

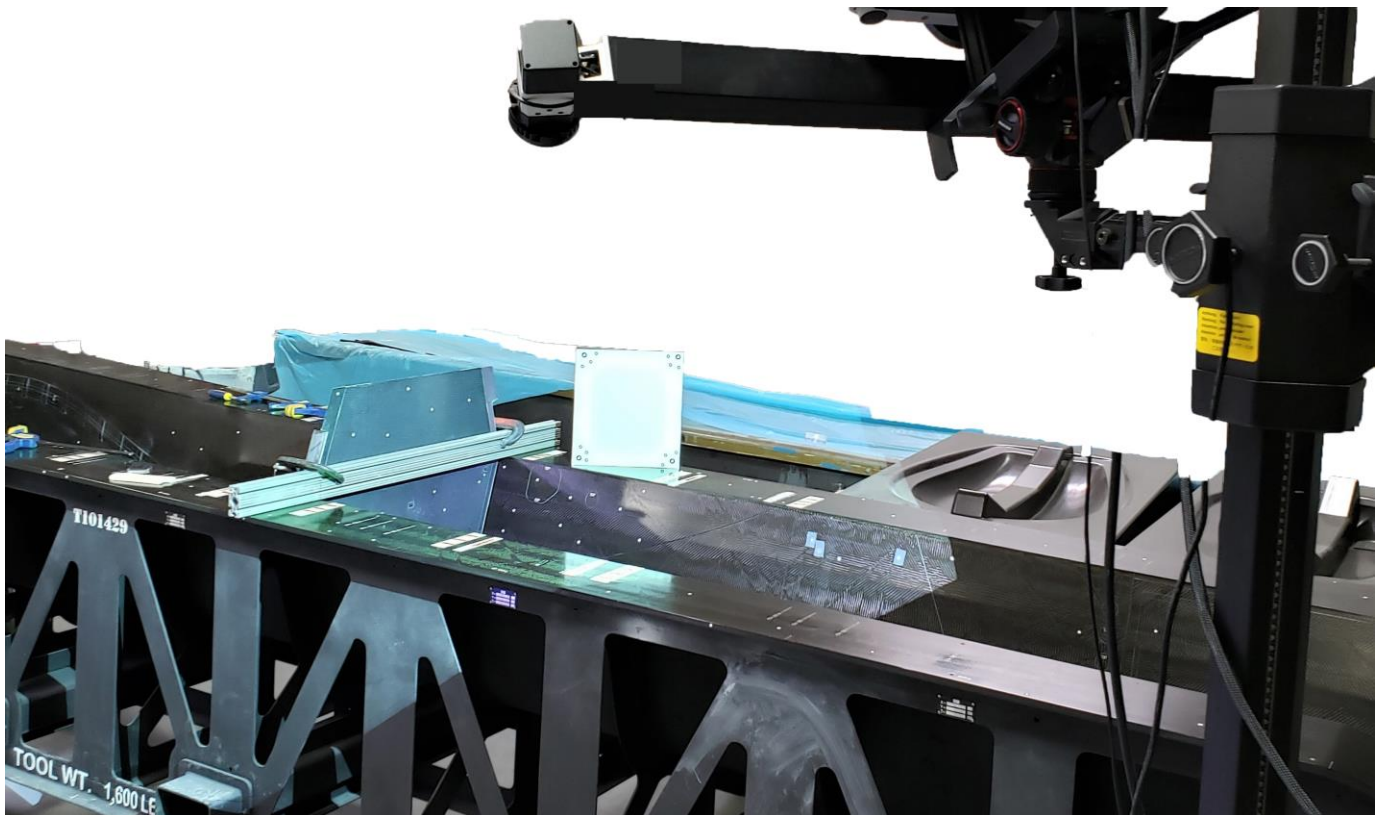
Industry 4.0

# Digital-Manufacturing

In-situ NDE

Digital Assembly

Trilion Digital-Twin

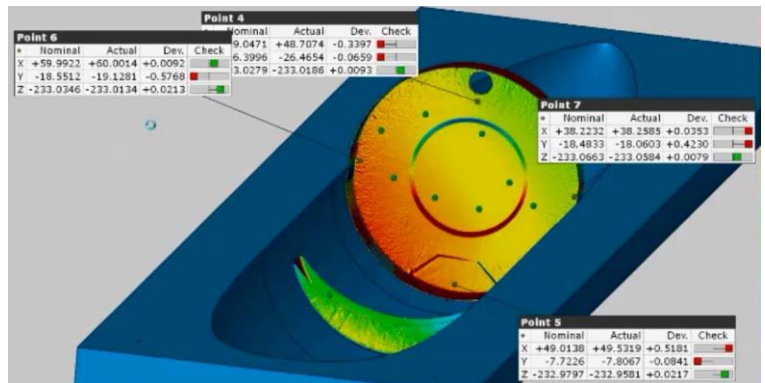


**Digital Manufacturing & QA from CAD**  
Non-Contact. Tool-less. Live Digital-Twin.  
The Power of Optical Metrology.

# Digital Manufacturing

Optical metrology is a revolutionary change in measurement and quality technology that will change manufacturing forever. Our goal is to provide our customers with cutting-edge capabilities with high measurement accuracy and highly efficient controls, and the wraparound training and services to support them. Trillion Manufacturing Digital-Twin is the collection of physical quality measurements throughout your manufacturing program, directly integrated with your ERP system. In-situ NDE allows you to perform real-time quality inspections during layup, quadrupling your production speed and quality.

Real-time Virtual Assembly Tooling (RVAT) provides real-time feedback to operators for precise positioning of the actual components in 6-DoF (degrees of freedom), controlling operations, integrated QA and documenting all, As-Built, for your Manufacturing Digital-Twin. This tool-less capability means that there is no need to design, build and store physical tools; just build directly from CAD with your Digital Manufacturing RVAT system. You can rely on RVAT as a resource to save man-hours, and improve manufacturing schedule and build quality, and fully document quality.



Engineers and manufacturing quality personnel are better connected since alerts flow automatically to QA managers and engineering as needed. Design and method changes can also be rapidly implemented; since it is all digital. In actual use, RVAT is 60% faster and more accurate than hard tooling, with QA built-in.

RVAT, with MRL-9 ARAMIS 3D sensor, provides 6-DOF guidance of assembly of the actual scanned part, allowing the operator to get real-time, step-by-step guidance and positioning information accurate to 0.1 mm or 0.005 inch for each manufacturing step. QA is simply performed with the same RVAT equipment used for assembly.

# Digital-Twin

**Manufacturing Digital-Twin** The Trillion Digital Twin captures the complete manufacturing quality digital-threads, monitored. This data set can then be published for various users. A configurable Digital-Twin publisher will provide these customized publications of the vehicle Digital-Twin to QA, engineering, and Digital-Twin subset, especially configured for customers, support, and FAA, supporting transparent manufacturing.

**Real-time QA with RVAT** Quality Assurance confirming part positioning and alignment, using the same precision equipment as for the digital assembly. QA manager gets real-time reports of manufacturing quality with comprehensive detail of quality concerns and configurable tools to address assessment, repairs, and approvals.

**As-Built Digital-Threads** RVAT captures the precise locations of each build operation, their components, including the related CAD and component scans. Implemented fully, this technology will equate to significant savings, improved product quality and documented results.

**RVAT Smart Tools** allow RVAT to track any Smart Tool in 3D space (6-DOF) with high precision and document its operations in the Digital-Twin. Smart Tools are used for assembly operations, Click-Bond placement, precision drilling and custom alignment fixtures.

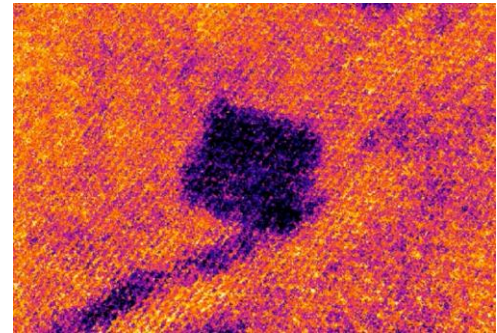
**Digital-Twin Server** provides a graphical interface of the full build documentation of the manufacturing operations digital-threads. The digital-thread recording of the As-Built details and dimensions, integrated QA, and testing from every step of the build, creating the complete Digital-Twin of the vehicle, with reporting, threads, and full graphical searchability.

**Structural Health Monitoring** is also possible with Trillion Digital-Twin, monitoring the vehicle's structure and systems throughout the vehicle's life, for structural quality, predictive maintenance, and life extension, without weight, sensors or power.

# In-situ NDE

The best composites manufacturing has quality problems with unexpected defects built into parts, and extensive inspections during and after builds. The efficiency of composite manufacturing can be greatly improved with real-time InSitu NDE (Non-Destructive Evaluation) detecting fiber alignment, bridging, FOD and other quality issues before curing and testing.

**CoolScan™ Layup NDE** Build Quality such as voids, bridging and FOD are built into parts, which are only detected after curing and NDT. Real-time InSitu NDE can detect these problems during the layup while they can be fixed, to greatly improve product quality, making good parts every time, and documenting these QA digital-threads for part validation.

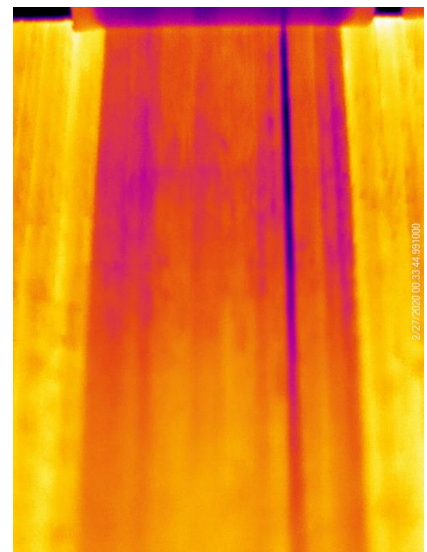


**InSitu AFP Layup NDE** Build quality such as lap/gap, twist, voids, porosity, voids and FOD, are critical to detect during the build. Typically, post-build quality inspection is 75% of the build time. Real-time InSitu NDE can detect these problems during the AFP build, and immediately fixed. This greatly improves product quality, making good parts every time, quickly and efficiently, and documenting these QA digital-threads.



**Tool-less AFP Builds** Thermoplastic future looks to create tool-less robotic AFP builds, which are also only possible with InSitu NDE providing real-time feedback of part 3D shape, precise robot head location and quality data, providing real-time robot guidance.

These quality inspection digital-threads are fully documented in your manufacturing Digital-Twin, documenting and validating build quality of every part. Implemented, this technology will provide significant savings and greatly improved product quality. Build it right the first time.





# Digital Assembly

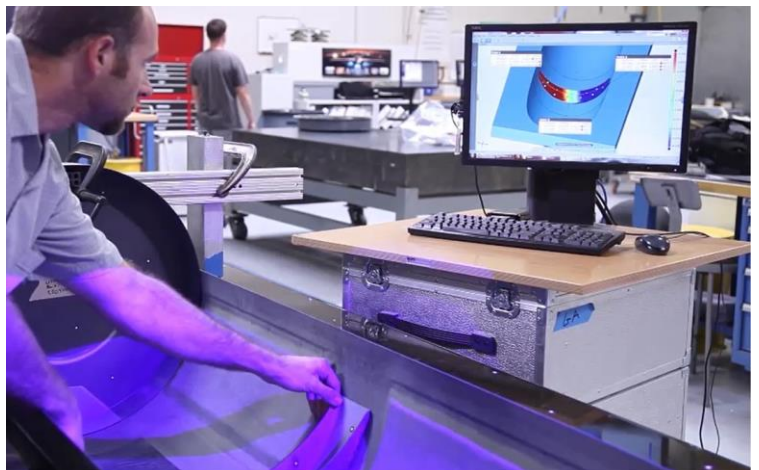
RVAT (Real-time Virtual Assembly Tooling) utilizing TRL-9 ARAMIS for real time optical measurement, allows composite structures to be assembled tool-lessly, directly from CAD. Operators position each component, using its precise scanned shape, into assembled CAD 6-DOF coordinates. Digital assembly allows for the documentation of each build step for QA and as a Digital-Thread of the assembly, documenting the vehicle As-Built.

**Real-time Guidance** RVAT Digital Assembly applications include the assembling components such as the bulkhead and composite bracket seen below. The guidance is in real-time (25 fps), even if components are moving, like with flexible components. Precision positioning of the component into CAD coordinates, the operator then marks the final As-Built positions, providing real-time quality assurance of each manufacturing step.

**Integrated QA** After curing, QA positioning and alignment checks can be made with the same system and method. Precision QA data is reported to quality and production management in real-time.

**As-Built Digital-Threads** RVAT documents all final positions and QA, As-Built Digital-Threads. Capturing all of these Digital-Threads creates the Digital-Twin of the vehicle; the full documentation of the build. These capabilities, while providing better quality and better production knowledge, also reduces costs substantially.

**Benefits and ROI** Digital Assembly is 50% faster and better quality than using hard tooling. Hard tooling is typically 40% of the manufacturing costs of an aircraft program. RVAT looks to substantially reduce hard tooling. Real-time integrated manufacturing quality, documented into the Digital-Twin, is the goal.



# SmartTools™

**RVAT SmartTools** allow RVAT 3D optical tracking of core or custom tools for precise operation in true 3D CAD coordinates, in full 6-DOF (Degrees-of-Freedom). CMM Touch Probes, Click-Bonds, Drilling Guides and Custom Alignment Adapters can be configured in minutes, and they provide an easy metrology platform for quick measurement:

- Any type of measurements required
- Independent from fixed sensor location
- Large measuring area
- Accuracy to 0.1 mm or 0.005 inch

**Click-bonds** The Click-Bond 3D locations are simply imported from CAD in true vehicle coordinates, and allowing an easy, fast and accurate placement. RVAT Pro projects the position of each Click-Bond as the operator steps through each step of a Job Pack, positioning each click bond precisely in 3D space.

**Sub-Component Assembly** After curing, QA positioning and alignment checks can be made with the same system and method. Precision QA data is reported to quality and production management in real-time.

**Smart Alignment Tools** RVAT SmartTool Alignment Tools have been used for every type of alignment to CAD coordinates, from aileron alignments, to engine components alignments, to entire wing to body assemblies. RVAT allows these precise alignments directly to CAD, provide integrated QA and document each to the Digital-Twin.

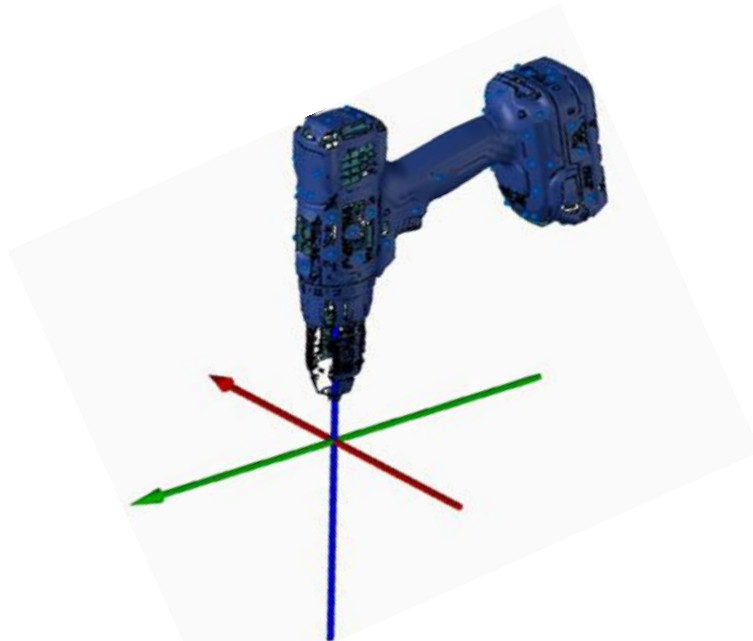


# Smart Drilling

RVAT Smart Drilling provides advanced guidance for drilling operations, saving hugely on operations and provide very high accuracy. Drilling of complex 3D structures, with RVAT guidance, allows existing assemblers to be 10x faster with greater accuracy.

During RVAT Smart Drilling with your team, guidance to each hole to be drilled is tracked to precise CAD dimensions, especially on complex 3D parts, with SmartTool Drill Guide. The SmartTool Drill Guide allows pilot holes, drill holes and reaming operations, all to be precise in 3D coordinates and documented As-Built. Blind holes can also be drilled precisely, relative to reference structures, in true vehicle coordinates.

Smart Robotic Drilling is directly guided by RVAT into precise location, and to depth. Each operation is fully documented, with the RVAT system for as-build documentation and build quality, to the Digital-Twin. RVAT Drilling allows greater precision, higher quality, and faster, more efficient work with your same workforce, or robotically.



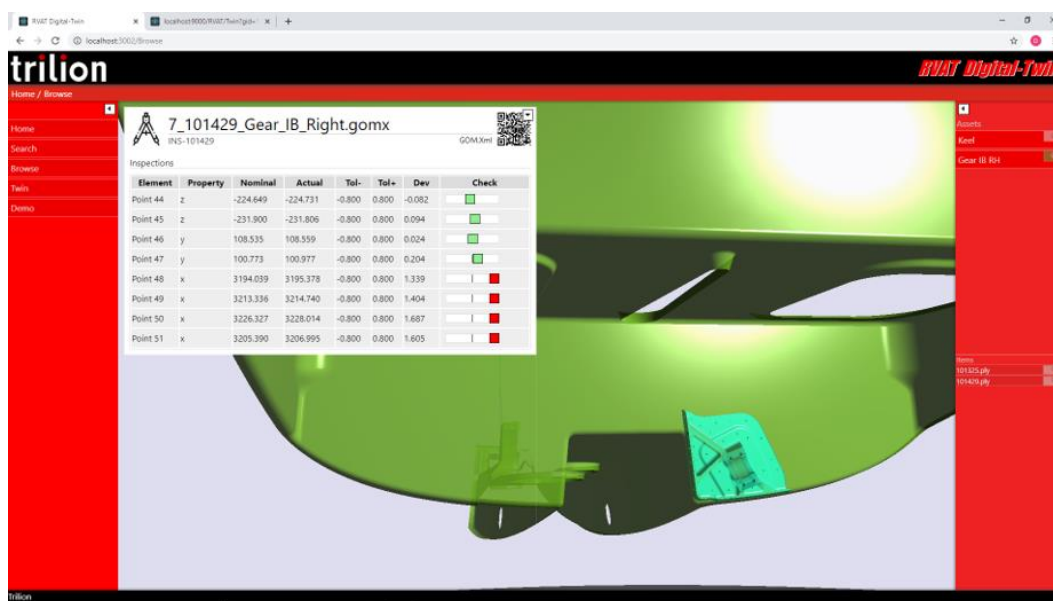
# Trilion Digital-Twin

The Trilion Digital-Twin is a collection of physical measurements throughout your manufacturing program, reporting to QA engineering, management in real time. This is a relational database synchronized with your methods, and with advanced analytics to provide real-time analysis of the manufacturing data, to meet your requirements. It is real-time, so that you can monitor your manufacturing throughout your organization dynamically. Trilion has designed its systems based on current Air Force data security requirements, using your internal corporate network for data communication.

The Trilion Digital-Twin contains all of your quality data, organized in a 3D coordinate graphical format for easy to top-down visualization of the entire aircraft build from quality to efficiencies. Dive into the wing to understand its details; all of the data is in there.

The Trilion Digital-Twin is also documents across aircraft builds for statistical analysis (SPC) and manufacturing problem solving, allowing you to optimize your entire manufacturing line.

The Trilion Digital-Twin publications provide transparent manufacturing documentation and control for the FAA to full see that your manufacturing is in control and allowing for your aircraft to be able to be directly certified.





# Benefits and ROI

**Faster time to market** – Trilion systems will reduce the time your workforce spends on complex (fit up / lay-up / assembly / measurement / fixture / jiggging/ testing / QA / etc.) tasks enabling your team to build quality aircraft in less time. ROI: Being the first one to market ... priceless.





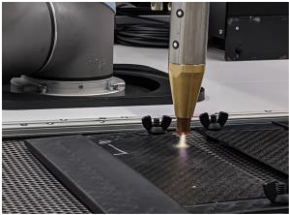


**Higher productivity/efficiency** – RVAT greatly increases the throughput of your existing workforce by using Trilion systems to improve productivity of most manufacturing tasks, maintain the highest quality, as well as reduce errors and rework. ROI: RVAT has improved production time and effort 10x for many operations, while improving quality and documenting every step in the Trilion Digital-Twin, capturing best practices and allowing for SPC analysis across all areas.

**Higher Quality** – Build it right the first time, RVAT provides detailed assembly measurement and comparison to CAD enable operators to build aircraft with high precision following the design. Trilion systems provide real-time quality documentation to improve accuracy and reduce errors. Digital assembly reduces rework delays and scrap. ROI: RVAT has helped reduce 50% scrape rates to near zero.

**Cost avoidance** – When in a growth mode, improve the efficiency and throughput of your existing workforce and meet increasing production. Build right from CAD, toollessly, and provide precise feedback to engineering on fit and quality. Document and improve assembly procedures as it is performed. ROI: Building right from CAD minimizes errors from translations, and documenting QA directly to design provides the ideal quality control.

**FAA certification** – FAA needs to know that you are following your procedures accurately and can document it fully. With Trilion Digital-Twin, the collection of a complete As-built record for each component including QA to your tolerances, including As-built measurements, assembly Quality Assurance and complete testing records. Your Digital-Twin provides all of the build detail needed for FAA certification in a secure and easy-to-navigate graphical database.

# Digital Manufacturing Toolbox

<p><b>CoolScan InSitu NDE</b></p>		<p>Manual Composite layup real-time NDE, providing real-time QA &amp; FOD NDE.</p>
<p><b>AFP InSitu NDE</b></p>		<p>Integrated Robotic AFP InSitu NDE, providing Lap, Gap, Twist, Void, Porosity, FOD NDE.</p>
<p><b>RVAT 3D Scanning</b></p>		<p>ATOS 3D Scan of actual part for precision alignment, bond thickness, QA.</p>
<p><b>RVAT Digital Assembly</b></p>		<p>RVAT Tool-less digital assembly of components directly to CAD &amp; Smart Tools guidance and alignment.</p>
<p><b>RVAT Smart Bonding</b></p>		<p>Robotic prep, clean, energize and smart bonding for perfect bonds. Automatically filling gaps and bond thickness validation.</p>
<p><b>ARAMIS NDE Optical Strain</b></p>		<p>Optical Strain provides full-field measurement of 3D shape, deformation and strain.</p>
<p><b>Trilion Digital-Twin</b></p>		<p>Full graphical interface Digital-Twin of manufacturing quality throughout production and beyond.</p>

# All-in-One Solution

**Trilion Quality Systems** Systems has been an industry leader in Optical Metrology for over 20 years, developing and supporting unique and advanced applications throughout North America. Finally, optical metrology brings long-awaited advanced Factory 4.0 capabilities to the manufacturing industry. The RVAT platform is an integrated solution package for tool-less manufacturing, digital assembly, and Trilion Digital-Twin.

**Trilion Engineering Services** is the perfect solution for companies who have a complicated application or are not ready to acquire a system. We will send an experienced engineer and system to get professional results every time.

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*A manufacturing revolution, reducing costs and improving quality!*

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**Trilion Digital-Twin is the tool of choice for industry leaders!**

Our customers are industry leaders, and their operations are the best proof of the importance of optical metrology in manufacturing.





For more information, visit:  
[trilion.com/TrilionDigital-Twin](https://trilion.com/TrilionDigital-Twin)

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