

► Reliable inspection of fasteners

Up to 600 metal or injection-moulded components such as screws, disks or other mass products in fastener technology, mainly employed in the automobile and aerospace industries, are inspected and sorted in an inspection plant manufactured by GEFRA GmbH in Friedewald. With STEMMER IMAGING machine vision playing a major role.

GEFRA GmbH is based south-east of Cologne, in idyllic Friedewald. Founded by Thomas Rothweiler in 1995 as Gesellschaft für Automation GmbH, the innovative company has gained a worldwide reputation as a leading provider of inspection systems. "Variants of our Optisort series are in use in many countries around the globe and ensure that the inspected fasteners reliably meet requirements", says the founder and managing partner of the company proudly. The majority of GEFRA customers are suppliers of the major automotive sub-contractors, but also the aerospace industry. "Our equipment must therefore meet the highest demands in terms of reliability", underlines Rothweiler.

The majority of objects inspected with GEFRA Optisort units are metal components in the so-called fastener sector, such as screws, nuts or disks. Plastic components, release pins for airbags or a selection of sealing caps are also checked for geometric and surface characteristics by the company's automated machines. This wide variety also has its perils as Rothweiler explains: "Every new part to be tested is always accompanied by certain challenges. This starts with the feeding technique, continues with automated handling and ends with the changing demands for machine vision, a key element in all our inspection processes." According to Rothweiler, the injection gates often present a problem with injection moulded components, as they can vary considerably in terms of geometry. "Such effects can turn into a real challenge for material flow and optical inspection", says the GEFRA founder. "Reliable detection of scratches or coating faults, i.e. on metal disks, is usually not easy to accomplish at the speeds required."



Overview of the entire unit without complete cladding.



Twelve cameras at six stations ensure reliable detection of faulty parts.



The technical control centre-piece of the plant: among other things, the switching cabinet contains four Gardasoft lighting controllers.

► FACTS

Industrial sector: Automobile and aerospace supply industry

Task: Inspection and sorting of mass products in fastener technology

Imaging components supplied by STEMMER IMAGING:

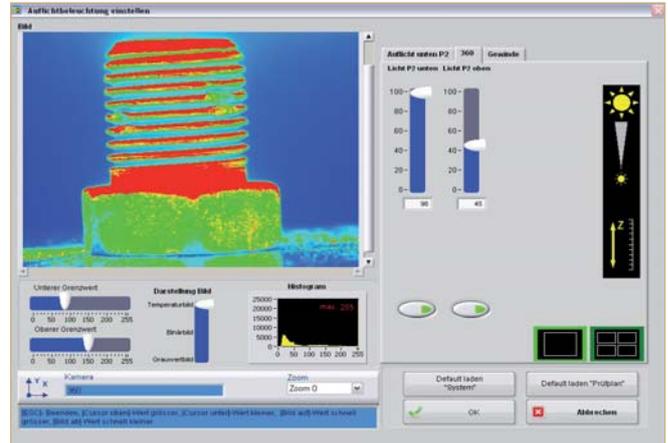
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| <input checked="" type="checkbox"/> Illumination | <input checked="" type="checkbox"/> Acquisition |
| <input checked="" type="checkbox"/> Optics | <input type="checkbox"/> Software |
| <input checked="" type="checkbox"/> Cameras | <input type="checkbox"/> Systems |
| <input checked="" type="checkbox"/> Cabling | <input type="checkbox"/> Accessories |

► Not a manufacturer of bespoke machines - despite the variety

Due to the variety of parts and materials to be inspected, GEFRA has hardly built two or more identical machines over the past 15 years. Nonetheless, Rothweiler does not regard the Optisort units as being bespoke machines, largely due to an intelligent modular system which has proven itself over the years. "Our machine concept is based on standard modules for all partial functions. This applies both to the mechanical elements, in other words, all elements dealing with feeding and handling the objects to be inspected, but also the PC components and the inspection software employed." An essential part of the company's know-how is devoted to this area: "Over the time we have developed a multi-faceted building block system comprising roughly 150 tools, which are used depending on the task in hand and, for example, allow inspection of the objects at different heights and diameters. Due to our many years of experience we are well able to assess which software tools are suitable for which components and for the detection of which faults."

Rothweiler and his engineers also base their imaging hardware requirements on standard components, most of which have for years been obtained from STEMMER IMAGING. "For us it is important to have good suppliers in all areas who we can rely on. In terms of imaging we have been working together with STEMMER IMAGING for years, a cooperation with many positive experiences. Their product portfolio covers all the components we require for our equipment." Rothweiler also finds the personal contact with Jürgen Buhr, the sales contact responsible for GEFRA, more than helpful: "In the past we have often found quick solutions jointly which has helped us in urgent cases."

The focus on standardised elements also applies to the current and so far largest plant that GEFRA has ever realised, both in terms of mechanical design as well as the effective number of vision components, states the managing director: "Until now the glass plates transporting the products past the inspection stations had a diameter of 500 mm. This limited us in the number of possible inspection stations and we therefore integrated larger glass plates with 800 mm diameter in the new equipment for the first time." The objects to be inspected are placed loosely on the glass plates and are now passed past six stations where they are inspected with the aid of twelve cameras.



Faults, as depicted here on the the thread of a screw, can be displayed in false colours.



LED illumination in various designs and different directions provide optimal lighting at each station.



The parts for inspection are transported on a glass ring and pass clockwise through all stations.

► Twelve cameras at six stations

The current plant is used for inspecting screw joints for the brake lines of vehicles. This requires strict adherence to the tolerances of all geometrical sizes including the quality of the threads to ensure 100% functionality. This is where the special 360° inspection with four cameras per pass, developed by GEFRA to detect faulty threads during a pass, comes into its own. It is also important to be able to detect chips or burrs resulting from previous work steps and to reliably sort out components with these faults.

The inspection process begins with feeding of the screw joints. "Sometimes customers provide us with finished bunker systems and adapt the feed accordingly", says Rothweiler. In this case GEFRA developed the entire mechanical side of the equipment: The screws are delivered in bulk, separated out via a vibrating bowl selected and mechanically adapted by us, and fed into the actual sorting system in two possible positions. They are then transferred to the rotating glass ring and passed by the six inspection stations.

The first of these six stations measures the geometric dimensions, such as the thread diameter, the drill holes and the hex of the screws via edge pursuit in order to ensure the correct spanner width. In addition, possible burrs on the inspection objects are detected here. "As with all measuring stations, we use telecentric lighting and lenses at these positions to determine exact values", explains Rothweiler with regard to the selection of extremely high quality machine vision components at these positions. "This gives us accuracy to the 100th mm."

A further partial system is located in the same space of the station which measures a side view of the nominal and core diameters of the thread, the phase, height and helix.

The next station is equipped with LED dark field illumination and allows further contour inspection for chips. This is followed by surface inspection of the screws which detects damage such as impressions, scratches, deformation or coating faults, i.e. incomplete coating.

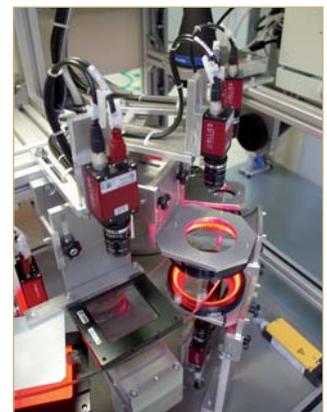
The next inspection station, which is illuminated from top to bottom, serves to detect differences in coating as well as deviations in brightness and colour. At the end of the completed inspection process, a check is conducted as to whether the threads follow the right direction, are continuous, and whether the thread tips and the thread roots meet requirements. Four cameras are installed at this station for this purpose, arranged at 90 degree intervals. Each of these cameras covers an angle of 110 to 120 degrees, so that the objects can be inspected all-round and overlapping.



Four cameras at the final inspection station record the screw from all sides. To the right one can see the illumination flash of the penultimate station.



On four of the five stations, the items for inspection are analysed from top to bottom.



Inspection stations 2 to 5

► Good parts proceed

After this final inspection station, all objects which have passed the inspections without fault are ejected from the system via a fast triggered pneumatic valve. "In other plants the faulty parts are often sorted out, but the automotive industry prefers the opposite approach. The OK parts need to be ejected explicitly", says Rothweiler. "This is the only way to ensure that only positively tested parts remain in the process, for example, in case of a faulty ejection valve or other equipment failures."

The ejected good parts pass through a pipe to a rotary table from which they are filled into boxes or small part carriers. A counter ensures that the correct number of parts lands in each container before the rotary table moves to the next section. In the current plant, the GEFRA engineers have achieved an inspection speed of up to 500 parts per minute. "Theoretically, 600 parts per minute are possible", adds the GEFRA CEO.

► A PC as control centre

According to Christoph Hüscher, GEFRA's EDP Manager, the biggest challenge was the simultaneous control and analysis of all components via a single PC. "Here we use a high performance computer, which, like all our PC's, is designed from standard PC components as a scaleable backplane system, and in which we only use the boards necessary for the system." According to the company's CEO, the present plant is unique worldwide in this context: "A single PC evaluates all images of the twelve cameras in the system with a performance of 500 parts per minute!"

► New ideas in the pipeline

The unit described here has meanwhile been delivered to the customer in France and is performing to the full satisfaction of the user. Prior to commissioning on site through a GEFRA employee, the customers of the Optisort system visited Friedewald for approval and received training. "This procedure has proven itself as customers can then generally operate their equipment by themselves as well as, for example, adapting to other objects", is how Rothweiler describes the last steps on the road to commissioning.

The GEFRA engineers are already working on the next plants and have a few interesting ideas to increase performance even further. Rothweiler did not want to disclose details, only to say: "The efficacy of our systems will definitely increase further."



Christoph Hüscher (GEFRA) explains the functions of the operating terminal to Jürgen Buhr (STEMMER IMAGING). In the background, GEFRA company founder Thomas Rothweiler.

A monitor and keyboard are integrated in the unit for simple set-up, display and operation and to allow communication between people. For example, this is where fault reports or sensor reports measuring the filling levels are displayed. Viewing of individual images from the unit, as well as the display of incorrect colours for easier representation of faults, are integrated here.

► GEFRA

The GEFRA (Gesellschaft für Fertigungsrationisierung) GmbH (www.gefragmbh.de) has been working on the development and manufacture of automated inspection systems for checking production parts since 1995. In 1998, the company received the innovation award of the State of Rhineland-Palatinate for its Optisort System. The fully automated inspection systems by GEFRA allow for economic zero defect rates of 0 ppm and are in use worldwide. GEFRA is a known and leading supplier and manufacturer to the fastener industry.