Interview

How artificial intelligence is changing optical quality inspection of punched parts

An interview with Dr.-Ing. Oliver Schnerr, Stephan Bellem and Ferenc Toth of Kistler

Information about progress of production and assured quality down to component level: even for the very smallest parts, requirements for traceability and quality are increasing in every industry – and the punching and stamping sector is no exception. To meet these growing expectations, punched part manufacturers need to vastly step up their quality control. How can a combination of an optical inspection system equipped with AI software and a laser marking process help them achieve this goal? In this interview, the answers are explained by three Kistler experts: Dr.-Ing. Oliver Schnerr, Head of Global Sales – Integrated Solutions, Stephan Bellem, Head of Test Automation and Head of Engineering, and Ferenc Toth, Head of Vision Systems.

What do the increasing requirements for quality and traceability mean for punched part manufacturers?

Schnerr: These requirements really do present a major challenge for the punching and stamping industry. Alongside high part quality, efficiency is an essential requirement – and the aim is to ensure production with the minimum possible scrap rate. Another challenging requirement is accurate and detailed documentation throughout the production chain, so manufacturers can protect themselves against recourse claims: it should be possible to implement this with maximum efficiency.

Bellem: The solution we've developed at Kistler makes us the first provider to launch a complete package on the market. The individual parts are checked with the "shape-from-shading" optical inspection process, which uses software equipped with artificial intelligence (AI) to detect any quality-relevant defects. An additional feature is an integrated laser marking process which then adds an identification number to the individual parts. By networking the system with the surrounding machines, we also make it easier to implement comprehensive process monitoring. As well as marking the individually inspected parts and storing the relevant documents in a database, the system saves information about the upstream and downstream steps of the process. What's more, the inspection system itself analyzes its own functionality before each batch or shift and generates a corresponding functional capability record: this is part of the Measurement System Analysis.

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Toth: Thanks to comprehensive documentation for the production chain, we're evolving from the random sample databases of the past towards complete inspection and traceability of the manufactured parts. This opens the way for users to take a major step towards digitalizing their production and process monitoring.

What is special about the "shape-from-shading" optical inspection method?

Toth: This process makes use of special illumination and imaging technology to separate information about the texture of an inspected part from its topological characteristics. To achieve this, the part to be inspected is illuminated from several directions and captured by a camera. This results in images where light and shade are distributed differently. We can then use these (real) individual images as the basis for calculating various topographical images which only show the 3D information about the surface of the inspected part. This makes the process independent of changes in the surface of the inspected part, such as color or brightness differences that would show up clearly in the texture image and thus prevent stable evaluation. In this way, even scratches, cracks or indentations with heights or depths of only a few micrometers can be detected reliably with conventional image processing methods.

Texture: no statement about errors is possible; may not be visible.	Curvature: minute errors (scratches, scoring) are clearly visible, regardless of direction; small angle chamfer is barely visible.

Schnerr: This process makes it possible to identify minimal defects in the surface of an individual inspected part. But that's not all: the method also ensures detection of surface defects that are actually relevant to quality – and that's another crucial advantage for manufacturers. It allows them to vastly reduce their pseudo scrap rates.

How is AI used for optical quality assurance?

Toth: Artificial intelligence makes quality assurance easier throughout the production chain. To start with, the deep neural network is fed with images of OK parts, so it "learns" their characteristics. Since our customers specialize in producing OK parts, a vast quantity of data is available to us. If the image of a part deviates from these characteristics, the AI software recognizes this and triggers separation of the part as appropriate. After a few production batches, we can then feed the software with more images of OK parts that may have different characteristics than the parts inspected in the first round. In this way, we continue to refine the AI – and we can also minimize the percentage of pseudo scrap even further.

Schnerr: By deploying artificial intelligence in quality assurance, we can achieve some major advances – especially as regards unusual defects, or those that only occur sporadically. The parameters defined in advance for conventional rule-based inspection methods often fail to identify these defects, so parts with faults of this sort remain undetected and are not separated out.

Will AI-supported quality inspection supersede conventional optical inspection methods?

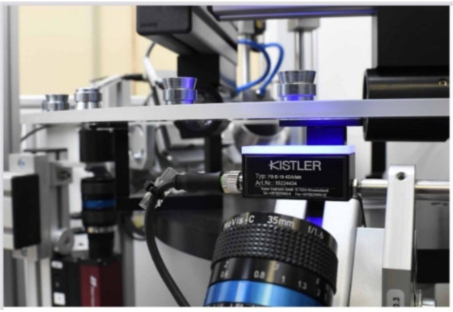
Schnerr: I think that's rather unlikely. Going forward, manufacturers will in all probability use a combination of the two methods – because one of these processes cannot replace the other one. The conventional processes will continue to be used for defect characteristics that we can describe in adequate detail with rule-based mathematical methods. AI-based inspection is the more obvious choice for detecting unusual faults, or those which only occur rarely.

Let’s dare to take a look into the future: in which areas will AI become the technology of choice?

Schnerr: In the future, we will mainly be using AI in cases where we want to make statements about the quality of parts, but where it’s very difficult to describe the defects with mathematical methods. Here at Kistler, we’re already making use of artificial intelligence in several areas: one example is plastic injection molding technology for the manufacture of medical devices, where quality calculations are based on cavity pressure data. Users always need to consider which method is most suitable for their requirements in each individual case. To assist with this, we are standing by to advise our customers right from the start. We check out the places where it doesn't make sense to use AI, and we also work out where – and how – quality control can be implemented optimally with the help of AI.

Image material (please name the Kistler Group as picture source)

With a laser marking system from Kistler such as the KLM 621 shown here, markings can be applied to as many as 2,500 parts per minute.



By choosing their own individual combination of illumination and sensor modules from Kistler, customers can gear their quality inspection to their specific needs.

At the 2022 Connector User Congress, Dr.-Ing. Oliver Schnerr gives a presentation on "100% quality control and traceability at component level meet artificial intelligence".

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About the Kistler Group

Kistler is the global market leader for dynamic pressure, force, torque and acceleration measurement technology. Cutting-edge technologies provide the basis for Kistler's modular solutions. Customers in industry and scientific research benefit from Kistler's experience as a development partner, enabling them to optimize their products and processes so as to secure sustainable competitive edge. Unique sensor technology from this owner-managed Swiss corporation helps to shape future innovations not only in automotive development and industrial automation but also in many newly emerging sectors. Drawing on our extensive application expertise, and always with an absolute commitment to quality, Kistler plays a key part in the ongoing development of the latest megatrends. The focus is on issues such as electrified drive technology, autonomous driving, emission reduction and Industry 4.0. Some 2,000 employees at more than 60 facilities across the globe are dedicated to the development of new solutions, and they offer application-specific services at the local level. Ever since it was founded in 1959, the Kistler Group has grown hand-in-hand with its customers and in 2021, it posted sales of mCHF 411. About 7% of this figure is reinvested in research and technology – with the aim of delivering better results for every customer.