

Yes, Again

After another delay, MRJ development will total 12 years

Mitsubishi Aircraft will add at least one prototype to the MRJ flight-test effort.

Mitsubishi Aircraft is holding out hope that it may beat the new schedule. Certification is due in 2019, and the company says its goal—not its commitment—is to deliver late that year. Powered by the Pratt & Whitney PW1200G engine, the MRJ will first appear in its MRJ90 version, seating 88 passengers in an all-economy cabin arrangement. The 76-seat MRJ70 is also in development, while a 100-seater, the MRJ100, is proposed.

Major suppliers for the MHI-built airframe include Parker Aerospace, UTC Aerospace Systems, Rockwell Collins, Nabtesco and Sumitomo Precision Products. Fukuhara emphasizes that the new certification problem is at

Bradley Perrett Beijing

The MRJ is the regional jet of the future. And it always will be if Mitsubishi Aircraft continues racking up development delays. After a fifth slippage, Japan's first effort to build a complete commercial jet is about 3.5 years away from programmed first delivery. That is just where it was in the second half of 2010.

Launch customer All Nippon Airways has been told to expect its first MRJ in mid-2020, two years later than previously planned. The latest delay—like the second, third and fourth—stems from challenges in achieving airworthiness certification. Slippage now totals a remarkable 6.5 years, and the complete development program 12.25 years. The obvious explanation for most of the troubles is simple: inexperience.

When a company finds that something is much harder to do than expected, moderation of ambition may seem in order. But Mitsubishi Aircraft majority owner Mitsubishi Heavy Industries (MHI) is taking an opposite view. It wants to use this hard-won experience to make a type that will follow the MRJ.

Mitsubishi Aircraft said on Jan. 23 that new certification requirements had forced it to defer first delivery. In fact, the problem was old certification requirements now finally understood.

In September 2016, more than eight years into development, engineers realized that MRJ wiring and avionics needed to be relocated. "These design changes will not affect aircraft performance, fuel consumption, or functionality of systems," Mitsubishi Aircraft and MHI say in a joint statement. Without the changes, Mitsubishi Aircraft would risk rejection of its application for a type certificate, says Yugo Fukuhara, vice president and general manager for sales and marketing.

The fleet of flight-test MRJs will have to be expanded. Production engineers are, yet again, reviewing plans for a manufacturing ramp-up. Customers are, yet again, awaiting updated delivery schedules—though some, faced with artificial limits on how regional jets may be used in the U.S., may not be very anxious.

Mitsubishi Aircraft says its customers remain supportive. Perhaps some are comforted knowing that only three of the delays are confirmed as program errors. But U.S. aviation consultant George Hamlin points out that airlines and lessors that have not yet signed for the MRJ may have little confidence in it. "Maybe one or two of the delays were not directly Mitsubishi's fault," he says. "But not everyone is going to take the trouble to parse that. They will say: 'This has happened five times. Where's the door?'"

the whole-aircraft level of design responsibility; suppliers are not at fault.

The specific issue is the resiliency of the avionics and electrics in case of extreme events such as water ingress in compartments under the floor or an explosion. Analysis indicated that wiring had to be rerouted and items in the avionics bay rearranged. Preliminary design of the changes has begun; they will go into detail design within a few months. One or more additional flight-test aircraft will incorporate the changes. The original five prototypes, four of which are flying, will retain the former configuration and so can be used to assess flight characteristics.

None of the 400 hr. in the air accumulated since the MRJ's November 2015 first flight has been invalidated, Mitsubishi Aircraft points out. This has all been company testing preliminary to certification testing under supervision of Japan's Civil Aviation Bureau. Verification work relevant to the location of the wiring and avionics, mostly thermal and electromagnetic assessment, has not begun.

The jet's structural design will not require changes. The program has completed verification of structural strength, subjecting one of its two static-test airframes to an ultimate-load test last November. The wing, carrying 150% of the maximum force expected in service, did not break. But

it will be tested until it does.

The additional flight-test aircraft will presumably be drawn from those that MHI has been building as delivery products for customers. No decision has been made on whether they will finally be delivered.

The first, perhaps only, additional prototype should be completed by the second quarter of 2018, when it will begin a new flight-testing campaign that was added to the schedule. The program's published time line shows manufacturing of flight-test aircraft continuing until the middle of 2018, apparently to allow for the possibility of making at least a second one with the new avionics and wire locations.

Mitsubishi Aircraft has provided itself a buffer in the new schedule by allowing at least six months between certification and first delivery; other manufacturers might leave as little as a few weeks. Fukuhara says the period is a little conservative. This helps to explain the hope of beating the new schedule.

The design problem appeared suddenly, and Mitsubishi Aircraft reacted quickly. On Aug. 31, 2016, the company signed a contract to begin delivering MRJs to Aerolease Aviation in 2018, possible under the schedule at the time. Within four weeks, Mitsubishi Aircraft was warning customers of

a potential delay. It noted it was still working toward certification—no longer delivery—in 2018, implying less than a year of slippage. The true impact became clear as the new engineering task was analyzed.

When development was launched in 2008, the MRJ was due for delivery in late 2013. The repeated delays have introduced new airworthiness requirements, because a newly certified commercial aircraft should conform with rules more than five years old. This is called the certification basis. The latest delay brings the MRJ's certification basis up to the state of airworthiness regulation as of 2014. But the additional requirements are minor, the company says. The rules that have forced avionics and wiring relocation predate the program launch.

The MRJ is no closer to scheduled first delivery than in 2010 because, as the years have passed, successive delays have added an equal number of years to the development program (see chart). The first slippage came in 2009 and was hardly controversial. Just 17 months after launch, the company made major decisions to drop carbon-fiber composite for the wing structure, increase the fuselage cross-section and reshuffle the space allocated to avionics and baggage. A stark example of how much easier it is to change things

early in development, this major revision added just three months to the schedule—compared with the two-year cost of moving wiring and avionics now.

Mitsubishi Aircraft's inexperience and certification challenges reared their ugly heads in 2012. Managers found that documentation for the manufacturing processes and the engineering analysis were not in order. This was distinctly a certification issue; the company said at the time that it had no technology problems. But it had to delay by two years.

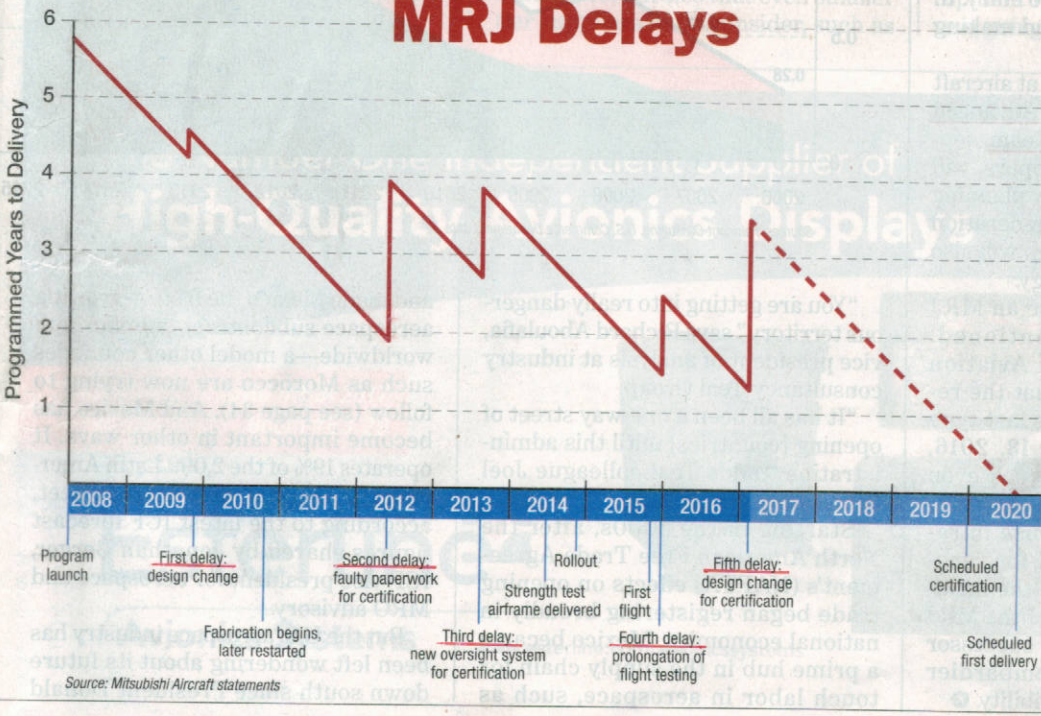
In 2013, Mitsubishi Aircraft announced another problem in working toward its type certificate. In 2009, it had been required to implement a new system of certification oversight, organization delegation authority (ODA). This unanticipated task turned out to be unexpectedly difficult, so about a year was added to the schedule. The timing of the announcement was odd, however. ODA implementation had been completed in 2012, raising the question of why it was being cited for an August 2013 schedule change.

The reason for the fourth delay, at the end of 2015, was a realization that more time would be needed for flight testing, another certification issue. U.S. experts had told the company that it needed to spend more time in

ground preparations between each flight. First delivery was pushed out by another year. But testing procedures cannot have been the only issue at that time, because the first flight, a month earlier, had been half a year late.

Some customers are probably not fretting too much about the delays, since the MRJ90's access to its largest market—the U.S.—is still subject to a restriction that program managers in 2008 must have assumed would soon disappear. The restriction, imposed by so-called scope clauses in pilot contracts, sets the maximum size of aircraft that major U.S. airlines may employ in

MRJ Delays



outsourcing deals. The MRJ90 exceeds those limits of 76 seats and a maximum takeoff weight of 86,020 lb. (39,018 kg).

Tellingly, Embraer cited the scope clauses' prohibition of its E175-E2 in November as a reason for delaying the first delivery of that version of its forthcoming E2 model by a year, to 2021. The E175-E2 and MRJ90 are close competitors, with identical seating capacity and the same engine. The MRJ70 complies with the scope clauses, but it is less efficient than the MRJ90.

The two biggest MRJ customers are SkyWest Airlines and Trans States Airlines, with orders for 100 and 50 aircraft, respectively. Those companies, which operate outsourcing contracts for U.S. majors, have not specified which versions of the MRJ they will take.

MHI CEO Shunichi Miyana-ga will now take a direct role in the MRJ program by chairing a committee overseeing the development team. But the giant industrial conglomerate plays down the effect of the latest delay on its profitability. "Although the payback period will be prolonged, the impact on profit for each fiscal year will be minimal," it says. The program will require more capital, however.

MHI stresses its suitability for the business of commercial-aircraft manufacturing, which it notes is a long-term activity with high barriers to entry. In other words, developing and making airliners requires patience.

Moreover, MHI is looking at aircraft beyond the MRJ. A Future Advanced Technology Development Team, separate from the MRJ developers, will work on "technical strategy planning and development of next-generation aircraft concepts." The team will also develop advanced technology.

This is not the first time an MRJ successor has been mentioned. Mitsubishi Aircraft told Aviation Week in February 2016 that the regional jet would not be its last type (*AW&ST* Feb. 29-March 13, 2016, p. 42). Determining the break-even point for the MRJ was not easy, the company said then, because infrastructure would be used for "succeeding programs." Since the maximum practicable seating of the MRJ appears to be 100 seats, a successor about the size of the Bombardier C Series must be one possibility. ☼

Mexican Standoff

A 20% Trump tariff on Mexican aerospace exports to the U.S. would be huge—and not

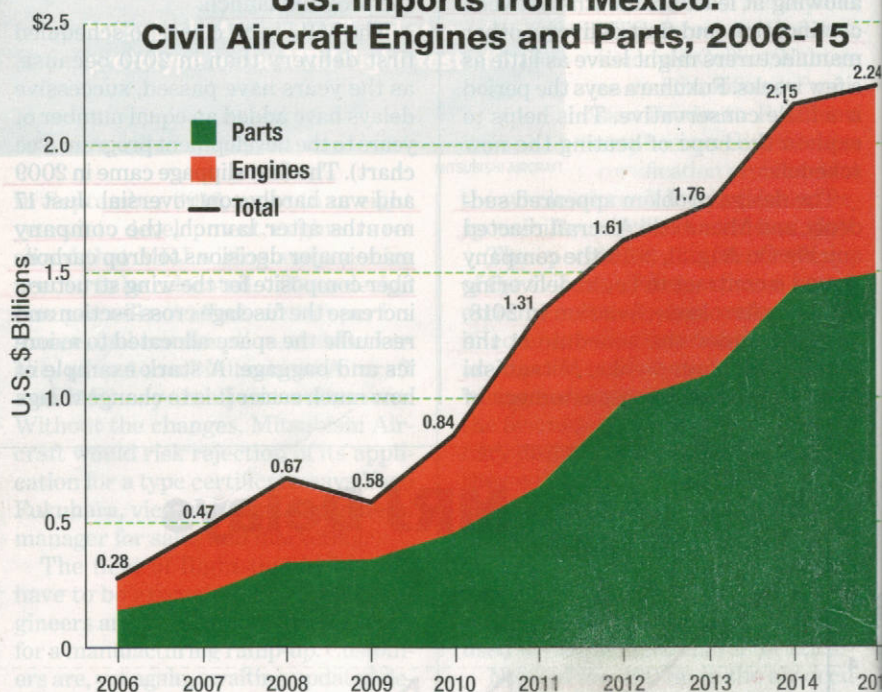
Michael Bruno Washington

What would a 20% U.S. tax by the Trump administration on goods imported from Mexico mean for the American aerospace sector? On a company level, it depends, according to industry insiders—but on a national and international level, it would not be good, they tell Aviation Week.

assembling wire harnesses (*AW&ST* April 1-8, 2013, p. 44.) Growth has climbed exponentially over the decade, with U.S. imports of aircraft engines and parts in 2015 reaching almost \$2.24 billion (see graph).

That surpassed imports from Italy and China combined, according to U.S. Commerce Department data,

**U.S. Imports from Mexico:
Civil Aircraft Engines and Parts, 2006-15**



Sources: Fairmont Consulting, U.S. Commerce Department data

"You are getting into really dangerous territory," says Richard Aboulafia, vice president of analysis at industry consultancy Teal Group.

"It has all been a one-way street of opening [countries] until this administration," adds Teal colleague Joel Johnson.

Starting in the 2000s, after the North American Free Trade Agreement's (NAFTA) effects on opening trade began registering broadly in national economies, Mexico became a prime hub in the supply chain for touch labor in aerospace, such as

and made Mexico the fastest-growing aerospace subcontract-supplier hub worldwide—a model other countries such as Morocco are now trying to follow (see page 34). And Mexico has become important in other ways. It operates 19% of the 2,099 Latin American commercial air transport fleet, according to the latest ICF forecast figures shared by Jonathan Berger, ICF vice president for aerospace and MRO advisory.

But the U.S. aerospace industry has been left wondering about its future down south since President Donald