Bravo, MAESTRO! - nextgen SAT engine gears up to perform

Strengthening European competitiveness in the Small Air Transport (SAT) turboprop market (aircraft with up to 19 passengers) – through the provision of next generation turboprop engines and propeller combinations – is the underlying objective of Clean Sky’s MAESTRO (More Advanced and Efficient Small TuRbOprop engine) project.

MAESTRO, which is part-funded by the European Commission’s Horizon 2020 framework, focuses on the development of design tools and manufacturing technologies for application in new engine architectures to bring tangible results in pursuit of ACARE objectives.

The project’s ambitious goals include a 15% fuel efficiency advantage; 10% reduction of total operating costs relative to a 2014 era engine, and contribution to the achievement of the SRIA 2050 NOx reduction target, derived from the Clean Sky 2 High Level Objectives.

MAESTRO also aims to realise up to 10 decibel noise reduction, relative to the ICAO Chapter 10 limit. This is a pertinent target for turboprop driven aircraft which must comply with increasingly stringent noise criteria in and around regional and city-centre airports alike. This also has relevance to the broader EU ambitions of 4-hour door-to-door mobility where turboprop aircraft will play a leading role in providing quiet and low-emission connectivity between provincial communities and city hubs.

‘We divided the activity into several pillars,’ explains the project’s coordinator, Lorenzo Fattorini, Program Manager-Engineering, EU Research Projects, at Avio Aero in Rivalta di Torino, Italy.

‘One of overall integration; one focusing on the propeller to reduce noise from the gearbox; one devoted to the gearbox which connects the thermal engine and the fan at the front of the engine. Other pillars are devoted to the compressor, the combustor, connected to the compressor; and finally, the turbine, the last module of the engine.’

The MAESTRO consortium – led by topic leader Piaggio Aero Industries, supported with the expertise of GE Aviation Czech, General Electric Deutschland Holding, GE Aviation System, and General Electric Company Polska – has been focused on reaching the ‘High Level Objectives’, developing new technologies as well as a new tool to predict engine performance which has been fully tested with data gathered from the GE Catalyst engine.

The MAESTRO consortium developed two engine combustors – a conventional one as well as one constructed using additive manufacturing (AM), also referred to as 3D printing.

‘We tested both (in 2019, in close collaboration with the START project – inveSTigation of an ultrA compact Reverse flow combusTor), and saw that with the additive manufactured one the reduction in NOx was 20% better with respect to the conventional 2014 baseline. So in terms of emissions we really see the potential of AM,’ Fattorini reports.
The benefits of additive manufacturing also allow new geometries which enable what were previously multiple parts fastened together to be manufactured as integrated parts.

‘A standard combustor comprises around 25 components, but if you’re able to manufacture it with AM, the number of components drops by around six, and lead time is reduced because you have to coordinate a lower number of suppliers, making the supply chain more manageable,’ Fattorini says.

Other notable accomplishments within the MAESTRO project include the design of an innovative light and low-noise propeller (which enables that targeted noise reduction of -10 dB), and, as previously reported, a new compressor has been designed and tested, confirming an impressive pressure ratio of 16:1.

The significance of this is that air ingested into the engine can be compressed up to 16 times at the outlet, a considerable advance for turboprop engines, which translates into a 7% reduction in total CO₂ emissions.

By mid-2019 the MAESTRO team had already surpassed its objectives. And then an interesting opportunity presented itself, as Andrzej Podsadowski, Clean Sky Engines ITD Project Officer, explains:

‘The MAESTRO consortium initially intended to improve turboprop technologies, however they had saved some budget on testing and this allowed them to think about doing something interesting. So they started looking at how the technologies developed in MAESTRO could be applied to electric and hybrid aircraft.’

Hence, e-Maestro. This is the informal name given to the hybrid-electric investigations being carried out — a sub-package within the overall scope of MAESTRO. The aim is to develop and validate (as far as possible within the remaining timeframe and budget of the project) a hybrid-electric architecture that could be used on future versions of the Piaggio aircraft’s GE Catalyst engines, with particular focus on the compressor.

When the MAESTRO project kicked off, the originally planned outcomes were to go as far as ground tests of parts. But as the project evolved, it became apparent that there was an opportunity to take things further, with the prospect of MAESTRO’s innovations being applicable to real flight test demonstrations.

‘During the process we saw a nice opportunity to leverage the studies and implement the work we’re doing with the new GE Catalyst engine which will fly next year – so we’ll have the chance to bring our newly designed parts and many of the benefits to that. We’re going beyond theory,’ says Fattorini.

‘Without the help of Clean Sky 2 we would not have been able to do that. MAESTRO has been a unique platform for testing innovative technologies – not only for the hybrid electric application we are doing now with eMAESTRO, but also with the project’s conventional Loop 2 studies. These technologies, especially additive manufacturing, if used correctly, will provide additional benefits compared to conventional manufacturing processes.’

From a dissemination perspective, the technical achievements of MAESTRO represent exactly the kinds of positive outcomes that can inspire and attract tomorrow’s talent into Europe’s air transport sector.

‘Clean Sky provides a flourishing environment not only for the engineering and technological aspects, but also for the wider communications environment,’ says Yari Bovalino, Senior Communications Manager & Chief Storyteller at Avio Aero and Turboprop Programs, GE Aviation.

‘Working on MAESTRO helps us develop our storytelling, especially with the sustainability narrative at the forefront of aviation,’ he adds, ‘and, sharing successful technology stories was not just a great exercise for us, but also generates interest and outreach to engineers and other tech experts, helping attract talent into the aerospace sector.’