Abstract:
ZEISS Reverse Engineering closes the gap between measuring systems and CAD programs. The software for reverse engineering and 3D point processing is particularly well-suited for users that want to convert into a CAD model their highly precise measurement data or the calculated point clouds without a loss of information.

KEYWORDS: reverse engineering, 3D scanning, point cloud data

From a fender to a wrench to the rotor on a windmill – the design of products today is completed largely in a digital process. However, most manufacturers still rely on prototypes to test their designs. For the validation and development process, these prototypes are digitized and compared with the virtual 3D model (fig. 1). As a result, reverse engineering has become a key element of the design cycle. Furthermore, companies are increasingly using reverse engineering to generate 3D models of parts for which they do not have any CAD data, e.g. older workpieces or products such as freeform lenses that are usually not designed in CAD programs. This has made reverse engineering essential to the manufacture of certain complex parts on modern machines.
Simply modern

In addition to the growing necessity for reverse engineering, the widespread use of reverse engineering software tools has made this process much easier than just a few years ago. As simple as possible and intuitive is also how the software from ZEISS should be. This is also why the team worked intensively with external software ergonomists for several weeks, who use their expertise to vastly improve the user-friendliness of software. And the results are obvious: thanks to the modern user interface and the well-structured, consistent design of the software, users are able to efficiently work with the solution following a short introduction period. Experience shows that operators can navigate the functions and features after just two days of training.

Users decide

ZEISS Reverse Engineering processes unstructured 3D point clouds regardless if the data was obtained via contact measuring machines, computer tomographs, laser scanners or cameras, or virtually calculated from mathematical models. The software detects the underlying geometries from the point clouds. The surfaces mathematically calculated from the point data are then merged to create a watertight model. This means that there are ideally no gaps between the surfaces or overlapping which would result in flaws in the CAD model and the subsequent product. What makes ZEISS software different from other programs is the possible user influence on the calculation of the surfaces. In the future, developers want to offer even stronger automation. But, this will not prevent users from utilizing their knowledge in the future. Where a computer only sees points, the ZEISS solution allows experienced operators to make decisions – does the wave in the point cloud belong to the product or is it just the travel path of the sensor during digitization that has to be meaningfully smoothed. The possibility of playing with the decisive parameters will ensure that the software strongly differs from other products in the future.

Fig. 2. Workflow: from product data set to corrected tool. Tool correction workflows are more efficient with the ZEISS solution
Perfect surfaces

But this is not the only aspect that makes ZEISS software more precise than other solutions. Thanks to the reverse engineering algorithms developed by Schmid and Co., users receive a really perfect surface for engineering because it is flat. In light of these benefits, ZEISS Reverse Engineering software is ideal for companies that require highly precise CAD data. As a manufacturer of high-end lenses, ZEISS uses this in-house development for the faster production of freeform lenses. Optical freeform lenses are usually not designed with a CAD program; optical designers generally calculate the surfaces for an ideal lens in dedicated simulation programs. Because these surfaces generally cannot be processed by the production machines, the ZEISS solution calculates a highly accurate, CAD-capable surface description from the point generated from a scan of the original surfaces. The resulting 3D models are then used to directly control the highly precise machines for lens manufacture.

![Form and injection-molded part: the reverse engineering of optical freeform lenses requires highly precise measurement data](image)

Focus on toolmaking

Another strength of the software according to Schmid lies in the specially integrated toolmaking functions. Using information from the simple nominal/actual comparison of the product data set and the actual data set of the initial test parts, injection molders can much more quickly employ reverse engineering techniques to correct their tools (fig. 2). Based on the experience gained with pilot customers in this field, ZEISS Reverse Engineering enables companies to reduce by at least 50 percent the standard 5-7 correction loops needed to
make a perfect tool. And, because the software can process a lot of points thanks to the algorithms, e.g. scanning data from computer tomographs, the results are very stable. Furthermore, critical surfaces already in the program can be checked, for permeability and fit for example. This allows users to focus on these surfaces and correct the CAD model locally to present their results more quickly. And because key CAD functionalities such as blending, extending and binding are also available in the ZEISS solution, even the most complex parts or tool inserts can be fully reverse engineered. Thanks to the support of this tool correction process, companies employing ZEISS Reverse Engineering can begin the volume production of their injection-molded parts much sooner (fig. 3).

Fig. 4 From a scan to the model: ZEISS Reverse Engineering closes the gap between digitization systems and CAD based systems

Even faster and easier

Schmid and his team are currently developing new algorithms to further accelerate the import of data and calculations of the processing steps in the software, which will enable the software to accommodate the trend towards increasingly large quantities of data. Furthermore, a higher degree of automation for tool correction will further enhance user-friendliness (fig. 4). The second release will hit the market in the spring. All that is required to run the software is a PC with a corresponding graphic card for visualization. The solution is currently available in German and English. Additional languages can be integrated upon request. Operators generally transfer the data to the CAD program via neutral data exchange formats (STEP and IGES); specific CAD exchange formats can be integrated upon request. Even if there are already a number of reverse engineering programs, Schmid is certain that “With ZEISS Reverse Engineering, we have introduced a solution that will impress customers with its precision and user-friendliness.”