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INLINE MEASUREMENT TECHNIQUES

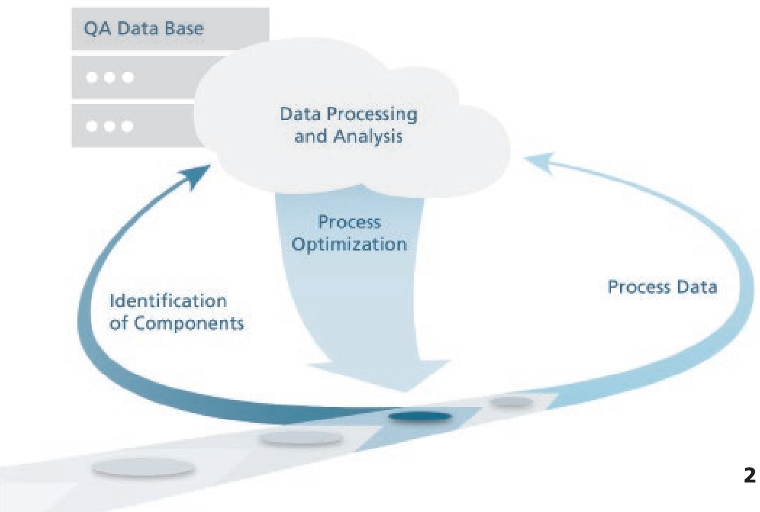
# Tracking everything down to the last screw

Traceability is one of the cornerstones of digitalized production. It enables data collected during production processes to be attributed to individual components and semi-finished products. The concept is the only way in which regularly occurring errors can be analyzed and the results feed back into the manufacturing process. In the »Track4Quality« project, Fraunhofer IPM is working on an innovative tracking procedure for mass-produced parts that identifies individual components on the basis of their surface structure.

The quality of complex industrial products depends on the quality of each and every component. For example, a single faulty connector, even if it is worth only a few cents, may impair the performance and durability of a complex electronic control box in a car. As a consequence, if an assembled component fails its performance test, all the semi-finished parts already fitted are »guilty by association« and the entire product is rejected. This results in companies incurring high costs, often without learning any lessons for the future. The project's goal is therefore to provide even the smallest of components and semi-finished products with a signature so that they can be traced along the supply chain, preferably from the outset. This is the only way of ensuring that in-process inspection systems are capable of detecting and permanently rectifying recurring production errors.

**Components identified by product fingerprints**

There is one thing that the process of tracing mass-produced parts must not be: expensive. Many established marking methods fail at this first hurdle because they require additional costly production steps. However, this is far from the only drawback of current solutions. Other techniques are not feasible because they affect certain component functions. For example, it is not wise for manufacturers to engrave serial numbers on sealing surfaces or place barcodes on decorative items. Furthermore, while some components are simply too small to be marked, those that can be are at risk of having their markers counterfeited. None of these problems apply to a tracking method being developed by Fraunhofer IPM in collaboration with Hahn-Schickard-Gesellschaft e.V. and industrial partners as part of the »Track4Quality« (T4Q) project. The technique does not require any markers to be added to the component whatsoever, making use of its existing surface structure instead. Viewed under a microscope, almost all technical surfaces reveal incidental characteristics like microstructures or interwoven colors that are as unique as a fingerprint. The T4Q sensor system uses an industrial camera to take high-resolution images of defined areas on the component's surface. The specific structural patterns captured by the image and the way in which they are positioned relative to each other is used to generate a numerical identification code, which is then stored in a database. This entire process can be repeated to identify the component at a later

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»**IF MACHINES ARE ABLE TO COMMUNICATE WITH EACH OTHER IN THE FUTURE,** what they actually say will be equally as important as their ability to say it. Measurement techniques will play an important role in this by providing a large part of the data that the machines will share. This data will determine whether the dominance of digital technology in the manufacturing process is actually leading to greater efficiency and better product quality.« *– Daniel Carl*

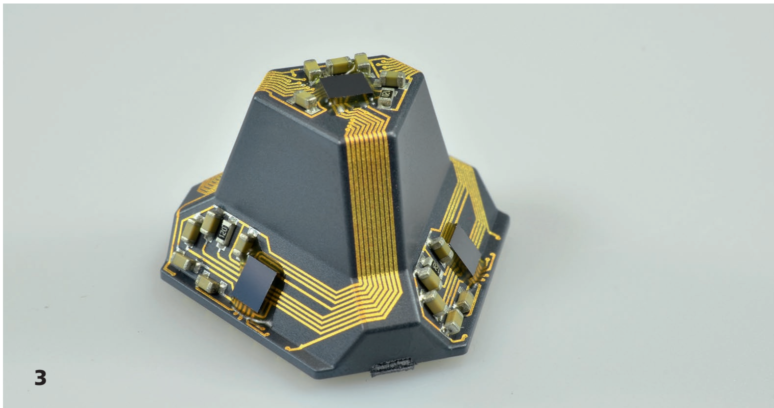
date. If there is a match for a code, users can be certain they have found the component they are looking for. The sensor has been designed to enable a wide range of materials, from smooth plastic to precision-machined aluminum, cast iron and varnished surfaces, to be identified in line with the rate of production using the same hardware.

As part of a study, the T4Q method was tested for practicability in a production chain for molded interconnect devices (MID). Fingerprints from 30 of these three-dimensional injection-molded plastic circuit carriers were produced as a test at the Hahn-Schickard Institute. The test pieces were then subjected to all the steps normally performed as part of the production chain, such as thermal shock tests, laser structuring, $CO_2$ snow-jet cleaning, wet-chemical cleaning, metal coating, reflow soldering and conductive adhesion. Despite these processes and the addition of conducting paths to a number of the substrates, which resulted in the region of the fingerprint being partially covered, the components could still be reliably identified. Now that the general feasibility and robustness of the T4Q method has been demonstrated, the scientists are working on implementing it in practice. If, by the end of the project, the process is also able to clearly identify components worth only a handful of cents, it will become an essential prerequisite for the long-term improvement of manufacturing processes – in the spirit of sustainable digitalized production.

**1** *The quality of components worth just a few cents frequently influences the performance and durability of expensive products.*

**3** *The practicability of the tracking method was tested in the production of 3D sensors, manufactured as MID devices.*

**2** *A huge amount of measurement and process data is generated during production processes. Clear component signatures are the only way of attributing this data to individual components and of tracing noticeable statistical anomalies to the sources of error.*



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