Production engineering | Industrial automation | Improved process performance | Regression analysis

Optimizing thermoplastic composites manufacturing with digital process intelligence

BUSINESS PROBLEM

Oribi Composites is a thermoplastic composite manufacturing company specializing in the production of medium-volume thermoformed products. Such high-draw composite thermoforming is a challenging process unique to Oribi. To date, process parameters have been developed through learned experience and trial & error, with limited understanding of the underlying drivers of material behavior or product quality. As a result, yields for some products are quite low, and as the company looks to scale, improved process insight and control is critical to tightening product development times and reducing costs.

APPROACH

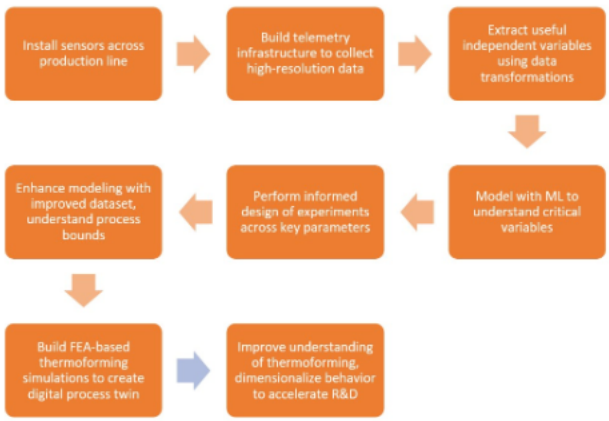
A suite of process and environmental sensors were installed across the manufacturing line to capture high-resolution data of the production process. In parallel, a telemetry & database infrastructure was built to stream this data and enable machine-learning based analysis. Leveraging those insights, targeted experiments were performed to understand drivers of quality and composite properties.

DATA SOURCES

This project included end-to-end data source creation and connectivity. Process sensors including temperature, pressure, current, flow, and environmental sensors were installed across the manufacturing line. Additional digital data sources such as infrared imagery were installed, with all sensors streaming through a custom telemetry system to AWS data lake and accessed via SQL.

Data Types and Format

Primary numerical data sources were streamed in a time-series format at 1-100Hz, depending on data needs. Triggered data collection was also implemented, including FLIR imagery and traceability data.



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IMPACT

Leveraging this high-resolution data and the series of experiments it enabled, scrap rates for the target product were sustainably reduced by 6X. This robust data telemetry infrastructure also provides the foundation for a scalable, multi-site digital backbone that will become the core to a machine intelligence program at Re:Build.

DRIVERS

Polymer composites are finding an increasing number of applications across industries like aerospace, automotive, sporting goods, and medical devices. However, traditional thermoset composites are expensive and slow to manufacture, increasing component cost. Thermoplastic composites have the potential to change this paradigm by enabling legacy high-volume methods of manufacturing like thermoforming to this industry.

BARRIERS

Oribi's deep-draw processes are highly unique in the industry, so little research has been done in the field around the properties that drive product quality, material behavior, or optimal process parameters. This challenge is compounded by the lack of documentation and experimental rigor in the culture at Oribi, which meant this project had to be built from the ground up in conjunction with a cultural shift towards science-first design.

ENABLERS

A culture of rapid change, engineering-led management, and strong executive support were all essential enablers of this process.

ACTIONS

This project involved the buildup of a data collection suite from the ground up. First, an initial suite of sensors were selected and installed across the production line. In parallel, a telemetry infrastructure and database system were built to send and receive this data. Finally, these systems were tied to a pre-processing suite and modeling software to extract valuable insights across a series of targeted experiments.

INNOVATION

The success of this project depended on multi-model data collection. Tying data from continuous, time-series, quantitative sensors such as time or coolant flow to triggered data capture such as infrared imagery was a critical enabler in distinguishing correlation and causation across process parameters.

IMPROVEMENT

The target product improved 600% over the course of the project when compared to the prior 6-month rolling average scrap rate, and this improvement was sustained month-to-month. In addition, it built a scalable data pipeline for deployment across future sites.

BEST PRACTICES

Adopting a broad, agnostic approach when tackling a novel question is critical to avoiding bias in the selection of sensors and modeling parameters. Avoiding inbuilt assumptions about the factors that were critical to the process enabled us to identify unexpected errors and correlations in our manufacturing processes.

OTHER APPLICATIONS

Such a system can be deployed across any manufacturing or experimentation line to better understand the correlation between process and environmental parameters with outcomes. Additionally, such a system should be core to any SPC or quality control program.