

3D Scanning for Manufacturing: Methods, Tools, and Applications for Industrial Reverse Engineering of Legacy Parts

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Founder & CEO

DIRECT DIMENSIONS





Joint Solutions for Depot Maintenance



Agenda

- About Direct Dimensions
- The Tools for 3D Scanning
- DDM: Direct Digital Mfg
- Industrial Applications for 3D Scanning











Background

DIRECT DIMENSIONS

- Va Tech engineering undergrad, 1985
- Masters in technical administration
- engineer in aerospace manufacturing
- tech & mfg problem solving roles
- co-developed portable FaroArm

Direct Dimensions

- founded in 1995 with a FaroArm \bigcirc
- 'one-stop 3D scanning shop'

Professional Life

- author for LiDAR News
- contributor to Wohler's Report
- active with many 3D conferences \bullet

















Range of Equipment

Direct Dimensions owns and also supports an extremely wide array of 3D scanning equipment.





Range of Scanning Solutions





Contact Digitizers

Portable Arm Probes







- Range = 0 to 2 meters
- Accuracy = +/- .024 mm
- Ideal Applications
 - Automotive Parts
 - Aerospace Parts
 - Power Generation
 - "Geometric" Shapes







Laser Line Scanners

Portable Arm Scanners



- Range = 0 to 2 meters
- Accuracy = +/- .035 mm
- Ideal Applications
 - Dimensional Analysis
 - Cad-based Inspection
 - Alignment
 - "Organic" Surfaces
 - Reverse Engineering





Laser Line Scanners

Coordinate Measure Machine



- Range = 0 to ? meters
- Accuracy = +/- .02 mm
- Ideal Applications
 - Dimensional Analysis
 - Cad-based Inspection
 - Alignment
 - Reverse Engineering
 - * Must fit in the machine





Optical Scanners

Structured Light







- Range = .6 to 2 meters
- Accuracy = as low as .005 mm
- Ideal Applications
 - Small area inspection
 - Miniature sculpture
 - Intricate parts





Optical Scanners

Patch Scanners







- Range = .5 to 5 meters
- Accuracy = as low as .04 mm
- Ideal Applications
 - Sculpture
 - Face/Body
 - Vehicle parts





Handheld Imagers

Structured-Light Based









- Range = .125 to 3 meters
- Accuracy = as low as 0.5 mm
- Ideal Applications
 - Human body
 - Medical
 - Automotive
 - Archeology
 - Forensics





Spherical Scanners

Phase-Based





- Range = .5 to 330 meters
- Accuracy = as low as 0.1 mm
- Ideal Applications
 - Buildings
 - Vehicles
 - Large Sculpture
 - Bridges
 - "Overall" scans





CT Scanners

X-Ray-Based







- Range = .125 to 1 meters
- Accuracy = as low as 0.01 mm
- Ideal Applications
 - Plastic parts
 - Interior features
 - Intricate detail
 - Inspection
 - Precious items







"Desktop" Scanners Low Cost Prosumer, Education, Labs





Reverse Engineering

CAD Modeling

Point Cloud

Polygon Mesh

Rapid NURBS







Hybrid Model



Engineered Solid Model



Engineered Surface Model







DDM Workflow

2D to 3D CAD Migration





DDM Workflow

Legacy Part - No Plans





DDM Workflow

Legacy Part - No Plans - Worn/Broken

Legacy Part Laser Scan Point Cloud Worn/ Broken "Design Intent"











3D Solid

Manufacture

















XEX















































Automotive









Facilities











Mechanical Design









4.85

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6311













Consumer Products







Medical



















Body Scanning









Custom Components















Direct Dimensions has served the needs of the Military/Aerospace industry for the past 10 years using the latest in reverse engineering, laser scanning, and 3D modeling capabilities.









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AIRCRAFT OML

Direct Dimensions' engineers captured the OML (Outer Mold Line) of a Gulfstream II aircraft using a Surphaser HSX 3D laser scanner. With this raw 3D point cloud data, DDI created a highly accurate reverse engineered 3D CAD model. This model allowed the client to "virtually" test new design modifications in CFD software.

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AIRCRAFT

Using a FARO Laser Scanner LS, DDI was able to capture 3D point cloud data of the entire aircraft. This data would then be aligned, cleaned and a complete solid model would be made. With this model, a CFD analysis can be performed on the aircraft.











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aging aircraft **REVERSE ENGINEERING**

The following examples show views of an actual aircraft internal structure versus the matching reverse engineered 3D CAD models. Using captured laser scan data, Direct Dimensions was able to precisely reverse engineer these parts into CAD data.











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737 interior SCANNING

captured 3D polygonal data

galleyraw

Using the Surphaser Laser Scanner, Direct Dimensions is able to capture large interior and exterior spaces quickly, and with highaccuracy. The captured point clouds, which consist of hundreds of thousands of 3D data points, can be used for documentation, reverse engineering, or any number of applications.





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AND ADD TO ADD

A BOR INE!



humvee armored **VEHICLE**

Direct Dimensions laser scanned and modeled an armored Humvee in order to deliver a solid 3D model that would provide the client with accurate bolt locations. These bolt locations and specific parts of the vehicle were needed in 3D in order to properly retrofit additional armor and plating onto the existing vehicle.









creating the humvee surfaces



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GRIP

Problem: More physical parts were needed to be manufactured at a low quantity.

Solution: Using reverse engineering, DDI was able to deliver a clean parametric Solidworks cad model that could then be machined to create the necessary amount of parts.











original

grip











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parametric models







large industrial CASTING

Advanced inspection and analysis tools simplify the dimensional verification of this complex cast part. The laser quickly scans the surfaces without contact and creates an accurate point cloud. The ense cloud is then compared to the nominal engineering CAD model and the results are displayed in easy to understand color graphical images.



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Presentation at LMI conference on June 27, 2012 in McLean, VA called "An Overview of Direct Digital Manufacturing" by Michael Raphael, Founder and CEO of Direct Dimensions, Inc.

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NATIONAL CENTER FOR MANUFACTURING SCIENCES