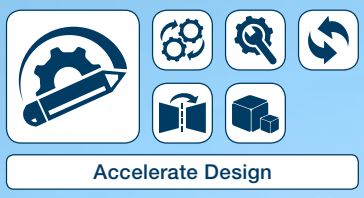
Solutions for Reverse Engineering, Rapid Prototyping and 3D Documentation



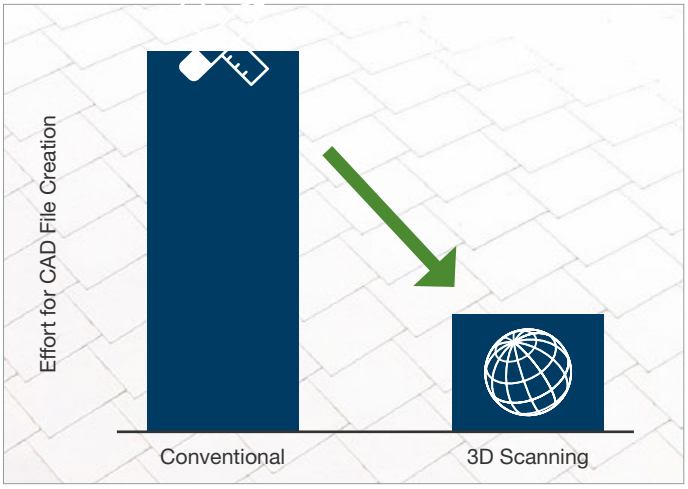
Accelerate Design

From Scan to CAD

Introduction

FARO develops portable 3D digitization solutions that accurately capture complex geometries in a huge variety of engineering and design scenarios, including prototypes, products, sub-assemblies, structures and entire working environments.

Reverse engineering data generated from point clouds gives engineers the ability to tackle complex design problems incredibly quickly – greatly enhancing their agility, flexibility, efficiency and speed of design.



3D data is only the beginning. Thanks to recent software advances – which have made scanning and the resulting data even more effective and simpler to deploy – contact and non-contact 3D measurement devices and 3D scanners allow users to even more easily, quickly and accurately digitize a part, an object or an environment and create a fully surfaced CAD model, which can then be deployed in a wide variety of subsequent design and testing procedures.

By bridging the physical and virtual world with a full 3D representation, everything a designer needs is at their fingertips. Work can be completed correctly the first time, using digital references to verify that models are both accurate and complete.

Different applications require very different deliverables and FARO understands these end goals. Support and best-in-class solutions will ensure that your project ends on time and on budget – every time.

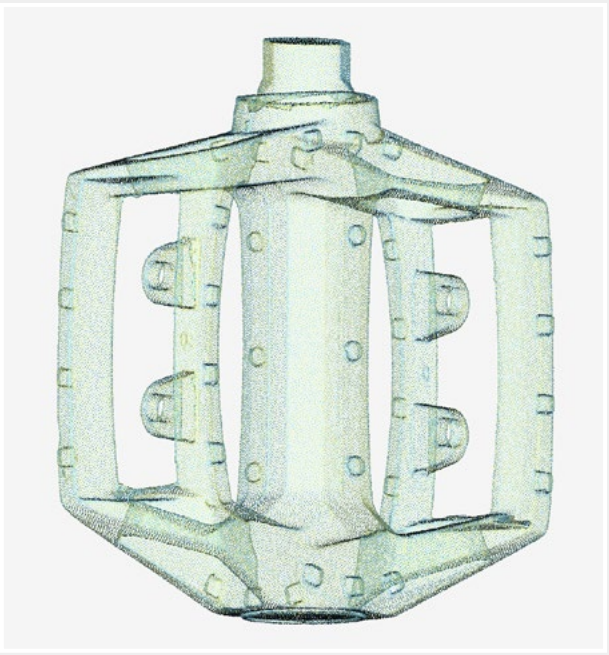
1 Scan

Based on the size and precision of your part, multiple hardware options are available to meet your measurement needs and budgets.

High-precision applications benefit from the use of hard probes – for alignment features and primitive geometry – while complex surfaces and larger parts or environments can be completely digitized with handheld, arm-based or tripod-mounted non-contact laser or structured light scanners.

There is no limit to how this technology can be applied, with applications being seen across a huge variety of industries and disciplines. These include product prototyping, retrofitting and replacement parts for aerospace; general, performance & custom automotive; rail; marine; mining; specialized vehicles (military and emergency services); and the planning of special machines and equipment.

The data generated by FARO's technology can be fed directly into many leading CAD packages using suitable plug-ins. If it can be seen it can be scanned, if it can be scanned it can be measured and if it can be measured it can be modelled, modified, tested, approved, displayed and built.

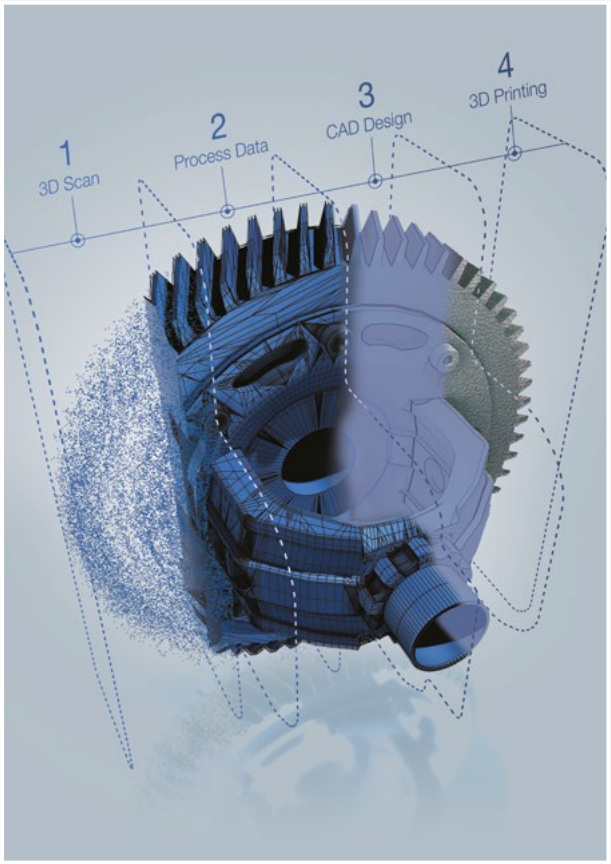


From Scan to CAD

2 Process

A three-dimensional representation (point cloud or mesh) of your part, assembly or environment can be further refined to create regions of interest that allow faster and easier fitting of geometric primitives and sketches.

Larger applications, comprising multiple point clouds, can be stitched together to create a single, homogeneous data set.



Subsequent software solutions can then leverage the data to create simple or even parametric, native CAD models for quick and accurate changes downstream and to confirm your model to the original scan data to verify design intent. The data can then be aligned, cleaned, meshed and smoothed in preparation for Reverse Engineering.

3 Utilization

Archive (point cloud or mesh)
Point clouds and meshes are invaluable for creating 3D geometric data where either none existed in the past or the data was in legacy or incompatible formats.

Using newly created data, older products can be brought back to life, improved and re-engineered or simply archived for spares and repair/ maintenance purposes.

Design (mesh)
Mesh data can create an accurate 3D representation of the scanned product or environment and this data can be deployed across a variety of platforms depending on the desired end result.

Software platforms can include CAD, FEA and CFD, which will use the design data to validate designs and highlight any areas where improvements can or must be made.

Generative designs for re-engineering can also be leveraged to aid new manufacturing techniques such as 3D printing, which can help to reduce component weight.

3D print (watertight mesh)
3D printing requires watertight meshes and FARO's software offers a fully integrated meshing tool that eliminates the need for third-party software. Watertight 3D meshes can be calculated, viewed and exported in various formats such as .STL, .OBJ, .PLY and .WRL (VRML).

Produce (CAD model)
Point cloud data can be fed into the major CAD systems on the market and can be used in conjunction with a number of different plug-ins in order to create the desired end format of the captured data.

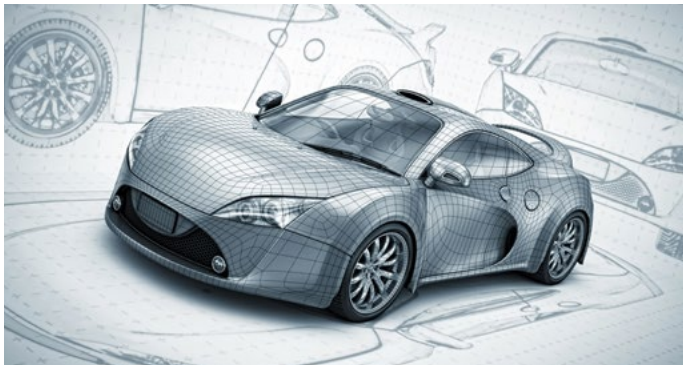
This newly created CAD data can then be deployed as if it had been originally created in the host CAD suite. Once the data is imported in the correct format, it is no different to the original CAD files.

Scan to CAD
Autodesk • SolidWorks • Siemens

Applications & Industries

Research & Development

Companies serving highly dynamic markets have to keep pace with changing trends and developments; with their engineers interrogating, designing, optimising and building quicker than ever before. Reduced lead times, shorter shelf lives, greater product variation, tighter differentiation and smaller batches, mean that research and development disciplines have to be flexible, fast and accurate in order to deliver crucial design data. Handheld, arm-based and tripod-mounted 3D scanning technology are vital tools towards maintaining this agility.



Industries: Transportation (Automotive, Rail, Aerospace, Marine), Motorsports, Heavy Machinery, Industrial Machinery, Renewable Energy, Aerospace, Defense, Medical, Consumer Products

Aftermarket Development

Improvements and additions can enhance a product or assembly and as products head towards lifecycle maturity, new accessories and redesigned components can deliver a new lease of life.

New parts may require variations in the original design data, which may not exist, be confidential or be in an easy-to-use format. Laser-based or structured-light-based scanning removes these hurdles.

Industries: Manufacturing Industry, Automotive, Consumer Products, Construction, Farming and Agricultural Machinery

Replacement Parts

Worn, non-serviceable and under performing parts can have a hugely detrimental effect on the optimum capabilities of a product, assembly or machine. A ‘make’ decision can often make more sense financially than a ‘buy’ decision, but it does rely on the accuracy of design data for replacement parts. A lack of accurate design data is not a hurdle if designers have access to 3D scanning technology. Comprehensive and accurate design data generated from point clouds can be used to improve replacement parts or fabricate them more economically using modern production processes and materials – such as 3D printing, which can help reduce overall weight.

Industries: General Manufacturing Industry, Transportation (Automotive, Rail, Aerospace, Marine), Motorsports, Heavy Machinery, Industrial Machinery, Energy and Renewable Energy, Aerospace, Mining, Defense, Consumer Products

Applications & Industries

Retrofitting & Customization

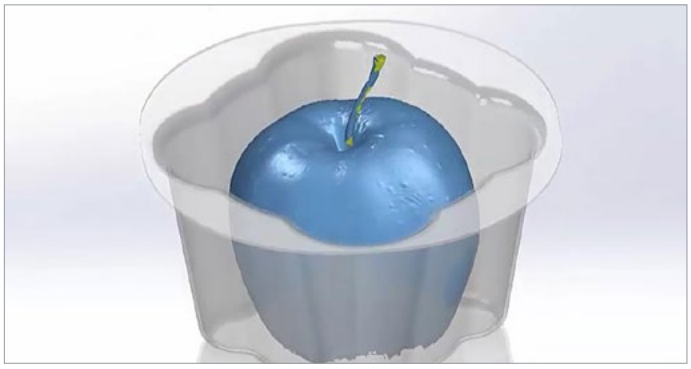
Standard products can be modified to make them more suitable for demanding applications, increase their performance or make them more aesthetically pleasing. Using handheld, arm based or tripod mounted scanning solutions, single products all the way up to an entire vehicle chassis, for example, can be measured, with multiple point clouds being stitched to create single homogeneous CAD files. The resulting CAD data can be deployed in subsequent software solutions, to perform additional modeling and design analysis of retrofit components, to help ensure optimum performance.

Industries: Special Vehicles, Construction Vehicles, Aerospace, Railroad, Defense, Industrial Machinery, Motorsports

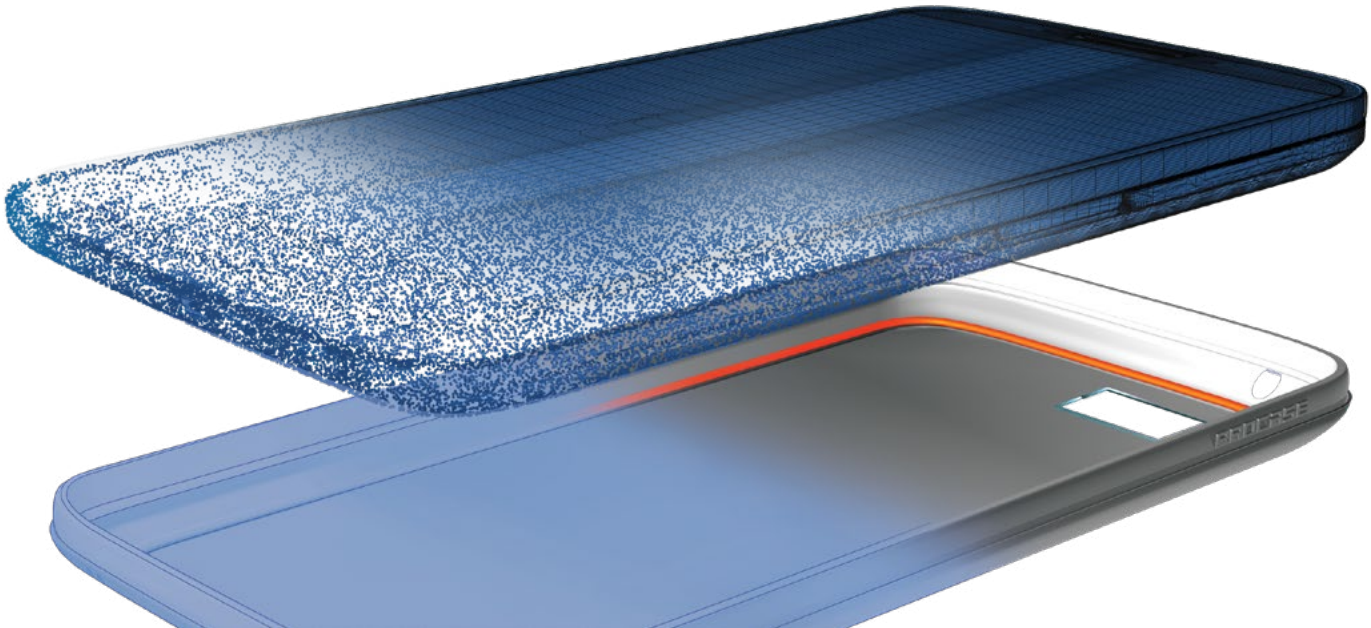
Packaging Design

Packaging says a lot about a company, its brand and the care it shows its customers, so accuracy and fit-for-purpose are prerequisites. CAD data may exist for a product about which a packaging concept can be created, but one offs and special designs often require unique capabilities to match product geometries.

Advanced 3D scanning can help engineers create customized packaging solutions and deliver greater protection to high-value components. Collections of products can also be grouped, analyzed and packaged far more quickly and effectively.



Industries: Airfreight & Logistics, Trading Companies & Distributors, Food Distributors, Beverage Producers, Packaged Foods & Meats, Health Care Distributors, Trade Shows and Events, High-Value Storage



Solutions for Research & Development

Agility is key to modern industry as customer and consumer demands dictate ever greater customization and individualization, smaller batch sizes and greatly reduced lead times. Key to this agility is accurate design and manufacturing data.

As a result, research and development has to keep pace – slashing time to market without sacrificing accuracy, product efficacy and quality – and 3D scanning has a pivotal role to play in delivering this accurate and timely design data.

Reverse engineering of prototypes for industrial or ergonomic design intention

Research and development and prototyping are iterative processes and multiple changes are often made to physical models and diagrams in order to gauge the feasibility, design effectiveness and suitability of different modifications.

The judicious collation of design parameters and measurements at each stage will allow engineers and designers to easily step forwards and backwards in their design procedures to assess, test and model different hypotheses and design combinations.

The dimensional data collected using handheld scanners or arm-based laser scanners can be fed into advanced post-processing software to create faithful and accurate 3D cloud and CAD representations of each individual design iteration.

Tools: Arm-based laser scanner | Handheld scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

Advantages

- Accurate reverse engineering, even for very complex parts
- Fast data capture
- Creation of accurate and instantly deployable CAD files
- Ad-hoc 3D printing of prototypes (duplicates) for field tests
- Possibility to capture textures (colors) of scanned objects

Planning and development of special machines and equipment

Case Study: A leading company for special machines deploys portable 3D scanning solutions to model the interior envelope of commercial structures prior to commencing with new machine designs or remodeling.

Using the scanners and the resulting point cloud it is able to define millimeter-precise dimensions, which are used as a baseline for the design of new machines or equipment

The laser scanner captures up to 1 million measurement points per second in a full 360° point cloud, which is then used to provide fast, precise 2D/3D CAD drawings and layouts.

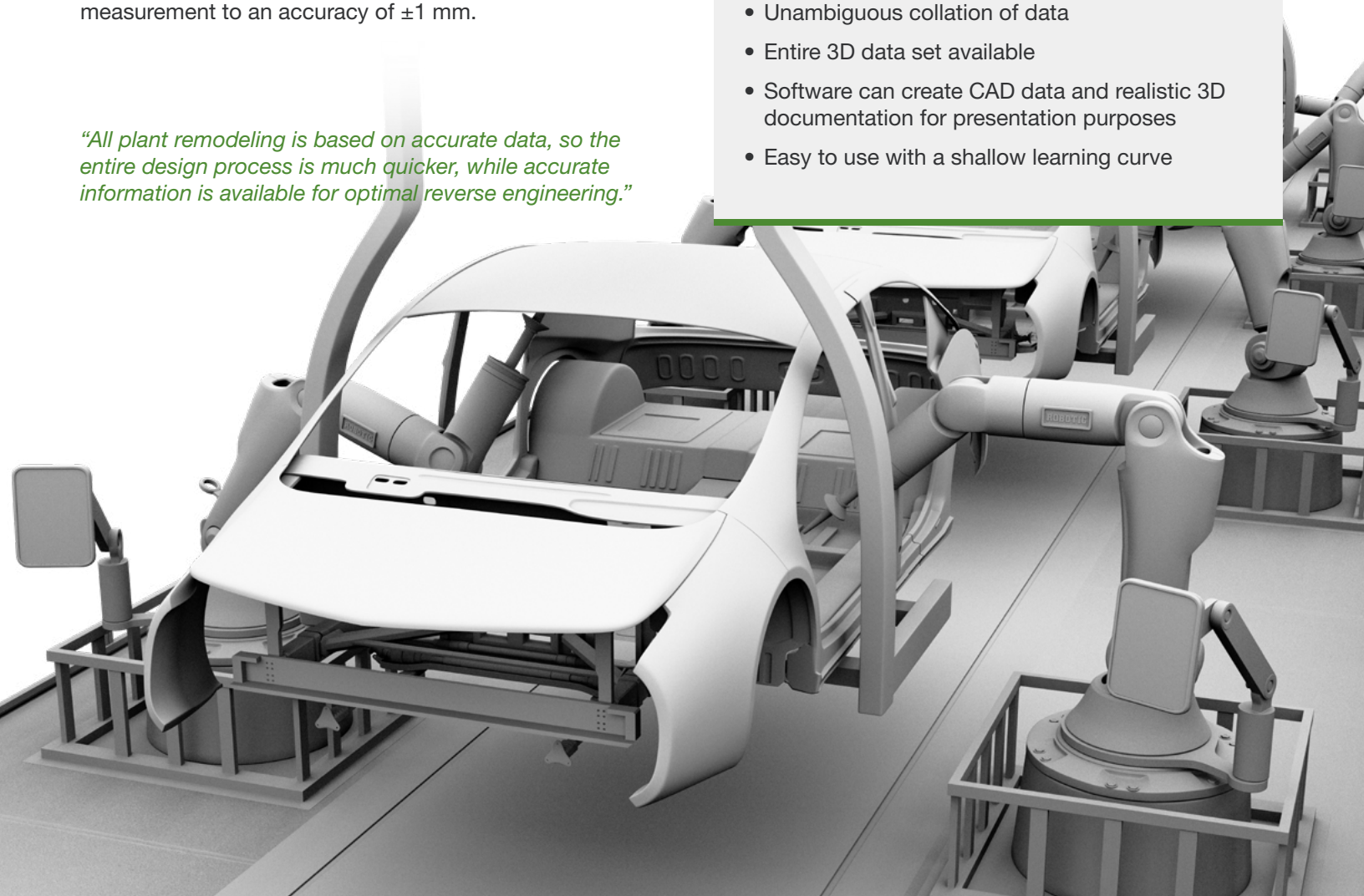
The process can be repeated at various locations – including the use of handheld scanners for hard-to-reach areas – and after post processing, including the joining of individual point clouds, a 'project point cloud' of the entire site can be created. A complete 3D walkthrough model of a factory can also be realized, with full point measurement to an accuracy of ±1 mm.

"All plant remodeling is based on accurate data, so the entire design process is much quicker, while accurate information is available for optimal reverse engineering."

Tools: Portable, easy to set up and easy to use tripod-mounted laser scanner | Hand-held scanner for hard-to-reach and non-line-of-sight areas | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

Advantages

- High speed capture of precise data – to single millimeter accuracy
- Removes reliance on historic and potentially inaccurate planning schematics
- Quicker and more accurate than manual measurements
- Unambiguous collation of data
- Entire 3D data set available
- Software can create CAD data and realistic 3D documentation for presentation purposes
- Easy to use with a shallow learning curve



Solutions for Aftermarket Development

When CAD data doesn't exist, or a part/component is being designed as an aftermarket ancillary or retrofit, advanced reverse engineering tools offer designers incredibly powerful capabilities to trace profiles and literally fill in the gaps. Using laser- or structured-light-based scanning hardware, designers can create accurate point clouds, mating surface geometries and joint paths, which can subsequently be deployed to create CAD files and presentation collateral.

Handheld and arm-based scanning technology can circumvent thousands of hours of reverse engineering procedures based on manual measurement, piece-by-piece template creation and profile tracing. Once collected, the point cloud data and the resulting CAD files can be fine-tuned to provide even greater strength, functionality, capability and flexibility to the original part.

Reverse engineering of new or used original products to support the design of replacement parts

Case Study: An engineering firm that reverse engineers products and assemblies to create or reproduce precision components found that conventional methods of data collection made the process more tedious, time consuming and costly than was palatable for its customers.

Using an arm-based laser scanner, the company can now collect thousands of points per second and uses third-party software to not only generate 3D CAD models of parts in real-time, but also perform non-rigid shape profile analysis, accident reconstruction and patent-protection.

Case Study: A marine windshield supplier uses an arm-based laser scanner to measure and model landing surfaces, as the complex nature of boat designs presents problems for traditional measurement methods. Using the arm-based laser scanner, the company saw a marked improvement in its processes, with fits being right first time.

The automotive aftermarket industry is another major proponent of laser-based reverse engineering, creating aftermarket accessories such as exhaust systems, chassis components, air filter and seals.

Tools: Arm-based laser scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

"This process works especially well when it comes to capturing sculptured Industrial Designed Models and importing surfaces into the computer for final editing."

"The improved processes and capabilities are the greatest value. A better product, a better fit, and in a shorter development time are the real returns."

Advantages

- Simpler, more accurate and quicker reverse engineering of complex original parts, profiles, mating surfaces and structures
- Creation of accurate and instantly deployable CAD files
- Right first time
- Faster time to market
- Greater customer confidence

Solutions for Aftermarket Development

Capture shape and installation space of original products and its environments for design of aftermarket products

Case Study: A chassis and suspension aftermarket supplier that serves the muscle car, drag race and sport truck markets creates direct-fit parts and systems that mount onto vehicles and must fit around OEM components and features.

Products include: suspension components; steering systems; chassis bracing; and the entire undercarriage of a vehicle.

An arm-based laser scanner is used to create accurate point cloud data for direct use in the CAD system.

The mobility of the arm-based laser scanner allows the company to deploy leapfrogging, where data captured from a large area is collated into a single point cloud. The portability also allows the equipment to be used in offsite locations.

This type of scanning is applicable to other aftermarket/ retrofit industries, such as mobile phone cases & holders, industrial enclosures, cabinet components and protective shields.

Tools: Arm-based laser scanner | Handheld scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

Advantages

- Simpler, more accurate and quicker scanning of complex installation envelopes
- Faster time to market
- Better utilization of installation space
- Data capture at almost all places where the object is available
- Leapfrogging to capture data from a large area into a single point cloud

"We found that not only was our accuracy of measurement improved, but also the detail in the data was astounding."

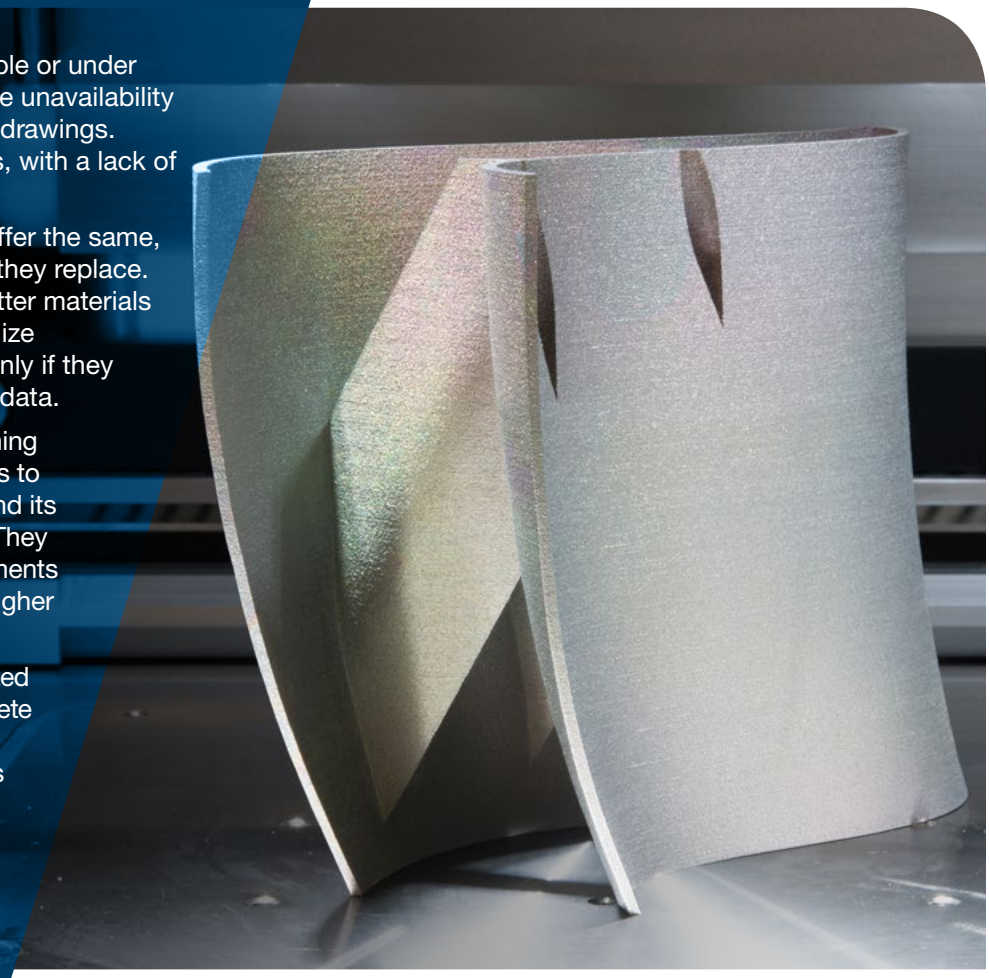
Solutions for Replacement Parts & Refurbishment

The replacement of worn, unserviceable or under performing parts is complicated by the unavailability of spares, or by a lack of engineering drawings. Refurbishment presents similar issues, with a lack of CAD data hindering remedial work.

Replaced or refurbished parts must offer the same, if not better, performance than those they replace. Engineers will also have access to better materials and processes and will be able to realize significant performance gains… but only if they have access to optimum geometrical data.

Laser- or structured-light-based scanning systems allow engineers and designers to precisely match a part's dimensions and its relationship to surrounding elements. They can build stronger and lighter replacements to upgrade and improve systems for higher quality and enhanced performance.

Replacement parts can also be fabricated in advance, reducing the time to complete maintenance. Should unexpected failures occur, accurate 3D data speeds repair procedures, quickly returning machines, processes and plants back to full operation.



Alloy wheel refurbishment

Using an arm-based touch probe and/or laser scanner, the geometry of an undamaged portion of an alloy wheel can be measured and then the resulting point cloud can be rotationally replicated to reproduce the entire rim.

The rim geometry CAD file can be adjusted to ascertain the amount of material removal required to eliminate the damaged portion and the resulting files can be fed to a CNC machine.

This process removes the need to perform the cutting operations by eye. It also delivers a fully featured CAD file, which can be used for other repair operations.

Classic car replacement parts

The car industry is a huge proponent of replacement parts, especially in the classic car sector. But the replacement of existing parts, in order to gain higher performance, is just as applicable for the contemporary car market too.
A case in point would be the replacement of a body mounted air-inlet louver for a vintage vehicle. In this instance there is almost certainly no existing CAD data and spares can be prohibitively expensive.

Using an arm-mounted laser scanner, engineers are able to scan an existing part and create a full CAD representation of the component and prior to re-manufacture, modifications can be made to enhance the performance of the inlet. The resulting CAD file can then be used to create a replacement component, using traditional manufacturing methods or through the use of 3D printing.

Remanufacture of cast components

Cast components can last for years and when they fail it may be difficult to source replacement parts or access useable design data.

In this instance, a laser-based scanner can be used to create a point cloud of the entire component, which is then fed into a CAD package to create an accurate and representative engineering schematic.

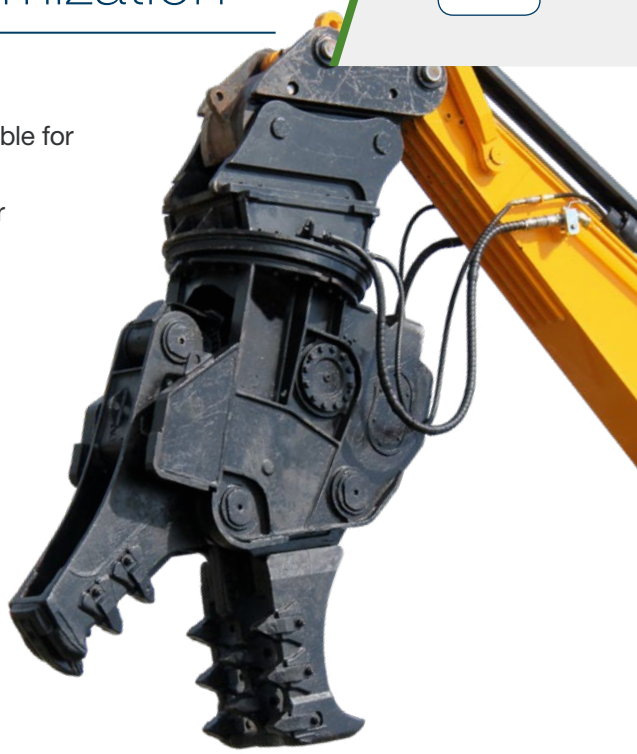
The CAD file can be shared with a variety of post-processing software suites to create new cutting paths, if it is to be remanufactured from a blank, or with moulding software that can create a new casting solution.

Tools: Handheld contact and non-contact arm-based scanner | Advanced complementary software for reverse engineering | Creation of parametric CAD models | Texturing point clouds for presentation purposes

Advantages

- High speed capture of precise data – to single millimeter accuracy
- Removes reliance on historic and potentially inaccurate schematics
- Far quicker and more accurate than manual measurements
- Unambiguous collation of data
- Entire 3D data available – no additional measurements necessary
- Software can create realistic CAD data which can then be shared with re-manufacturing software, including 3D printing
- 3D documentation can be created for analysis and presentation purposes
- Easy to use with a shallow learning curve

Solutions for Retrofitting & Customization



Standard ‘base’ products often require modification to make them more suitable for specialized applications.

Larger projects, such as customized vehicles, will see body parts modified for safety, security, space, access and the incorporation of special equipment. Smaller projects may just involve single components or structures.

A detailed understanding of the working envelope, including fixing points and potential conflicts, is essential, but the vehicle design data is often not available from OEMs. In some instances, it may also be necessary to analyze the effects of any changes using FEA and CFD software.

Advanced 3D scanning technologies can help designers and engineers build up a full and accurate schematic of a project, even when no original design data is available. Applications include fire trucks, ambulances, armored vehicles and vehicles for the handicapped. Aerospace, rail and marine have similar demands, for new equipment, internal remodeling, re-purposing and customization.

Capturing installation space and fix-points of original equipment as basis for the design of special products and equipment

Case Study: A German specialist-vehicle-modification company deploys 3D laser-based scanning for a variety of purposes, leveraging arm-based contact and non-contact scanners to create high-resolution 3D CAD data.

In one example – the incorporation of armored plating – a third-party software solution is used to virtually align the visual data points with the assembly points and, as a result, can quickly establish clearances any required refinements.

Conventional, tactile measurement would be extremely complicated. In this instance an arm-based laser scanner can scan both sides and by using software to align them, the material thickness of entire components can be displayed.

Tools: Arm-based contact and non-contact laser scanner | Handheld scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

Advantages

- High speed capture of precise data – to single millimeter accuracy
- Removes reliance on proprietary and unavailable CAD drawings
- Better utilization of available installation space and fix points
- Far quicker and much more accurate than manual measurements
- Unambiguous collation of data
- Entire 3D data available – no additional measurements necessary
- Software can create realistic CAD data and 3D documentation for presentation purposes
- Easy to use with a shallow learning curve

“Daily challenges consist of ever-changing measuring tasks on a wide repertoire of parts. A perfect habitat for 3D scanning solutions, which enable both precise tactile and remote measurement in just one operation.”

Solutions for Retrofitting & Customization

Reverse engineering of original equipment to be able to incorporate design updates

Reverse engineering of existing equipment is a necessity should modifications need to be made to incorporate design updates, increase performance or install additional functionalities and equipment.

In one instance, a leading consultancy was tasked with creating an exact copy of an aircraft nose cone prior to fitting new sensors. There was no existing design data for the nose and manual measuring would have been extremely difficult, inaccurate and time consuming. What is more, precise geometries were also required for subsequent CFD analysis.

The company deployed a 3D laser scanner in combination with a handheld 3D scanner to create a complete and accurate model of the nose cone, not only for the design modifications, but also for the subsequent CFD airflow analysis.

Tools: Laser scanner | Handheld scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models, design data for CFD analysis and texturing point clouds for subsequent presentations

Advantages

- Accurate reverse engineering, even for very complex parts
- Creation of accurate and instantly deployable CAD files
- Fast data capture (time-sensitive project)
- Ability to capture complex structures for subsequent CFD and FEA processes
- High-accuracy simulation model delivers better simulation results

“Without 3D laser scanning we could not have produced the exact design data we needed. We saved about a month of working time and completed the job ahead of schedule.”

Solutions for Packaging Design

Packaging has an incredibly important role to fulfill and precision design means better protection and presentation.

From simple food and beverage packaging up to customized hard cases for fragile, high-value equipment, packaging can say a lot about a company, its brand and the care it shows its customers.

Custom-made products and their various packaging formats create many challenges, as complex-geometry products have to be matched to the right packaging materials and the optimum style of external casing.

This type of design process is not always possible based solely on the product's design data and, if it is to be grouped with other components in the same case, the position, wall thicknesses and profiles have to be incredibly precise to ensure optimum protection.

Customized packaging design for high-value products

Case Study: A UK company that's specialized in transit cases and the creation of foam inserts faces daily situations where it must tailor make packaging solutions for a wide range of different products.

In order to be as responsive as possible to its customers' needs and to provide the most accurate, custom cut-foam inserts, it invested in a portable arm-based laser scanner.

Products are scanned quickly and accurately, creating profiles and dimensional data that is used to create a CAD files in third-party reverse-engineering software for subsequent transfer to CNC operations and for virtual representations for the customer to examine.

In combination with advanced metrology software, arm-based laser scanners provide a complete metrology package for both contact and non-contact measurement. Using 3D scanning the company can achieve the optimum foam-insert design for both aesthetic purposes and maximum product protection.

Tools: Arm-based contact and non-contact laser scanner | Advanced complementary software for reverse engineering, the creation of parametric CAD models and texturing point clouds for subsequent presentations

"We decided that the use of an even more advanced means of precise contact and non-contact measurement would further improve our design department's accuracy capability and speed-up our design processes."

Advantages

- High speed capture of precise data – to a tenth of a millimeter accuracy
- Removes reliance on proprietary, unsuitable and often unavailable CAD drawings
- Far quicker and much more accurate than manual measurements
- Unambiguous collation of data
- Entire 3D data available – no additional measurements necessary
- Software can create realistic CAD data for design and CNC functions and 3D documentation for presentation purposes
- Easy to use with a shallow learning curve

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