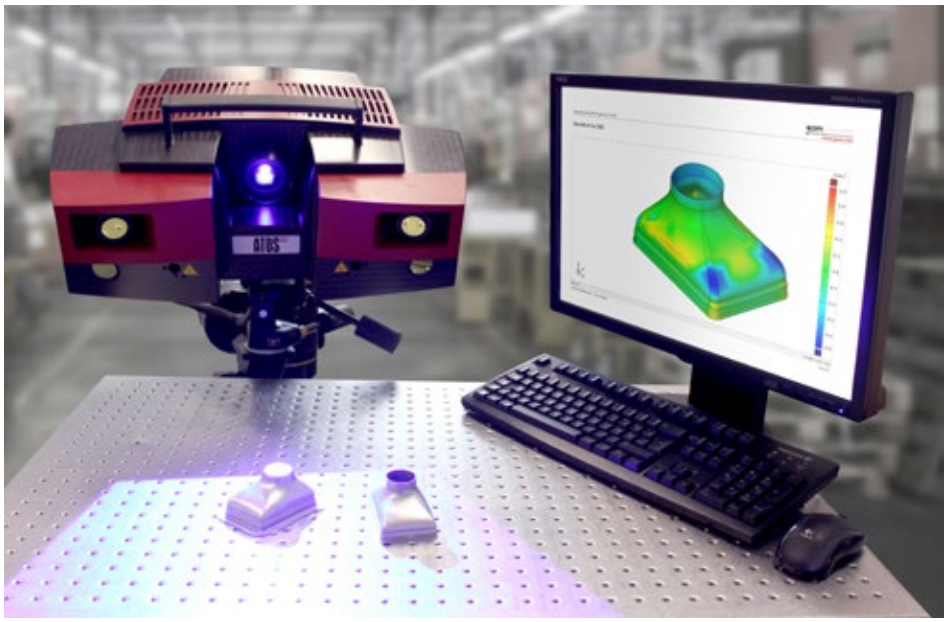
Application Example:
Defined Thinning – Combining CAD/CAM, simulation and optical metrology for faster tool try-out

Measuring system: ATOS Triple Scan
Keywords: Automotive, sheet metal, tool making, simulation, CAD/CAM, 3D design, optical 3D metrology, springback, material thickness

Getting the tool perfectly right for complex sheet metal parts used to involve a long trial-and-error process. But now the Bernecker Group has combined a CAD/CAM solution with a simulation software and optical metrology. Thus, the company achieved a substantial reduction in the number of tool iterations.



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Higher engine power requirements in the automotive industry go hand in hand with ever more stringent exhaust gas limit values. In order to meet the tight standards, turbochargers are increasingly combined with a downstream exhaust gas recirculation (EGR) system to reduce the engine's untreated NOx emissions – a solution implemented in the new VW Golf GTD, for instance. (Fig. 1)
"This technology is becoming increasingly popular because emission limit values cannot be met without it," reports Thilo Maisenbacher, Head of Design at Bernecker.

Fig. 1: The new Golf GTD is equipped with an exhaust gas recirculation (EGR) system. With an engine power of 184 hp, average fuel consumption is 4.2 l/100 km and CO2 emissions are 109 g/km.

Despite Bernecker's wealth of experience in the production of sheet metal parts gained over many years, the EGR – which is composed of several stainless steel sheet profiles – poses new challenges for the company's tool specialists. This is because in the production of the EGR (and an increasing number of other components) customers request that a defined percentage reduction in thickness resulting from an ironing operation must not be exceeded. Taking account of this percentage in the tool design and then checking it on the manufactured component is quite an undertaking.

Intelligent link between design, simulation and measurement
To ensure faultless development and production of ironed parts meeting the specification, Bernecker has created an integrated design, simulation and measurement solution: a process loop from 3D design using the VISI CAD/CAM system, simulation using the Stampack simulation software with springback calculation, VISI Advanced Modelling for springback compensation, right up to fast optical 3D measurement with a high-resolution digitizer, the ATOS system from GOM – and back in reverse order.

The size of the objects that can be measured with the ATOS system ranges from a few millimeters to several meters. The measuring accuracy for small parts such as the EGR is in the region of hundredths of a millimeter. To perform the measurement, a fringe pattern is projected onto the object. The distortion due to the object's contours is captured by two cameras. The resulting images are used to compute a point cloud that depicts the component surface precisely. Full-field measurement of a component is the advantage of this method, which gives the user a digital view of the entire component so that potential problems can be identified instantly. (Fig. 2)

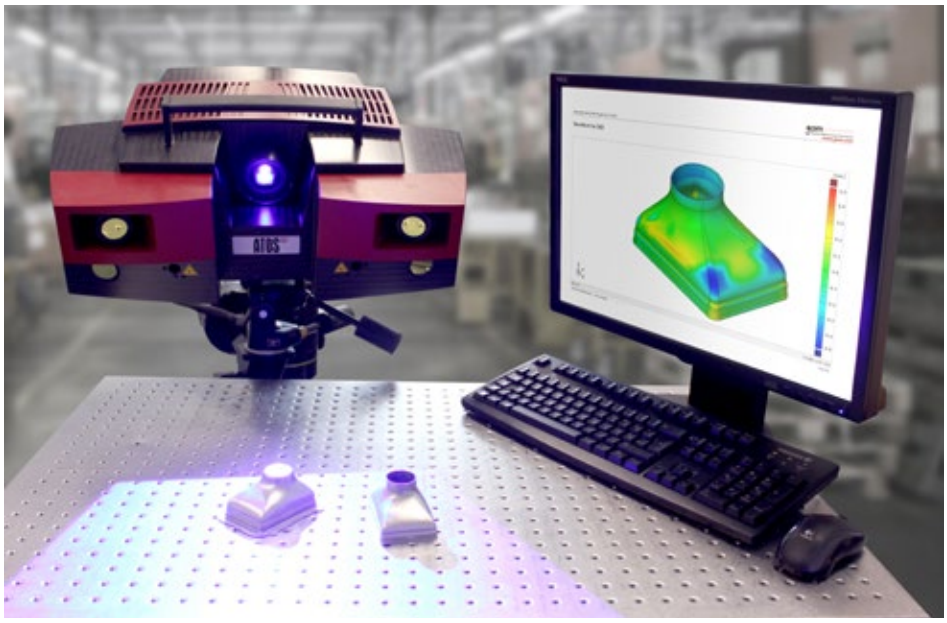

Fig. 2: Measurement and full-field comparison with CAD data using the ATOS Triple Scan 3D optical measuring system.

Bernecker has recently started to use the ATOS system's fast measurement capabilities for its tool development operations, too. First of all, the tool is designed in 3D with the VISI software before the geometrical data are copied to the Stampack system to simulate the part. The tool specialists then compensate for the springback calculated using the integral Advanced Modelling module in the VISI CAD system. It is this optimized tool version that is then used on the machine tool. "We measure the part manufactured with this tool by means of the ATOS 3D digitizer from GOM, compare the results with the existing 3D model and make corrections if necessary," explains Thilo Maisenbacher. "Using the Advanced Modelling feature, we once again correct any remaining springback, adjust the tool, produce the part, and then measure it with the ATOS digitizer. And then it fits." (Fig. 3)

Fig. 3: The component in the Stampack simulation system during thickness distribution simulation (left). The component in the Stampack system after completing the simulation (middle). Degree of utilization of the forming limit (right).

Bernecker has been using the VISI 3D CAD/CAM software and Stampack simulation software for several years for fast and simple tool design and simulation. The idea to round off this solution by adding the ATOS system to create a closed iteration loop emerged much later. Initially, Bernecker used to cut open the manufactured parts. In a time-consuming process the thinnest portion produced by the ironing operation was identified using tactile measurement. That was until Bernecker learned from Men at Work that GOM data could be used in VISI CAD without any difficulties.

Men at Work, an IT and engineering service provider based in southern Germany, sells CAD/CAM solutions and simulation software. The mesh data acquired in a GOM measurement can be transferred effortlessly to the VISI system for easy further processing. Working in VISI, the designer can add sections to the GOM mesh data. Bernecker uses this feature to reproduce old tools, for example. This is necessary because there are many old tools in use which have to manufacture spare parts for up to 15 years. In many cases, drawings no longer exist, partly because some of the tools are customer-supplied models. Today, when defects occur, the parts are measured on the GOM machine or the mobile measuring system is simply taken to the tool to be measured. Once the tool has been measured, a 3D drawing is created in VISI.

Drastic reduction in iteration loops
The procedure is also possible in reverse order. That means that the VISI data can be imported into the GOM software for fast creation of the measurement program. Using the VISI data model, the measurement program can be created almost automatically. By combining 3D CAD/CAM, simulation and optical metrology, the Bernecker Group has managed to achieve a drastic reduction in the number of try-outs in the tool development iteration loop, thus saving time and money.

The challenge of ironing
Ironing is a process in which the material is thinned during deep drawing of the sheet metal blank. In general, the greatest reduction in thickness during an ironing operation occurs at the highest point. In the production of the EGR, for example, three radii coincide at the thinnest point on one part. This is where the fine art of tool design and measurement comes into its own because the maximum percentage reduction in thickness specified by customers must not be exceeded, and measuring that percentage with conventional methods is virtually impossible. Of course, it is possible to cut open the part – but in that case the reduction in thickness can be measured along one line only. And if the cut is performed just 0.5 mm to one side of the thinnest point, that point is not included in the measurement. What makes it even more difficult is that a border several millimeters wide needs to be left when drawing the sheet metal. When the part is removed from the deep drawing tool and trimmed, the stresses generated during the deep drawing operation are released. All these factors need to be considered in the tool design.

Top part of progressive deep drawing tool with untrimmed component.

Simulation and measurement reduce the number of correction loops required for the deep drawing tool.

End-to-end data chains such as those implemented by the Bernecker Group represent the right strategy for tool and mold makers to move on from the trial-and-error approach to a well-targeted, time and cost saving process. “This is the key for tool making: designing, simulating, measuring, correcting – done,” is how Thilo Maisenbacher sums up. “To accomplish it all, it takes a partner like Men at Work who fully understands the entire process chain. But obviously, an IT system provider with a good grasp of the sheet metal forming process chain and the ability to combine CAD/CAM, simulation and metrology in the way Men at Work do is the exception, not the rule.”

Bernecker Group
The Bernecker Group, with headquarters in Mühlacker in southern Germany, develops and manufactures deep drawn, bent and punched parts, flat and round tubes, profiles, insert molded plastic parts or fully mounted subassemblies from different materials or material combinations. They produce the exhaust gas recirculation (EGR) system for several European automotive manufacturers. Affiliates include Profiltechnik Söll GmbH in Pausa, Germany, and BeShape Tech k.s. in Slovakia. Founded in 1962, the Bernecker Group today has a total workforce of more than 300.

We thank Bernecker and Men at Work for the trust in our measurement technology and the professional realization of this project.