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Predictive-Prescriptive Quality Control in the Steel Industry: A Synergy of Human Knowledge, Machine Learning and Auto-mation Framework

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Quality Control is an established process for all metals manufacturers. However, identifying a critical quality deviation at the finished product stage can be cost-intensive. Not only is the original order affected by delays due to late deallocation, but the reallocation of a finished product to a prime order becomes improbable, leading to a greater financial loss. Predictive-Prescriptive Quality Control aims to minimize finished product downgrades through a two-step strategy: first, by anticipating downgrade risk at the earliest possible stage; and second, by offering the best solution to mitigate this risk during subsequent production steps or by suggesting early deallocation. To achieve this goal, predictive models of finished product characteristics are systematically integrated into quality control operations at every suitable production step. These models use upstream data collected throughout the material's history, as well as downstream production instructions and expected process results, requiring comprehensive knowledge of the entire production route. The prescriptive model "inverts" the prediction by suggesting downstream changes to the material-specific production instructions to meet the target at risk. Such precise models are assumed to be not just business-specific but even plant-specific. Therefore, a synergy of metallurgical knowledge and machine learning methods (relying on plant-specific historical data) looks promising for delivering useful models. To operate such Predictive-Prescriptive Quality Control in an industrial environment, a stable Quality Management framework is required to orchestrate each model and quality operation and ensure synchronization with the MES—a pivotal task that should not be underestimated for achieving the goal in day-to-day operations. By gradually integrating Predictive-Prescriptive Quality Control into Quality Management, the potential of collected process data can be harnessed to systematically reduce deviations and downgrades.

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