DLR: German Aerospace Center Uses Optical Measuring Systems for Researching Fuel-Efficient Technologies

City/Country: Braunschweig, Germany
GOM System: ATOS Triple Scan / TRITOP
GOM Inspect Application: 3D inspection and evaluation software
Company's workspace: Aeronautics and space research center

The German Aerospace Center (DLR) uses non-contact measuring systems for fundamental and application-specific aeronautical research. In this regard, DLR uses GOM's optical measuring systems for its research aircraft "ATRA" (Advanced Technology Research Aircraft) – an airbus A320.

Fig. 1: GOM supports DLR in its aeronautical research by providing precise measurements of the part geometries.

In order to make aircrafts more energy-efficient and eco-friendly, the German Aerospace Center (German: Deutsches Zentrum für Luft- und Raumfahrt e. V., abbreviated DLR) uses an airbus A320 as a flexible experimental platform. The various tests on the aircraft serve for developing technologies that help reduce fuel consumption and thus environmentally harmful carbon dioxide emissions. In this context, DLR focuses on the impact of surface geometries on the flow resistance. Examining this impact with the help of the Advanced Technology Research Aircraft's tailplane aims at improving the aerodynamics of aircrafts.

What is essential for developing improved components is to optimize the geometry by producing as little flow resistance as possible. The surface friction on the wings and fuselage slows down the aircraft, which results in an increased fuel consumption. The resistance depends on whether the flow surrounding the aircraft is laminar or turbulent. Whereas turbulent flows form a wider boundary layer because of the turbulences, laminar flows lead to a thinner boundary layer. The wider the boundary layer is, the stronger is the frictional resistance, which has to be compensated with an increased fuel consumption. DLR's research activities therefore aim at minimizing the resistance by keeping the flow at a laminar level as long as possible.

Fig. 3: The Advanced Technology Research Aircraft has been in use at DLR since 2008 in the field of aerodynamics research.

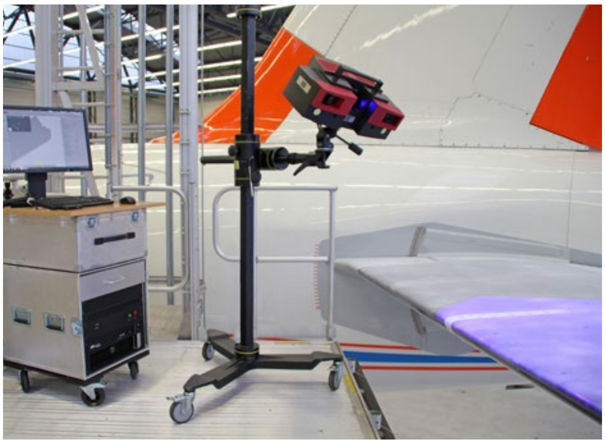

Fig. 2: Due to the Blue Light Technology, parts can be measured regardless of the ambient lighting conditions.

In order to research the transition from laminar to turbulent flow and to influence it in a further-step, a part of the empennage was taped with a foil showing a defined roughness that makes the wing surface more homogeneous. In addition, any waviness and other influencing factors, such as weld seams and rivets, were filled and straightened. Afterwards, the complete surface of the modified component was measured with GOM's optical measuring systems in a non-contact way. To measure the 3D coordinates of the object, the empennage of the Advanced Technology Research Aircraft was first measured with the portable TRITOP system, which saved a lot of time and increased the measurement accuracy. Subsequently, the part was measured with the flexible ATOS Triple Scan 3D measuring system, which was operated from a scaffold at the height of the wing to be measured.
GOM's measuring systems can be used under factory and production conditions, thus implementing the principle of "measuring device is taken to measuring object".
Thanks to its state-of-the-art camera sensors and projection technology, the ATOS Triple Scan system requires a reduced number of individual scans and thus accelerates the entire measuring procedure.
A high-resolution and full-field representation of an area of 1.5 m × 3 m was made available in less than 15 minutes.

The first measurement provided a precise representation of the wing geometry. Furthermore, the measuring results formed a basis for the following test series. For the next flight tests, the wing was further adjusted in an iterative process in order to represent the displacement of the transition point. For this purpose, thermographic measurements were carried out directly during flight. Five flight tests in total involving thermography have shown a positive effect of the geometry change: Modifying the roughness of the surface made it possible to displace the transition of laminar to turbulent flow and to visualize it.

The effect was visualized with the help of a thermographic measurement of the empennage. As turbulent areas cool down faster, significant thermal differences become visible on the infrared image. This method made it possible to identify the exact transition point of laminar to turbulent flow. Following the last adjustment of the wing and the last infrared measurement, GOM's TRITOP photogrammetry system and ATOS Triple Scan were used once again to optically measure the part including the changed geometry. In this way, the researchers also obtained a representation of the empennage including the geometry changes and thus could directly compare it with the representation of the component's initial state.

In the future, the qualitative knowledge gained by DLR's aerodynamicists concerning the sensibility of the flow with respect to the wing geometry is supposed to be applied on the wing and fuselage. As a consequence, the researched effect can be used extensively to improve the performance of aircrafts and to allow a more energy-efficient and eco-friendly production.

The user

DLR is the national aeronautics and space research center of the Federal Republic of Germany. The scope of its work covers fundamental research up to application-specific product development. At the site in Braunschweig, DLR's research activities are focused on aerodynamics and fluid mechanics, among others.

The manufacturer

GOM (Gesellschaft für Optische Messtechnik) is a global industrial manufacturer that develops and produces industrial measuring systems and technologies for 3D coordinate measurement analyses and deformation analyses. GOM's measuring systems are based on digital image processing and are used in product development, quality control, materials and components testing.