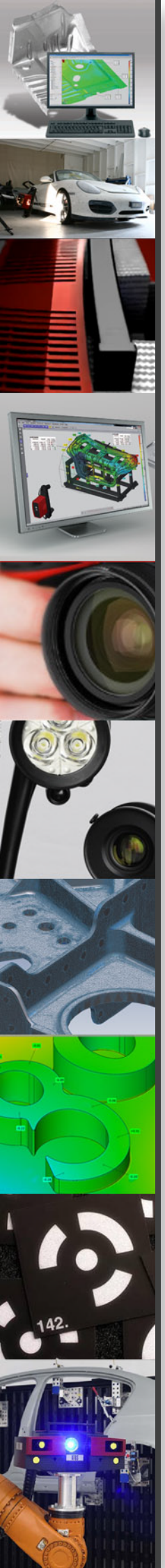


SCAN-XPRESS

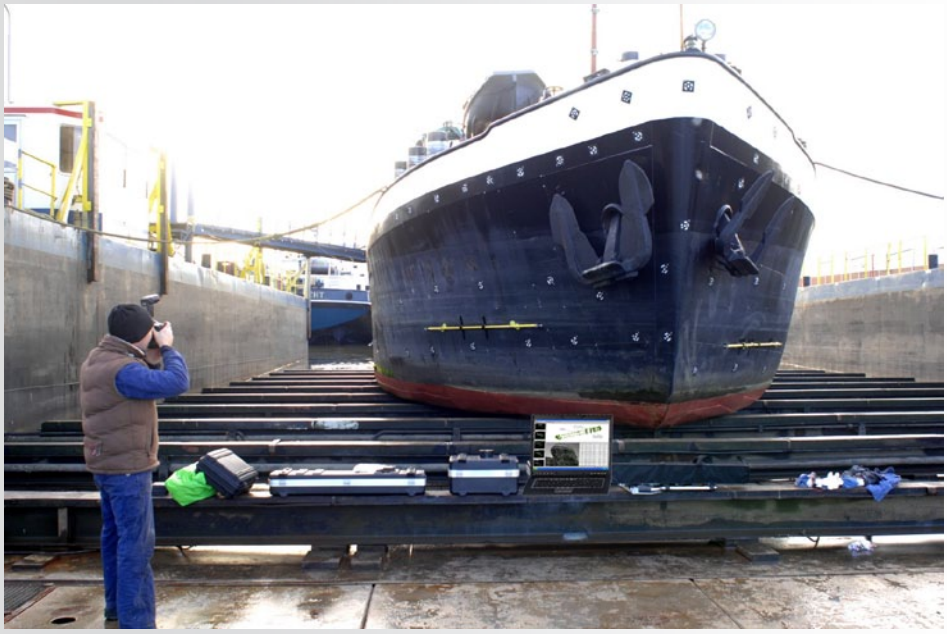
EXCELLENCE IN 3D MEASUREMENT

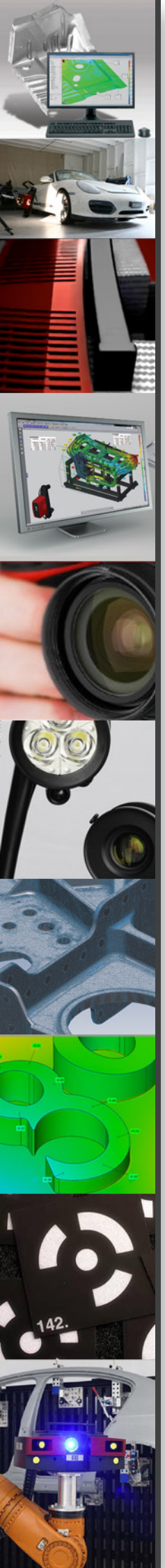
Application Example: 3D-Coordinate Measurement

Mobile 3D Coordinate Measurement for Shipbuilding

Measurement system: TRITOP^{CMM}
Keywords: reduction of down-times, shipbuilding industry, efficient repair & maintenance, hull measurement, in-cabin layout measuring, 3D-Coordinates for CAD-Systems, measuring technology for shipyard & dry-dock

Mobile optical 3D Coordinate Measurement System TRITOP^{CMM} helps to reduce downtime of ships in dry-docks from month to days.





SCAN-XPRESS

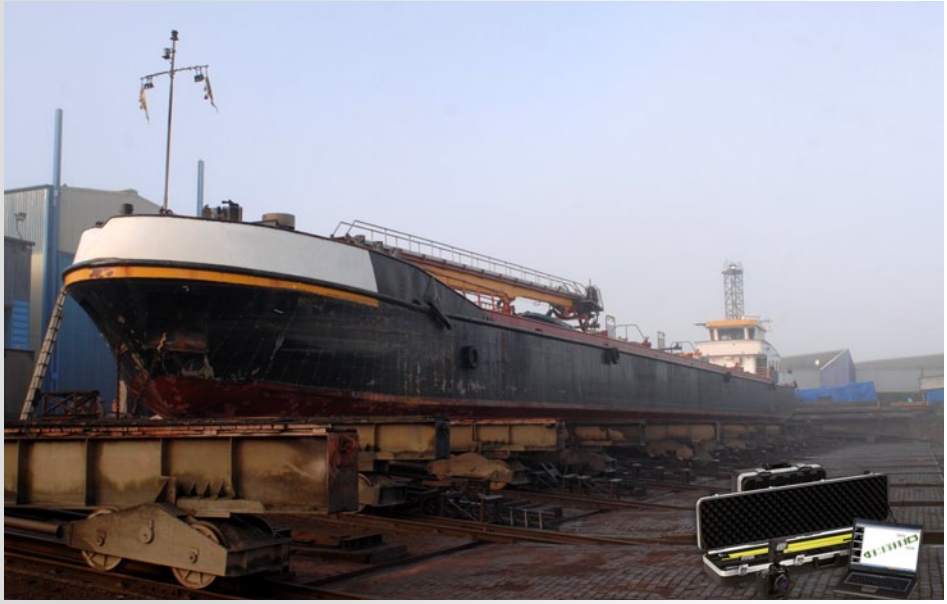
EXCELLENCE IN 3D MEASUREMENT

Mobile 3D Coordinate Measurement for Shipbuilding

Optical CMM shortens down-time in shipbuilding industry

Measurement system: TRITOP^{CMM}
Keywords: reduction of down-times, shipbuilding industry, efficient repair & maintenance, hull measurement, in-cabin layout measuring, 3D-Coordinates for CAD-Systems, measuring technology for shipyard & dry-dock

The successful, safe and economic construction and maintenance of ships today, requires an intelligent combination of knowledge, experience and craftsmanship. The integration of high-end CAD-Programs and Optical Measurement Systems enhances precision and cost efficiency within the ship building industry. The digital measurement system TRITOP^{CMM} enables rapid manufacturing of spare parts with modern CAD/CAM systems and CNC machines. The down-time of ships in dry-docks is reduced from months to days. Optical 3D-Metrology increases efficiency and precision of repair and reconstruction within the shipbuilding industry.



De Kooiman Group takes the business to the next level
De Kooiman Groep in Zwijndrecht, The Netherlands, specializes in repair, modification and construction of ships up to sizes of 135 meters. Located in "Swinhaven" the shipyard offers perfect access to open sea as well as inland waterway transportation. Founded in 1884 directors Rinus Kooiman and his brothers are looking back on long successful history. "With our own design department, carpentry and machinery shop we are capable to perform all tasks from new building to major modifications and from small repairs to complete overhaul" explains director Rinus Kooiman. "Our company is well equipped and up-to-

date in regards to hardware such as slipways, modern docks, outfitting keys and lifting capacities", Rinus Kooiman continues "But for the repair and overhaul of ships we experienced extremely long downtimes. Damaged ships due for repair always had to come over to the shipyard to be repaired (by hand with good craftsmanship). But the downtime for these manual repairs can be reduced much, when you can prepare all parts by modern CAD system and digital cutting machines."

For the Kooiman Shipyard it was time to take the business to the next level.

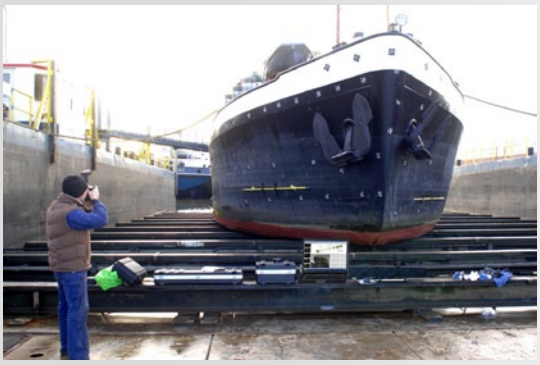
De Kooiman Shipyard goes Digital
In the design office, Directors Rinus Kooiman and his brothers invested over the past few years in state of the art CAD technologies including a high-end engineering platform. The input for the CAD systems however was still down to measures and templates made by hand.

Peter Vrolijk from Kooiman´s Department of Heavy Industry Ships explains "The vision of the management was to reduce downtime extremely. Therefore it was necessary to give digital input into the recently installed CAD system by making use of advanced 3D measurement techniques".

Therefore the shipyard started an investigation on the available 3D measuring and scanning techniques available in the industrial metrology market.
It was Ingenieurbüro Mühlhoff, a pioneer in the use of 3D design for ship design, which pointed De Kooiman Group to the GOM mbH who`s optical measuring systems are globally applied in applications like 3D digitizing, deformation measurements and quality control. The GOM mbH, experienced developers of optical metrology systems, proposed Kooiman to test the TRITOP^{CMM} system, a photogrammetric solution based on a digital camera, markers and software (Fig. 1).

Fig. 1: TRITOP^{CMM} measuring system: Photogrammetric camera with accessory, self-adhesive and magnetic markers, adapters for primitives

Principle of photogrammetry: Optical 3D Coordinate Measuring System TRITOP^{CMM}
TRITOP^{CMM} is a portable optical measuring system that precisely determines 3D coordinates of specified object points. The gauging points are easily marked with self-adhesive or magnetic markers before the measuring process. The measuring object is then captured with the TRITOP^{CMM} photogrammetric camera from different viewing angles (Fig. 2).



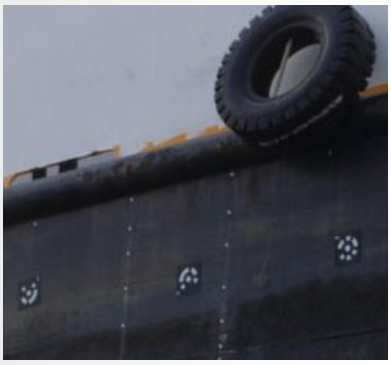


Fig. 2: The mobile optical TRITOP^{CMM} system in use at a dry-dock. System and accessory can be easily transported by a single person. The system can be operated during measurement and evaluation without external power supply

Based on all captured 2D images the computer automatically calculates the 3D coordinates of the gauge markers by means of bundle adjustment (Fig. 3 and Fig. 4). Two certified scale bars guarantee the accuracy and process security of the measurement result. Primitives such as cylinders, holes, spheres, border lines, etc. can be measured by using corresponding adapters.
The TRITOP-Software is also capable of inspection and analysis. The measured 3D coordinates can be applied for dimensioning, comparison against CAD-Data, GD&T or can be exported as measurement reports and to Excel-Sheets.

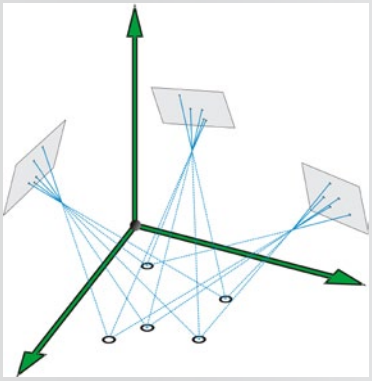


Fig. 3: Display of bundle adjustment of three camera positions

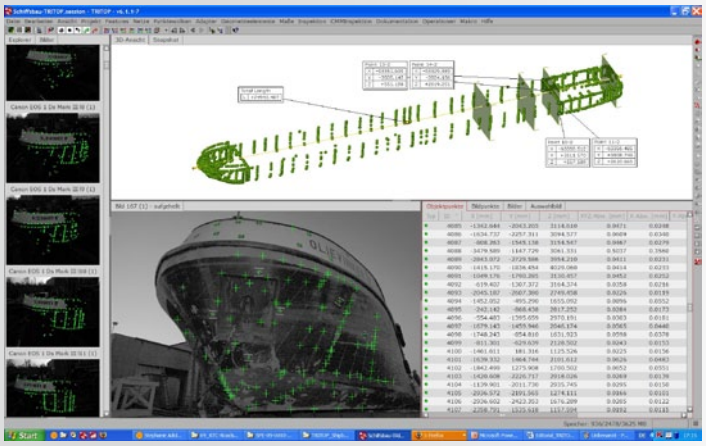
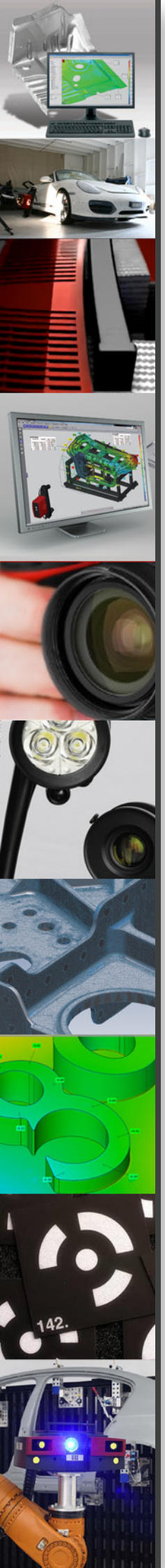


Fig. 4: 3D coordinates measured from a series of 2D images in the TRITOP software



Data can also be exported as IGES-files for Reverse Engineering, as was the case here with Kooiman (Fig. 4). The TRITOP^{CMM} System is very mobile and flexible. The entire equipment consisting of camera case, laptop and scale bar case can easily be carried by one person. The measuring process as well requires one operator only. Since data acquisition is carried out with a photographic camera and data evaluation takes place on a laptop, measurement projects can be recorded and inspected without the need of an external power supply.

Choosing and testing of 3D measuring system: Inside and Outside
"Of course we wanted to invest only in the most suitable 3D measuring technique available. So we were looking at different techniques like Terrestrial Laserscanning and Photogrammetry" describes Peter Vrolijk the challenge of selecting the appropriate system. "We also wanted to make sure that the measurement system is able to perform all our requirements, so we defined a number of challenges for the system" he continues.

Besides the task of measuring the outside body shell the selected system needed also be able to perform measurements of small indoor compartments within the belly. The challenge here is to carry out a reliable measurement with only limited space and very short measuring distance available. So the TRITOP^{CMM} system had to proof the capability of measuring dimensions and inner reinforcement structures such as sections, ribs, beams and frames of 6 m by 6 m compartment behind the engine room just above the propeller area. Although it was impossible for a person to stand upright in this compartment (due to the beams and sections), the TRITOP^{CMM} measurement went flawlessly and a 3D layout of the room geometry was created within a few hours (fig. 5). Such the specific units for installation could be easily adapted and integrated smoothly into the compartment.

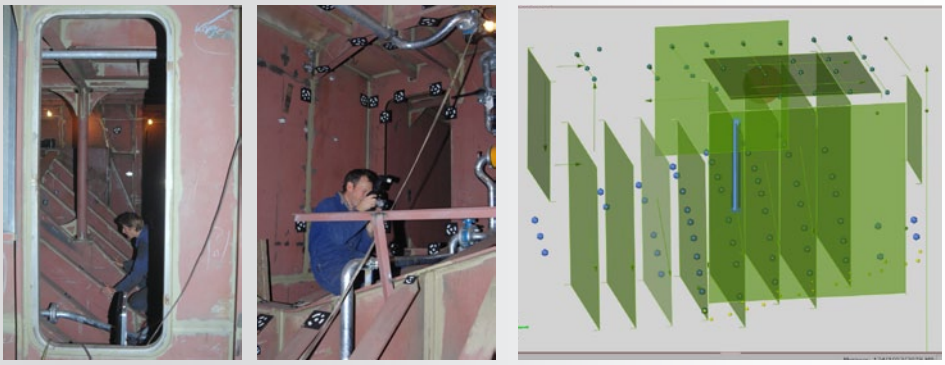


Fig. 5: Measurement of ribs, vertical frames and rossbeams in a narrow in-cabin room to gain a layout of the room geometry (export of planes, lines, points and circles in IGES-format)

From small repairs to complete overhaul: 3D reverse engineering of a 75 meter long hull
The second necessity is measurement of outer hulls of complete ships for major reconstruction outside in the dry docks. A 75 meter long bunker ship which serves oil and petrol to other ships in the harbor of Antwerp in Belgium required a second hull shape to fulfill the upcoming EU-laws and safety demands. In order to design the new sections and second hull shape, Kooiman´s engineering office needed the entire shape of the existing hull.

The traditional technique would have been to create wooden templates and measuring dimensions with conventional techniques such as tape measures. The typical downtime for this action would have been four to five weeks. The goal now was to improve both, the quality of the 3D measurements, as well as to cut the down time significantly.

For preparation each hull section was located and defined by several markers from top to bottom, at starboard and portside. A crane was used to “fly” the photographer along and over the ship while shooting pictures in different directions, since it is important to capture overlying pictures all around the hull. A standard workstation laptop was used to calculate the 3D coordinates from the 2D-images. The overall fit error between was less then 0.6 mm.
Then for each section on the ship, primitive planes were created in the TRITOP software. The resulting 3D point cloud describing the hull shape together with the section planes was then directly exported into Kooiman´s CAD system (Fig. 6).

Fig. 6: Mobile measurement of the complete hull with the TRITOP^{CMM} system.

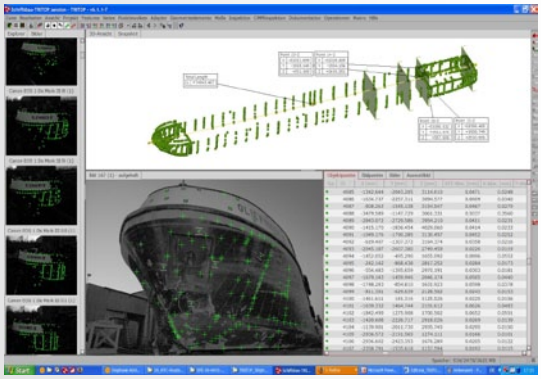


Fig. 7: Measured 3D coordinates and sections within TRITOP software describing precisely the shape of the hull. Data were directly imported as IGES-format into CAD system of the Kooiman shipyard.

The ship had been in the dry-dock for measurement campaign for barely 48 hours, before it went into water again back to normal service. Using the precise, digital 3D data, the Kooiman Shipbuilders could pre-produce all the needed parts for the reconstruction while the ship was able to return to work and make money. During the following months, De Kooiman groep designed the entire second hull in CAD, then prefabricating all the different parts needed. When the ship returned to the shipyard, all parts were ready for assembly. The total downtime was cut by several weeks, making the project much more cost efficient.

Mobile Optical Metrology speeds up repairs and overhauls in Shipbuilding Industry
Looking at optical metrology, De Kooiman groep’s first intention was to improve the 3D input towards the CAD design office. The use of GOM´s TRITOP system meant also a breakthrough towards efficient and accurate 3D modeling of hull assemblies.