SURVICE METROLOGY
3-D Scanning, Reverse Engineering, Modeling, And Inspection

Comprehensive Services Overview
Since 1981, SURVICE has supported the DoD community, as well as the homeland security, advanced technologies, environmental, and commercial markets. We have also worked hard to retain the original vision upon which the company was founded—to provide the Warfighter with the safest, most survivable, and most effective equipment possible.

- Recognized leader in DoD Survivability, Lethality, Vulnerability studies; Test & Evaluation; and Modeling & Simulation
- Recognized leader in metrology and reverse engineering services (metrology.survice.com)
- Recognized expert in visualization and high-performance computing
  - Only SB with NVIDIA CRC accreditation
- Dozens of highly-competitive DoD research grant awards
OUR SERVICES

Our customer-acclaimed support primarily falls into five core business areas:

- **MODELING & SIMULATION/SOFTWARE ENGINEERING**
  Delivering a broad range of modeling and simulation, software engineering, and systems engineering capabilities.

- **TEST & EVALUATION**
  Providing experience in the test and evaluation roles that are vital to the design, acquisition, and fielding of all new and modified combat systems.

- **STUDIES & ANALYSIS**
  Conducting a wide variety of safety, survivability, effectiveness, and systems engineering studies.

- **INFORMATION TECHNOLOGIES & MANAGEMENT**
  Collecting, maintaining, distributing, storing, verifying, and protecting the nation’s critical defense information.

- **DIMENSIONAL METROLOGY & REVERSE ENGINEERING**
  Offering customers precision dimensional measurement, modeling, and related services.
OUR LOCATIONS

Corporate Offices
Belcamp, MD

SURVICE Metrology – Atlantic Coast Facility
Belcamp, MD

Washington Area Operation
Dumfries, VA

Aberdeen Area Operation
Belcamp, MD

Applied Technology Operation
Belcamp, MD

Dayton Area Operation
Dayton, OH

Defense Systems Information Analysis Center
Belcamp, MD

Gulf Coast Operation/SURVICE Metrology – Gulf Coast Facility
Fort Walton Beach, FL

Huntsville Area Operation
Huntsville, AL

Michigan Area Operation
Warren, MI

Patuxent Area Operation
Lexington Park, MD
PMO Operation
Socorro, NM

Ridgecrest Area Operation
Ridgecrest, CA

SEMATS Operation
Eglin AFB, FL
SURVICE METROLOGY TECHNICAL AREAS

PRECISION DIMENSIONAL INSPECTION AND ALIGNMENT

PART TO CAD REVERSE ENGINEERING
SURVICE METROLOGY TECHNICAL AREAS

FAILURE ANALYSIS AND FORENSICS STUDIES / TEST SUPPORT
SURVICE METROLOGY TECHNICAL AREAS

MUSEUM ARTIFACT AND ARCHITECTURAL SCANNING / MODELING / REPRODUCTIONS

ENGINEERING DESIGN SERVICES

RAPID PROTOTYPING / ADDITIVE MANUFACTURING
We Utilize a Variety of Measurement Systems To Ensure the Ability to Meet Your Requirements.

• Laser Trackers
• Digital Photogrammetry
• Portable CMM / Measurement Arms
• Laser Scanners
• Structured Light Scanners
• X-Ray Computed Tomography (XCT)
# Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement type</td>
<td>Individual point or scan</td>
</tr>
<tr>
<td>Measure components of</td>
<td>2 to 50+ meters</td>
</tr>
<tr>
<td>Accuracy</td>
<td>From 25 microns</td>
</tr>
<tr>
<td>Tracked measurement target</td>
<td>Must touch location measured</td>
</tr>
<tr>
<td></td>
<td>★ Very accurate, robust, well proven technology.</td>
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**FARO LASER TRACKERS**

**MEASUREMENT SYSTEMS – LASER TRACKERS**

SURVICE METROLOGY - BEYOND MEASURE
**Industries and Applications**

<table>
<thead>
<tr>
<th>Aerospace</th>
<th>Jig, fixture alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>Tool qualification, certification</td>
</tr>
<tr>
<td>Precision Engineering / Fabrication</td>
<td>Tooling / line installations and moves</td>
</tr>
<tr>
<td></td>
<td>Part and assembly inspection</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Power Generation</th>
<th>As-found measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alignment, final checks on install</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research / Medical Systems</th>
<th>Particle accelerator alignments</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Proton Beam Therapy Systems</td>
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<table>
<thead>
<tr>
<th>DoD/Test &amp; Evaluation</th>
<th>Live Fire Test Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre- and post-test measurements</td>
</tr>
</tbody>
</table>
SURVICE specializes in the Power Generation Industry
- Skilled in Hydro, Fossil, and Nuclear plant inspections
- Employ highly experienced personnel with broad skillsets
LASER TRACKERS ON THE JOB

PROTON BEAM THERAPY SYSTEMS

• Large volume laser tracker, optical level, and digital level measurement network setup and component alignment support – 0.2-0.5mm accuracy required over +200m spans
LASER TRACKERS ON THE JOB

NAVY SHIPBOARD SYSTEM ALIGNMENTS

- Precision measurement support to alignment of systems and components such as aircraft landing arrest system components during installation/construction phases
- Primarily using Faro Laser Trackers
### Characteristics

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<td>Individual points</td>
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<tr>
<td><strong>Measure components of</strong></td>
<td>2 to 50+ meters</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>From 25 microns (similar to Laser)</td>
</tr>
<tr>
<td><strong>Location measured</strong></td>
<td>must be pre-targeted with reflective target</td>
</tr>
<tr>
<td><strong>Targetless photogrammetry systems exist, and work well for measurements/modeling of highly “featured” objects</strong></td>
<td>Very accurate, robust, well proven, technology, very portable, suitable for remote locations!</td>
</tr>
</tbody>
</table>
Industries and Applications

- Jig and fixture measurements
- Structural deformation analyses
- Precision spaceclaim studies
- Signature-quality models

- Large-scale, as-built surface measurements for large structures, vessels, hulls, aircraft, spacecraft, antenna dishes
- Can be integrated with structured light, laser scans, and other measurements

- In-situ monitoring of discrete features and complex surface geometries
- Ability to use adhesive retro-reflective tape targets and/or hard tooling targets
PHOTOGRAMMETRY ON THE JOB – HYDRO TURBINE PIT

- Retroreflective targets are placed where critical features and surface measurements are required
- Multiple digital images are captured using a specially-prepared camera
- Images are processed in software to determine 3-D positions of targets
PHOTOGRAMMETRY ON THE JOB – ANTENNA STUDIES

- Sophisticated techniques for measurements of antenna deformations over a 24-hour period
- Portable, can make measurements in remote areas
MEASUREMENTS SYSTEMS – PORTABLE CMM ARMS

FARO PORTABLE MEASURING ARM

Characteristics

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<th>Details</th>
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<tbody>
<tr>
<td>Measurement type</td>
<td>Individual points or scan</td>
</tr>
<tr>
<td>Measure components of</td>
<td>0.5 to 3 meters</td>
</tr>
<tr>
<td>Accuracy</td>
<td>From 36 microns</td>
</tr>
<tr>
<td>Accuracy drops off rapidly for parts larger than 3</td>
<td>Medium accuracy, fast, robust, well proven</td>
</tr>
<tr>
<td>meters</td>
<td>technology for smaller parts, easily portable!</td>
</tr>
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</table>

☆ Medium accuracy, fast, robust, well proven technology for smaller parts, easily portable!
MEASUREMENTS SYSTEMS – PORTABLE CMM ARMS

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<thead>
<tr>
<th>Industries and Applications</th>
<th>FARO PORTABLE MEASURING ARM</th>
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</thead>
<tbody>
<tr>
<td>• Aerospace</td>
<td>![Image of aerospace application]</td>
</tr>
<tr>
<td>• Automotive</td>
<td>![Image of automotive application]</td>
</tr>
<tr>
<td>• Precision Engineering / Fabrication</td>
<td>![Image of precision engineering application]</td>
</tr>
<tr>
<td>• 3D Scanning or Touch Probe</td>
<td>![Image of 3D scanning]</td>
</tr>
<tr>
<td>• Reverse engineering</td>
<td>![Image of reverse engineering]</td>
</tr>
<tr>
<td>• Tool qualification, certification</td>
<td>![Image of tool qualification]</td>
</tr>
<tr>
<td>• Part inspection</td>
<td>![Image of part inspection]</td>
</tr>
<tr>
<td>Rapid Prototyping</td>
<td>![Image of rapid prototyping]</td>
</tr>
<tr>
<td>• As-built part modeling</td>
<td>![Image of as-built part modeling]</td>
</tr>
<tr>
<td>• Spaceclaim/integration modeling</td>
<td>![Image of spaceclaim]</td>
</tr>
<tr>
<td>DoD/Test &amp; Evaluation</td>
<td>![Image of DoD/test &amp; evaluation]</td>
</tr>
<tr>
<td>• Pre- and Post-Test 3D Feature and Surface Measurements</td>
<td>![Image of pre-and-post test]</td>
</tr>
<tr>
<td>• CAD modeling for FEA/CFD studies, target exploitation</td>
<td>![Image of CAD modeling]</td>
</tr>
</tbody>
</table>
FARO ARM INSPECTION REPORT EXAMPLES
DIGITIZATION/REVERSE ENGINEERING
SURVICE REVERSE ENGINEERING (SRE)

DIGITIZATION / REVERSE ENGINEERING PROCESSES

Point Cloud Scanning/Surfacing

Direct Part-to-CAD Modeling
PART-LEVEL REVERSE ENGINEERING EXAMPLE

PART/SUPPLIER OBSOLESCENCE

ACTUAL PARTS

MODELED PARTS
Component-Level SRE Direct-to-CAD & Scan-to-CAD Modeling Example TDP Level

Obsolete component used to create TDP for remanufacture

Scan mesh with laser scanner/X-Ray scanner

Feature based CAD Models
Component-Level SRE Scan-to-CAD Modeling Example

TDP Level

CAD Model from CT Scan Data

Actual Components to RE

New Part

Technical Data Package
Acquire point cloud data and mesh on the fly using laser scanner.

Create curves, patches and fit NURBS surfaces.

Import NURBS model into CAD package, such as SolidWorks, Creo, etc.
SURVICE REVERSE ENGINEERING (SRE)

DIRECT PART-TO-CAD MODELING
DIRECT PART-TO-CAD MODELING

EXISTING CASTED PART

EXISTING PART SCANNED INTO A PARAMETRIC 3D MODEL

2D DRAWINGS CREATED INSTANTLY FROM SCANNED GEOMETRY

SOLID GEOMETRY DIRECTLY INTO FEA ANALYSIS SOFTWARE
• Portable systems – Primarily Faro CMM Arms.
• Fast turn around, lower per-part cost than point cloud scanning
• Accuracy +/- .002 in.
• Direct-to-CAD - Parts to parametric SolidWorks or ProE/Creo models.
• Great for modeling accurate sections of aircraft, vehicles, systems for interface/integration, part-level reverse engineering, re-engineering, modeling & simulation, design and engineering efforts.
• Very limited post-processing - complete, editable models on the fly!
PART-TO-CAD REVERSE ENGINEERING EXAMPLES

AGING AIRCRAFT PART / SUPPLIER OBsolescence

Actual Aircraft Parts

Modeled Aircraft Parts
TECHNICAL DATA PACKAGES
VEHICLE-TO-CAD MODELING EXAMPLE – MRAP COUGAR

MRAP CAT I Cougar in SURVICE High Bay Facility

Discrete points, features collected with touch probes; point cloud collected with laser scanning

Complete vehicle modeled in Pro/Engineer

Interior and exterior geometry precisely modeled for system integrations, modifications
VEHICLE-TO-CAD MODELING EXAMPLE – ABRAMS M1A2 SEP

FARO ARM DIRECT TO CAD MODELING (SOLIDWORKS, CREO, ETC.)
### Characteristics

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<tr>
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<tr>
<td>Accuracy</td>
<td>From 0.5 to 2 millimeters</td>
</tr>
<tr>
<td><strong>Fast medium accuracy</strong></td>
<td></td>
</tr>
<tr>
<td><strong>measurements, robust, portable!</strong></td>
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FARO FOCUS 3D AND SURPHASER

MEASUREMENTS SYSTEMS – LARGE VOLUME 3D SCANNERS
Industries and Applications

<table>
<thead>
<tr>
<th>Aerospace</th>
<th>Large volume point cloud scanning</th>
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<tr>
<td>Automotive</td>
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<tr>
<td>Precision</td>
<td>Outer Mold Line surface modeling</td>
</tr>
<tr>
<td>Engineering</td>
<td>Large part/assembly inspection</td>
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<tr>
<td>/ Fabrication</td>
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Architecture / Construction

Building Information Modeling (BIM), indoor/outdoor 3D layout

DoD/Test & Evaluation

• Pre- and Post-Test 3D Feature and Surface Measurements
• Target Exploitation
• Signature models
SURPHASERS ON THE JOB

LARGE VOLUME COMPOSITE PART INSPECTION – 3D SCANNING WITH SURPHASER
SURPHASERS ON THE JOB

WING SECTION INSPECTION – 3D SCANNING WITH SURPHASER AND LASER TRACKER

Current Triangles: 4,851,746
Selected Triangles: 0
LARGE VOLUME SCANNERS ON THE JOB

FACILITY SCANNING – BUILDING INFORMATION MODEL (BIM) – REPAIRS / REPLACEMENTS

• Ability to accurately capture 3D data in cluttered and confined spaces
• Rapid data collection
  • Minutes vs. hours
  • Ease of use
• Post-processing can be done remotely
• BIM, MEP, plant engineering, clash detection models can be produced
# Characteristics

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- Rapid, high accuracy point cloud measurements.
- Multiple fields of view.
- Can integrate with photogrammetry
High-accuracy scans performed by SURVICE metrologists using the Brueckmann OptoTOP HE scanner enable the inspection and production of components and assemblies to very tight tolerances.
STRUCTURED LIGHT SCANNERS ON THE JOB

STRUCTURED LIGHT SCANNING + ARTIFACT = HISTORICAL FINDINGS

SURVICE scan and 3D print of ancient artifact

3D printed replica produced by Applied Rapid Technologies

Cinmar Discovery – Earliest man made tool found in America (22,000 years old)

Equipment used: Brueckmann OptoCAT-HE | Software used: OptoCAT and PolyWorks
**Characteristics**

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<tr>
<td>Accuracy</td>
<td>From 1 to 2 millimeters</td>
</tr>
<tr>
<td><strong>Fast medium accuracy measurements, robust, very portable!</strong></td>
<td></td>
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</table>
MANTISVISION F5 ON THE JOB

VEHICLE SCANNING

- Large-volume scanning technology
- Portable, ruggedized
- IR structured-light scanner in hand-held, ruggedized form factor
MANTISVISION F5 ON THE JOB

SHIPBOARD SCANNING – SPACE CLAIMS / CONDITION MONITORING / REPAIRS / UPGRADES

- Rapid data collection & processing
  - Scanned in 2 minutes
  - 19,971,072 Points
  - Processing 30 minutes
  (Alignment & Surface Mesh)
MEASUREMENT SYSTEMS – XRAY COMPUTED TOMOGRAPHY

XT H 320LC – 320KV XCT SYSTEM – VIA CHESAPEAKE TESTING

• 320kV microfocus source
• 225kV ultrafocus source
• State-of-the-art Perkin Elmer 1621 detector panel
• 0.002mm - 0.5mm resolution
  • Material and part size dependents

Common uses:
• Composites/Combat helmets
• Aluminum castings
• Plastics
• 450kV microfocus x-ray source
• 225kV ultrafocus x-ray source
• 37” scanning diameter
• CLDA linear array for 2D XCT
• 0.002mm - 0.5mm resolution
  • Material and part size dependent

Common uses:
• Armor/Munitions
• Castings/Turbine blades
• Airfoils
• Batteries (Li-Ion, etc)
## Industries and Applications

### Precision machining and fabrication
- Cast, forged aluminum, steel, titanium, etc., part inspections
- Crack, inclusion and void detection
- Turbine blade inspection

### Advanced Manufacturing
- Inspection of Additive Manufactured parts
- Inspection of composites

### Electrical and Energy Storage
- PCB inspection and reverse engineering
- Li-Ion Battery inspection

### DoD/Test Support
- Pre- and Post-Test 3D measurements – helmets, armors
- Non-destructive failure analysis
- Technology Exploitation
PART IS SCANNED USING X-RAY COMPUTED TOMOGRAPHY (XCT) THEN EXPORTED AS POINT CLOUD AND STL. FEATURE-BASED CAD GEOMETRY IS BUILT.

FEATURE-BASED CAD FILES ARE EXPORTED INTO END-USER’S PREFERRED CAD PACKAGE.
PRINTED CIRCUIT BOARD (PCB) SCANNING

- QA/QC Inspection
- Reverse engineering / component identification
- Forensics / failure analysis
- Non-destructive, multilayer board analysis
XCT is an excellent non-destructive testing method that allows for many of these internal defects to discovered BEFORE a failure can occur.

- Die casting defects are a result of the cooling processes, material properties and transitions between thick and thin walls.
- CT Scanning is an excellent tool to detect porosity, cracks, inclusions, micro-porosity and non-uniformity.
- When internal defects are found they are color coded based on their respective size.
SURVICE also possesses a wide array of in-house specialized technologies and capabilities that complement our core business areas. They include:

**ARGUS™**
SURVICE’s Autonomous Remote Global Underwater Surveillance system uniquely combines crowd-sourced bathymetry and automated collection/processing of vessel chartplotter and environmental data to map the country’s major waterways.

**HAWKEYE™**
SURVICE has developed a low-cost, self-contained means of capturing accurate 3D data in the field. HAWKEYE™ combines Structure from Motion (SfM) technology, low-cost structured-light technology, portability, and data security.

**ENHANCED-CLR™**
SURVICE’s Enhanced Coherent Laser Radar is one of the most accurate noncontact dimensional inspection tools in the world, integrating a professional-grade photogrammetry system with advanced computer-vision technology.

**TRAINING**
SURVICE Metrology has a knowledgeable and experienced staff available to offer training support. We can provide training at our facility or on-site, tailored to your needs and mission.

**Hardware Training:**
- Laser Trackers
- Photogrammetry and Arms
- Structured Light Scanning

**Software Training:**
- PolyWorks
- Insight
- CAM2

**EQUIPMENT RENTALS**
Need equipment for a project, but it’s not in the budget? Whether you need it for a day, a week, or month, SURVICE Metrology offers several rental options to meet your needs and help you get the job done:
- FARO Edge Arm (with or without Laser Line Probe)
- Vantage Laser Tracker
- Vantage S Laser Tracker
- MantisVision F5 (long-range and short-range)
SYNOPSIS

• SURVICE METROLOGY provides innovative and integrated dimensional inspection services, 3-D modeling, and metrology application development. From our metrology facilities in as well as our portable field measurement teams, we provide responsive support and quality products to our customers.
  › Extensive commercial metrology inspection services and reverse engineering capabilities
  › Metrology systems integration services and R&D capabilities

• SURVICE METROLOGY is a division of the SURVICE Engineering Company (www.survice.com). SURVICE has been providing the DoD and industry customers with specialized products and services supporting the design, development, testing, and fielding of systems for more than 35 years. SURVICE's corporate headquarters is in Belcamp, MD, and has technical operations in Maryland, Michigan, Virginia, Ohio, Alabama, Florida, and California.
  › Unmatched reach-back to SURVICE engineers, research scientists, analysts, and software developers

WE EMPLOY:

• A suite of state-of-the-art metrology equipment – laser and white-light scanning, portable and fixed CMMs, laser trackers, photogrammetry, x-ray computed tomography
• Advanced measurement and modeling tools
• Extensive measurement and modeling experience
• Unique custom application development capability – Enhanced Laser Radar, I-CARS, HawkEye
• Additive manufacturing – 3D printing services
Beyond Measure…

Chris Cosgrove
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