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Case Study

SCALING AUTOMOTIVE RUBBER OPTIMIZATION FOR THE DIGITAL ERA

INDUSTRY CONTEXT

Manufacturers of automotive rubber products grapple with variable input materials.

These compound other process optimization issues in tire production. In combination, adjustable interdependencies and uncontrollable factors can lead to excess waste if not understood completely. In an industry feeling pressure to achieve more energy-efficient production, data-driven techniques can shed light on the road ahead.

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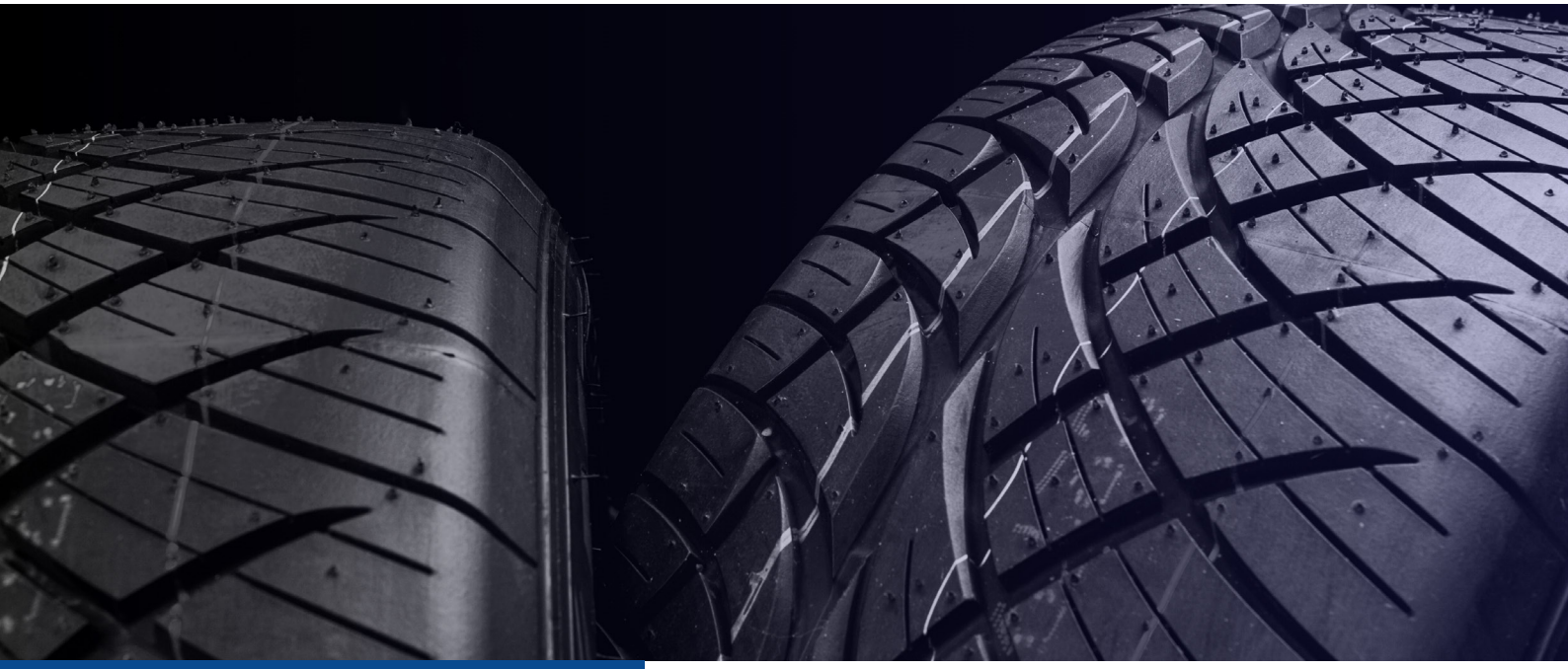
BACKGROUND TO PARTNERSHIP

A world-leading tire manufacturer engaged DataProphet to optimize its rubber mixing process, seeking a data-to-value solution that could also **accelerate its digital transformation roadmap.**



PROBLEM STATEMENT

The proprietary nature of the tire manufacturing process added complexity to outsourcing target quality optimization. Simultaneously optimizing the six target quality metrics was necessary. The solution would also have to account for variability in weather and raw-material quality.

USE CASE SCOPE AND OBJECTIVES

The project aimed to determine peak process efficiency for the tire manufacturing process.

DataProphet needed to deliver prescriptive optimization guidance for the manufacturing process to improve the six quality metrics on two product lines.

Strategically, the collaboration set out to help position the automotive OEM for successful process optimization in the digital manufacturing era.

METHODOLOGY

DataProphet adapted its techniques by analyzing and modeling the factory's historical process and quality data statically. Advanced data analysis methods revealed multiple best-of-best (BOB) operating regions. Contextualizing these operating regimes crystallized optimals based on a particular plant state over time.

KEY PLAYERS

The team consisted of functional manufacturing experts and data scientists from DataProphet, in collaboration with plant engineers and in-house data scientists from the tire manufacturer.

OUTCOMES

The manufacturer only previously targeted one metric for rubber mixing optimization. The DataProphet team deployed PRESCRIBE to optimize all six target quality metrics simultaneously.

The solution provided a unified view of multiple plant states for given periods. It accounted for hundreds of controllable and uncontrollable parameters and delivered context-based recommendations, handling variations in weather and raw material properties. The solution simultaneously resulted in a 39% average increase for all six quality metrics.

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ACCELERATING THE DIGITAL TRANSFORMATION ROADMAP WITH TRANSFER LEARNING:

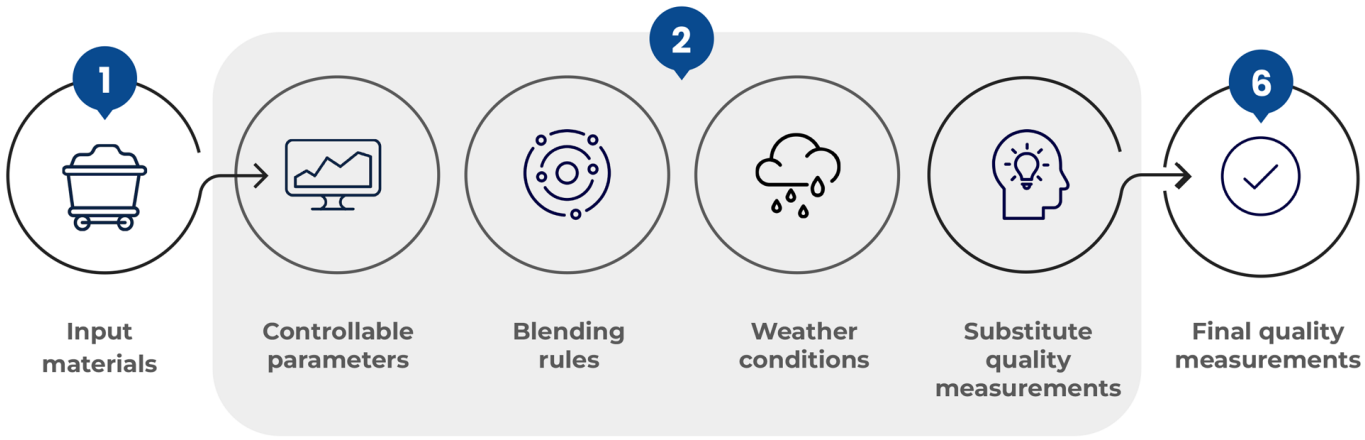
The collaborative partnership approach drew on the core capabilities of functional manufacturing expertise and data science.

The use-case discoveries described above were a proof of concept for a potential commercial partnership to embed in the tire manufacturer's digital transformation roadmap. Specifically, the partnership's mission was to systematically scale the data-driven insights and learnings across the customer's other rubber manufacturing plants.

However, working from the ground up, the tire manufacturer and DataProphet first looked at critical KPIs in one plant which the data-driven technology could target.

ESTABLISHING SIX KPIS FOR RUBBER MIXING OPTIMIZATION

Figure 1:



Initial conversations with the tire manufacturing experts revealed the need to address their rubber mixing process and quality challenges. As mentioned, these challenges presented opportunities to optimize the mixed compound product.

Collaborating with the manufacturer and its in-house data scientists, DataProphet relished adapting its solution. This adaptation meant addressing the data obfuscation and input variability constraints for high-quality rubber outcomes. Without access to the plant, the team agreed to explore the predictive capabilities of its data-driven technology with static data.

Six quality metrics on two product lines were targeted for simultaneous optimization, as illustrated in figure 1.

DATA-DRIVEN ANALYSIS FOR TIRE MANUFACTURING IN CONTEXT

The goal was to determine peak process efficiency for the tire manufacturing process. However, DataProphet needed its adaptive approach to leverage extensive data analysis of the six quality metrics without seeing the actual parameters.

As a project team member and DataProphet data scientist, Renita Raidoo explains:

> *"Typically, with deployments, DataProphet consults with plant teams on the factory floor to get a dynamic understanding of their process from input A to result Z. This means, for example, we can learn optimal temperatures and unreasonable values. Our teams thus apply some process knowledge while we train models and find optimal plant states with sight on specific parameters."*
>
> - Renita Raidoo

However, in this case, the data scientists did not have the luxury of inherent process knowledge to guide their decisions. By analyzing the data, they found a way to adapt their techniques.

"Preprocessing reduced the effects of outliers, and we identified appropriate imputation methods to handle missing data points," said Raidoo.

Jumps in the data suggested production regime changes. Digging into the regime changes yielded valuable optimization insight. The team observed that the plant operated in one band for specific periods.

But after a couple of weeks, another period of operation in a different band could be detected across various parameters. This variability suggested that the plant's peak operating efficiency varied with changing, uncontrollable conditions.

MULTIPLE BEST-OF-BEST TIRE PRODUCTION REGIONS IDENTIFIED

Let's take a step back.

DataProphet analyzes and models a factory's historical process and quality data. This analysis reveals a plant's best-of-best (BOB) operating region. Once DataProphet teams establish the BOB, they can suggest changes to plant control plans (See figure 2).

These adjustments guide the plant towards its holistic optimal.

The targeted rubber manufacturing process presented an interesting test for the PRESCRIBE system.

Rubber mixing is a critical phase in the tire manufacturing value chain. Additionally, it is particularly susceptible to uncontrollable factors over time. According to Raidoo:

"A manufacturer may produce in summer with a certain supplier for a period. In this instance, a BOB range for winter from a different supplier may not apply."

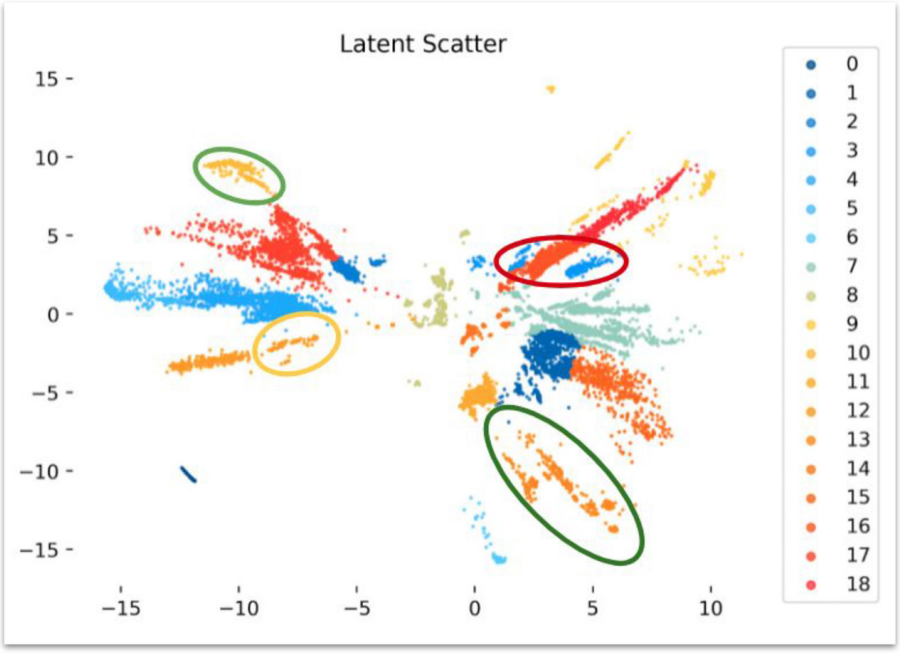
Therefore, the crux of the work was context discovery.

"The aim was to prescribe for different BOB states and plant state shifts. So, we had to proceed based on uncontrollable values. These led us to find multiple BOBS." (See figure 3)

Contextualizing these operating regimes crystallized optimals based on a particular plant state over time.

Figure 3:

PRESCRIBE's AI discovered multiple best-of-best (BOB) regions over time. It achieved this by accounting for uncontrollable recipe inputs and working with completely obfuscated data. The latent scatter shows quality variation for historical periods of production.



INITIAL RUBBER MIXING OPTIMIZATION RESULTS

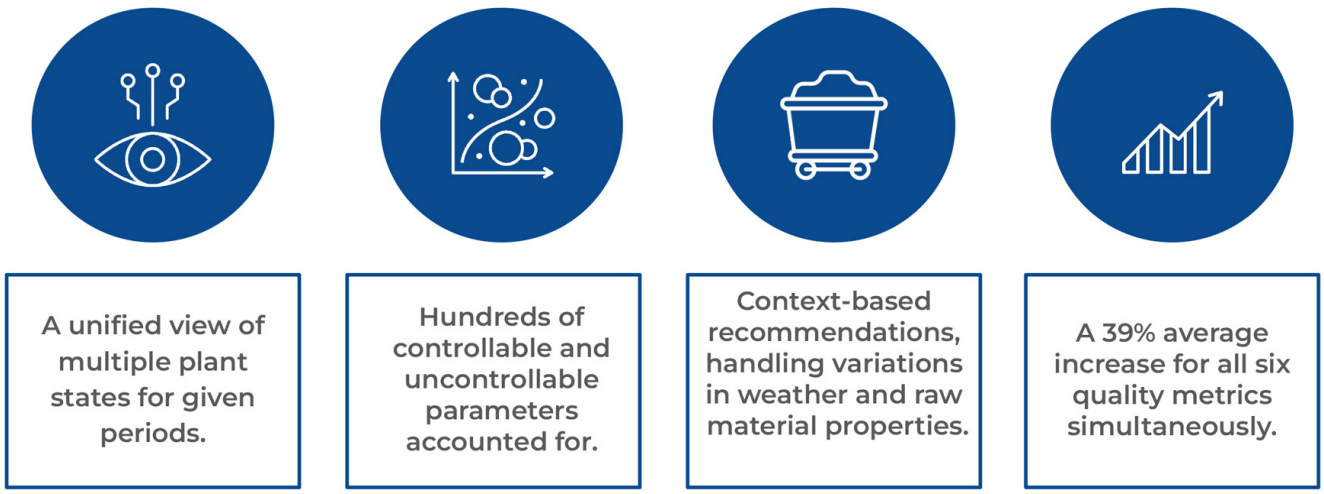
The team sent the initial prescriptions to the tire manufacturer's in-house data scientists to interpret. DataProphet's data scientists then consulted with the plant engineers to determine if the recommendations made sense. Happy with the prescriptions, the manufacturer was confident in the abilities of the PRESCRIBE system (See figure 1) to add value.

Extending the solution, DataProphet's team looked further into jumps in the production regimes. The deeper analysis determined other specific plant state contexts. These unique states apply to the rubber mixing process and their controllable and uncontrollable values. This deep dive confirmed that a global BOB might be relevant to one distribution but unattainable for different rubber production process contexts.

TIRE MANUFACTURING PROCESS OPTIMIZATION OUTCOMES

The manufacturer only previously targeted one metric for rubber mixing optimization. The DataProphet team deployed PRESCRIBE to optimize all six target quality metrics simultaneously. Figure 4 shows the specific rubber mixing outcomes and their broader operational impact:

Figure 4:



With this collaborative solution, plant engineers now have the insights to leverage their rubber manufacturing process knowledge with high-quality data. These insights are an opportunity to guide better decision-making — around tire production parameters, blending rules, raw material quality, weather, and substitute quality.

ACCELERATING THE DIGITAL TRANSFORMATION ROADMAP WITH TRANSFER LEARNING

What are the next steps of the collaborative process?

The success of this use case ushers in a commercial partnership to scale the insights across other rubber manufacturing plants. The partnership will examine the potential for various transfer learning methodologies and their applications to high-quality tire manufacturing.

In particular, DataProphet and the global tire OEM will aim to leverage transferability with multi-product lines and process shifts in time. Raidoo acknowledges the great potential for this partnership:

“We are very excited to be part of the fast rollout journey with this tire manufacturing partner. As a group, we believe our insights from the use case can greatly impact the quality outcomes of this next phase at scale.”

The team will take the models trained on quite an advanced tire manufacturing plant regarding data maturity. It will then apply that learned knowledge to a less mature plant that is yet to have six months’ worth of tire production data to train models on. Raidoo concludes:

> *“In partnership, we will leverage our AI and their rubber manufacturing expertise to find the best applications for transfer learning at different plants in this manufacturing space.”*
>
> - Renita Raidoo

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Contact our sales team for more: hyram@dataprophet.com