Gerdau to track the progress of each station with the click of a few buttons. Each station will have an individualized, separate program for tracking the time it takes to complete the sequential steps at that station. The data collected will be combined into one large file for future data analyzation. The tool will also allow for system visibility for the floor manager to better monitor the progress of each step.



Tool Usability for Stations and Floor Managers

The floor manager and each station will have access to different parts of the tool. Each station will have the capability to collect its own, time-stamped, data using buttons. The floor manager will be able to input this data from the collection tool every 12 hours. The floor manager will also be able to use the decision support tool to aid in decision making for the caster speed by entering estimated data into an equation. This data will be beneficial for future analysis of the delay impact on caster speed.

Impact on Pacing of the Melt Shop

The floor manager will now be able to see where a unique heat load is within its specific process step. Station processing times from this heat load will be placed into an organized excel file for future analysis of system performance. Decisions for downstream pacing upon upstream delays will now be aided by a tool that utilizes historical data to recommend an operating caster speed based on station attributes. This will potentially allow for more efficient pacing and quicker decision making in the event of delays. Our tool opens opportunities to explore future melt shop pacing to increase TPH through improved process visibility and documentation.