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DLR tests new helicopter control system: successful first flight with two active sidesticks

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Helicopter controls with a difference: in test flights with the research helicopter FHS (Flying Helicopter Simulator), a modified Eurocopter EC 135, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) in Braunschweig replaced the conventional control system with two active sidesticks for the first time. A sidestick looks similar to a joystick.

Simplified control

Due to its special flight handling characteristics, controlling a helicopter is an extremely complex affair. While the pilot controls vertical movement using the collective pitch lever and uses the foot pedals to adjust for the varying turning forces generated by the main rotor, he or she controls pitch and roll movements using the cyclic stick (centre stick). In the flights carried out by DLR, a sidestick mounted to the pilot's left replaced the operating element for vertical movement. An additional sidestick installed to the pilot's right took over cyclic pitch control, which is responsible for horizontal movements of the helicopter.

The use of two active sidesticks and the resulting total replacement of the conventional helicopter control system are new. In 2007, DLR tested the right-hand sidestick in flight and is now setting new benchmarks with the first flight to use two sidesticks.

Improvement in flight safety and ergonomics



Flying Helicopter Simulator (ACT/FHS) with fly-by-light and fly-by-wire control systems

Unlike conventional passive sidesticks, the active sidesticks are equipped with an electric motor to generate the forces felt by the pilot with conventional controls. Integrated into the FHS, the active sidesticks complement the electrical fly-by-wire control concept. Fly-by-wire, which since the 1980s has been used in the Airbus A320 family of airliners, among others, does not transmit the pilot's commands via a conventional mechanical method but instead with the aid of electrical signals. It thus forms the foundation for controlling the aircraft using active sidesticks and makes it easier for the pilot to handle it. "The active sidesticks can simplify flying enormously. In addition, the ergonomic improvement of the man-machine interface promises a higher level of flight safety", says Herbert Kistler, one of the two helicopter test pilots at DLR.

The main task of the active sidesticks is to adjust the control forces to the situation at hand during the flight, in order to provide the pilot with an optimum level of support. Information is also transferred haptically (using the sense of touch): the sidesticks give the pilot signals that he or she observes directly, for example via vibrations. The pilot can then react more intuitively to the signal. Information about flight boundaries or system limitations is transmitted in this way, for example. Moreover, the pilot receives precise acknowledgement of the control inputs that he or she gives. Together with the test pilots, the scientists from the Institute for Flight Systems Engineering are testing the optimum method for information transfer. "As the relevant parameters no longer appear exclusively on the visual displays in the cockpit – they are also communicated via the controls as 'boundaries that are felt' – the workload for the pilots in difficult flight situations is reduced", explained Kistler. This is even more important due to the fact that a good proportion of helicopter flights are conducted under visual flight conditions and the pilot must continuously observe the airspace. Thanks to the integration of active controls, the man-machine communication on board is being prepared in an ideal manner for systems that are automated to an increasing degree, and the situational awareness of the pilot is being improved.

Modification collaboration between DLR and Liebherr



The team in front of the FHS

DLR's Institute of Flight Systems (Institut für Flugsystemtechnik) performed all of the work required for the integration and commissioning as a multidisciplinary assignment. DLR's Flight Operations team in Braunschweig was a large contributor to its success: the two helicopter test pilots provided support for issues concerning the integration of the controls optimally in the cockpit and for issues concerning the configuration and operation interface. They also evaluated the new system in the system simulator in preliminary tests. A flight test engineer from DLR supported them.

The sidestick that has now been installed was developed by Liebherr Aerospace GmbH. The project was funded by the Federal Office for Defence Technology and Procurement (Bundesamt für Wehrtechnik; BWB) and DLR.

This enhancement makes available to DLR a unique test environment, which will keep them at the leading edge in helicopter research.

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