BOEING'S STRUGGLE WITH 777 ASSEMBLY ROBOTS ADDS TO EVERETT PRODUCTION SNARL

News / Manufacturer

By Dominic Gates

Boeing's new robotic 777 fuselage-assembly system is gearing up very slowly, with some mishaps requiring rework. That's compounding supplier issues to cause a buildup of incomplete jobs, slamming 777 final assembly and requiring heavy overtime to keep deliveries on track.

Production of Boeing's large 777 twinjet in Everett is significantly backed up, with incomplete jobs on each aircraft forcing catch-up work, some of which is being finished only after the jets roll out onto the airfield.

Final-assembly mechanics are slammed. Scrambling to fix the mess, they've kept 777 deliveries on track only by working long overtime hours, including weekends, with just two days off a month.

What's going on? Workers blame the new 777 robotic fuselage assembly system that

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management has been ramping up.

This critical new technology, which Boeing must get right before the forthcoming 777X, automates the precise drilling and fastening together of fuselage panels for the big moneymaking jet.

Boeing executives insist the robotics — known as Fuselage Automated Upright Build, or FAUB — are not the major hang-up.

“The disruption in final assembly is not just caused by FAUB,” said Jason Clark, Boeing vice president of 777/777X operations, in an interview. “It’s not the major cause.”

Rather, the executives finger supplier issues for much of the incomplete work cascading through and choking the production system. Clark cited the nearly six-week Machinist strike at Triumph Composite Systems in Spokane that ended in late June as one source of parts shortages.

Still, he conceded the robot system is proving painful to set up. Thesystem is gearing up much more slowly than expected and has contributed to the pileup of incomplete work, he said.

“To downstream mechanics, it feels like FAUB,” Clark added. “It looks like something coming out of that shop that isn’t complete, and it’s very disruptive to their work.”

Several final-assembly mechanics said that’s indeed how it looks to them. They spoke on condition that they not be identified for fear of retribution by the company.

“FAUB is a horrible failure,” said one mechanic. “They keep forcing these unfinished, damaged airplanes on us.”

Another veteran employee said each section is coming out of FAUB with hundreds of incomplete jobs. “It’s a nightmare,” he said.

Early last month that view was reinforced when Boeing restarted the robots after pausing the system for several weeks and ran into a major mishap.

Stitching together the forward fuselage of a China Eastern 777 passenger jet, the robots scored a metal skin panel bad enough that it had to be replaced.

Clark said that was a one-off error by the machine’s human operator. It was the only skin panel damaged on the 20 fuselage sections built by FAUB so far, he said.

Once the technology is debugged and matured, he said, the new robotic systemwill be faster, more accurate and more flexible than Boeing’s traditional manufacturing method. Its adjustable tooling will be able to build the new larger 777X fuselages on the same production line now building the current 777 fuselages.

“We are changing the way we build the airplane so that we can accommodate the 777X … That’s the flexibility and gain from this,” Clark said. “It’s a little tough in the teething, but as we get through it, it will create the rewards necessary for us to compete.”

“There’s a lot of change,” Clark added. “When you have that, you’ve got a lot of disruption.”

Inside the FAUB facility

Boeing has a dwindling backlog of just 162 current 777s and it will cut back production from 8.3 jets per month now, to 7 jets per month early next year, and then down to 5.5 jets per month in

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2018 or 2019.

By then, Boeing will begin transitioning to the 777X, which has 306 orders.

Boeing chose to introduce the automated FAUB system before 777X so it can iron out all the kinks and have a smooth production flow that will reduce risk for the new airplane program.

To make the case that FAUB is progressing despite its troubles, Clark and Brad Zaback, 777 deputy vice president and general manager, invited The Seattle Times to see how the robots are deployed.

It's the first time a journalist has been allowed into the new, 325,000-square-footfacility near the even larger 777X composite wing center on the huge Everett site.

Inside, the first set of FAUB equipment is up and running. Partially assembled fuselages sit on cradles surrounded by metal frames and light tooling that detaches and pulls away from the airframe when the work is done.

Having built 777 aft fuselage sections earlier, the FAUB facility is now producing only forward fuselage sections. Once that's perfected, the plan is to do both aft and forward sections with separate sets of tools for each.

By 2018, the plan is to build new 777X fuselages on this same line.

The traditional way Boeing still makes these fuselage sections is for mechanics to drill and fasten them together manually while massive, rigid fixed tooling holds the skin panels together.

In FAUB, there is no rigid tooling. Boeing has instructed its 777 fuselage parts suppliers to drill additional holes in the incoming skin panels, frames and floor beams that can be used to line up the pieces for an exact fit.

In the first FAUB position, mechanics lever the 14 major panels into place on a cradle atop an automated guided vehicle so that these holes align. The mechanics then tack the panels together with temporary fasteners.

"When we first started, the panels didn't fit together very well," said Clark. "We had to go back in our supply chain with our engineers and change it a little bit."

Once the fuselage section is tacked into shape, it rolls over to the automation cell, where four robots apply permanent fasteners, though only to the heaviest-duty circumferential and longitudinal splices connecting the section — the more difficult work where it's necessary to insert larger rivets through thicker metal.

One pair of robots drills and fastens in unison on the upper half of the fuselage section — one inside, one outside. Another pair works down below in similar fashion.

The outside robot can insert a rivet while the inside one simultaneously flattens it at the other end to create the fastening.

Once the automated work is complete, the flexible tooling separates and the fuselage section rolls off to the next stage.

In two further positions, mechanics manually insert the remaining fasteners and brackets, including

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those in areas of limited access — such as the confined space under the flight deck.

In the new setting of the FAUB facility, mechanics find this manual work to be slow and difficult.

“It’s not easy on our folks,” said Clark, adding that any unfinished work coming out of FAUB is “a combination of the manual as well as the automation work.”

Image result for Boeing’s struggle with 777 assembly robots adds to Everett production snarl

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Baby steps

In a separate area of the FAUB building, Boeing is now setting up similar though simpler equipment to fasten together the mid-body fuselage sections, which include the center wing box and stubs of the wings.

For this section, the automation installs only two-sided fasteners — no one-piece rivets — so just an outside robot is used, while mechanics chase its work inside, manually installing collars on the fasteners.

The robots used on the mid-fuselage, designed by Mukilteo engineering firm Electroimpact, are the same ones — known as Quadbots — that Boeing uses in South Carolina to fasten the aft fuselage of the 787 Dreamliner.

In theory, the FAUB automation system is designed to handle many different fasteners, from one-piece rivets to various two-piece fasteners and bolts. The goal is that the robots will do the hardest 20 percent of the fastening in each fuselage section.

In practice, Boeing is taking small steps, slowly introducing new elements of the work that haven’t been done previously, and testing each new piece of the process as it does so.

“We are looking at the different types of rivets and we are slowly adding them in one type at a time,” Clark said. “We have not done all the automation on the forward section yet.”

“We run it very, very slow,” he said. “We don’t turn it up to 100 percent until we are absolutely confident.”

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Each time engineers complete the painstaking work of testing and debugging the software that tells the robot where the holes go, the results are encouraging, Clark said.

“The quality of the automation is very good,” he said. “That machine drills a perfect hole every single time. It installs a fastener every single time.”

He said it “takes a little more time to learn” how to close the fasteners so they fit with the required precision.

The testing and qualification of the FAUB equipment and processes for Federal Aviation Administration (FAA) certification should be completed over the next several months, he said.

Zaback, the 777 deputy vice president, described a recent example of the slow learning process.

On the first FAUB fuselage section built in August — which workers identified as a Korean Air 777 freighter jet — Boeing for the first time used automation on a particularly curved part of the skin.

But after inserting several hundred rivets, he said engineers saw that the work was not precise enough.

“We saw it and we stopped, and those rivets had to be removed,” Zaback said.

Such rework complicates and slows down the work that comes after.

Incomplete jobs cascade down

With Boeing production scheduled like clockwork and tied to expected jet deliveries, management policy dictates that incomplete jobs and rework travel ahead on the assembly lines, to be finished later — if necessary out on the field.

“No matter what, the production system moves,” Clark said. “If we’ve got traveled work, we move it.”

“By doing it this way, we contain the disruption within the walls of Boeing. We don’t threaten deliveries,” he added.

Assembly mechanics describe having to work on fuselages with multiple temporary fasteners called “clecos” — which stick out a couple of inches from the skin — so that the aircraft “look like porcupines.”

Boeing says inserting clecos is standard when dealing with traveled work and that the number of clecos on FAUB-built fuselages is not abnormal — and may be as much due to the manual work in the facility as to the robotics.

Clark said the robotics may also produce incomplete jobs not as a result of any defects but because engineers have slowed the system down as they introduce new work.

“As soon as you slow it down, you create a traveled work bubble,” he said. “It’s not a quality issue. It allows us to get through the learning with the new equipment.”

Still, he said it’s not possible that the relatively small number of FAUB fuselages sections being built — one section every other airplane for the moment — is solely to blame for the level of incomplete work that’s been traveling downstream to the 777 mechanics in the main assembly

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building.

“We’ve had issues with the IAM strike at Triumph in Spokane and notices of quality (problems) from other suppliers,” he said.

Triumph supplies ducting for passenger-cabin ventilation as well as floor panels on the 777.

As for the damage to the skin panel on the China Eastern plane, that was highly exceptional, Clark said.

After a minor change to the system’s software code, someone ran the equipment without first checking via simulation that the robots would still operate as planned.

Clark said Boeing has introduced checks in the operating process so that shouldn’t happen again.

“Is it perfect? No. It’s much harder than we expected,” Clark said. “But we are making inroads on every single line number.”

Boeing will begin to build the first 777X next year. By then, FAUB needs to be much closer to perfect.

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