Taking carbon fibre to new heights

Huge contract: Spirit's A350 XWB work represents a big opportunity for the company

The new generation of long range aircraft from Airbus and Boeing both represent a multitude of 'firsts' for the use of carbon fibre in critical structures, and in doing so have necessitated wholesale changes in the ways these components are produced. Simon Lott reports.

The A350 XWB programme has become a highly valuable business opportunity for Kansas-based Spirit AeroSystems. Now responsible for producing fuselage section 15, front wing spars, the fixed leading edge and stringers for the aircraft, it is set to take delivery of a range of equipment from Spanish machine manufacturer MTorres as production becomes a reality.

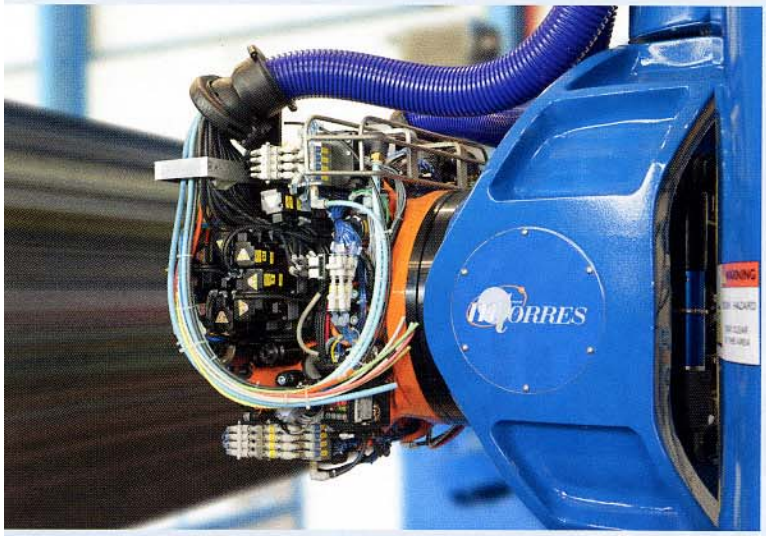
MTorres has been a key enabler in reaching the productivity required of these new methods with its carbon fibre laying technologies, with the most substantial order so far being the provision of seven machines to Spirit's new 500,000ft² facility in Kinston, North Carolina, which is due to open in the third quarter of 2010.

The most complex of the machinery being delivered will be two advanced automated fibre placement systems (TORRESFIBERLAYUP) for the production of front spar components to shape, marking the first time such components have been constructed from carbon fibre on a large aircraft. Along with orders from Kawasaki Heavy Industries and GKN Aerospace, these are part of a new breed of fibre placement solutions. Designed to accommodate greater flexibility and productivity over gantry – or column-type machines, the machines offer claimed lay-up rates of 60m/min, an order of magnitude larger than previously possible and crucially, making the process economically viable. The assembly of each machine is a substantial project in itself and given the long term nature of the end products, both those being provided to Spirit have been built especially for the production of spar components. A third cantilever-type fibre placement machine for 2D construction of stringers with the focus on high speed lamination is also being supplied.

Along the process chain, MTorres is supplying two TORRESMILL routers for the drilling and milling of wing spars and fuselage skins. The first is a 5-axis gantry system with high speed 30,000rpm spindle and will be supplied with the highly flexible TORRESTOOL system, designed for products with complex or varying geometries. The second will be utilised on the processing of fuselage skin panels up to 20m long, requiring only hard tooling.

For inspection, a 15m long and 2m wide gantry-style TORRESSONIC ultrasonic inspection machine will be used to examine completed front spars at the Spirit facility. In this case, MTorres provides the framework to which a commercially available Kuka robot is installed. The end effector and electronics are provided by MTorres' technology partner, Tecnatom. A further set of two, 5m tall column-type machines, comprising of two separate scanning arrays, will be devoted to the simultaneous outer and inner mould line scanning of fuselage skin panels, which can be up to 20m in length.

It is however the huge fibre placement machines which really



Finer control: The Spirit and GKN FIBERLAYUP machines are both configured for consistent deposition over tight radii

define the programme. Along with GKN Aerospace, which will produce rear wing spars for the A350 using the same kind of technology and equipment, spar components represent an altogether different type of configuration to MTorres' first ever machine of this type, delivered to Kawasaki Heavy Industries and now undergoing testing prior to production of monolithic fuselage sections for Boeing's 787 programme.

The defining feature of the front spars in terms of the machine's set-up is the sharp 'U-shaped' angle on the component's edges. The machine provided to Kawasaki, configured for the gradual curvature of the fuselage section, is able to lay 0.5 inches material from 24 tows. By contrast, the tight radii of the spar components mean that 16 tows of 0.25 inches are more appropriate. Although this narrower bandwidth means a reduced production rate, it ensures there is no compromise in structural integrity.

Sales director, Juan Solano explains further: "These corners are where most of the effort is put in terms of mechanical, electrical, software, control, programming, every area, to maximise the performance of the machine when laying those parts. Since we ran the first trial on a small scale spar a couple of years ago we knew they were going to be critical points. Running a 45° tape over a 90° corner requires a lot of attention and we have to look at a lot of different parameters."

The size of the spar components also means that the headstock and tailstocks have changed. Although, in the case of Kawasaki, it is possible for the machines to take an Invar mandrel weighing up to 90 tonnes, the maximum loading required of the spar components is only around 15 tonnes. Despite this, these machines are still capable of taking components up to 15m in length as those being provided to Spirit will eventually produce all three front spar sections.

Another consideration has been a need to adapt to the differing materials used by different projects. A trend in the industry for both the latest Airbus and Boeing aircraft is that due to the properties of the resins involved, performance parameters are getting tighter.

Solano continues: "When we first started working towards the 787 programme, the material Boeing was using was very low tack and it took some time to work out the necessary adjustments. You need to reconsider speeds, pressures and temperatures in order to get the resins to the necessary level of tack and with Airbus we're in the same boat. From an MTorres point of view we need to build equipment for all kinds of programme, so we have to give the machines the flexibility to run a very wide range of materials."

Both the Toray Torayca 3900-series epoxy prepreg used on the majority of 787 components and the Hexcel Hexply M21 material selected by Airbus for A350 parts - such as spars and stringers – offer the best proven structural solution after curing (as far as the OEMs are concerned), but are defined by their lower resin viscosity. This makes automating the lay-up process more challenging, as only under greater temperatures and increased compaction are they able to perform as they need to.

Installation and debugging of the first FIBRELAYUP at Spirit is expected to be completed by March, with the second unit following one to two months later. They will then undergo customer and certification testing, which should take around six months. Solano concludes: "With a machine this complex, you are always learning; it's a very didactic process. The real feedback however will come over the next few months as customers begin to go into production." The rest of the equipment will also be installed and prepared for Spirit's Kinston facility during this time to meet its proposed autumn launch, and the A350 programme's move into production. |

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GKN's inner rear spar demonstrator: One of the components that will be produced using MTorres machinery