Case Study C-CAT - Kennedale
Prototyping Eliminates Tooling, Nets Millions in Savings
Metrology-assisted assembly harnesses costs in building carbon-carbon aerospace components

By Belinda Jones

Building complex prototypes can often grind a budget and timeline into mincemeat. With declining funds for space programs and tight budgets in the aerospace industry, every dollar spent is vital...every dollar saved is survival. Serving those industries, Carbon-Carbon Advanced Technologies, INC (C-CAT) has taken steps to drive new efficiencies into longstanding practices. And their resourcefulness has yielded big rewards and quality products.

In 2006, C-CAT expanded and relocated to a new headquarters in Kennedale, Texas near Forth Worth. Their state-of-the-art facility has oxidation protected carbon-carbon component manufacturing capabilities, including composite curing equipment, pyrolysis and densification equipment, a machine shop for tooling and components, coating furnaces, and a variety of ovens and test furnaces, and quality control inspection equipment. Current on-stream equipment is sized to process a 5 ft. x 10 ft. (1.5 x 3.1m) panel or 70 inch (1.8m) diameter nozzle through coating.

What is Carbon-Carbon?
Carbon-carbon or C/C is a composite material comprised of carbon fiber reinforcement in a matrix of graphite. C/C has gained a space-worthy reputation due to its high temperature resistance withstanding temperatures from 3,200 to 4,000 degrees Fahrenheit (1760 – 2204°C). And the material becomes stronger as it gets hotter. Components constructed from C/C will hold their shape and remain relatively sound under serious duress. Industry insiders say if the Space Shuttle was being built today, the lower half of the wing skins and panels would more than likely be constructed of carbon-carbon, as the structure would be substantially lighter and much less complex.

After early generations, C-CAT began to formulate an advanced grade of the material with the intent to use it for more complex structures than in the nose cap of the Shuttle. Now carbon-carbon is being used throughout an entire vehicle. For example, a quick glance at current generation reusable hot structure space-related programs reveals the flight controls are fully C/C instead of the outdated aluminum-and-tile shuttle structure.

Quality Moves
Raj Narayanan, quality assurance representative, arrived at C-CAT in 2003 to help move prototype programs toward flight qualifications and readiness. With a healthy background in both aviation safety engineering and quality engineering, Narayanan was ready to leverage his experience in the repair, overhaul and maintenance side of the aerospace business to deal with the new level of quality and certification requirements for C-CAT.

The evolution of small carbon-carbon components into much larger structures was unfolding at C-CAT. When the company began to work on hardware related to NASA/DARPA/U.S. Air Force projects and flight critical applications for space vehicle deployment, overall specifications for C-CAT became more stringent. Narayanan and his team focused on building quality system requirements, as well as inspection and certification capabilities into manufacturing and assembly processes.
The company employs the use of laser tracking in several ways. First, the portable CMM is used as a true, traditional inspection tool to measure part width, thickness, features and more. But most importantly, during the build process of a significant complex structure such as a large scale aerostructure, the laser tracker is used in lieu of having expensive complex tooling.

"When building an aircraft or a component in the past, there were hundreds of jigs and fixtures used to hold components in place, as well as molds and tools to hold inside features, ribs and more. At that time, we were using standard metrology equipment such as height gauges, and fixtures to align those parts. During the early prototyping phases of a program, no one could calculate the number of on-the-fly changes that would be made during product development. Each change can impact how many fixtures or jigs that would be needed. And that would, of course, impact the bottom line," states Narayanan.

Today, C-CAT takes a much different approach to assembly using the laser tracker literally as a live alignment “fixture” tool. Aircraft parts and different sections of the aircraft are scanned, then assembled systematically using a laser tracking system. The 3D data acquired from the device is then compared to the 3D CAD model of part. The steps are straightforward. Take a set of data points, import them into the inspection software, build the assembly, import a CATIA model into the software, and compare the data.

When building a Carbon-Carbon aeroshell comprised of 40 or 50 pieces, C-CAT’s in-house metrologists will take reference points off the internal parts and align the external components to them prior to the bonding process. Because it is a C/C composite structure, all parts will be bonded together. The portable CMM is used to precisely align where these parts should be in 3D space, as opposed to having a complex fixture.

Reality Check
For C-CAT, there are two realities of space vehicle development. One is the very low production realm of constructing prototypes and one or two flight critical vehicles. The cost to build multiple sets of tooling can be very high. The second reality is time. C-CAT is under the gun to rapid prototype these components in the later part of this demonstration technology for building and alignment components in the later part of this system. For the carbon-carbon hot structure reusability program, C-CAT rolled out the laser trackers for final inspection and provided coordinate data to its end customer, so they could align the C-CAT structure with their own structure and determine proximity to the target tolerances. Narayanan explains, “Everything boils down to interface control drawings. The laser trackers tell us whether we are in the ICD envelope or not, and where the deviations are. We use trackers for build at the start, and verification at the end.”

Feeling the Potential
With C/C moving into the mainstream as a material for space vehicles and beyond, C-CAT has carved out a strategic niche for its expertise and capacity. Successfully driving out antiquated practices and introducing new efficiencies into their production model, the company has gained a unique insight into the benefits of metrology-assisted assembly, which arguably has made the biggest bang of all.
Whether building the fastest car, the biggest plane, or the most precise tooling, you need exact measurements to improve quality and productivity. So when it has to be right, professionals trust Leica Geosystems Metrology to help collect, analyze, and present 3-dimensional (3D) data for industrial measurement.

Leica Geosystems Metrology is best known for its broad array of control and industrial measurement products including laser trackers, Local Positioning Technology (LPT) based systems, hand-held scanners, 3D software and high-precision total stations. Those who use Leica Metrology products every day trust them for their dependability, the value they deliver, and the world-class service & support that’s second to none.

Precision, reliability and service from Leica Geosystems Metrology.

**Leica Geosystems**  
Metrology Products  
Moenchmattweg 5  
CH-5035 Unterentfelden  
Switzerland  
Phone +41 62 737 67 67  
Fax +41 62 737 68 68

[www.leica-geosystems.com/metrology](http://www.leica-geosystems.com/metrology)  
[www.hexagonmetrology.com](http://www.hexagonmetrology.com)

© 2011 Hexagon Metrology – Part of Hexagon Group  
All rights reserved.