■ Composite production with CAD/CAM

Controlled, Stable Processes

The composite manufacture of aircraft parts requires an integrated, tailored process chain. The CNC functionality of the Sinumerik 840D guarantees controlled, stable processes.

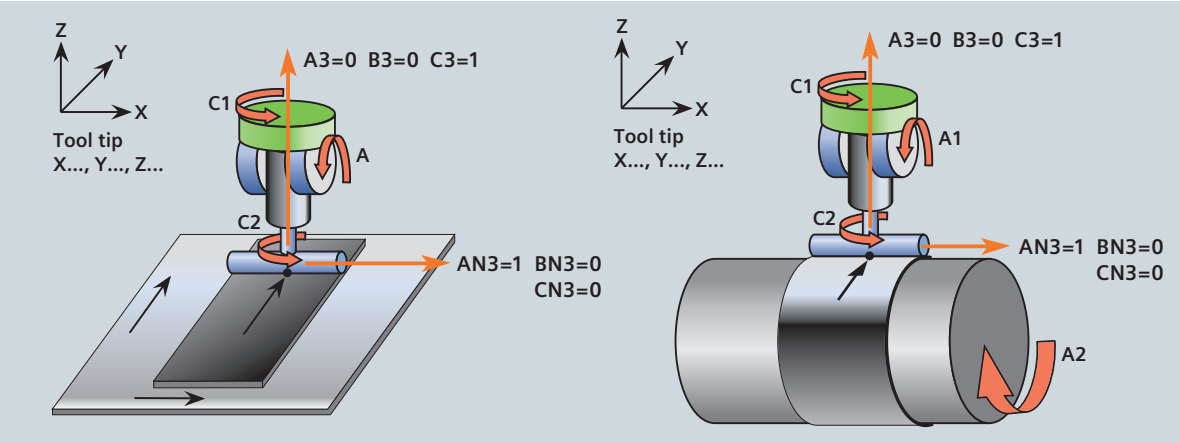
The aerospace industry increasingly uses carbon fiber-based composite materials for wings, tail assemblies and fuselage segments. Tape laying and fiber placement have now become key technologies in aircraft construction. In the case of tape laying, 70- to 200-millimeter-wide tapes made from carbon fibers and composite resin are placed layer-by-layer on a flat support and are then cut off parallel to the edges of the workpiece. Where edges are complex, pre-cut tape segments are used, which requires the tape to be positioned precisely.

The fiber orientation of the tape must, where possible, conform precisely to the direction of the point tension that will occur in the material during flight. For this reason, the tape must be applied without any tension or folds, and with precisely defined pressure. As a result, instead of wider tapes, components with complex curved surfaces, for example the segments of the aircraft fuselage, have several very narrow tows placed on the mandrel with fiber placement machines.

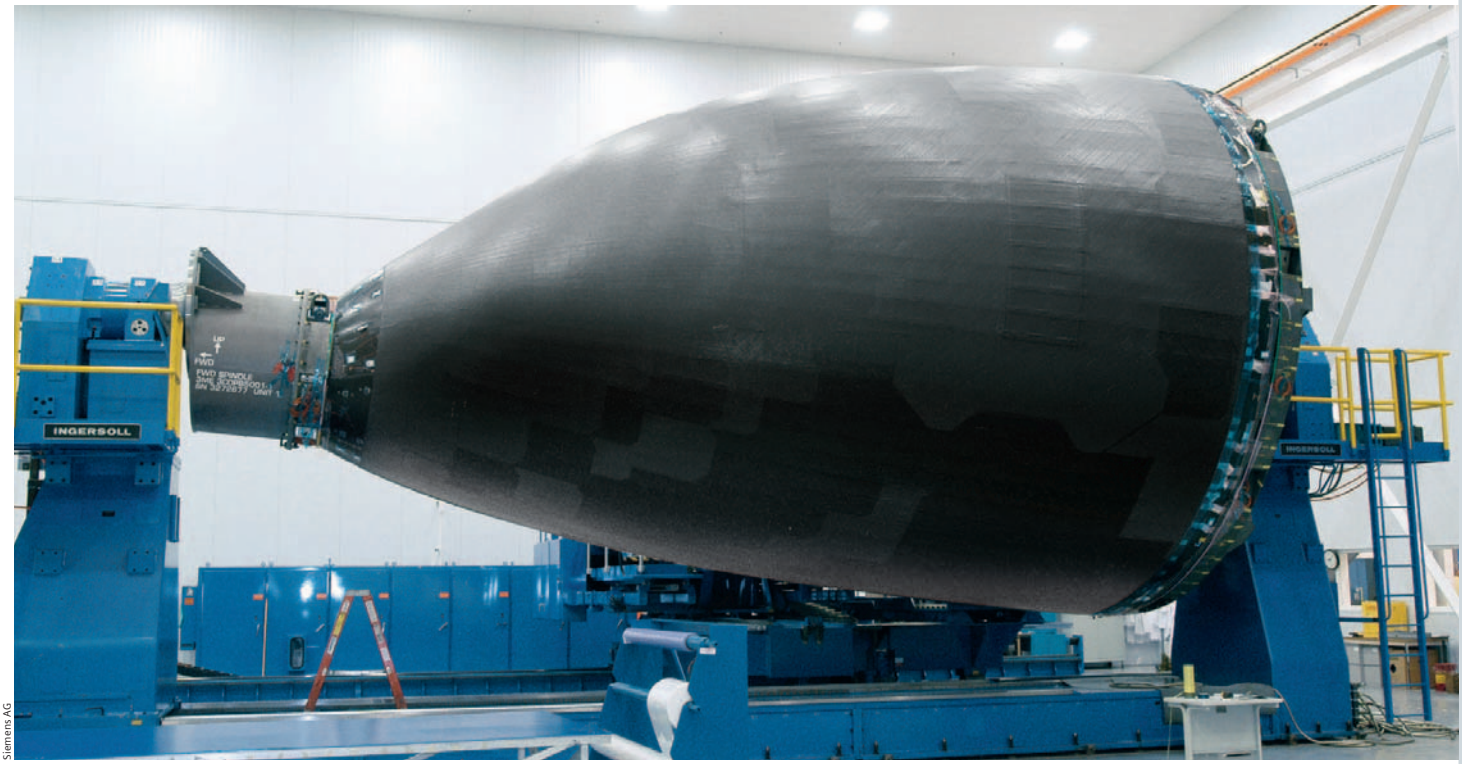
To achieve the maximum strength and load capacity of the aircraft component, the tape layers must be applied to each other so that they adhere across the whole surface, without any air or dust entering. Therefore, the quality requirements for placement are uncompromisingly high. To prove the quality and safety, each composite component is subjected to an extensive, area-wide and nondestructive material test. If delamination is detected during this test, the entire part is normally rejected, which means a considerable amount of time and material is lost in the case of large-scale aircraft components. The economic and timely manufacture of wings and fuselage parts made from composite materials requires the reliable control of tape laying and fiber placement quality, as well as new solutions for drilling, cutting and trimming.

High-performance CNC functions ...

Different requirements are placed on the CNC for the building processes of tape laying and fiber placement, compared with cutting applications. To coordinate cutting control and motion control in the best possible way for fiber placement, the Sinumerik 840D offers synchronizing functions controlled according



Part programs that are programmed in workpiece coordinates are advantageous for process security. This is enabled by CNC transformation functions



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As carbon-fiber tapes are almost completely non-elastic, they must be built up in two-dimensional curved shapes from narrow carbon-fiber strips

to actual positions, which synchronize the switch actions of the user or parts program with the motion control and position control. As a result, all the cuts "sit" precisely in their target positions, even at high laying speeds, which produces very clean laying edges.

High-performance transformation functions are also integrated in the Sinumerik 840D, which make it possible for workpiece coordinates to be programmed in. This makes the part programs, in principle, independent from the machine kinematics and also improves clarity and the maintainability of the part programs. Even if an accurate axis-parallel mounting of the mold is not possible due to the size and weight of the mandrel, high-performance transformation functions guarantee the synchronous programming of the laying head movements and of the mandrel, as well as the appropriate alignment of the laying roller. It is necessary for it to be designed for genuine five-axis operation or, as in the case of fiber placement, for at least six or seven synchronous axes.

... and cycles for high quality

In addition, the Sinumerik 840D supports composite material production with special cycles for composite drilling and other lightweight construction materials, for laser and waterjet cutting and for many other operations. High-performance open interfaces enable seamless logging of the actual values for all the process-relevant parameters and machine data for quality assessment. Again here, programming in workpiece coordinates is a key factor, in order to utilize the results of an automated material test with very little effort, or even automatically, for process optimization.

Realistic process simulation

In order to be able to precisely simulate the time-consuming production of large and complex aircraft components, not just geometrically, but also technologically – including all process-relevant machine properties – the Sinumerik 840D has a virtual NC kernel (VNCK). The real-time control software can be run on the Windows platform without any CNC hardware and enables a realistic simulation of all the CNC functions as a plug-in to conventional simulation systems. The production machine's data are also applied here. This means that the use of the simulation is no longer restricted just to the pure test of the part programs generated in the CAD/CAM system, but also enables an optimization of both the part program and of major process parameters.

Controlled stable processes, which lead to perfect results, are an essential pre-requisite in economic aircraft construction with a high proportion of composites. That's why well-known system partners in the aerospace industry prefer to rely on Sinumerik-based machine automation solutions. ■

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