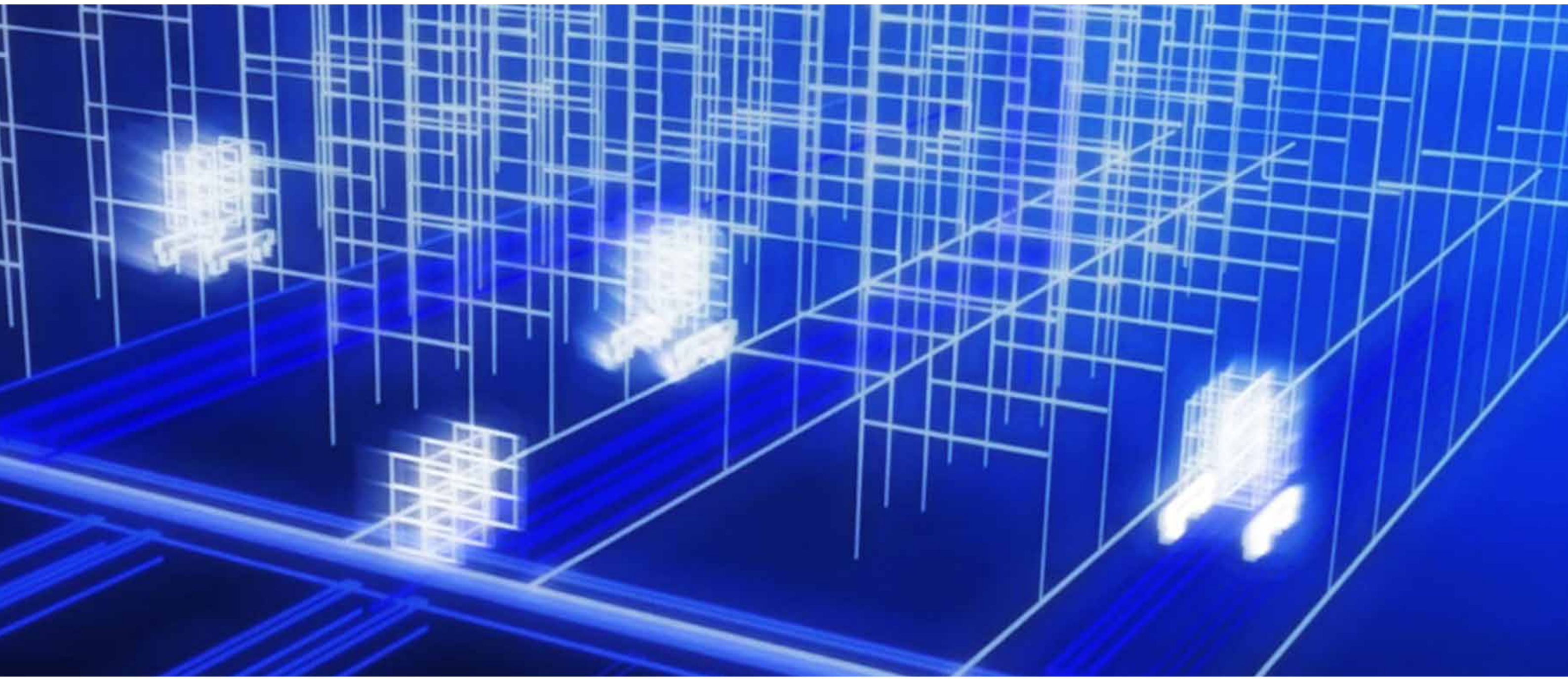

Digital Transformation in intralogistics

Still a source of untapped potential

The global cost of unplanned production downtime is estimated to be as much as 56 billion dollars per year. Against this background, machine manufacturers in particular face the challenge of making the availability and the condition of production machines transparent. Digitalization is of major importance in achieving this goal.

Many operators expect that digitalizing their production systems will produce great benefits in the area of maintenance. We often hear the phrases “condition monitoring” and “predictive maintenance” in this context. These predictive methods enable us to make the change from maintenance based on time intervals to maintenance based on the actual condition of the machine. This means, for example, that components only have to be replaced when necessary, and not prophylactically, before they have reached the end of their useful life.

Condition-based maintenance is meant to increase the profitability of a system. But this concept can only succeed economically if the scale of the digitalization is comprehensive. Nonetheless, we still see machine manufacturers in particular only being offered partial digitalization solutions. There is often a lack of clarity about the overall digitization solution that is needed, and the issue is often left to the operator to solve.

A company's path to digital transformation is mapped out with the help of a phase model.

Approaches for a beneficial digital transformation

The drive and automation specialist Lenze provides its customers with comprehensive support in the digital transformation process. The company's approach is based on a phase model that sets out all the steps needed for digitization.

The first step is to visualize data, maintaining and consolidating the transparency of the installed base and the system performance and also showing system downtimes or failures. The focus here is on the machine or the entire system. This is what makes the approach different from earlier models, which could only assess individual components or sections of the machine. What is particularly interesting here is the visualization of the system performance and the balancing of the system utilization. This allow us to draw important conclusions about the processes and procedures in the individual sections of a networked system – this is important because it is no good increasing the performance of one individual component such as a storage and retrieval system if, further down the line, the goods cannot be processed or transported because there is no truck at the loading ramp, for example. In addition, it makes remote maintenance possible, which can reduce the cost of commissioning and service and make more efficient use of personnel.

In the next step, Lenze supports the operators with digital services and cloud services for everything to do with the machine. The calculation and display of a machine's or system's OEE (overall equipment efficiency) can be used to optimize its availability, throughput and production yield. Also, the data can be compared across machines, systems and, most importantly, across plants, which provides information about the "real" performance. From this data and our existing domain knowledge we derive initial models for reducing downtimes by means of condition monitoring. Based on the installed components, the data also allows us to make precise statements about the general condition of the machine. If an error occurs frequently in one system but does not occur in another identical system in the same network, the cause of the error can be analyzed and then eliminated.

The drive and automation specialist Lenze provides its customers with comprehensive support in the digital transformation process.

Tim-Oliver Ricke, Global Segment Manager Intralogistics.

It is clear that this step requires the system to be networked, with a high level of transparency and a sufficiently high level of domain knowledge.

Once all of this has been achieved, the final step is to generate predictive models. Predictive analytics independently reveal such things as anomalies that would lead to a possible system downtime. As is so often the case, automakers are at the forefront of these innovations. Some initial projects for predictive maintenance with Lenze are already being implemented in Europe and Asia.

Description or prediction?

In discussions about digitalization in intralogistics, many people immediately think of condition monitoring and predictive maintenance. The two terms are often used synonymously, even though they are different concepts. Predictive maintenance is the prediction of events or the assessment of the probability of events. For example, it looks at the probability of a gearbox defect occurring in the next 50 operating hours and tells us when the probability increases to more than 90 percent. With such a forecast, we can plan the replacement of the gearbox in good time before the system actually fails.

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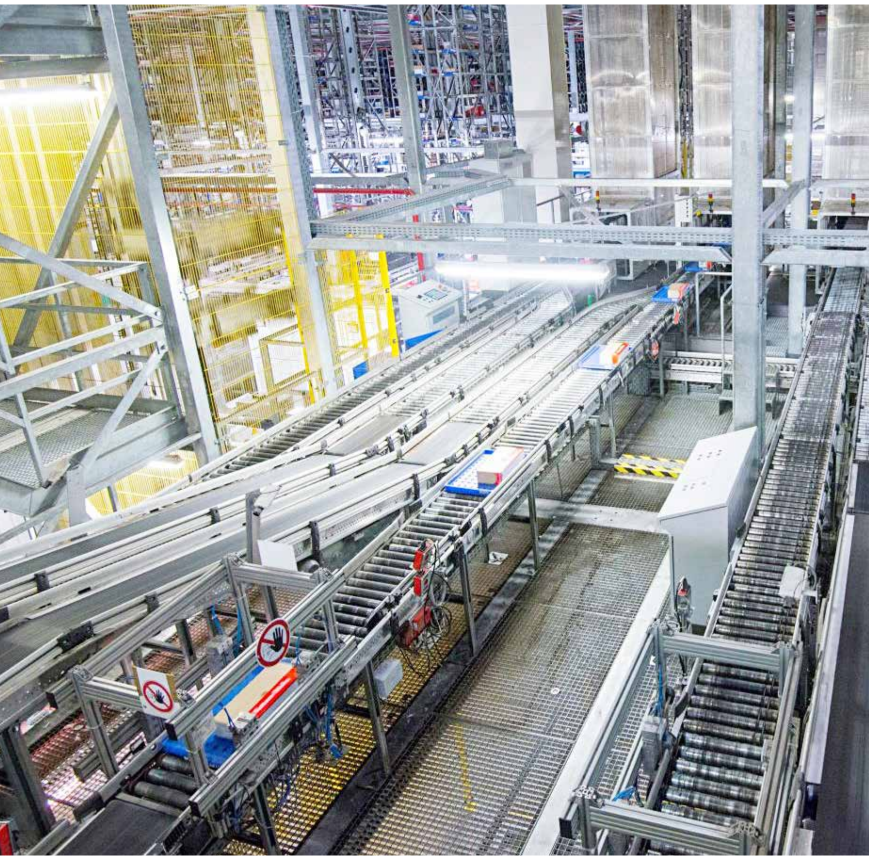

Condition monitoring, on the other hand, is a preliminary stage that enables us to get a more in-depth description of the current condition by interpreting the existing data. This requires a deep understanding of machines and processes in order to generate meaningful information from „bare“ data. Analyses based on machine learning (ML) and artificial intelligence (AI) can help to detect anomalies more quickly.

Lenze is working intensively on both of these approaches and has already presented a model-based and a data-based approach. The model-based approach compares the recorded data with a mathematically deduced model of the application and interprets the detected deviations from the previously defined model.

The data-based approach, by contrast, uses a neural network – or, to put it more colloquially, artificial intelligence – and learns machine behavior independently. The recorded data is then interpreted with data from the self-learned behavior. For example, the combinatorics of several different factors can be merged into one behavior: increased motor speed, reduced power consumption and a longer conveying time between the light barriers provide an indication of slippage or wear in the conveyor belt over the drive drum. However, this approach requires greater computing power, so, currently, processing still has to take place in a higher-level controller or in the cloud, and the edge controller is used for local data compression. If we apply the calculations set out in Moore’s Law, the technological possibilities will increase dramatically within a short time and lead to more distinctive models and processing possibilities in the control and the frequency converter.

Implementing projects, step by step

The projects that are already being implemented each use data from around 1,000 drive packages, which are distributed across multiple systems. The data access alone is enough to enable us to compare data from the systems and to detect deviations. The data is saved and evaluated locally, within the company‘s own network. This provides initial experience with the handling of the data, the amount of available data, and the processing and analysis of the information. The system has an open design and distributes the load to multiple edge controllers, which communicate with the higher-level data servers or data lake via MQTT or use OPC UA in the downwards direction. In addition to supporting the actual Ethernet-based fieldbus as a connection to one's own components, this also enables external third-party components to be connected to the system, and it can still be scaled up using the given number of edge controllers. This means that the information gained is useful for large-scale installations such as baggage-handling systems in airports or fully automated warehouses, where more than 10,000 drive packages and components from various suppliers are often in use. The edge controllers make it possible to gain experience with data preprocessing, compression, real-time behavior as well as with integrating third-party components and establishing a connection to the data lake.

Collecting and interpreting available data is already a solid path to machine condition monitoring.

The second step involves the practical application of predictive maintenance and using the algorithms already verified in the laboratory environment to detect system anomalies and to verify the data required for the domain. In the laboratory environment, the processed data has already provided good results. It will be interesting to find out how the pre-processing of massive amounts of data, with fast Fourier transformation, Kalman filters or envelope curve analysis, affects the real data volume and the degree of capacity utilization in the production process. A direct transfer of theoretical knowledge from a laboratory to a practical environment cannot always be guaranteed. For example, error patterns in the algorithms can be caused by the behavior of components installed near the sensors and drive packages, and that can have a negative effect on the robustness and adaptability of the data-based model. The problem and phenomenon described above is familiar to us from everyday life: the glasses in the cupboard on the kitchen wall start to rattle and the cause cannot be found in the wall cupboard, but instead in the compressor on the nearby refrigerator, which has just boosted its cooling power.

So, are we already in „tomorrow's world“, and are the developed processes already effective enough to secure increases in efficiency and avoid unplanned system downtimes? The future remains exciting.