

Case study

Reverse engineering restores old classics to their former glory

Reverse engineering: process of recreating a car part

Optical measurement system: scan3D surface 5 MPix

Software: SMARTTECH3Dmeasure, Design X

Industry: automotive

SOUL CARS
BACK ON THE ROAD

Volkswagen T1 Transporter is cult classic. It not only conquered the hearts of Europeans but Americans as well by becoming one of the iconic symbols of the hippie movement in the 70s. The development of this marvel of automotive industry officially began in 1950 and just four years later more than hundred thousand models took to the road. The car has also risen to popularity in Poland where it got the nickname "cucumber" based on his cylindrical shape.

Despite years passing by the popularity of T1 Transporter didn't drop. The German Classic is still a hit thanks to car enthusiasts, collectors and businesses that deal in restoring vehicles to their former glory. One such company is 'Soul Cars' which handles renovations of antique cars.



Fig. 1. Renovated by Soul Cars Volkswagena T1 model. Source: www.soulcars.de.

Spare parts shortage

Manufacture of the T1 Transporter ended in 1967. What it means is that for the time being this cult classic can be only bought on the second hand market. The issue here is that even the most well preserved units are in need of repairs. In addition, in order for the car to be considered an antique, it must contain at minimum 75% of original parts, to this end Soul Cars deals only in renovating vehicles with documented history to ensure that the purchased model is completely genuine.



Fig. 2. Measured object: corroded pillar B removed from a T1 Transporter.

After many months of work, Soul Cars managed to buy an acceptable Volkswagen T1 Transporter. Unfortunately, it was inoperable and in need of a variety of repairs, including mechanical and bodywork. Among the elements awaiting bodywork repair was a center pillar or specifically pillar B which separated the driver's door from the back section of the car. After performing the examination it turned out that the originally equipped component isn't fulfilling its designed function properly and doesn't hold its strength parameters in which case it needs to be replaced in its entirety. It's not an easy task as brand new parts have been out of stock for decades and the secondary market offers a limited choice. In addition, with pillar B being part of the vehicle's bodywork finding an acceptable replacement was close to impossible.



Fig. 3. Volkswagen T1's bodywork during dismantling. Source: www.soulcars.de.

In this situation there is a way of using reverse engineering in order to recreate the original part. Performing an accurate measurement of the damaged element's geometry allows to produce the exact data for preparing the mould. Soul Cars decided on using certified metrologically 3D scanner produced by SMARTTECH to acquire the pillar B component need for restoring the cult classic Volkswagen T1 Transporter.

3D scanning means high accuracy within a considerable volume



Fig. 4. Optical measurement system scan3D surface.

Measurements with the scan3D surface 5 MPix metrological system enable not only dimensioning with referential accuracy but also allows to gather incredibly sophisticated data. The device is based on the structured LED light technology and was designed for preparing CAD documentation. With the volume of 400 x 300 x 210 mm the 3D scanner acquires a cloud of points that represents the intended shape with 0,060 mm accuracy.

In contrast to other available solutions on the market, SMARTECH 3D scanners are permanently calibrated for a single volume. Thanks to this they are handheld devices and enable to perform the measurements not only at the laboratory but also on the objects outside in the field due to the fact that the user doesn't need to recalibrate the machine when attempting a 3D scan. It's an enormous time-saver in addition to ensuring that the environment doesn't affect the calibration process which results in precise measurement accuracy of the 3D scanner. It's worth noting that attempting calibration outside in large number of cases might be impossible to perform.

Accurate measurement produces calculable results

Very bad condition of the corroded part prevented advancing with the measurements. The object needs to be sprayed with titanium oxide first in order to cover the corrosion that festered on the surface and to matt out any shiny leftovers that could result in creating unintended reflexions. Due to the fact that the object is thin-walled, and the fact that we require it's full geometry, magnetic markers need to be attached to the component – orbs in this case. These types of geometrical markers make it easier for the software to properly attach singular scans together.

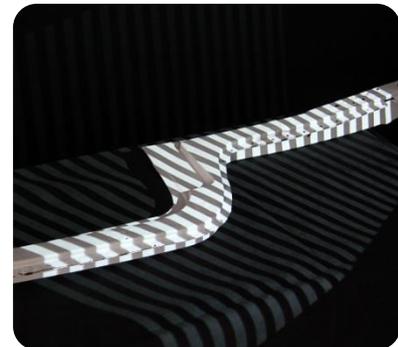


Fig. 5. 3D scanning process: fringes displayed on the object.

Measurements with the help of SMARTECH 3D scanner is based on examining the curvature on the projection of patterns that are being displayed on the measured surface. Their deformation will be registered by an in-built detector in the scanning head. During the measurement, the visual from the detector is transferred onto the cloud of points thanks to a special algorithm. Each of the points is a piece of geometrical data described via X,Y,Z coordinates which after some work can be used to recreate the components data.

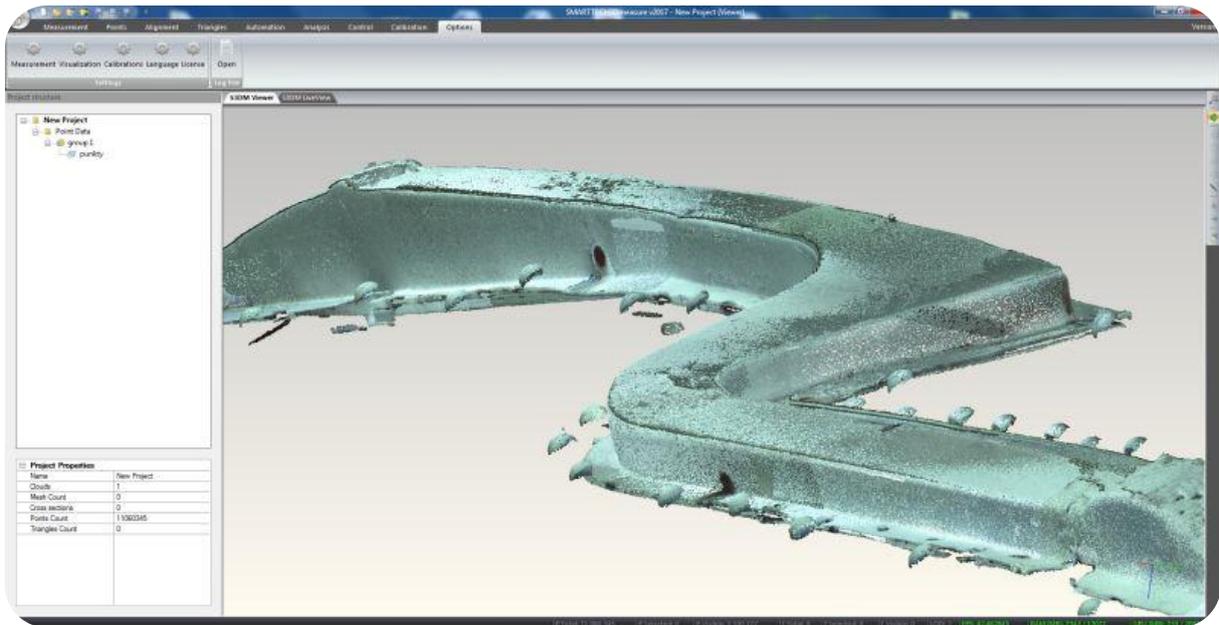


Fig. 6. Result of the measurements in form of a cloud of points (40 mln measure points) representing pillar B.

Because of the faulty shape of the pillar approximately twenty scans from different angles were performed in order to achieve the precise model. Full measurement of the object from both sides took about an hour and a half and promptly pointed out that due to incorrect repair Pillar B didn't retain the manufacturer's established geometry.

Preparing the model using Geomagic Design X software

After finishing the measurements the results need to be cleaned off any noise in the cloud points. SMARTTECH3Dmeasure guiding software attached to the scanner comes with an automated feature that removes the noise. Thanks to the intuitive design of the process, the user isn't required to possess any metrological knowledge to perform it.

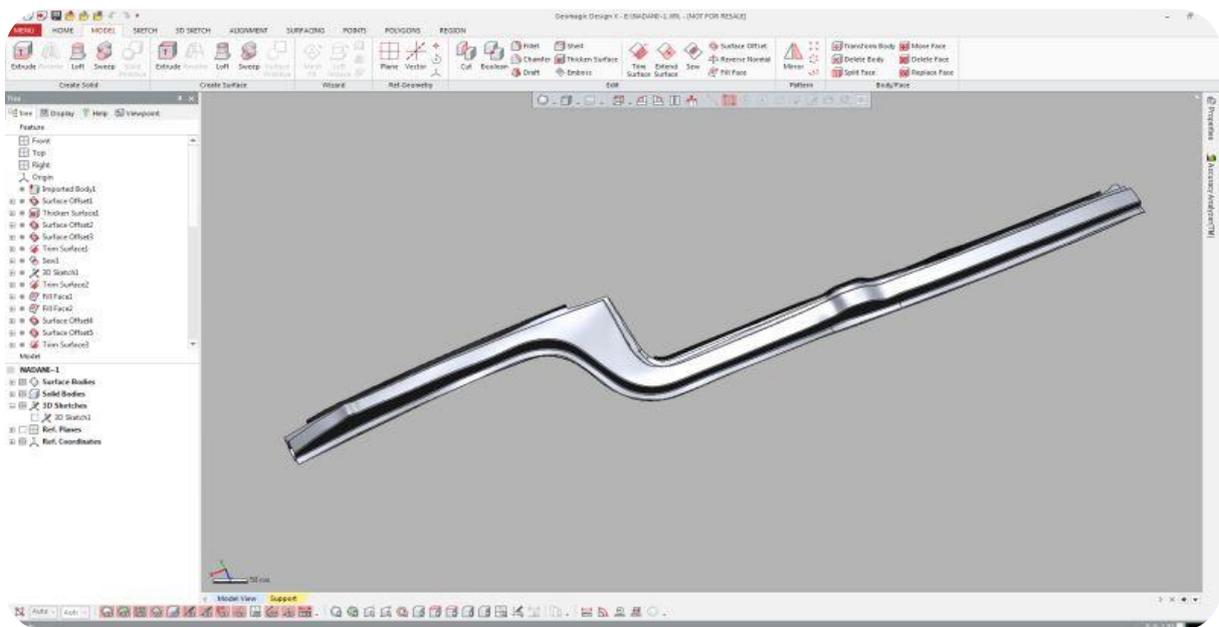


Fig. 7. A completed CAD model of pillar B.

After cleaning the measurements we can attempt connecting them. The client decided to use his own Geomagic Design X software. With the use of spherical markers (orbs) all solitary measurements automatically connected into a single cloud which represented the measured component. After creating a triangle mesh the work carried on.

At the beginning a complete model needs to be prepared based on the polygon net. To this end a new pillar was generated without any errors that resulted from corrosion (geometry was restored using the software). Following it, a cross-section of pillar B was created enabling an accurate dimensioning and preparation of its technical documentation. The end result was the technical documentation and a complete CAD model on which basis Soul Cars constructed a matching groove and die to manufacture the car part.

Reverse engineering recreates technical documentation



Fig 8. High level details within the restoration.

Conducted by SMARTTECH measurements point out that reverse engineering enables recreating expensive or unavailable on the market parts. In many cases, it's the only method for providing the necessary components. In addition, it's a way for recreating technical documentation which is very substantial in resuming rare manufacturing lines.

In order to attempt the process of reverse engineering, a precise measuring device is often required. Traditional contact measurement methods (caliper, meter sticks) can appear to be too inaccurate or impossible to implement if we are working with an object consisting of a free surface.

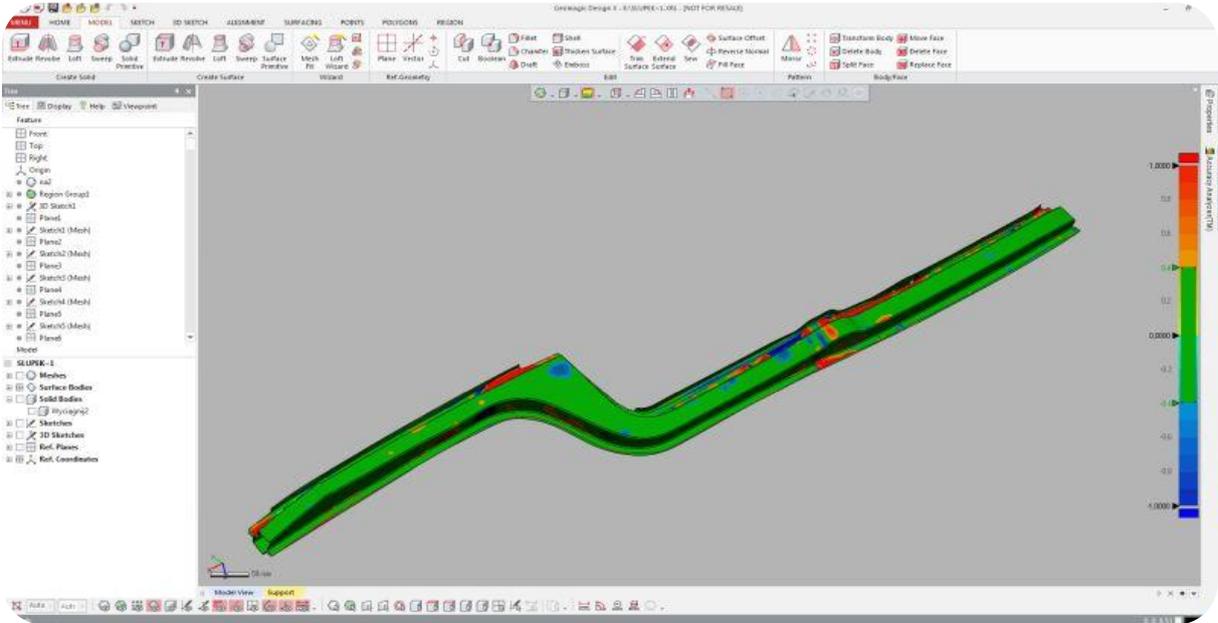


Fig. 9. Anomaly map: comparison of the remodeled CAD model with the scanned object.

Whereas SMARTTECH optical measurement systems ensure the required accuracy of the results, by attaining data via structured LED light technology. The geometry is precise enough that on its basis a CAD model can be generated.

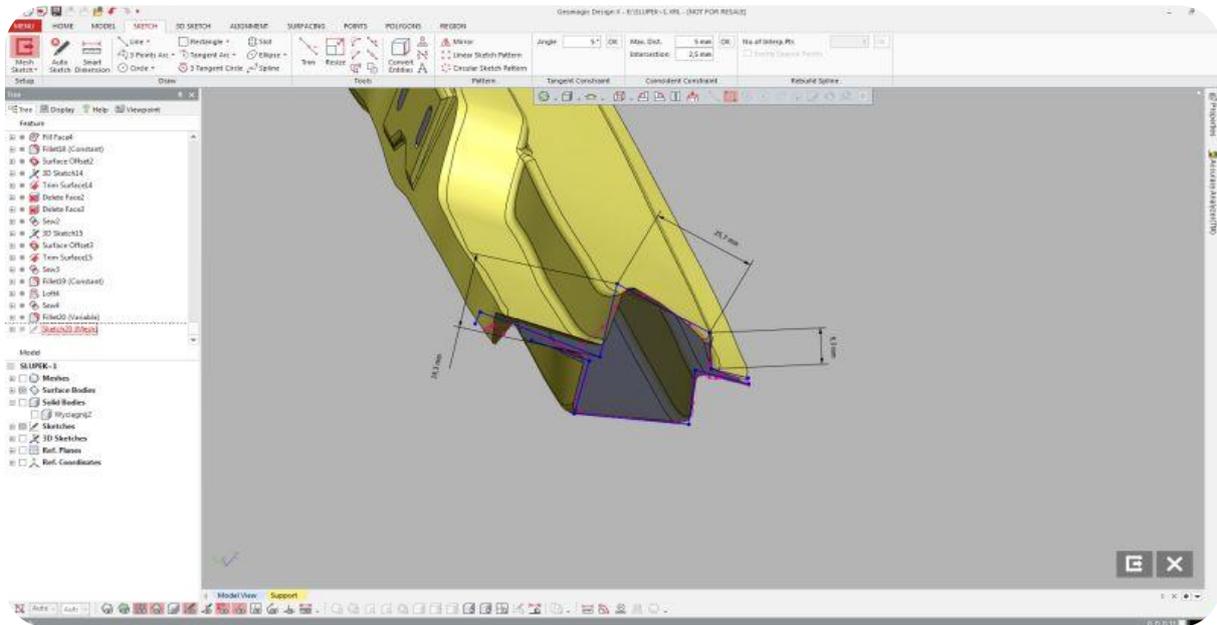


Fig. 10. Dimensioned cross-section.

In addition calibration provided by the manufacturer of the metrological device substantially shortens the measuring process. It also safeguards from incorrect configurations that could influence the results. With the use of SMARTTECH 3D scanners process of reverse engineering, quality control or quick prototyping of parts and tools can be performed.

Soul Cars

Family business dealing with restoring classic old cars and motorbikes. It operates since the year 2000 making dreams of its customers about owning their own historical car come true. The entire process of renovating vehicles takes place in the company's workshop.

Read more at www.soulcars.de

SMARTTECH

Polish developer of professional optical measuring equipment. It successively develops and improves its range of devices, delivering top-notch metrological solutions used by the manufacturing industry, museology, education and medicine.

Read more at www.smarttech3dscanner.com