MATERIAL MACHINE

Custom machine adds vertical production to vertical lift

BY MELISSA BOBAN, BOEING WRITER
ALL PHOTOS BY FRED TROILO

Inside the Boeing Composite Center in Philadelphia stands a single automated tape layup (ATL) machine, developed by Boeing engineers especially for rotor blade production.

Just months into its life span, the ATL machine envisioned a decade ago by Boeing engineer Steve Cullison is creating huge efficiencies.

“The last machine of this kind was built in 2003, and it went through phases of layup, quality and maintenance issues,” said Cullison. “About four years ago, we began to understand how to better use new technologies through a new ATL machine that would offer tremendous improvements in quality and throughput.”

BLADE MAKER
Engineers Hans Mehling, left, and Steve Cullison check the settings of the ATL machine. Developed over the past several years, the one-of-a-kind machine fabricates rotor blade components for the H-47 Chinook more efficiently.

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TAPING TECHNIQUE

Composite fabricator Matt Haldeman inspects a section of tape that will become part of the inner structure of a rotor blade.

Plying it on

Boeing teammates use the ATL machine to fabricate uniform rotor blades for the H-47 Chinook. The heavy-lift helicopter, operated by the U.S. Army and defense forces of 20 other nations, is known for its ability to adapt to rugged terrain. The H-47 Chinook can fly up to 20,000 feet (6.1 kilometers) and haul over 27,000 pounds (12.2 metric tons). To do that, the helicopter relies on its powerful rotor blades.

To create the internal structural components of a rotor blade, the ATL machine layers ply packs, or plies, on top of one another, then slits each stack-up to create multiple parts. Operators used to trim each ply layer by hand to ensure standard conformance.

Cullison proposed a concept for a rotating head for the machine that allows bidirectional tape layup, layering the plies both horizontally and vertically. Switching to vertical tape layup offers three benefits — greater layup and trimming accuracy, improved material quality and less weight variability in final assembly.

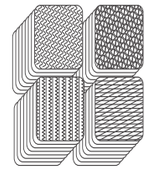
Saving four production hours per blade and cutting almost three hours of manual labor per blade, teammates can devote more time to collecting production data and improving production quality. They are also scrapping fewer parts and reducing waste along the way.

Automation advancements

The composite manufacturing industry at large was a source of ideas for Cullison as he developed requirements for the new ATL machine.

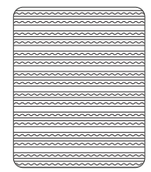
“Insights from an enterprisewide automation project, site visits and technical conferences helped me understand how to implement newer technologies into our production system,” Cullison said.

For example, he discovered that configuring horizontal vacuum tables vertically helped to better manage film releases and parts handling. Suction constrains the release film and supports the laid up parts, easing the manufacturing process.



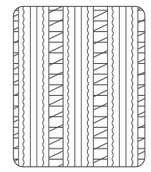
PLY PACKS

Each ply stack-up, or ply pack, varies. Up to 19 different ply pack designs contribute to the blade’s strength and durability.



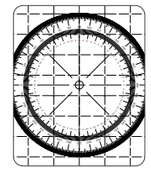
LAYERED LOOK

Over 100 layers of composite resin glass fibers create a candylike pattern in the tape. A cure cycle softens the material, then hardens it, before moving to the next stage of production.



TACKY TAPE

The composite material is known as pre-impregnated tape, referring to its ability to adhere with other layers. More tacky than sticky, the material is coated in resin and epoxy, and the tacky glass fibers solidify when cured.



LASER RULER

Lasers measure the thickness of the rotor blade components, which are about 30 feet (9 meters) long, or about the length of a school bus.

IDEAS TO IDEALS

Engineering manager Peggy Castaneda routinely visits the production area to check the ATL machine's performance, collect production data and discuss ideas for improvements with the team.

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> **PEGGY CASTANEDA, ENGINEERING MANAGER**

Bumpy to smooth

Cullison and his teammates navigated many challenges on the road to smooth production, and their persistence paid off.

“You can’t buy this type of machine off the shelf, and you don’t know what you’re dealing with until you cross the bridge,” said engineering manager Peggy Castaneda.

In hours of trial and error, the team stayed motivated, pushing through doubts to find new solutions in additive manufacturing or through spool tension optimization. When the challenges piled on, the solutions flowed, and now the final result is in use on the floor.

“Anytime we innovate our processes, the technical challenges come with it, so it’s not a smooth journey,” Castaneda said. “Talented engineers find a way to make things work. They overcame many challenges and worked together to implement this equipment. To make it work is huge.”

LAYER BY LAYER

Quality inspector Drew Lowry watches the tape layup process as the ATL machine does its work.

What’s next?

After using the new ATL machine for about a year, Cullison and his teammates are collecting data to assess the machine’s reliability and sustainability. As they continue evaluating their fabrication processes, they are considering other uses for the machine and looking to further enhance its efficiency. For example, they are studying ways to reduce the number of material spool changes.

“Every bit of time saved frees up capacity to increase production, and each improvement ultimately leads to a better aircraft,” Cullison said. “We’re always looking into technologies to improve processes, increase efficiency, and improve the safety and quality of our products.” **IQ**

LOADS BETTER

Haldeman starts the fabrication process by loading a short section of tape into the ATL machine. The new machine’s design reduces time spent loading tape.