Eight aero concept innovations point the way to 75% CO2 emissions reduction by 2050

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The EU's 2050 vision for aviation is to make Europe a world leader in sustainable aviation products and services while meeting the needs of its citizens and society. To this end, it has set an extremely challenging goal: to reduce aircraft energy consumption and CO_2 emissions per passenger kilometre by 75 % by the year 2050.

However, this goal wouldn't be feasible if the aviation industry were to rely solely on the incremental improvements of state-of-the-art technologies. Part of the reduction needs to be achieved through radical new technologies, which the EU-funded ULTIMATE project has targeted in its 3-year duration.

"To reach the 75 percent reduction target, it is estimated that the last 18 percent will have to come from step-changing technology developed within ULTIMATE," says Tomas Grönstedt, professor at Chalmers University of Technology in Sweden and coordinator of the project, in a recent press release.
Through its work, the project has sought to address the three main sources of energy loss in existing aircraft engines: combustor irreversibility, core exhaust heat and bypass exhaust kinetic energy. Together, these are responsible for more than 80 % of overall losses in energy. The eight engine concepts presented at the 2018 Farnborough International Airshow represent ULTIMATE's energy-efficient solutions.

Eight innovative aeronautical designs on show

Two developed designs revolve around the concept of pre-cooled cores and pulsed detonation combustion. As described on the project website, "pre-cooling the core flow before detonation combustion, improves the volumetric efficiency, allows for increased combustion pressure ratios, reduces the risk of pre-ignition and reduces the engine cooling requirements." The project partners have proposed one design for flights within Europe and a variation using geared turbofans for long-haul flights.

ULTIMATE has developed three advanced engine concepts. The first, an open rotor with a nutating-disc topping cycle, combats the component inefficiencies of open rotor power plants through the introduction of

topping cycles. The team's other two concepts include a turbofan with a closed-circuit bottoming cycle and a turbofan that combines an open-circuit air bottoming cycle with a nutating-disc topping cycle, intercooling and secondary combustion. The designs propose solutions with increased core-specific power, reduced power plant weight and enhanced thermal efficiency.

The ultra-thin adaptive inlet concept proposed by the project offers a potential solution for improving the operation of ultra-high bypass ratio turbofan engines equipped with ultra-thin and ultrashort nacelles.

Yet another contribution is a secondary fluid recuperator concept in which two heat exchangers have been installed inside the engine core. Finally, the composite cycle engine developed by the partners combines conventional gas turbine with piston engine solutions.

"We are now on the way to mature these technologies to TRL 2 (Technology Readiness Level)," says Grönstedt.

Following these achievements, strategies will be formed to develop the ULTIMATE (Ultra Low emission Technology Innovations for Mid-century Aircraft Turbine Engines) technologies into products and market them. These strategies will also serve as roadmaps for future European propulsion and aviation research.

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