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AEROSPACE & DEFENSE TECHNOLOGY™

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3D Scanning: Improving Manufacturing Efficiency

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Weapon-Mountable Counter UAS

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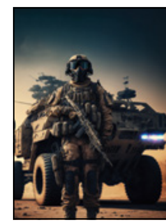
ON THE COVER

Electrification and autonomous technologies open a new world of possibilities for the defense sector. While there are barriers and challenges to integrating these technologies and making them commonplace in the near term, there is also huge potential to revolutionize the state of warfare and defense, especially when considering unmanned ground vehicle platforms. To learn more, read the UGV Technology feature article on page 6.



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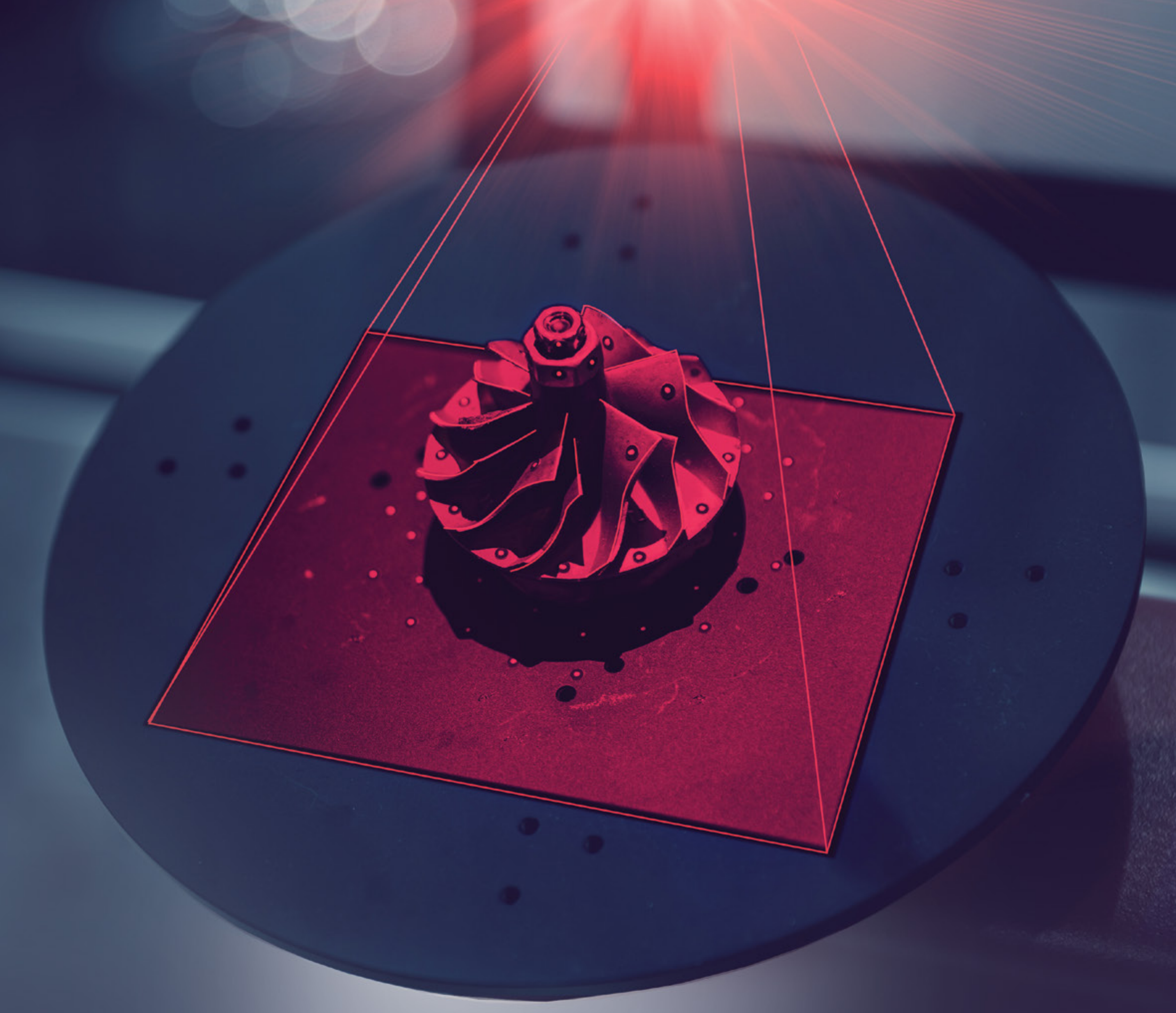

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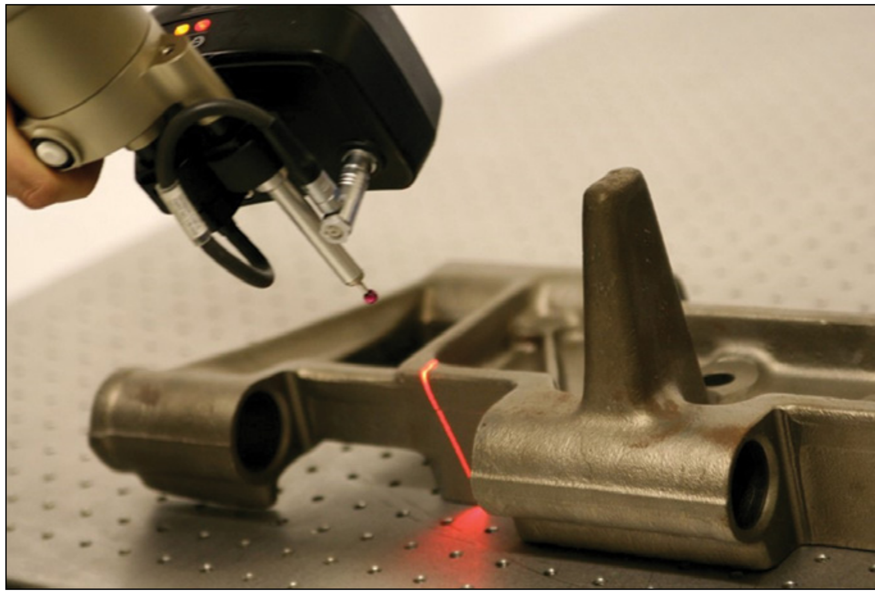
3D Scanning Provides Key Weapon for Aerospace and Defense Manufacturing

Recent events have shown that challenges to the global status quo can arise rapidly, making it imperative that military manufacturers remain agile and prepared to meet new circumstances as they emerge. As author Jim Pattison succinctly stated: "No matter what business you are in, there is change, and it's happening pretty quickly." The challenges posed to military manufacturers include shorter design and production timetables, the need for greater efficiency in parts replacement and material usage, and an accelerated time to market; challenges that must be met with every technological tool available.

The current revolution in manufacturing driven by digital technologies, is transforming the global production landscape. While artificial intelligence, augmented reality and the Industrial Internet of Things (IIoT) are increasing production efficiency and time to market, 3D scanning still has not been exploited by aerospace and defense manufacturers for its full potential to do the same.

3D scanning is a non-contact, non-destructive method of digitally collecting accurate measurement data on the shape, size, and texture of a real-world object or environment. Capable of measuring and inspecting parts with an accuracy exceeding that of traditional measurement tools, 3D scanning can be an invaluable tool for rapidly reverse engineering parts, reducing design and production cycles, and detecting manufacturing errors, making it a powerful "weapon" in the arsenal of manufacturers determined to maintain their competitive edge while keeping the U.S. safe.

No doubt there are many manufacturers who don't fully understand 3D scanning and its capacity to improve the quality and speed of their output. This article addresses the most frequently asked questions about the use of 3D scanning and how it can help manufacturers establish shorter design and production timetables among other improvements.



A tank track component being scanned with a laser scanner. (Image: NVision)

CMM probe being utilized to characterize geometric features of the interior surfaces of the pictured assembly. (Image: NVision)

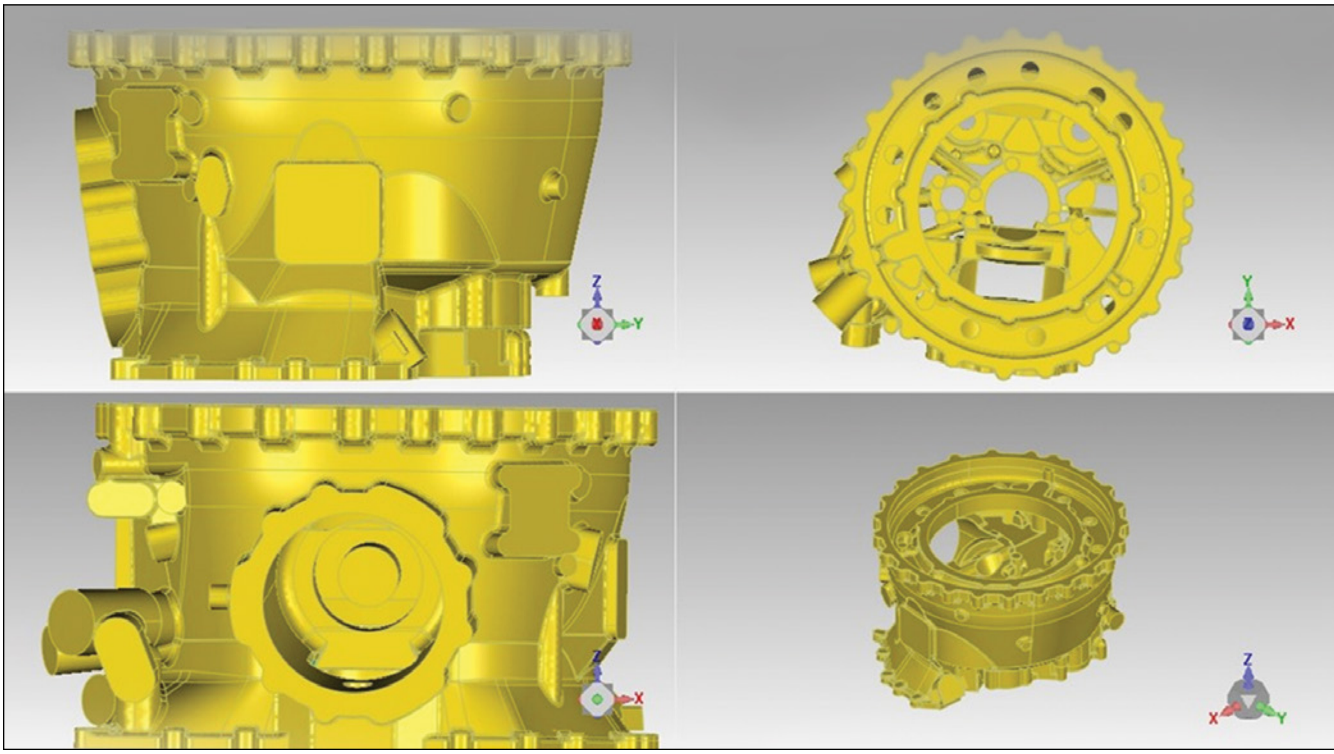
How can 3D Scanning Improve Military Production?

One way is by increasing the speed and quality of weapon system repair and maintenance. With each day that passes, every piece of military equipment ages, eventually failing and becoming unusable. Using 3D/laser scanning, engineers can capture the 3D geometry of older parts, then quickly reverse-engineer, machine, and reinstall them, keeping equipment in peak working condition.

A common challenge with aging equipment is that you may be working on parts for which no design files exist. The original computer-aided design (CAD) file may be unavailable or the parts may have been designed without using CAD and the original blueprints are missing. In either case, 3D scanning is the fastest and most accurate way to capture and preserve the parts' full dimensional details and feature definitions.

Design optimization is also easier using 3D scanning. Once a CAD file of the part has been created, it can be used forever to improve the part's design and performance. Laser scanning is extremely useful in preventing production errors as well. By comparing scanned parts with their original design file, engineers can determine whether an as-built part conforms to its OEM design. They can even detect where a manufactured part deviates from the original design and thus correct defects in production or materials early in the manufacturing process. This is especially helpful with hard-to-measure parts like turbine blades. Dimensional accuracy (such as the degree of "spring-back effect" occurring during sheet metal forming) can be analyzed and the tolerances of tools like molds and dies can be examined. If necessary, the 3D scan data can be used to create new stamping dies.

3D scanners come in many forms, including laser triangulation, projected light, Time-of-Flight (TOL) large-area scanners, and CT (X-ray computed tomography). Each type of scanner has



This validation of a helicopter component's conformity for OEM design criteria was created from 3D-scanning data. (Image: NVision)

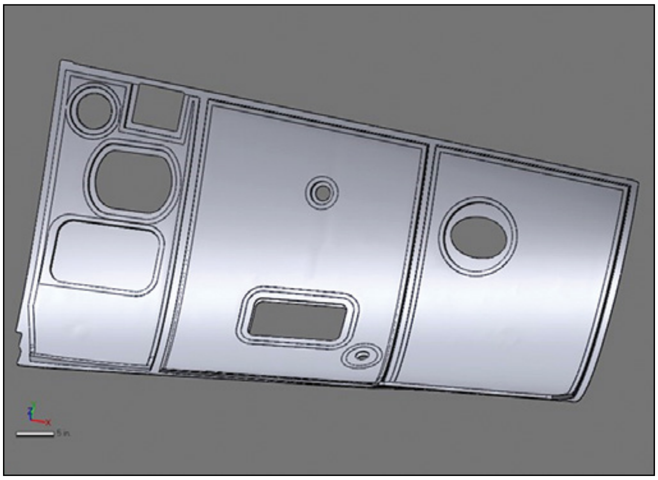
specific strengths and weaknesses that may make it more suitable for certain applications; for example, TOL scanners are excellent for scanning buildings, but would not be a good choice for scanning a part with internal components. Conversely, a CT scanner, which utilizes x-rays to produce 3D representations of both internal and external components, is highly suitable for scanning devices with internal geometry. But you wouldn't use it to scan a railroad trestle or the exterior of an office building.

There are, of course, scanners that are very capable of handling a myriad of diverse applications with excellent results. The most versatile 3D scanner overall is a handheld laser scanner. It's portable and able to capture 3D geometry from objects of virtually any size, from the exterior of an advanced fighter jet to an extremely small part such as an aircraft angle-of-attack sensor.

Different 3D Scanners for Different Applications

The scanner you'll want to use will depend on what you're measuring, the type of measurement data you want to obtain, and when you need it. Below is an overview of the various types of 3D scanners available on the market today and what they're useful for.

- Light-Based Coordinate Measuring Machine (CMM): A CMM that employs a laser or light-based triangulation sensor to capture an object's 3D dimensions. CMMs are an excellent choice for applications requiring accuracy greater than 0.0001" or 0.0254 mm, such as inspecting turbine blades, test equipment, injection molds, and master gages.
- Computed Tomography (CT): CT scanners are capable of capturing internal geometry, an excellent choice for measuring medical devices and other mechanisms possessing internal components, as well as applications with measurement requirements that exceed the capabilities of line-of-sight scanning.
- Structured Light Scanners: If you need to measure intricate and detailed parts, these scanners are an excellent choice. They utilize white or blue light to create a series of reference patterns on an object. The light deflects with the object's surface and the scanner uses the captured images to calculate the object's depth and other surface information. The spatial data points can be gathered in object-specific density and the different scanned patches are "stitched" together, typically with pre-mounted stickers.
- Time-of-Flight (TOL) Scanners: These scanners provide 3D measurement and geospatial data about very sizable objects or environments where manual measurements are difficult or even impossible. As their name implies, they capture measurement data by calculating the time it takes for a laser pulse to reflect from the object's surface back to the scanner. Ideal applications for TOL scanners include measuring large structures such as factories, power plants, oil rights or civil engineering projects and other construction or landscape-related projects.
- Laser Scanners: These are the true Swiss Army Knives of three dimensional measurement and inspection.



3D scanning can be used to generate digital models that help inspect and validate the tolerances of modes and dies. (Image: NVision)

They can be employed in a myriad of environments and capture accurate 3D data across a broad range of shapes and sizes – from boat propellers to full-sized automobiles. They are a good choice for nearly every type of inspection because of their speed, portability, multipurpose functionality, and ease of use.

A 3D laser scanner projects laser light onto the surface of an object then detects the reflected light and calculates the distance from the scanner to each geospatial point on the object's surface. As its laser sweeps the object's surface, the scanner creates a "point cloud" of geospatial entities from the object's surface, which defines the object's surface shapes and dimensions.

The scanner's integrated software converts the point cloud to an Stereolithography (STL) polygonal file while intuitive software allows real-time rendering, full model editing, polygon reduction, and data output to all standard 3D packages. The STL file is used to create a 3D IGES/STEP/Parasolid model, which is then converted into the required CAD format. Once it's converted to a CAD format, you can use the file to create a 3D replication of the object for measurement, analysis, reverse engineering, inspection, rapid prototyping, or mass production.

There are some jobs where the best results are obtained by using a combination of scanners. For example, when we scan gun parts, we typically use a laser scanner to create the initial 3D model and then refine the model further by utilizing even more precise measurements from a traditional CMM, which is accurate to 0.0001", or 2.54 microns. For comparison, the thickness of a human hair is about 70 microns.

A HandHeld scanner can capture 60,000 separate spatial measurements per second and has an accuracy of +\- 0.025 mm or 25 microns, which is +/- one-thousandth of an inch. Its ability to accurately inspect for tight tolerances is so well-regarded that its results have been used in court cases as expert evidence in determining the existence of product flaws and charting their timeline in the manufacturing process.

Today's scanners can capture the geometry of virtually anything, small or large; from a heart stent to a petrochemical plant. In our work for the DoD and defense contractors, we have scanned everything from machine guns to grenades, M16 rifles, jet fighter ejection seats, anchorage systems on Coast Guard cutters, and more.

Over the past 30 years, we've scanned many large vehicles and weapons platforms, including entire tanks (and their tracks), combat jets, other fixed-wing and rotary aircraft (including helicopter interiors), and experimental craft. Even military transport aircraft which were scanned on the Air Force Base flight line. Due to the sheer size of aircraft carriers, the technician would likely incorporate the use of TOF large-area scanners mentioned earlier.

Different personnel carriers, including Mine Resistant Ambush Protected Vehicles (MRAPs) can, and have, been scanned. The U.S. military wanted to measure MRAPs so that they could be retrofitted to defend against Improvised Explosive Devices (IEDs). In retrofitting, accuracy is foremost, which is why the military now typically requires that measurement be done using laser scanning.

How Does 3D Scanning Save Time and Money?

It depends on the job, but it's not unusual for time savings to be measured in weeks or even months with corresponding reductions in costs. For example, the Corpus Christi Army Depot (CCAD), which overhauls, repairs, and modifies rotary-wing aircraft, reduced the time required to reverse engineer components from two weeks to two hours using laser scanning, a time savings of over 99 percent. The net result is that the CCAD can now accurately define the part surface in a matter of hours and get aircraft back into service much faster.

Leading defense contractors and military organizations such as Lockheed Martin, Raytheon, L3, Boeing, Bell Helicopter, the National Institute of Standards & Technology (NIST), and all branches of the U.S. military, have now integrated 3D scanning into their production process. For good reason, by providing rapid and precise dimensional measurements, 3D scanning creates highly accurate CAD models from an object's geospatial data. This facilitates rapid analysis of part geometry, boosts the speed and accuracy of reverse engineering, aids design optimization, reveals flaws in tooling, and most importantly, speeds the development and delivery of critical weapons and systems to U.S. fighting forces around the globe.

This article was written by Steve Kersen, President of NVision Inc. **For more information, visit www.nvision3d.com.**