How algorithms track down manufacturing defects - thus optimizing production processes

Scrap and rework rate reduced by 84 %

„With Xplain Data, the added value of machine and production data reaches a new level along the entire supply chain. The solution fits seamlessly into our portfolio and is a fundamental part of our strategy."

Hendrik Jacobsen, Product Manager - Industrial Data Services

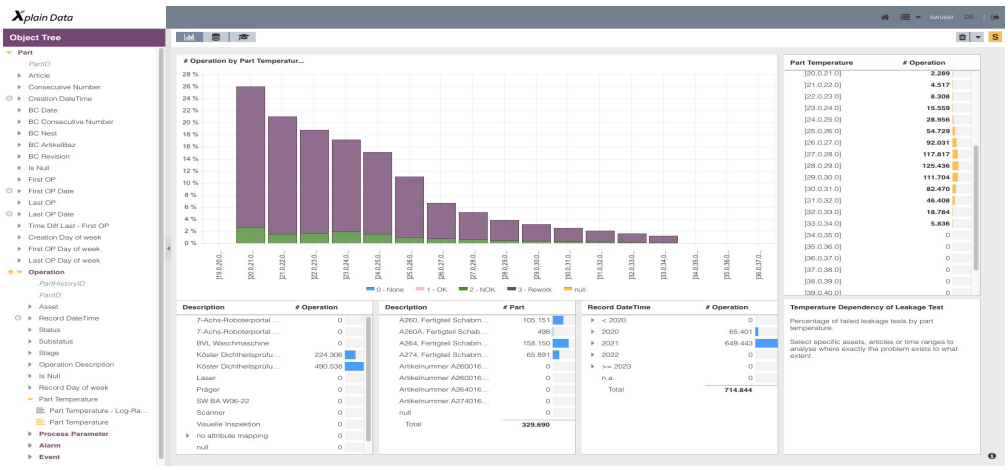
SW Machines (SW) and Xplain Data achieve breakthrough in pilot project.

Together with Xplain Data, SW has applied algorithms previously developed in healthcare to the analysis of production data in order to identify and eliminate causes for manufacturing defects. In fact, the first deployment of the algorithms on a production line was an immediate success. SW is now integrating the technology into its generic offerings.

SW's digital product portfolio has grown strongly in recent years and offers various solutions for monitoring machine tools and for automation, for material flow simulation, communication with third-party systems, and also for the traceability of workpieces in production lines.

However, when analyzing optimization potentials, manufacturers are typically facing the following problem:

A production parameter that correlates to subsequent failures does not necessarily mean that this parameter causes the failures: "Correlation does not equal causation". Therefore, the identification of causes for defects based on observation data of a plant is becoming a challenge. In addition to smart algorithms, it requires large amounts of information, and also in-depth application knowledge. With thousands of workpieces and the associated millions of process parameters, events and messages, this task no longer seemed to be manageable.



The Object Explorer allows descriptive analysis of the root object.

For such cases, Xplain Data provides patented procedures originally developed in the healthcare industry. Based on extensive patient data, algorithms extract a small set of potential causal factors from millions of observed correlations. These hypotheses for potential causes can be easily evaluated by the domain expert. In healthcare, these algorithms are used, for example, to understand side effects caused by specific treatments, or why people switch their insurance company (churn).

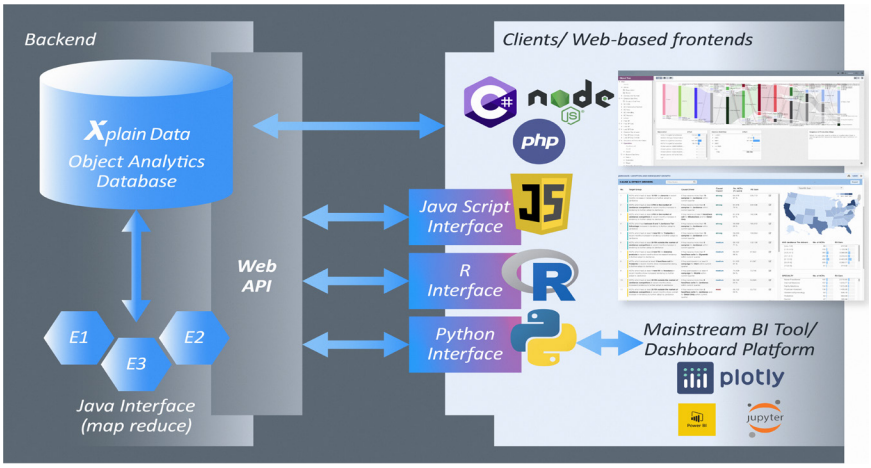
This is the key challenge: There are millions of patients and billions of prescriptions, issued diagnoses, hospital admissions, etc.; in other words, there are countless data sources which have to be analyzed holistically and there are millions of irrelevant correlations which obscure the most important cause-and-effect relationships. In discrete manufacturing the situation is alike: There are millions of workpieces and billions of measurements, events, and alerts along production and lifetime of the produced parts.

In a pilot project, SW and Xplain Data applied this methodology to industrial manufacturing, and thereby gained insights that helped to reduce the production defect rate (scrap and rework) from over 10% to just under 1.6%.

The causes identified using this process led to instant cost savings for Schabmüller Automobiltechnik GmbH. Schabmüller is a Bavarian automotive supplier focusing on high volume production of high precision components for car parts including: the chassis, the engine, drive control and transmission. As an example, it has been detected that the leakage test (one step in the manufacturing process) is strongly impacted by the component temperature of the tested part, which in turn varies with deviations in the waiting period prior to the test. To avoid parts cooling down between washing and testing, the waiting period between those two steps should therefore be kept at a minimum. Furthermore, significant quality differences were found in the casting nests of the supplied blanks, this being an influential factor that was previously difficult to evaluate due to the complexity of the plant as well as many other related factors in other production steps which can conceal the essential causal effect.

Further strengths of Xplain Data technology became clear when hypotheses for causal factors generated by the algorithm needed to be visualized and further validated by experts. Instead of dealing with tedious SQL queries, the "Xplain Object Explorer" offers descriptive analytics for complex objects. In a relational database, those objects are distributed across many tables; how-

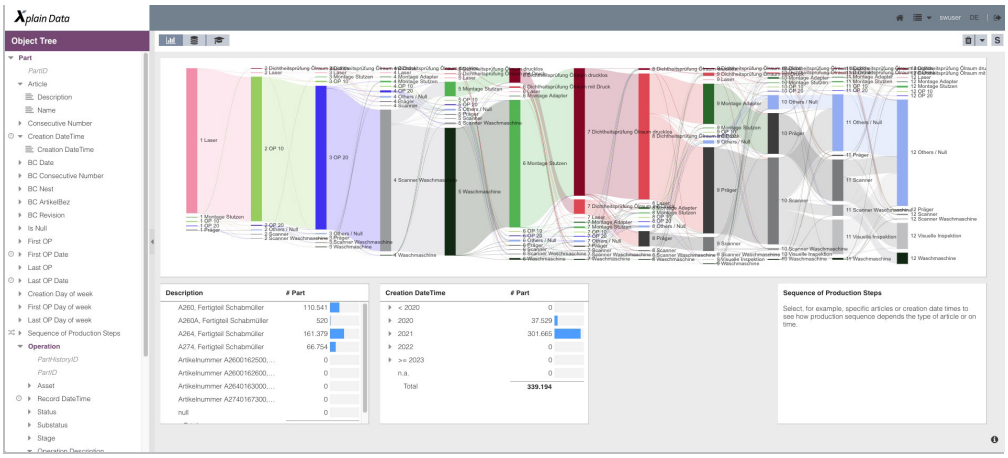
Causality vs. correlation - an example:
Gray-haired people often wear glasses (correlation), but glasses do not cause your hair to become gray (nor vice versa). There is a common cause for both hair color and the wearing of glasses: age. The older you get, the more likely you are to wear glasses, and get gray hair. In statistical terms, this common cause is called a "confounder".



Xplain Data solution technical overview.

„It's innovations like this that have made us a digitization pilot customer with SW for many years. This application will be used in all production lines from now on."

Helmut Häckl, Managing Director Schabmüller Automobiltechnik GmbH



An example from manufacturing: Representation of the production flow to track faulty parts.

ever, the Object Explorer enables holistic analysis across different data streams. Application experts and data analysts can work together to evaluate hypotheses and investigate follow-up questions. A convenient additional benefit is that the integrated reporting functions provide customers or other external stakeholders with evaluations during ongoing operations.

There is more to come: It is planned to deploy the algorithms "in the loop". This involves the constant scanning of new data for emerging causes for failures, so that stake holders can receive alerts as soon as new causal factors become significant. Furthermore, additional data along the life cycle of a workpiece will be integrated into the analysis, from material composition during casting to further processing and final assembly at an automobile manufacturer. The goal is a 360° perspective: In other words, each additional source of information increases the validity of the cause-effect analyses.

In addition to the significant productivity gain and the successful technical data migration, the pilot project also provides an example of successful collaboration between an agile, medium-sized enterprise and an innovative startup.

"With Causal Discovery at production and machine level, we are opening the door to a whole new world," says Jochen Heinz, Head of Industrial Data Services at SW. This requires entrepreneurship and a pioneering spirit: SW is planning to develop a cloud-based offering in cooperation with Xplain Data, in which data will be integrated along the entire supply chain and life cycle of a workpiece. This will enable the analytical methods to be used by others in the ecosystem of a multi-tiered production chain.

„We would like to see innovative technologies not only being developed in Germany, but also finding their way into application across industry boundaries."

Jochen Heinz, Head of Industrial Data Services at SW

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