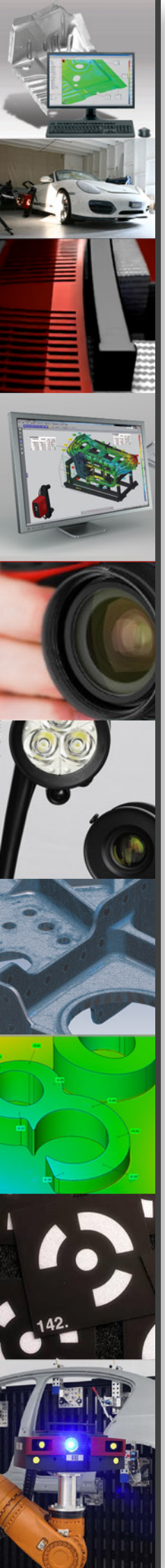


SCAN-XPRESS

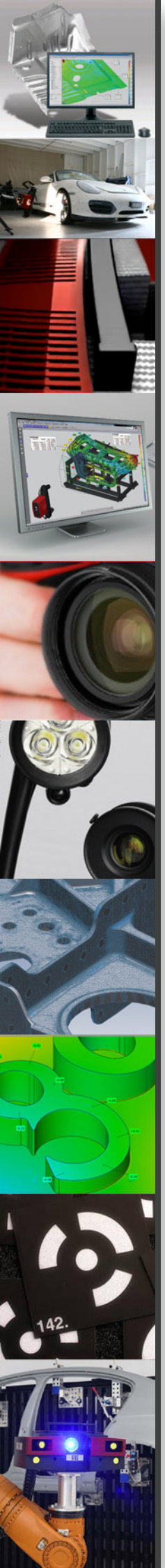
EXCELLENCE IN 3D MEASUREMENT

Application Example: Rapid Manufacturing

Toolmaking: Digitizing tremendously saves time and costs when modifying series tools

Measuring Systems: ATOS, TRITOP
Keywords: Optimized milling, hybrid modelling

Modifications to the tools are required during starting up the tools or in the first production phase of car body parts. Thus, the real shape of the tool does no longer correspond to its original and basic design. To repair or reproduce the tool efficiently, the best technical solution is to digitize the surfaces of the tool and prepare the digitized data as CAD data set.



SCAN-XPRESS

EXCELLENCE IN 3D MEASUREMENT

Rapid Manufacturing / Toolmaking

Digitizing tremendously saves time and costs when modifying series tools

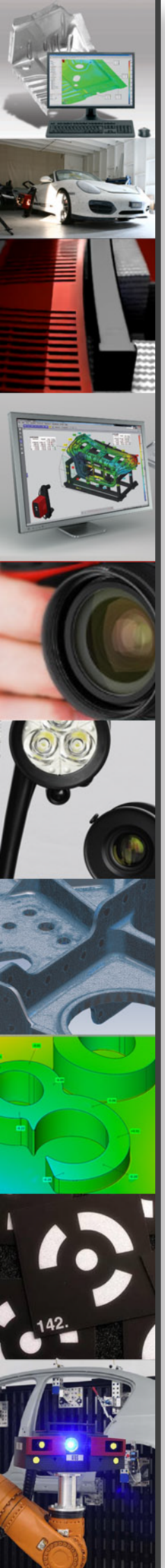
Measuring Systems: ATOS, TRITOP
Keywords: Optimized milling, hybrid modelling

When in 1895, H. Wilhelm Meckenstock started his small ribbon weaving business, he laid the foundation for a successful development of the company bearing his name to become a recognized system developer and supplier for the international automotive industry. The headquarters, located in Mettmann close to Düsseldorf, Germany, specialized in the production of heat shields and metal stampings made of steel and aluminum. This includes the development and manufacturing of welded parts and assemblies for the mass production of the mentioned sheet metal parts.

Manual modifications during tool try-out

Due to reasons of costs and capacity, most of the tools are not manufactured by the company itself. External suppliers design these tools using CAD and manufacture them based on the CAD data. When starting up the tools, modifications are required due to the technology. This means that effective areas are manually modified in order to optimize the transformation process of the metal sheet and get the desired shape. These manual modifications are neither documented nor integrated in the CAD data. Thus, the real shape of the tool does no longer correspond to its original and basic design.

Fig. 1: H. Wilhelm Meckenstock GmbH, specialist for metal stampings, welded parts and assemblies for the automotive industry.



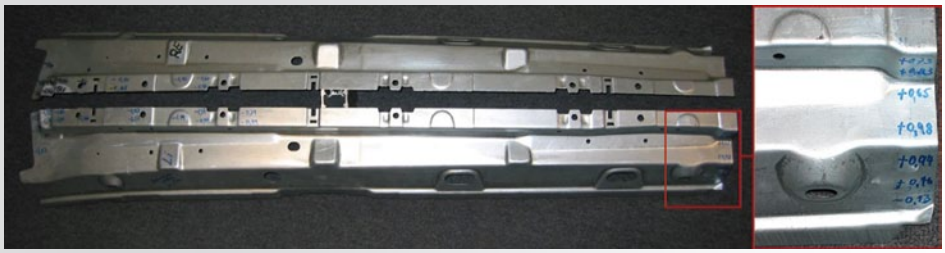


Fig. 2: There are no current CAD data for the calibration tool of the roof frame. Nevertheless, some modifications are to be milled into the tool using CAD/CAM (see markings on the finished metal sheet, detailed view right figure).

Additional design modifications when starting series production

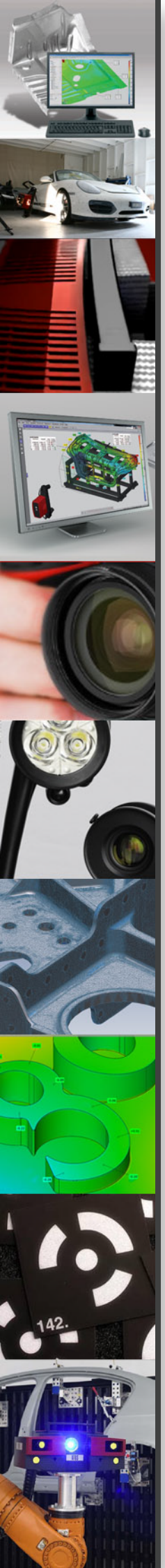
Frequently, minor for example, when welding the car roof cross-beam to the roof frame, high strain occurred at the welded joints which caused problems in the welding line. In order to avoid these strains, the roof frame needs to be bended stronger in certain defined areas which can be done by adapting the corresponding calibration tool. Roland Decuzzi, Head of Tool-Making, explains the task to be carried out: "Our Quality Assurance Department and I defined this and other additional modifications. In the front area, the roof frame needs to be drawn deeper about 0.2 mm to 0.7 mm. It is our goal to modify this tool within the shortest possible time to keep the production halt at a minimum."

Updated CAD data considerably facilitates modification and reproduction

Modifications can only be applied to a tool efficiently by a milling process. Meckenstock's Tool-Making successfully uses the CAD/CAM system of Tebis for more than nine years now to calculate the NC programs required for such a process. Andreas Kups, responsible for CAD/CAM in Tool-Making, knows the problems of this task: "The calculation of NC programs for the required modifications is based on the CAD surfaces of the tool. However, because of the manual adaptation during the try-out, the CAD model does no longer corresponds to the real tool. As long as the current state of the tool does not exist as CAD data set, the required modifications can only be applied to the tool in a laborious and time-consuming way. The chance to use the comfortable method of CAD and CAM is spoiled then". In addition, a second, much more critical situation may happen: "If during the production of the metal sheets the tool breaks, the respective component needs to be repaired or replaced as fast as possible. But as the existing CAD data are not identical to the current tool, the entire manual adaptation of the tool try-out needs to be carried out again. In addition, for externally manufactured tools, the reworking often is not documented. Therefore, the problem becomes more critical if it is necessary to produce the tool again under time pressure. In the worst case, this may cause a production downtime which costs a lot."

Digitizing tool surfaces by Tebicon

The best technical solution is to digitize the surfaces of a proven and well run in tool and prepare the digitized data as CAD data set. This provides for modifying the tool on a consistent basis and – if necessary – to repair or reproduce it efficiently.

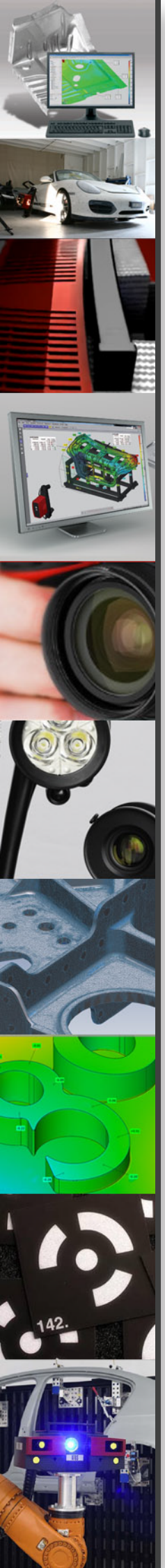


Meckenstock, too, decided to use this procedure for the current case. However, seen from the economic point of view, it so far does not make sense to invest in a high-quality digitizing system because such a system would not be used enough. When looking for a service provider who would carry out digitizing of tools, Mr. Kups soon came across the Tebicon Tebis Consulting GmbH. He knew this company already from qualified Tebis CAD/CAM training and consulting work.
As a service provider subsidiary of Tebis AG, Tebicon's scope of services includes to digitize any complex tools directly at the customer's premises, to compare the measured data with the CAD data and to integrate the recorded deviations into the CAD data set. Based on such an updated CAD model, NC production may follow. The CAD model can also be used as basis for additional adaptations and modifications of the design and thus provides to integrate modifications in existing or new tools.

Non-contact digitizing using the ATOS and TRITOP systems of GOM
After a supply of metal sheets for two weeks has been manufactured, Meckenstock takes the calibration tool off production. In order to keep the downtime costs at a minimum, everything needs to be done fast. To transform the tool into the virtual world of CAD, the Tebicon specialists used the optical measuring system ATOS of GOM. This system digitizes freeform surfaces fast and in a non-contact manner. As ATOS is very flexible, even complex tool geometries can be digitized exactly with all their details.

Prior to measuring, the tool is sprayed with a powder that can be wiped off later. This guarantees optimum conditions for the optical measurement as it avoids reflections and excessive differences in contrast. Now, adhesive or magnetic reference point markers are applied to the tool and photos are taken from various views using a special digital reflex camera of the TRITOP photogrammetry system. Now, the photogrammetry system TRITOP automatically evaluates these images, determines the exact positions of the reference points and registers them to the coordinate system of the component. Subsequently, the ATOS fringe projection sensor, which can be positioned flexibly, is used to scan the whole tool in overlapping scans. In combining the technology of photogrammetry and fringe projection, an absolute accuracy of below a tenth of a millimeter is achieved when measuring the about 1.50 m long tool. After a digitizing time of just two hours, the data are available in STL format and the Tebicon consultant can load them into the Tebis CAD/CAM system.

Fig. 3: Within just two hours, the Tebicon consultant completely digitizes the tool. The data is then available as STL file.



Processing the scanned surface data in Tebis

After the digitized data of the tool was loaded into the Tebis system, they are displayed as a mesh of triangles. The CAD/CAM system treats this geometric element type like surfaces which were generated by means of design curves and sections. Using the Tebis CAD module to process scan data, the Tebicon consultant removes unnecessary areas from the mesh. Wherever possible, the number of mesh triangles is reduced without facing a loss in quality. In addition, the mesh is smoothed and thinned.

Integrating the modified areas into the original CAD surface model

The next step is to find the modifications carried out manually during the tool try out. For this purpose, the original surface model and the mesh obtained from the digitized surfaces are loaded into a Tebis CAD file and are compared with each other. Tebis displays the difference between the reference data and the measured data by means of a color overview. Immediately, Mr. Kups finds out: "Individual draw radii increased even by 4 mm with respect to the original tool."

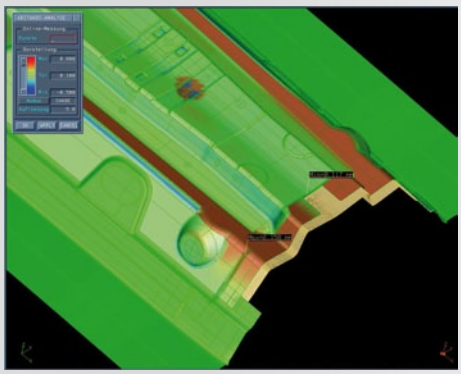


Fig. 4: By comparing the CAD model with the actual tool, the modifications carried out manually are determined and displayed.

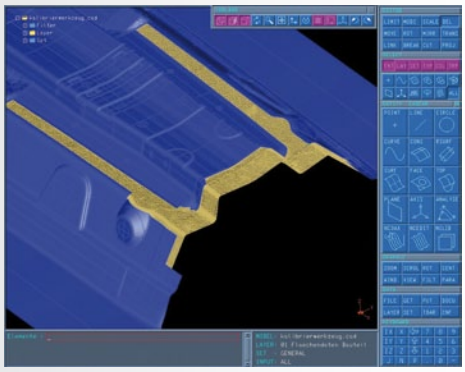


Fig. 5: Areas, in which the measured tool deviates from the original design are extracted and inserted into the CAD model. The current data set, consisting of a combination of meshes and surfaces, thus exactly corresponds to the real tool.

Based on this analysis, the detected areas can be extracted from the STL mesh and inserted into the surface model. The design functions of Tebis allow for any combination of surfaces and STL meshes. The whole process results in an exact match of the actual existing tool and the CAD data.

This new data set can be used to reproduce the tool in case it broke, as Tebis NC programs also calculate on the basis of hybrid CAD models (mixture of surfaces and meshes).

Modifications designed in the current CAD data set

The next and priority task is to create the NC programs for milling the determined modifications. If these modifications are in the hybrid areas, these parts of the mesh data are replaced by exact polynom surfaces for easier handling. For this purpose, the Tebicon consultant uses the Tebis CAD functions for wire and surface design and the new software for rapid surface creation. In no time, the mesh data in the affected areas are replaced by surface patches.

According to the specifications of Mr. Decuzzi, then the required modifications can be designed into the tool within just minutes while the tool itself is mounted to the milling machine.

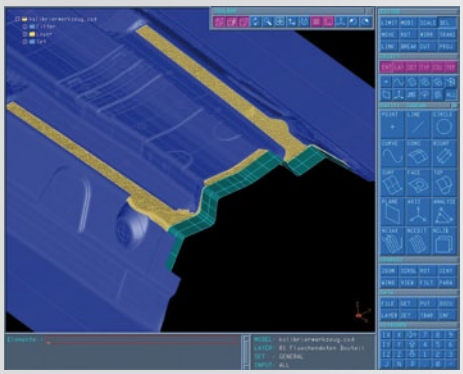


Fig. 6: Using the new Tebis software for rapid surface creation (RSC), the mesh is replaced by surfaces in the areas to be modified

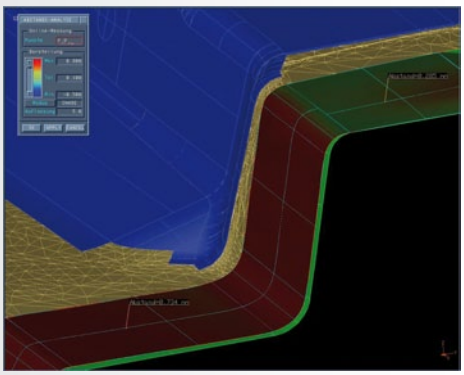


Fig. 7: According to the specifications, the modifications are designed into the current CAD data set.

NC programming with Tebis

In order to implement the virtual CAD result quickly and exactly in the tool, Mr. Kups uses the Tebis CAM module for creating 3-axes plus 2-axes NC programs. These work on mesh data as good as on mixed data structures consisting of surfaces and meshes. Roughing and smoothing programs are quickly calculated and transferred to the machine. The machine immediately starts working on the tool already mounted. The programs are completely executed within 30 minutes. For additional modifications required that will be integrated as described, the tool remains in the machine for a total of two more days. At the end, one day is required for manual try-out and measuring work prior to make the complete calibration tool available for production.

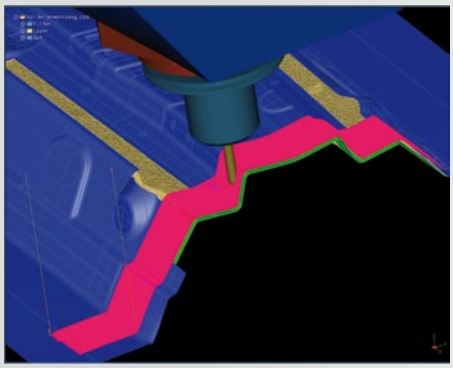
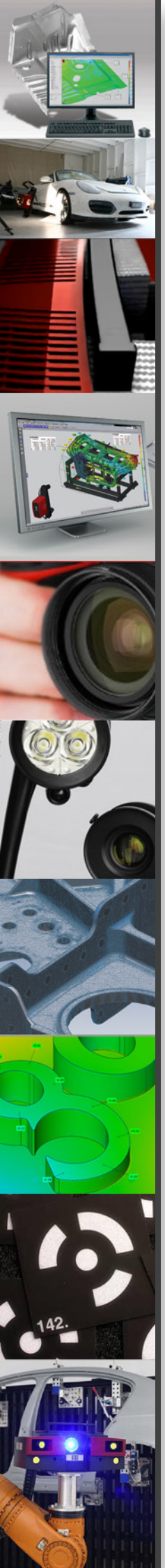


Fig. 8: The NC programs required for milling the modifications into the tool are calculated on the basis of the mixed data of surfaces and meshes.

Fig. 9: Roughing in the modification area. After 30 minutes, the tool is modified.



Mr. Decuzzi is pleased and states: "The modified tool can be handed back to production already after four days. We needed at least twice as much time with our previously used procedure."

Mr. Kups, Head of CAD/CAM in Tool-Making, finally adds: "In addition to considerably save time, we eliminated guessing from the process and are able to carry out modifications exactly and correct. For similar tasks in the future, we will always use this innovative process in cooperation with Tebicon."

Fig. 10: Mr. Kups (right): "By digitizing the tool, the modifications are cut in exactly and correctly."

We would like to thank Tebicon and Meckenstock for this interesting report and for their confidence in our measuring technology.