CLEAN SKY: MTU AERO ENGINES AND PARTNERS DEVELOP NEW PROPULSION TECHNOLOGIES

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Clean Sky is the largest aviation technology research initiative ever launched by the European Commission. Under the effort, over 600 partners have joined forces to develop new technologies to further improve the environmental compatibility of aviation in the future. MTU Aero Engines, Germany's leading engine manufacturer, also has a role in the project. "Our work doesn't stop at developing new technologies for our high-pressure compressor and low-pressure turbine modules, we also qualify new partners for the European aerospace industry," explains Dr. Rainer Martens, Chief Operating Officer at MTU Aero Engines.

Clean Sky aims at strengthening the European aviation industry and enhancing its international competitiveness. The two central tasks in pursuit of this objective are to develop advanced aircraft and engine technologies, and to qualify and integrate new partners from research and industry. In the industrial sector, the focus is on small and medium-sized enterprises. Germany's leading engine manufacturer is doing a great job on both fronts. New, innovative propulsion system technologies were developed and integrated into a demonstrator: MTU is responsible for SAGE 4 (Sustainable And Green Engines), one of five Clean Sky engine demonstrators. The SAGE 4 demonstrator was tested in Munich late last year. The demonstrator is based on a geared turbofan

engine and incorporates a number of innovations, including components – blades for example – that are made from new materials and come in a new design. In addition, the demonstrator features components produced using new manufacturing techniques. Advanced simulation methods and measurement techniques round off the gamut of new developments.

Partners from industry and research are participating in this sub-project alongside MTU. Most of the new companies and institutes to join MTU's innovation value chain come from Germany, but not all: some are based in the United Kingdom, Italy, Austria and Sweden. "Our objective was to bring together the best in class, and that's exactly what we've done," Dr. Jörg Henne, Senior Vice President Engineering and Technology at MTU, sums up. The outcome is a win-win situation for both sides: "In addition to new hardware, we also gain new partners," he explains. The cooperation under Clean Sky provides the partners with an opportunity to get a foothold in the European aviation industry for the first time, or to establish themselves in a specific segment of the industry.

Meggitt
For Meggitt Polymers and Composites (formerly Cobham Composite Technologies), the work under the Clean Sky program marked the first time the British specialist for carbon fiber materials cooperated with MTU. Together the two companies developed a new high-temperature material for a seal carrier with a honeycomb structure: The innovative carbon-fiber-reinforced inner ring will be installed in the high-pressure compressor. "The main challenge of the project was selecting a composite material system which would meet the design requirements of a high-pressure compressor and of course for such a high temperature environment, in which typically it has been difficult to utilize composite materials," explains Matthew Denmead, design engineer at Meggitt.

Both partners are highly satisfied with the outcome. "The opportunity to have these parts incorporated into an engine and tested in a real life environment, will allow greater understanding of the material performance," says Denmead. The weight of parts made from carbon fiber materials is up to 400 percent lower than that of parts in metallic materials, such as titanium. "Moreover, their production is considerably less expensive," adds Dr. Stefan Weber, Senior Vice President Technology and Engineering Advanced Programs, at MTU in Munich. Denmead predicts: "The use of high temperature composites in aero engine applications is becoming more and more widespread throughout the industry. High temperature composites have a great potential to drive weight out of future engine designs." He also has words of praise for the collaboration with MTU: "The co-operation was very successful and MTU were supportive in terms of implementing design changes to ease manufacture."

iwb application center
iwb Anwenderzentrum Augsburg, which is part of Munich's technical university (TUM), is no stranger to MTU. Says Weber: "We know each other quite well from previous cooperations in various areas of production engineering." Under the Clean Sky initiative, the two partners joined forces to develop a simulation tool to analyze additive manufacturing processes that permit engine parts to be built up layer by layer. The aim was to gain a better understanding of these processes and to improve the quality of the parts thus produced, while keeping an eye on costs. The advantage for the manufacturer: Computer simulations can now replace time-consuming experimental investigations and trial production runs. The partners' work specifically focused on the additive process used byMTU to manufacture borescope bosses for the high-speed low-pressure turbine for the geared turbofan powering the A320neo. These parts are being produced by the selective laser melting process, or SLM for short.

Johannes Weirather, graduate physicist at iwb: "The simulation of laser beam melting is one of our key topics of research in the field of additive manufacturing. So we are particularly pleased that the

work under the Clean Sky initiative enabled us to expand our know-how in this area. But the project also raised some new questions to which we'll have to find answers in the years to come if we want to enlarge the scope of application of simulations in additive manufacturing." Additive manufacturing processes are becoming increasingly important also at MTU. This is why the company keeps pushing their further development. "What we have in mind is to tap and leverage the potential unleashed by freedom of design for an ever increasing number of components. Also, we want to come up with more new materials," says Weber as he looks ahead.

Hexagon Metrology
As part of the Clean Sky activities Hexagon Metrology worked on the development of a new measuring and inspection system. The metrology specialists from Wetzlar have already demonstrated their expertise in the field of quality assurance in several projects conducted jointly with MTU. The task they had to tackle this time was finding an integrated, fully automated solution for the surface and dimensional inspection of blisks. Blisks (blade integrated disks) are high-tech components manufactured in one piece that eliminate the need to fix separately manufactured blades to the disk. They are currently used in compressors for military and commercial applications. So far, measurements and inspections have had to be performed in several steps. So the experts decided that it was time to make a change for the better. "In the industry there is a clear trend towards integrating several measuring processes into one single system," explains Stefan Fall, Project Manager at Hexagon Metrology.

The result is quite impressive: In a joint effort, the two companies came up with a practicable and efficient solution for the inspection of blisks. Says Fall: "We can now offer our customer extended functions for our measuring systems, such as – in this special case – the visual inspection of blisks. This marks another milestone in the development of automated and flexible systems using sensors that can be optimally adapted to solve complex measuring tasks." Hexagon Metrology is now planning to optimize the new system for production use based on the insights gained from the project. The company is confident that it will be possible to further improve the efficiency of coordinate measuring machines and to incorporate additional functions that would permit other aviation components to be inspected too. "In a next step, we'll explore options of using the technology in other industries as well, as we see great potential here," says Fall. And the benefit forMTU? "The integration of new measuring methods in conjunction with a higher degree of automation will reduce set-up times and increase production throughput," explains Weber.

Before the new technologies, materials and processes developed as part of the Clean Sky initiative can be implemented in practice, they first had to prove their worth in extensive testing at MTU: Incorporated on the SAGE 4 demonstrator, they were put to the acid test in the company's test cell in Munich. Dr. Jörg Henne: "Following detailed analysis, the results will be available to us sometime in the next few weeks. But from what we've seen so far, we are very confident that everything will turn out as we had hoped." The newly developed technologies will then be used on the next generation of geared turbofan engines to further improve their eco-efficiency.

09 MARCH 2016

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