News-Archive Braunschweig

Lower rotor noise thanks to a modified approach path – DLR on the way to the silent helicopter

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The FHS (Flying Helicopter Simulator)

Helicopters do not have to be loud. This is the conclusion of scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) working on the FRIENDCOPTER project. On 24 and 25 November 2009, this EU project was concluded with an official presentation in Braunschweig.

Objective: A passenger and environmentally friendly helicopter

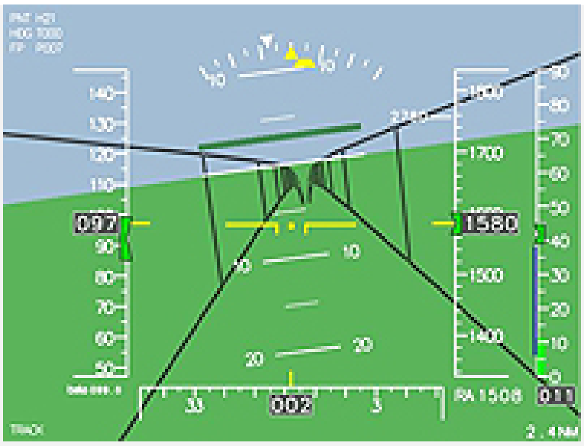
A total of 34 institutions were involved in the FRIENDCOPTER project, from helicopter manufacturers to university faculties and research agencies, with the aim of developing helicopters which are more passenger and environmentally friendly. Along with reduced fuel consumption and reduced noise and vibration in the cabin, one of the main objectives of FRIENDCOPTER was to lower noise during flight. The DLR Institute of Aerodynamics and Flow Technology (Institut für Aerodynamik und Strömungstechnik; IAS) at Braunschweig found a way to cut down the noise of helicopters, especially during the noisy landing phase, in a very simple and economical way. Even simply changing certain flight procedures can be of enormous value and reduce noise by up to 10 decibels.

Lower noise due to modified flight procedures

During flight, the main rotor experiences numerous aerodynamic interactions. During descents, the noise is produced mostly by what is known as the Blade Vortex Interaction (BVI), the interaction of vortices in the air with the rotor blades. The tips of the rotor blades shed vortices and the following blades, due to the particular characteristics of helicopter flight, repeatedly cut through these vortices. This results in the familiar 'chopping' sound made by helicopters in flight. With the aid of thorough aero-acoustic flight experiments, simulations and optimisation with generic algorithms, the researchers were able to calculate that modified flight procedures when descending would significantly reduce rotor noise.

A conventional helicopter landing follows a uniformly descending path. The optimised landing procedure calculated by IAS scientists, on the other hand, has the helicopter climbing once more before landing, after which it lands in a steep, delayed descending trajectory. Less noise is generated when climbing, because the edge vortices are driven downwards under the rotors, so that the following blades do not pass through them. This makes the flight of the helicopter less noisy. In a similar way, the delayed, steeply descending trajectory enables the vortices to dissipate – this time, above the rotors. This means the loud chopping sound of the interaction between the rotors and the vortices is eliminated for much of the landing procedure. It is heard at most during the one- to two-second transition between climbing and descending. This is a huge improvement, since helicopters normally produce disturbing noise for the entire several minutes of a conventional landing procedure.

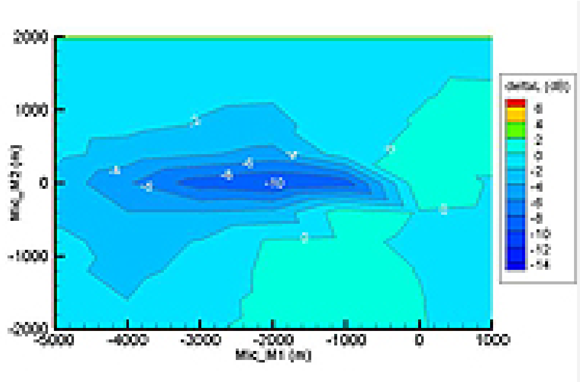
Proof by test flight



FRIENDCOPTER pilot display

The calculated flight procedure was tested with DLR's Eurocopter EC135-FHS research helicopter. In order to aid the pilot in keeping to the optimised flight plan, the researchers, with the aid of the DLR Institute of Flight Systems (Institut für Flugsystemtechnik), installed a 'tunnel in the sky' display. Once the flight path, speed, height and attitude of the helicopter are input to this system, it displays a tunnel for the pilot to follow. Special attention has to be given to the attitude, because this has the greatest effect on low noise flight.

On helicopters with shrouded tail rotors (Fenestron), like the EC135, the rear rotor is another source of noise. During a steep, delayed descent, the main rotor can approach auto-rotation. In this condition, the rotor turns without being driven and derives lift only from the flow of air. The counter-torque generated by the tail rotor or Fenestron is not required during autorotation. In order to keep the helicopter straight, the pilot reverses the flow through the Fenestron using the control pedals. The reversed flow through the Fenestron means that the wake of the fixed blades in the shrouded tail rotor is driven through the rotor. This results in very noisy pressure variations through the rotor. To prevent this noise, the researchers and pilots tested the possibility of not reversing the flow of the Fenestron. While this leads to a high angle of yaw, the additional noise of the Fenestron is completely eliminated. In the future, the tail rotor may be made quieter without the resulting yaw by means of a rudder on the tail of the helicopter.



Noise reduction chart

A further possible way of reducing the noise results from the assumption that the noise level is highly dependent on engine torque. Once this idea had been tested in flight, a new way of reducing flight noise was found. By avoiding a particular torque range, using an instrument found in every helicopter, the noise of vortices can be prevented throughout the helicopter’s speed range. In other words, if the pilot flies in a suitable torque range, the helicopter is quieter. A special flight display is not necessary for this; the usual GPS (Global Positioning System) is sufficient.

DLR's researchers felt that the programme had been a complete success. Using no more than normally available instrumentation and indicators, the noise of helicopters in flight can be reduced by up to 10 decibels. The quieter landing flight pattern was no problem for pilots to learn and would be easy to train them for.

A documentary video about the FRIENDCOPTER test flights is available in the right-hand column of this page, under 'Downloads'.

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