At Boeing's 777X wing factory, robots get big jobs

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As the first 110-footlong wing skin panel for Boeing's new 777X jet moved slowly across a mammoth new factory building one recent morning, a small crew walked alongside, watching for any possibility of an expensive collision.

The "spotters" escorted the panel's bright-orange transport platform as it followed invisible tracks embedded in the concrete floor and slid with a tight fit into the big cylindrical autoclave where the part would bake to hardness.

Until the automated system for moving these big wing parts is proved, "we do have four people watching it," said Darrell Chic, acting director of 777X wing fabrication. "But the intent is to work our way to autonomous and allow the navigation system to do its thing."

Autonomous. Not needing any humans to guide it.

The 777X Composite Wing Center in the Seattle-area city of Everett, Boeing's latest venture in advanced manufacturing, marks a significant step toward a future in which much of an aircraft factory's work is done by automated machines and robots.

Once the wing skin was inside the giant pressurized oven, the lone operator at a computer station pushed a button. Lights flashed, a klaxon sounded.

Slowly, a 55-ton, 28-foot-wide circular door slid into place and locked to form an airtight seal for the seven-hour baking cycle.

Eric Lindblad, the newly appointed head of the 777X program, said having machines load the wing parts autonomously is safer and more precise. There isn't room for error inside the oven: When the long stiffening rods called stringers are baked in the autoclave, they'll go in six at a time with just 3 inches of clearance between them.

The only necessary human will be the person at the computer.

"There'll be one guy that essentially runs this station," Lindblad said.

The trend toward automated manufacturing was evident already at Boeing's older area plants.

In Frederickson, robots drill 80 percent of the holes in the 787 and 777 tails fabricated there.

In Auburn, robots drill the engine heat shields for the 787 and 777 jets, and will do the same for the 737 MAX. Another robot uses lasers to clean the dies used to shape the heat shields.

In its most productive factory, the 737 final-assembly plant in Renton, Boeing has replaced the traditional multistory fixtures used to hold wings in place during assembly with smaller, flexible, increasingly automated equipment as it ramps up toward an unprecedented output of 52 planes per month by 2018.

Introducing new automation is a challenge: In another new building in Everett, Boeing is struggling to smooth out the kinks in a robotic system for assembling the 777's metal fuselage.

Still, a new generation of airplanes like the 787 and 777X built with carbon-fiber-reinforced plastic composite structures have triggered a transformative shift taking automation to a new level.

Fabricating complete fuselage barrels or huge wings out of this material is simply not possible by hand. Only robots can lay up the strips of carbon fiber with enough speed and precision.

Mark Summers, head of technology at the U.K. government's Aerospace Technology Institute, said increasing automation will allow Boeing and Airbus to ratchet up production rates without adding employees.

"Jobs will not be lost, but there will not be so many new jobs created," Summers said during a panel discussion at the Farnborough Air Show in England in July. "I don't see it as an impact on the current aerospace workforce. There's just fewer jobs in aerospace in the future."

He foresees blue-collar machinist jobs increasingly supplanted by "more technologically focused" positions operating the machines.

However wary machinists may be of what the new technology means for the future, Pete Goldsmith, who led automation-technology projects at Seattle-area companies Electroimpact and Nova-Tech, and now works for a third, MTorres America, said he got "a universally positive reaction" from mechanics at both Airbus and Boeing when he installed equipment to do repetitive riveting.

"That's a job that beats you up all day every day," Goldsmith said. "We were replacing an operation that was physically very debilitating for the mechanics."

Gary Laws, a Boeing mechanic for more than two decades who operates computer-controlled machines assembling wings in Renton, said

automation makes his job much easier.

And if this region wants new work in aerospace, he sees no choice but to embrace the shift.

"It's the way it has to be," said Laws. "Technology is obviously going to be the future."

Today, the current 777's metal wing parts are made largely by machinists in Auburn and Frederickson, then assembled into a wing by machinists in Everett.

Though Boeing doesn't provide a detailed breakdown of employment figures, this work certainly provides hundreds of jobs.

With the new 777X, that work changes dramatically. But it does stay in the area.

Boeing is spending $1 billion to make the giant 777X carbon fiber wing in-house, rather than outsourcing the wing to Mitsubishi, as it did on the 787.

Lindblad said that after a production ramp-up that will take a few years, the new wing center will, at peak, employ somewhere between 600 and 900 people.

The first production 777X parts that will fly on an airplane won't be made before April. Until then, workers in the wing center are making test parts, used to certify and fine-tune the new manufacturing process.

With wing skin No. 1 in the autoclave over on the fabrication side of the wing center, Jerry Schultz operated an Electroimpact machine making wing skin No. 2.

White lab coats are required in this "clean room" environment, where an overhead robot like a giant tape dispenser zips back and forth along a 110-footlong mold, building up the skin panel layer by layer.

As the robottraverses the part at various angles, it lays down plies of epoxy resin-infused carbon fiber in about 300 separately programmed runs.

Between setup, inspections and the robot work, completing a wing skin this way takes six shifts over three days.

The goal is to have just two people operating the cell, Boeing said, with possibly another worker floating between it and an adjacent cell also making wing skins.

Nearby, similar big Electroimpact machines are making the first 777X spars - the long, U-shaped, single-piece beams to which the leading and trailing edges of each wing attach.

Again, just three people will operate a pair of these spar manufacturing cells, says Boeing. The spars will then be inspected by robots that use an ultrasonic probe to check for invisible flaws in the material.

An exception to the full automation is the way Boeing is producing four of the 43 stringers, the rods that stiffen each 777X wing. These four are partly made by hand because of their more complex shape.

A half-dozen workers - five of them women, who are often preferred by manufacturers for jobs that require meticulous handwork - stood on each side of a long, thin stringer tool, positioning 4-foot-long ribbons of uncured, textilelike carbon fiber.

When they'd lain out each piece of fabric by hand, an overhead machine

swung over and pressed down to secure it for curing.

"For this particular shape ... it turns out to be more cost-effective to do it this way," Lindblad said.

It's a mistake to think robots can do it all, said Ben Hempstead, chief of staff and lead mechanical engineer at aerospace-tooling designer Electroimpact.

After these 777X skin panels, spars and stringers are fabricated in the wing center, Boeing will deliver them to the main Everett factory building where mechanics will first assemble the pieces into a basic wing box, then add the folding wingtip and the leading- and trailing-edge control surfaces.

That assembly process is inherently more labor-intensive.

"With wing-box assembly, if in the future it's half-automated, that'll blow my mind," said Hempstead, whose company supplies Boeing and also provided much of the equipment Airbus to build the composite wing of the A350.

"Many of the steps require skill and judgment and are very hard to automate," he said.

Hempstead said Boeing asked Electroimpact to look at automating one specific 737 wing process in Renton that's done today by about a dozen mechanics.

"We couldn't figure out how to do it faster with machines," Hempstead said.

And don't even think about robots doing intricate jobs like installing

hydraulic tubes and electrical wiring in the crowded space of an airplane wheel well.

"Oh, man, nobody has even talked about automating that," Hempstead said. "I can't even envision how you'd do it."

After World War II, Boeing gave Washington state a thriving middle class, allowing blue-collar workers - some with only a high-school education - to live the American dream.

As robots revolutionize the industry, the region has become a hotbed of leading aerospace-automation firms - including Electroimpact, Nova-Tech and MTorres America as well as Janicki Industries - that are hiring young engineers as fast as they can.

But is a golden age of manual labor ending with Boeing's automation drive?

In 2005, almost 3,500 machinists in Renton produced 21 single-aisle 737s per month, according to employment data filed with the state.

In 2014, just over 6,000 machinists there produced exactly twice as many.

While production rose 100 percent, employment of machinists rose 75 percent.

As robotic systems and the automated processing of carbon fiber proliferates, that gap is certain to widen.

While Boeing employed more than 100,000 in Washington state in the late 1990s, it seems unlikely those days are ever coming back. Its payroll here is down to about 73,000 today.

Yet that's still a big workforce, crucially important to the economy. And well-paid manual jobs remain a vital thread in the social fabric of the state.

"We can't all be baristas and software engineers," said Electroimpact's Hempstead.

At the industry discussion of automation in Farnborough, Craig Turnbull, director of engineering at Electroimpact U.K. who oversees the company's work at the Airbus wing plant in Broughton, Wales, emphasized that "there is a point where man and machine have to meet."

Even in a highly robotized auto plant, he said, the car radio is installed by a mechanic. It's too difficult for a robot.

And when it comes to hiring an operator for this new equipment, he suggested looking to machinists.

"The best person to operate a machine that drills holes is someone who has done it for 20 years by hand," Turnbull said. "They know what they are looking for. They are then becoming more of a quality-control person than actually pushing the drill through a hole."

To prepare the next generation of factory workers for such jobs, the state is pushing STEM education (science, technology, engineering and mathematics) and providing community-college-level training for hands-on careers.

Becoming a machine operator will probably require a two-year associate degree with course work on the basics of electromechanics.

"These are some of the highest skilled and best compensated jobs in the factory," Hempstead said.

John Janicki, president of Janicki Industries, sees the drive toward more automation speeding up, "driven by the need to get the price down."

Though expensive to install, he said, robotic systems should allow plane makers to sell more jets over a production run that can last more than 20 years.

"If you amortize all the equipment over the life of the program, it's not that big a deal," Janicki said.

His firm - currently employing about 750 people in the state and expanding - still regularly hires local people straight out of high school and trains them to operate its sophisticated machines.

And he points to a big upside for the Pacific Northwest in having the 777X wing center: After investing so heavily, Boeing needs to use it to the fullest.

"It's absolute state of the art. It's not going anywhere," said Janicki. "You have all that equipment and the personnel trained to use it. It'll build 777s, yes. But 50 years from now, they'll still be building something in that plant."