Implementing IIoT and AI-Driven Process Optimization for Foundries

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Abstract: Implementing a proven IIoT solution can quickly deliver a real-time digital picture of a foundry process and build a consistent, trustworthy database for monitoring, reporting and analysis. Adding AI optimization maximizes the value of this process data and delivers performance improvements that are impossible with traditional manual techniques.

This paper will discuss how collecting and storing data via an IIoT system can deliver huge benefits for any foundry, from identifying bottlenecks, faultfinding and measuring energy consumption to scrap reduction and precise metrics for quality improvement.

It will explain how to bring together data from multiple vendors' equipment and other systems like ERP and MES via a single IIoT cloud platform, how a step-by-step cloud implementation minimizes project risk and how to effectively translate insight from the data into process improvements.

With an accurate foundry database available, full process optimization using service-based Artificial Intelligence (AI) and machine learning software is now a mature and proven route to large performance improvements. The presentation will share IIoT and AI learnings from multiple global foundry IIoT and AI implementations including Huaxiang (China), Condals (Spain), Morikawa (Japan) and MAT Group (UK). Deployed with application knowledge, AI has driven an average of 40% scrap reduction at these companies.

The paper will also discuss full casting-level traceability. This technology links every single casting to the process parameters used to produce it. This casting-level tracking enhances IIoT effectiveness in areas like faultfinding and scrap reduction, and improves AI modelling accuracy for faster, more successful optimization.

Keywords: digital foundry; IIoT; Huaxiang; Morikawa; MAT group; AI; process optimization

1 Introduction

The green sand process is complex. Each sub-process involves tens or hundreds of machines, material and other variables, from sand moisture content to pouring temperature. This complexity makes it challenging to manually monitor production and find improvements.

Troubleshooting often relies on experience. As more experienced staff retire, a skills gap appears and it's even harder to control casting quality, cut costs and lower emissions.

Digital is an effective way to find substantial gains. That may be lower scrap levels higher productivity, sustainability or equipment utilization.

2 Digitalization

A single IIoT (Industrial Internet of Things) solution is the best basis for foundry-wide digitalization. A secure in-house network connects sensors, PLCs, gateways and edge devices to a central storage platform. Sensor data is forwarded to the central database where it is stored and combined with other data from the whole process.

The central data platform should be instantly compatible – "plug and play" – with all other system components such as edge devices. The platform should be able to automatically import, check and store all input data while computing any required derived variables in real time.

Dashboards and KPIs should be able to be created and edited easily without any knowledge of SQL or the system's back-end coding or data configuration. This will allow every user to construct their own view of the data available to suit their actual needs.

The platform should include further visualization features such as charting, tabular reporting and color coding. The central platform's data and applications should be cloud-hosted. This makes it easier to link together multiple global sites to feed a single system, though this is also possible with an in-house system.

3 Optimization

Digitalization and analysis are effective in improving single sub-processes like moulding or pouring. But the complexity and volume of the data needed to optimize the entire green sand process overwhelms conventional analytics.

Artificial Intelligence (AI) is the solution, built on top of a mature data platform as described above. An AI-driven Expert Execution System (EES) like Norican's Monitizer | PRESCRIBE can consider all the process parameters from an entire production line in order to maximize one target variable: casting quality.

The AI examines historical data to learn how parameters like sand compressibility or pouring temperature influence each other and affect final casting quality. It calculates which combination of machine and

material settings will produce the best results for each pattern.

During production, the EES updates its recommendations for the control plan every 30 minutes in response to AI predictions based on real-time data from the line. That maintains stable, high-quality production, even as factors like air temperature or sand moisture content vary.

4 Casting-level tracking

Process data gathered via IIoT has many applications. But conventional batch-level data does not have the resolution needed to precisely pinpoint the root causes of quality problems.

That's because, even when a parameter like pouring temperature is sampled for every mould or casting, it's impossible to know which data points relate to which individual defective castings. There can be multiple, interwoven reasons for defects like porosity or sand inclusions.

Adding a unique physical ID to each casting allows each one to be tracked through the entire process. Scanning or digitally entering any casting ID calls up its individual process parameters and, if scrapped, its defect type from the process database.

Casting-level data will also reveal when in-tolerance process parameters interact with each other and cause scrap, something that is very hard to diagnose at batch level.

5 Digitalization case study: Grede

Grede is currently implementing IIoT and AI-driven optimization at all 10 of its US foundries. It is connecting its melt, sand and moulding sub-processes in the first phase, then AI in the second.

The main drivers of the project were to create a single standardized process database, replace slow manual data with automated collection, timestamping and data integration, give new staff more support, and to react very quickly to any operational problems. Upon full implementation, Grede's foundries will be able to see historical and real-time production data side by side, helping them to solve quality issues and prevent scrap.

6 Digitalization case study: Morikawa

Leading Japanese foundry Morikawa started implementing IIoT in 2021. It connected its entire casting process and began to use its data to implement AI-driven full process optimization.

The results of the first test showed an uplift of 66.6% and 86.9%, respectively for two different patterns.

7 Digitalization case study: Huaxiang

Huaxiang is China's fifth largest private foundry. It started implementing IIOT in 2021 and was implementing full process optimization within 2 years. Testing produced scrap reduction figures from four automotive castings of 86.1%, 57.3%, 46.6% and 30.3%.

8 Digitalization case study: Condals

Spanish foundry group Condals is a data-driven company; it takes decisions based on the data from its process. It delivered a step-by-step IIoT program that has so far connected three casting lines. During process optimization testing, Condals saw a 40% scrap reduction and that figure has continued to be improved.

9 Conclusions

Traditional manual techniques are insufficient for the needs of a modern green sand foundry. Digitalisation provides the data and tools required to manage and further improve casting production. An IIoT system that can collect and send data to a single, central database is the optimal solution. The central database must be easily accessed and be combined with tools that allow monitoring, visualization, reporting and analytics.

As the database builds over time, it becomes a foundry's most valuable asset. If desired, it can support AI-driven, real-time process control across one or more entire lines to deliver the most efficient and stable possible process.