The test cell uses optical measurement technology to check the injection molded parts for dimensional accuracy, surface defects and anomalies specific fo injection molding.

AI AND AUTOMATION: LEADING THE WAY TO THE FUTURE OF RANDOM SAMPLE TESTING

Kistler is researching new possibilities for fully automated optical quality assurance – with a particular focus on how injection molding production can benefit from these developments.

High standards, high quality, high risk: manufacturers in the automotive, metalworking and medical technology industries have to meet ever-increasing demands for the quality of their products – especially when complex and intricate parts are involved. In the worst-case scenario, they must also be able to present complete proof of compliance with quality parameters to protect themselves against recourse claims. In response to these challenges, the entire quality control process must be designed to ensure maximum precision and reproducibility. However, the quality of manual checks depends on the skills and knowledge of the employees as well as the time available. Documentation, too, often proves to be a complex and time-consuming task. These variances can be minimized by automating the process. To show just how far this sort of process automation can go, Kistler has developed some examples of solutions for a research project. In collaboration with the Eastern Switzerland University of Applied Sciences (OST) in Rapperswil, the Swiss measurement technology expert is researching new possibilities that can be leveraged for data quality in particular, with a focus on the ongoing improvement of quality predictions based on artificial intelligence (AI).

Manual spot checks allow variances

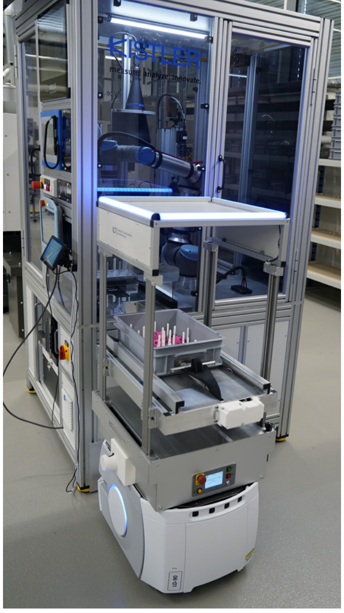
In most cases, manufacturing companies opt for the statistical process control (SPC) method to check the quality of their production. This procedure defines the frequency and scope of the random samples to be taken and tested, so users can monitor the production process according to predefined relevant quality parameters.

Until now, these samples have always been removed, transported and tested manually – so the process ties up extensive resources in terms of time as well as personnel, depending on the scope of production and the throughput rate. Another factor is that the quality of the collected data depends on the skills of the inspectors, which may vary from one individual to another. However: if the manufactured parts are more safety-relevant, the error tolerances must be lower and the spot checks must be performed more frequently – so the inspection process becomes even more prone to errors. At the same time, the costs of potential recourse claims are increasing. For all these reasons, automated and reproducible random sample testing is an attractive alternative to minimize the costs of parts with production defects.

Individual inspection with consistently high reliability of the testing process

A holistic automated inspection concept delivers particular advantages for production operations involving high throughput volumes and parts subject to similar inspection requirements. In mass production, cycle times and the numbers of parts produced cause enormous effort and expense for manual spot checks. By automating the entire quality assurance process, manufacturers benefit from enhanced reproducibility and lower costs.

Additional advantages can also be gained from an inter- disciplinary approach such as the one Kistler pursues. Sensors, process monitoring, automation, optical image processing, software for data analysis and mechanical engineering: all these areas work together under one roof on the company site, and they cooperate efficiently thanks to many years of experience. This is also the case with numerous projects in the injection molding sector.



Kistler is setting up a fully automated manufacturing and testing process together with the Institute for Materials Engineering and Plastics Processing at the OST - Ostschweizer Fachhochschule in Rapperswil

The autonomous vehicles transport the parts to the test cell and then to the storage area for retained samples

When starting to design an inspection concept of this sort, the focus is initially on the requirements for the part being tested. The team assigned to the project collaborates with the manufacturers to develop the required quality-relevant test parameters – mostly related to surface defects and dimensional accuracy. They also select appropriate test methods such as reflected or transmitted light illumination and 2.5D or 3D inspection. Kistler sensors make it possible to integrate mechanical pressure, force and torque tests into the concept as well. Experts from the Competence Center then design the test cell accordingly: alongside the number and positioning of camera stations with lighting elements, the key factor here is the path followed by the part being inspected: the objective is to achieve consistently smooth and efficient part handling throughout the entire test process. The integrated safety concepts monitor the systematic progression of the individual steps in the process – and also the handshakes – so as to guarantee process reliability while also preventing data losses. The automatic system then sends the collected data via the OPC UA interface to the operator's higher-level quality assurance system and also to relevant databases for analysis.

Research project: automation offers an extensive and reliable data basis for injection molding

Quality control is a particularly sensitive issue in injection molding production – especially in the medtech manufacturing segment. So that medtech manufacturers can also benefit from automated random sample inspection that is as comprehensive as possible, and to give them more accurate AI-based quality predictions while the injection molding process is still in progress, Kistler is cooperating on a research project with the IWK Institute for Materials Technology and Plastics Processing at the Eastern Switzerland University of Applied Sciences. This project is financed by Innosuisse, the Swiss Innovation Agency.

For this purpose, the project team is setting up an example of a fully automated manufacturing and testing process.
An injection molding machine produces parts, serializes them with the help of individual QR codes, and sorts them onto trays. While production is still in progress, the ComoNeo process monitoring system uses cavity pressure sensors to monitor the respective cavity pressures. With support from appropriately trained AI, the ComoNeoPREDICT software feature generates quality predictions for the individual parts. Driverless transport vehicles convey the parts selected for spot checks to the optical test cell, which is already standing by to test them: this is the first time the transportation has been performed autonomously. The parts then pass through the predefined inspection program: they are carefully checked for dimensional stability and surface defects as well as specific anomalies that occur in injection molding, such as black specks or moisture splay. In their concept, the experts are also taking account of issues specific to plastics processing such as post-shrinkage due to cooling and crystallization. Later on, additional injection molding machines with other parts can be integrated into this setup and incorporated into the material flow with the use of the autonomous vehicles: this means that quality control can also be automated in complex production environments. The prerequisite for this: the test cell must be equipped with different inspection programs as appropriate for the purpose. The inspection system recognizes the different parts so the relevant test program is triggered.

Data analysis opens up new possibilities for automated optimization

After inspection, the autonomous vehicle transports the tested parts to the warehouse and the test cell sends the analyzed data to higher-level QA or MES systems. The experts use the available quality data to check the quality forecasts previously generated by ComoNeo PREDICT. If variances occur, the AI models are retrained using new test data.

As well as exploring the options for designing a comprehensive system of this type, the research project is investigating possible ways to automate data matching and the adaptation of neural networks. Thanks to this approach, manufacturers not only gain the benefit of improved data quality from optical inspections: they can also design their entire process to be as rigorous and error-free as possible – even in complex production environments with a variety of different parts to be tested.

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