What does the future hold in store for the Open Rotor?

Discover the article about the Open Rotor written by Stéphane Cueille, Safran Senior Executive Vice President, R&T and Innovation, and Chairman of the Clean Sky Governing Board, published on his Linkedin account on 2019 March, 25. Enjoy the reading!

On March 14 in Washington, D.C., Aviation Week organized its Laureate Awards, which have recognized major achievements in aerospace and defense for over 60 years. The Open Rotor being developed by Safran won the Propulsion category in this year's Laureate Awards. At Safran we are of course very proud of this award, which also honors everybody's tremendous work on this flagship project, one that has made front-page news for the last two years.

Back in May 2017, we carried out the first ground tests of a new configuration of the Open Rotor aircraft engine, characterized by its two counter-rotating fans and the absence of thrust reversers. Marking a total break with the turbofan engines that power today's single-aisle commercial jets, this type of architecture is designed to reduce fuel consumption and carbon emissions.

Where does the Open Rotor program stand today? And what lessons can we learn from these tests for tomorrow's engine architectures? Is the stage set for the advent of the Open Rotor?

First, however, let's take a step back and look at the context. In an industry like aviation, with its long cycles, extremely complex technologies and uncompromising safety standards, any disruptive technologies have to be prepared dozens of years in advance and marshal the forces of many different actors, from aircraft and engine manufacturers, to airlines, research labs and more. This all applies to the Open Rotor type architecture, just one of the paths being explored by manufacturers to power the next generation of single-aisle commercial jets, set to make its appearance towards 2030. The new technology is the subject of in-depth research efforts, carried out for the last ten years within the scope of Europe's research program, Clean Sky.

We may wonder why we should embark on a new architecture when current aero-engines have already made such tremendous progress. In the mainline commercial jet market (over 100 seats), for example, we have seen a 15% reduction in fuel consumption between the previous-generation CFM56*, which entered the market some 40 years ago, and the new-generation LEAP*, its replacement on the latest single-aisle twinjet models, the Airbus A320neo, Boeing 737 MAX and shortly the Comac C919. In a direct corollary, CO₂ emissions have also decreased.

Which brings up the question: can we achieve a further 15% reduction on upcoming engines if we retain a conventional architecture like that of the LEAP? It's going to be hard using conventional engines, which is why we're conducting research to identify new and higher performance configurations, such as the Open Rotor.

While the Open Rotor solution holds out the greatest promise of delivering a further 15% improvement, it's also the most complex technologically speaking.

In terms of the structure, it has two counter-rotating fans, one behind the other. In terms of acoustics, it has no nacelle to attenuate the noise generated by the rotating blades. In terms of aircraft integration, the Open Rotor engine will be about twice the diameter of current turbfans, at nearly 4.50 meters (or about 15 feet). And, of course, in terms of certification, it's a brand-new architecture. A number of studies were conducted in all of these areas, prior to the culminating stage of ground tests on a demonstrator at Safran's test facility in Istres (Southern France). The aim was to demonstrate our ability to design and operate an engine with this new architecture, and to measure the Open Rotor's performance in terms of fuel consumption and emissions.

We logged more than 70 hours of operation across the entire power range, from idle all the way to full throttle, and even thrust reversal. We are very proud, as prime contractor for the project, to have scored this first in aviation history and reached this key milestone. Of course, we still have a long way to go, and work must continue. Even if the Open Rotor concept is not chosen in the future, by working on this project we can develop vital technology building blocks that will ultimately be used.

Furthermore, given the above-mentioned challenges, we can't ignore other, sometimes equally intriguing options.

Alongside the Open Rotor, we are therefore exploring alternate paths, including a conventional design, but with larger diameter fans.
By enlarging the fan, we also increase the bypass ratio, meaning the ratio between the airflow accelerated solely by the fan, "bypassing" the engine core and undergoing no combustion, and the airflow though the engine core, where it undergoes combustion. The higher the bypass ratio, the more efficient the engine and the lower its fuel consumption.

A jet engine with a higher bypass ratio would allow us to reduce fuel consumption by a further 5% to 10%, which is far from negligible. But at the same time, a larger engine is harder to mount under the wing and is heavier, which means we have to lengthen the landing gear and strengthen the aircraft's structure – two very important factors when evaluating the engine's overall performance.

However, the higher bypass engine is still a perfectly credible option, one on which we are also expending considerable efforts. The ultimate aim is of course to give the market the best possible propulsion systems for generations to come.

As I said earlier, in a long-cycle industry like ours, we have to consider these different possibilities well in advance of market entry. Projecting ourselves into a seemingly distant future is a daily challenge in aviation, and also explains why so many people are passionate about planes!

The Open Rotor tests clearly show the importance of European research programs such as Clean Sky, which allow manufacturers to investigate "risky" technologies. Without Clean Sky and our partners, we couldn't have built this demonstrator, and Open Rotor would still be just an idea. Today, however, we are offering a real option for the future, one that still faces challenges but has proven to be technically feasible.

And that's why we would like to share our Laureate Award with all the public and private partners in Clean Sky!

Find Stéphane Cueille's article on his Linkedin account

*CFM56 and LEAP engines are developed, produced and marketed by CFM International, a 50/50 joint company between Safran Aircraft Engines and GE.*