'Open Rotor' engine for sustainable aviation

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To advance the goal of achieving environmentally sustainable aviation, the jet engine giants of the U.S. and France on Monday unveiled a joint vision that would significantly change both the look of airplane engines and how they work. Their timeline suits Airbus but may be problematic for Boeing.

For the next big advance in future aircraft propulsion, CFM International—the 50/50 joint venture between GE and Safran—proposes to deliver in the mid-2030s a dramatically new gas-turbine engine design.

It will be open rotor, which dispenses with the conventional pod around the rotating fan blades. This allows a larger fan, sweeping backward a greater volume of air.

Additional technologies inside CFM's proposed engine will make it compatible with sustainable biofuels or hydrogen and allow it to be adapted to hybrid-electric operation, the companies said.

GE Aviation CEO John Slattery said the planned engine will reduce fuel burn by at least 20% and enable aviation to "rise to the challenge of decarbonization."

However, the announced timeline for entry into service means a finalized new CFM engine won't be launched until perhaps a decade from now.

That has big implications for Boeing and for Airbus, which in the past have relied upon significant improvements in engine efficiency to launch any all-new airplane design. CFM's latest engine—the LEAP, launched in 2008—powers Boeing's 737 MAX and about 60% of the rival A320 family of jets built by Airbus.

The prospect of CFM's hydrogen-compatible replacement for the LEAP coming in the mid-2030s fits neatly with Airbus' planned timeline for a successor to the A320neo jet family.

The European jet maker has declared it will try to develop a zero-emission commercial jet by 2035 powered by hydrogen combustion

through modified gas turbine engines.

The CFM timeline is more problematic for Boeing.

After two fatal crashes grounded the MAX and then the pandemic downturn halted planned development of a plane that could match Airbus' long-range A321neo, Boeing lost substantial market share in the single-aisle jet market.

To make up that lost ground, Boeing needs to launch a new airplane in the mid-2020s, not the mid-2030s.

But it will be hard to justify the billions of dollars needed to develop a new airplane if Boeing cannot guarantee airlines at least 15% better fuel efficiency than the planes they are already flying. Typically, new engines provide most of that improvement.

Slattery said that if Boeing does launch a new airplane this decade, "we will compete strongly" to provide its engine. However, that would be a more conventional jet engine with a far lower improvement in fuel efficiency.

CFM's timeline for its future engine means that if Boeing goes forward with a new airplane launch sooner, it will have to rely on new airframe design and manufacturing methods to produce a sales breakthrough.

Stretching for sustainability

CFM surely would have hoped to announce its future vision at the 2021 Paris Air Show, which should have been this month but was canceled due to the COVID-19 pandemic.

Instead, GE's Slattery and Safran CEO Olivier Andries laid out their

program to mature, demonstrate and test the proposed new engine technologies from Safran's research and development center in Paris—the city where in 2015 the international treaty on climate change was adopted.

Andries noted that through advancing technology CFM has cut the fuel consumption and therefore the carbon emissions of its engines by 40 percent over the past 40 years.

However, he said that given the expected steep rise in air traffic over the next decades, much more drastic progress is necessary if the world's airlines are to meet their target of cutting total carbon emissions in half by 2050.

To achieve that even as the number of aircraft grows, "the next generation of airplanes must reduce emissions by 90% as compared with the current fleet," Andries said.

He added that 40% is expected to come from new engine and airframe technologies, 40% from the use of sustainable fuels and 10% from streamlining air traffic flow.

CFM has dubbed its new engine project RISE, for Revolutionary Innovation for Sustainable Engines.

Andries and Slattery said work on RISE began in 2019, and by the end of this year the CFM research team will swell to more than 1,000 engineers.

Ground tests of demonstrator engines are expected by the middle of this decade, with flight tests of the engines mounted on current aircraft to follow afterward.

New technology

The most substantial change in the new engine design is an open rotor fan, also called an unducted fan, which provides the greater part of the expected fuel efficiency improvement.

CFM proposes an open fan—similar in look to a propeller—with scimitar-shaped rotating blades, and behind that a circle of fixed blades, or stators, that straighten the air flow. The fan blades will be made from woven carbon composites.

In contrast, the large fans at the front of today's jet engines are entirely encased in a protective pod called a nacelle, which is armored to contain any fan blade that breaks off.

There have been repeated instances recently of engine fan blades breaking off during commercial flights and causing serious damage to aircraft. It happened on an older United 777 climbing out of Denver in February. However, these incidents have all involved metal blades, cracked by metal fatigue.

The GE carbon composite blades on its GE-90 and GEnx engines that respectively power Boeing's 777-300ER and 787 airplanes have never had an incident of a fan blade breaking during their more than 140 million flight hours in service.

GE previously tested an open rotor engine in the 1980s. It was never adopted, in part because of concerns about much greater noise from the unsheathed fan.

More recently, Safran conducted open rotor research funded by Europe's Clean Sky government-funded aeronautics program.

Slattery said the open rotor technology has now advanced to a level that ensures the RISE engine will be no noisier than the current LEAP engine on Boeing's MAX.

In addition to the open fan, the engine includes a suite of cutting-edge technologies.

An intricately manufactured high-temperature engine core will feature advanced metal alloys and ceramics. An electric generator embedded within the engine will enable hybrid electrification. And the engine will be designed to potentially run on alternative energy sources such as biofuels or hydrogen.

Mohamed Ali, vice president and general manager of engineering at GE Aviation, said during the Paris presentation that because each of these technologies is very challenging, "we are stretching ourselves."

"There will be learnings, and maybe setbacks," he said. "But we are resolute."

"I'll talk as an engineer here," Ali added. "This is nirvana."

Delphine Dijoud, Safran's executive manager of the RISE program systems engineering, said the project commands "the full financial and intellectual strength" of both multinational companies.

The technology research will be partially funded by the French government. Andries said he also expects financial support from the European Commission.

The project builds upon research funded by the U.S. government a decade ago, when GE conducted wind tunnel tests on open rotors with NASA and the Federal Aviation Administration.

Slattery, an Irishman and former head of commercial aviation at Brazilian jet maker Embraer, was appointed head of GE Aviation in September. Andries, a former French government official and a vice president at Airbus before joining Safran, took the top job there in January.

Monday's announcement was the first physical meeting between the two since that appointment.

The two kept socially distant during most of the presentation. However, when they signed documents extending the CFM joint venture through 2050, they made a flourish of pumping hand sanitizer before sealing the deal with a handshake.