ERROR-FREE PROCESS CONTROL: QUALITY MANAGEMENT 4.0

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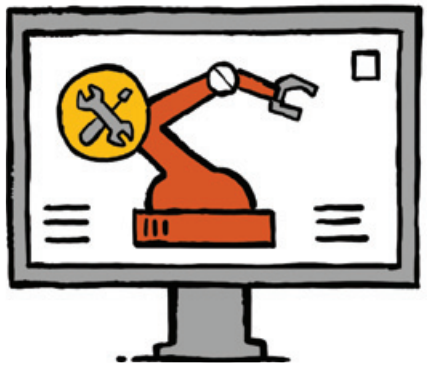


The mystery surrounding the intelligence of a smart factory has been revealed. Anyone linking materials and products optimally using automation and management processes can also design complex manufacturing and logistics processes more effectively and efficiently – and hence more "intelligently". However, this also speeds up the development of global production networks within which the boundaries between a company and its partners, suppliers and customers will blur in the coming years. And it is precisely this that will have significant implications for quality management. It will be vital to adapt processes and tools used for quality assurance to the smart factory in such a way that they can be deployed in a highly automated and digital way. Instead of this, even pioneers of "intelligent manufacturing" continue to focus on standardized production and quality processes that are already defined. This is, however, exactly what is not appropriate for increasingly large and transparent manufacturing and value-added chains that require constant risk mitigation in quality issues to assure error-free production.

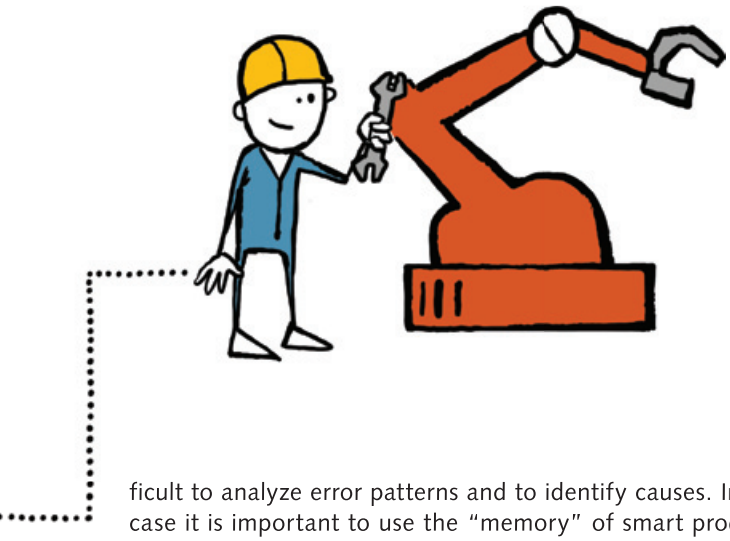
Virtual Quality Control

It is not only short product life cycles, scarce resources and pressure from the market for flexibility that create enormous obstacles to quality assurance, but also the increasing complexity of development and production processes for customized serial products. Digital interconnection also means, above all, that manufacturers can respond to their customers' personal wishes since ever more consumers demand products that meet their individual needs – and at the most attractive price. However, manufacturing with a batch size of 1 and the associated increasing number of variants in particular require new quality assurance measures.

Simulations and virtual models, which are continuing to gain significance as information grows denser, can help in such cases. Companies can model production systems that mirror reality using data captured and prepared in networks and available in real time. This provides the basis for analyzing optimization, commissioning and restructuring measures inexpensively, simulating them virtually and implementing the most efficient solution without having to make major adjustments or take risks in real life, since virtual models can be used to bring about increased productivity and reduce changeover times. This potential can be used especially for detecting risks and increasing efficiency as well as in quality assurance. For example, one well-known manufacturer of filling and packaging equipment uses 3D simulation software to check whether new control concepts work. The control software tested in this manner can then be transferred 1:1 to the machine. This assures quality at an early stage and saves considerable costs for each machine supplied.

Assistance Systems for Error Prevention

Assuring the quality of the process chain is essential for production operations in particular. Nevertheless, the anticipated flexibility and dynamics in the production processes of a smart factory can in an extreme case result in every product being routed through the manufacturing process along a different path. This makes it significantly more dif-



ficult to analyze error patterns and to identify causes. In this case it is important to use the "memory" of smart products that can remember their individual path through production, for example with the help of an RFID chip. In this way, every product generates an individual "quality stamp", much like a fingerprint, as it passes through the various steps of the production process. Depending on requirements, it includes not just the product's entire path but also quality-related information such as production tolerances.

Comprehensive data capture and the corresponding comparison of these quality stamps ensure that abnormalities can be detected fast. Special assistance systems will ideally trigger an alarm even before errors occur thanks to precise measurements in real time. As a general rule, companies should deploy three essential elements for quality assurance in a smart factory:

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1. Inline Quality Control:

It is advisable to integrate quality checks as inline quality controls, i.e. into the working production line in order to assure product quality. This guarantees that measurement data are reported back reliably, allowing automated corrections to be performed. Ensuring the traceability of data relevant for the quality of a product not only minimizes liability risks but also allows possible sources of errors to be localized quickly. At the same time, automated correction, for example through assembly controlled in real time, is also possible. Integrated measuring systems capture material parameters quickly and effectively and send any variations to the next machine in order to perform an update of the process parameters.

2. Direct and Indirect Process Parameters:

The capture and analysis of various parameters is necessary for comparison using reference patterns. This involves both direct process parameters like varying forces or torque as well as indirect process parameters like temperature or humidity, allowing proactive measures such as the adjustment of machine settings to be initiated wherever necessary at any time. However, controlling process parameters on their own is not enough to guarantee error-free production. They are nevertheless an important element for preparing decisions about the type of intervention that may be required in the production processes under examination.

3. Transformation of Big Data:

In the smart factory it is important to transform the volume of information gained from "big data" into "smart data" – i.e. into precisely the type of information that is relevant for assuring product quality. It is especially important to avoid media disruption, which almost inevitably results from merging analog information in the operational field with digitally structured databases. The use of big data allows important analytical steps to be performed in order to achieve significant improvements in productivity and quality. These include, first, quality-related analysis that serves to return field data such as pressure, temperature and tension as well as to recognize patterns and investigate causes in quality statistics. Second, the analysis of usage data in the field plays an important role in optimizing the development of components such as pumps, batteries and power brake units. Moreover, the use of SCM-related analysis is of great importance in the early detection of critical supply chain events. In this case, a special plant information system enables patterns in disruptions and output volumes to be identified, speeding up the correction of errors and bringing about improved delivery reliability.

Quality assurance and management thus remain essential success factors in the smart factory. Companies must therefore start identifying promising areas of activity based on existing Industry 4.0 technologies, implementing initial pilot applications and defining their own personal roadmap.