FLEXIBLE UT INSPECTION

Ultrasonic testing is one of the most effective ways to validate the integrity of aerospace composites

BY SAM H SERHAN

The introduction of automated ultrasonic testing for aerospace composites has benefited the non-destructive testing (NDT) field through increased inspection speed, imaging capabilities and repeatability. The issue with testing these unique and exotic materials is primarily due to their shape. NDT is by far the most efficient way to have advanced testing on complex components, and with automated systems it creates an added value due to highly repeatable inspections. The problem is this requires exceptionally capable NDT system hardware, electronics and software which guarantee inspection speed, reliability and repeatability.

Manual or conventional testing techniques are impractical or simply impossible in the case of complex composite parts or structures. This article discusses the generalities of using automated UT systems for composite materials designed for aerospace component testing.

ABOVE: **A squirter gantry uses a water jet for ultrasonic testing**

AUTOMATED UT SYSTEMS

For those unfamiliar with NDT, UT involves the propagation of ultrasonic waves into the subject being tested. The frequencies used for standard UT testing can range between 0.5MHz and 25MHz, while select TecScan products can easily go up to 50MHz. Most often the couplant used which facilitates the transmission of ultrasonic energy from the transducer into the test specimen is simply water. This can be done through water jet (squirter) or immersion style testing.

Some of the solutions for automated testing include UT immersion, squirter gantry, phased array, robotic arms and more. Immersion systems are used for ultrasonic testing and detection of flaws in both metallic and composite materials. These systems are usually designed with highly accurate actuators, servo or stepper motors, and optical encoder modules, making them ideal tools for real-time signal acquisition during the axes movement. They also provide automation with increased inspection speed, real-time signal processing, imaging capabilities and scanning repeatability.

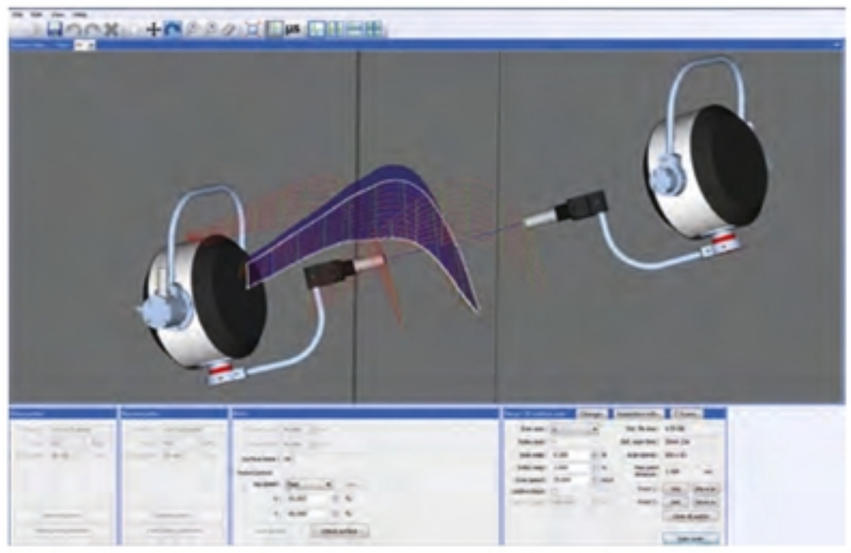
Ultrasonic C-scan and tomography are achieved using these automated systems by performing a raster scan on the inspected samples with appropriate ultrasonic transducers. Specifically, immersion scanners designed or retrofitted for 3D scanning applications perform at higher speeds and are well suited for the inspection of complex and curved parts by using contour-following features and/or full 3D scanning techniques.

Squirter gantries are most commonly offered in two configurations: a 9-axis system with a single bridge, or a 10-axis system with independent X-axis bridges. The 9-axis gantry system is best suited for larger parts with less complex geometries, whereas the 10-axis system is well suited for 3D scans of complex parts. Gantry systems can also be custom designed to meet clients' needs if necessary. Inspection can be conducted in through-transmission and pulse-echo from each side simultaneously.

Some of the modern articulated arm robots are believed to have appropriate characteristics to be used for automated NDT systems. More recently, and in order to increase productivity, a growing interest in robotic solutions was reported within the aerospace sector. However, despite these efforts, several inspection factors and design challenges need to be addressed to achieve robotic solutions for automated UT testing with reliable positional accuracy and repeatability performance capabilities.

NDT SOFTWARE

Due to the complex nature of composite parts and structures, the NDT software involved is much more complicated especially since many of these structures are geometrically unique, a common phenomenon in



aerospace. This begs the question: How can we use automated systems with generic motion control tools to scan something very specific?

TecView 3D, for example, is an NDT software with advanced data acquisition and control capabilities. It allows the scanners to achieve arbitrary motions and also performs path planning in order to follow all the contoured shapes that need to be scanned. This NDT technique is a complex and demanding feature for any software and electronics available today. There are multiple ways to set up scan plans such as: 'teach and learn' of parts that are slightly curved or axially symmetrical; or CAD import capabilities for full 3D inspections. Complex shaped parts can be scanned with a single probe, or an array probe.

ABOVE: **An automated immersion UT system for aerospace parts**

ABOVE RIGHT: **NDT software with advanced 3D and CAD tools**

SOUND ANALYSIS

Another common challenge with the testing of aerospace composite materials, which is also geometry dependent, is the variation of wave attenuation. These variations in the wave attenuation make 3D data analysis more difficult. Data manipulation and display modules need to be optimized for multiple computer processors and designed to handle large amounts of data.

Due to the required high-precision 3D scans, the collected data will result in large file sizes. Therefore to interpret the data correctly, we must ensure we have proper data position information, as well as the ultrasonic analysis tools in order to quantify defects correctly.

As we enter a new age of composite material manufacturing, not only in the aerospace industry but in all industries, faster, more accurate and especially more flexible automated UT systems with advanced inspection tools will be needed. ∎

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