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LASERGUIDE HELPS NASA BUILD A TELESCOPE COMPONENT DIRECTLY FROM FIBERSIM™ DATA

ABSTRACT

As both a pioneer and a singularly focused provider of 3D laser templating systems, Assembly Guidance proved to be the go-to supplier for a new endeavor in composites layup. The NASA Goddard team tasked with developing composite components for the Wide-Field Infrared Survey Telescope (WFIRST) improved upon the speed and precision with which it built a prototype "element wheel" for the telescope by employing a LASERGUIDE system for the build. LASERGUIDE's direct use of Fibersim™ data; its straightforward and easy-to-learn interface; and its exclusive, user-friendly remotes all contributed to these significant improvements.

As the National Aeronautics and Space Administration (NASA) advances the state of the art in space telescopes with its Wide-Field Infrared Survey Telescope (WFIRST) mission, the agency is also moving spacecraft structural technology into a new realm – that of advanced composites. Structures of existing spacecraft almost exclusively employ lightweight metals. But the intricate design of some WFIRST components make traditional materials cost-prohibitive, due both to the challenge of forming metal to these shapes and the mass that would be required of metals like aluminum to meet structural demands.

"The strength-to-weight ratio of advanced composites was key," notes Russell Rowles, advanced composite process specialist for the WFIRST mission. "But additionally for us, harmonic resonance is also a large driver. The design required a natural frequency of more than 50 hz."

Having established the need for composite components, WFIRST product development lead Pat Jordan reached out to NASA's Advanced Manufacturing Branch, and in particular to Rowles. With composites technology having advanced into critical structures in aerospace, automotive and other sectors, NASA Goddard benefited from cutting-edge technology transfer. This transfer included the LASERGUIDE system from Aligned Vision.

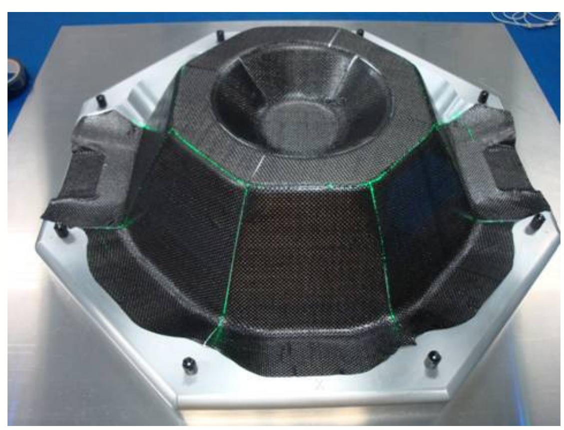

Figure 1: LASERGUIDE projecting layup instructions on the element wheel.

THE WFIRST MISSION

WFIRST is a space-based observatory that will gather data on exoplanets and dark energy. It will also conduct galactic and extragalactic surveys. WFIRST payload includes a wide-field multi-filter near-infrared imager and spectrometer; a 2.4 m telescope; and a coronagraph that will enable direct imaging of ice and gas giant exoplanets. This instrumentation is expected to provide imaging of equal quality to the Hubble telescope, but with a view range 100 times larger than Hubble's.

The "element wheel" represents the first structural component to undergo pre-program development for the WFIRST mission. This tapered octagonal component has a cross-section at its widest point of approximately 20 inches, and it is about 7 inches tall. Its 3/16-inch thick walls consist of 16 to 24 plies of Cytec square-weave carbon/epoxy prepreg, and its overall weight is 1.6 lb.

The first step for the NASA Goddard team was to develop experimental design models of the element wheel, which houses all WFIRST optics. Prototypes that the team builds from the design undergo environmental testing to assess whether the element wheel meets all requirements for the actual program. The design is developmental, and it was modified substantially between the first two prototype builds.

NASA Goddard built the first prototype without the aid of laser templating. "You really don't have a starting point without a laser," Jordan notes. "It was difficult to do, working with just coordinates."

"This approach took some artistry," Rowles recalls. The team utilized paper templates that they visually aligned. "We developed a 'feel' for where the patterns should go, and then we did some hand trimming as needed." Such trimming allowed the team to create a close facsimile; but of course, each trim compromised the precision with which the as-built part matched the design.

After this first build, Rowles raised the question whether investing in a laser projection system would make sense for NASA Goddard, both financially and in terms of quality, as the WFIRST mission progressed toward a full build of all of the composite components. "This kind of 3D projection had been in the back of our minds," he says, "but prior to WFIRST, we had no current need for the technology."

ENTER ASSEMBLY GUIDANCE

NASA Goddard's interest in exploring laser templating fortuitously arose just as the SAMPE Baltimore event was going to take place. This trade show's proximity to NASA Goddard allowed team members to "see some real-life applications right in our own backyard," Rowles says. The NASA Goddard team spoke to the two laser guidance system providers at the show, and both the expertise and customer service demonstrated by Assembly Guidance staff members won them over.

"Assembly Guidance's customer service was A1," Rowles reports. "We walked up with a notion and they followed through 100 percent. We don't typically get that! All of the company's techs knew their product and were able to accomplish exactly what we asked for."

After providing in-depth answers about LASERGUIDE to all of the NASA Goddard team's questions, Assembly Guidance staff members worked out a rental agreement and schedule to give NASA Goddard an opportunity to try out the technology.

Along with the rented system, Assembly Guidance sent an application engineer to help with installation and training. Just one day was required to install the system and train NASA personnel sufficiently to build the second element wheel prototype. Because LASERGUIDE accepts data directly from Fibersim™ (Siemens PLM, Plano, Texas), integration time was also minimal. "No special modules were needed to create 2D patterns from the 3D modeling data," Jordan says.

LASERGUIDE BENEFITS

The procedure with LASERGUIDE was significantly more exact and straightforward than the procedure for the first prototype. "We simply followed the patterns laid out by the analyst and engineer," Jordan says. Rowles adds that the biggest benefit of LASERGUIDE was "making the part that we analyzed. I would judge the use of the projector to have given us a 100 percent improvement in ply placement accuracy."

Key among additional benefits is time savings. Although worker hours were not precisely tracked, and the design was modified between the first and second prototype, Rowles estimates a 50 percent improvement in production efficiency. The elimination of hand trimming was a significant factor in this improvement.

Figure 2: LASERGUIDE projector

Another contributing factor to the reduced production time is Assembly Guidance's exclusive Android remote system. This device runs an Android app that enables the operator to perform all required laser tasks right at the tool. Locating and scanning targets, cycling through the ply list, selecting multiple plies for projection, isolating specific areas of a projection – all can be performed without walking away from the tool to interact with the control PC. The remote also relays information such as target names and ply names, and it has the option of displaying electronic work instructions so that operators are well informed of where they are in the work process and what the next step is. This exclusive technology eliminates production time each time a remoteless system would require a trip to the controller. "We found this feature to be very user friendly, as comfortable as using a cell phone," Jordan says. "It was one of the things that sold us on the LASERGUIDE system."

Another valuable advantage of a LASERGUIDE-built component is the potential to reduce knockdown factors, possibly reducing plies and therefore costs. "We gain greater assurance of the analysis," Rowles says, "because we know that the as-built part will match the design to a high degree of precision." He also notes that the design/analysis phase may involve fewer iterations because of greater confidence in the build.

A FIRST OF MANY?

Assembly Guidance has delivered systems to other NASA sites, and a previous NASA Goddard mission utilized the APV (Automatic Ply Verification) technology. The goal of the APV project was to capture all of the fiber orientations on an as-built part and feed that information back to the computer model to analyze the differences between predicted and actual performance.

But the WFIRST project has been the first at NASA Goddard to employ a LASERGUIDE system for the full build. Based on the success of the first component built with LASERGUIDE, a second WFIRST component will be built with LASERGUIDE as well.

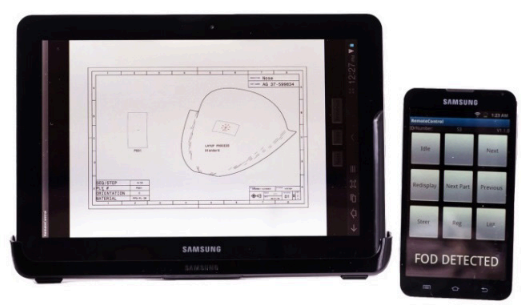

Figure 3: Android remotes for LASERGUIDE

"When integrating a new technology into a process, it is sometimes hard to justify the startup cost for us, as we are mostly a one-off prototype lab," Rowles notes. "But in this instance, with the outstanding customer support and responsiveness of the Assembly Guidance team, we were able to be up and confidently running within a day."

Conversely, coming to the aid of NASA and its pioneering missions has been a rewarding undertaking for Assembly Guidance.