Application Example: US foundry Bradken implements optical measuring technology

Measurement system: ATOS Triple Scan, TRITOP
Keywords: foundry, steel castings, simulation, assembly analysis, coordinate measurement, photogrammetry, optical 3D metrology, quality control, inspection

Conventional shape and dimensional analysis of castings with tactile coordinate measuring systems has its limitations. Therefore, US steel foundry Bradken has implemented optical 3D metrology for its large-sized castings. This enables inspection processes to be accelerated, tolerance requirements to be met and rework to be reduced.

GOM mbH
Mittelweg 7-8
38106 Braunschweig
Germany
Phone +49 531 390 29 0
Fax +49 531 390 29 15
info@gom.com

GOM International AG
Bremgarterstrasse 89B
8967 Widen
Switzerland
Phone +41 5 66 31 04 04
Fax +41 5 66 31 04 07
international@gom.com

GOM UK Ltd
Unit 14 The Cobalt Centre
Coventry, CV3 4PE
United Kingdom
Phone +44 2476 639920
Fax +44 2476 516990
info-uk@gom.com

GOM France SAS
10 Quai de la Borde
91130 Ris Orangis
France
Phone +33 1 60 47 90 50
Fax +33 1 69 06 63 60
info-france@gom.com

GOM Branch Benelux
Interleuvenlaan 15 F
3001 Leuven
Belgium
Phone +32 16 408 034
Fax +32 16 408 734
info-benelux@gom.com

GOM Italia Srl
Via della Resistenza 121/A
20090 Buccinasco (MI)
Italy
Phone +39 02 457 01 564
Fax +39 02 457 12 801
info-italia@gom.com

Application Example: US foundry Bradken implements optical measuring technology

Measurement system: ATOS Triple Scan, TRITOP
Keywords: foundry, steel castings, simulation, assembly analysis, coordinate measurement, photogrammetry, optical 3D metrology, quality control, inspection

The Bradken foundry in Tacoma, Washington (USA), has a long tradition. Tracing its roots back to 1899, it was established under the name of Atlas and initially concentrated on the production of iron castings for the logging industry in the thriving north-west of the United States. In the 1930s, Atlas shifted its focus to steel castings before changing its emphasis in the 1950s to the manufacture of pump housings for use in pipelines, refineries and chemical plants. During the 1980s the company made turbines and compressors its priority – and, some years later, large high-strength alloyed steel castings for offshore platforms. This product portfolio has been extended to include components made of HY-80 and HY-100 steel alloys for applications on US Navy ships and submarines. These high-tech materials can withstand water pressures of over 700 metric tons per square meter. After the acquisition of Atlas by the Bradken engineering group, Bradken invested in modern technologies in order to maintain the Tacoma facility's leading position in the production of high-quality castings. Today, the plant produces castings for the energy sector – and other industries – such as turbine components, pumps, valves, compressors, and hydropower generators with a net weight of up to 25 metric tons. **(Figure 1)**

Fig. 1: Bradken's steel foundry in Tacoma, Washington (USA), develops and manufactures castings for the energy sector, such as turbine components, pumps, valves, compressors, and hydropower generators.

The system evaluation process
Since the production of growing volumes of high-quality castings, complete and consistent quality control became increasingly important. This made faster and full-field measuring and inspection methods necessary. Those methods not only had to cope with the requirements, but also needed to handle complex geometries and dimensions of up to 4.5 meters. When performed with the conventional coordinate measuring machines on articulated arms, shape and dimensional control of these components took several weeks. The problem encountered in the past was that, each time the arm had to be repositioned, errors occurred in the calculation of coordinates of overlapping areas. Moreover, the applied measuring system was difficult to operate. As a result, tactile measurement had its limitations in terms of the throughput of parts that could be measured internally by Bradken. Also, larger castings with tight tolerances could not be measured at all with the measuring system on articulated-arms, so that their inspection by means of a laser tracker had to be contracted out. Consequently, in order to enable in-house inspection at its Tacoma facility, Bradken needed to invest in more efficient, flexible and reliable 3D metrology systems designed to allow complete measurement of large and complex castings.

In an extensive selection process, various metrology systems such as 3D laser scanners, hand-held 3D laser scanners, laser trackers and 3D scanners with Blue Light Technology were tested on large, machined domed castings intended for use on a production line for transport containers. Because of their small scanning range and limited scanning distance, the 3D laser scanner and the hand-held 3D laser scanner led to difficulties in capturing the large domed castings and, in fact, only managed to scan less than 25 percent of the casting in one working shift. Furthermore, the requested 1.5 mm surface tolerance was not met, and the hand-held 3D laser scanner revealed ergonomic difficulties and proved unsuitable for prolonged use. While the laser tracker enabled precise measurement of the domed casting, it had poor resolution (only few points), delivering insufficient data for complete surface measurement. The most compelling argument against the use of the laser tracker, however, was that the results varied between operators.

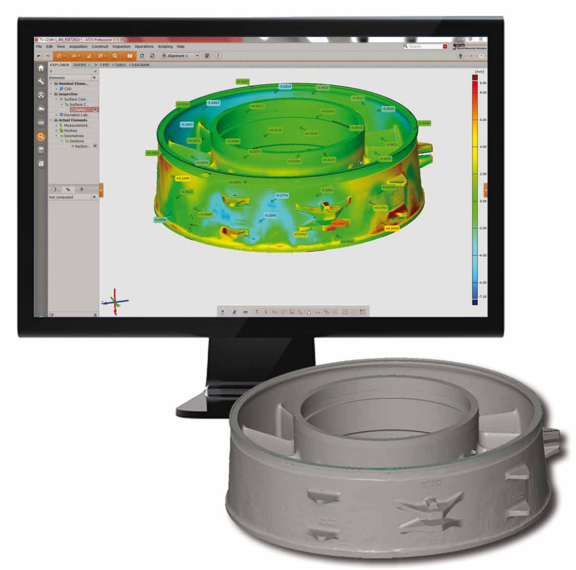

Fig. 2: Tests conducted in Tacoma demonstrated that, within eight hours, ATOS Triple Scan, an optical 3D fringe projection scanner, was able to deliver precise scans with the specified tolerances along with an extensive analysis of the complete casting.

Faster inspection
In the end, Bradken chose the ATOS Triple Scan from GOM, an optical 3D fringe projection scanner equipped with measuring cameras with high resolution of up to 12 megapixels **(Figure 2)**. Tests conducted in Tacoma demonstrated that, within eight hours, ATOS was able to deliver precise scans with the specified tolerances along with an extensive analysis of the complete domed casting. Other key criteria in Bradken's decision included the flexible range of different measuring volumes and simple handling. Another plus offered by the ATOS Triple Scan is the Blue Light Technology **(Figure 3)**. The narrow-band blue light of the projection unit allows the scanner to perform measurements independent of ambient lighting conditions and better scanning of shiny surfaces.

Fig. 3: Blue Light Technology, the narrow-band blue light of the projection unit, allows measurements to be taken independent of ambient lighting conditions and better scanning of shiny surfaces.

ATOS Triple Scan is a 3-in-1 sensor system: It uses the right and left cameras individually in combination with the projector. This new method results in three individual sensors each with different viewing perspectives of the object, so that three views instead of one are captured during a single measurement. This means that the number of individual scans is significantly reduced, even when scanning complex parts. Scanning in deep pockets is a further advantage offered by this solution.

Unlike conventional tactile coordinate measuring systems (which scan only individual points) or laser scanners (which analyze measurement data for specific sections), optical 3D metrology systems such as ATOS capture the entire surface of the Bradken castings. This is done by applying the principles of triangulation: Using a projector, fringe patterns are projected onto the object to be measured and captured by two cameras. In this manner, millions of measuring points with precise details can be obtained in a few seconds by non-contact measurement. Using the information thus gathered, the ATOS software automatically determines the 3D coordinates in the form of a high-resolution point cloud (ASCI/STL).

The generated polygon mesh describes freeform surfaces and primitives which can, during shape and dimensional analysis, then be compared with the drawing or directly with the CAD data **(Figure 4)**. Bradken's engineers are thus able to instantly identify dimensional deviations in the on-screen color plot, thus providing substantial time savings for the Tacoma-based foundry.

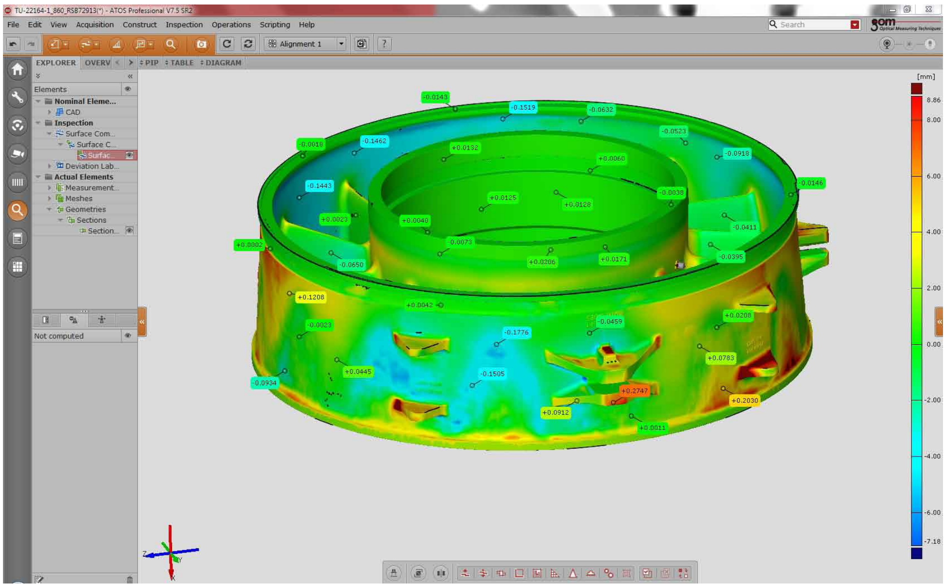

Figure 4: The measurement data can be analyzed immediately and compared directly with the CAD data. Deviations to CAD are highlighted in color and problematic areas are easy to recognize, enabling specific improvements to be made to the manufacturing process.

In addition to the ATOS Triple Scan, Bradken also uses the mobile TRITOP photogrammetry system to improve the dimensional accuracy of large castings and assemblies such as turbine housings. To enable point-based coordinate measurement and deformation analysis, photographs of the component are taken from different angles.

Having incorporated the GOM metrology systems into its inspection processes, Bradken is now able to measure large and complex components as well as mounted assemblies – capturing the complete object, meeting tight tolerances and working within appropriate time limits. As a result, the foundry's investment has paid off faster than originally expected. Inspections no longer need to be outsourced, delivering additional cost savings.

Less rework due to the combination of simulation and 3D measurement
Since the introduction of GOM metrology solutions, Bradken has managed to reduce rework significantly, and to optimize and accelerate its production processes overall. Large objects in particular, such as gas turbine housings, may experience severe deformation or distortion during the cooling process. In order to predict the resulting loads, Bradken uses the Magmasoft casting simulation software. In this context, it was important for Bradken to be able to relate the actual dimensional deviation to the calculated results. This was possible thanks to the measurement of the individual castings with the ATOS and TRITOP systems. Based on the measuring results, the pattern was modified in such a way that the new casting could be manufactured with the correct dimensions right from the very start. The combination of simulation and 3D measurement speeds up manufacturing processes because it enables the foundry to avoid time-consuming rework, this being otherwise necessary to achieve the requested tolerances. Without the ATOS and TRITOP metrology systems it would not have been possible to check object surfaces and geometries during the search for the best solution.

We thank Capture 3D, USA for the trust in our measurement technology and the professional realization of this project.