Making lightweight aircraft safe from gusts

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Lighter aircraft save fuel and are environment friendly, but they also need to be safe and offer comfort for passengers. Gusts of wind are a particular challenge for lightweight aircraft, because they can cause the wings and horizontal stabilisers to oscillate, subjecting the passengers to a shaking motion. This has prompted the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) to study a model of a lightweight aircraft's wing and tail unit in a wind tunnel at its Göttingen facility.

There are two parts to the model. Air flows around a rectangular wing in the 50-metre-long transonic wind tunnel. The wing is then caused to oscillate, as can happen during flight. This leads to turbulence in the airflow, which impacts another, smaller aerofoil that also begins to oscillate. The science of aeroelasticity examines the phenomena that occur. Without observing these, it is not possible to make flights smoother and more controlled.

Cruising and descent conditions

The front wing of the wind tunnel model can create very strong turbulence, simulating what happens during a wind gust. The impact this has on the rear wing provides important data about the loads acting on the aircraft. The model design also takes into account the typical effects of the interaction between the wing and the horizontal stabiliser of a commercial aircraft. "We are simulating the conditions during cruising as well as during descent," says Dr Ralph Voß from the DLR Institute for Aeroelasticity in Göttingen.

The aim is to create more environment-friendly aircraft

The aim of the experiment is to validate computer models that predict the loads on the wings and stabilisers and reduce them by means of new control surfaces. These computer models will then be used to develop new environment-friendly aircraft.

The research is being carried out as part of the DLR project iGREEN (integrated green aircraft), a study into the aeroelastic effects of different technological innovations for future fuel-saving 'green' aircraft. This includes larger engines, thinner wings with laminar-flow profiles and new control surfaces. The researchers are exploring specific aeroelastic phenomena by using computer simulations and wind tunnel experiments, so that they can be taken into account early in the design of future aircraft.

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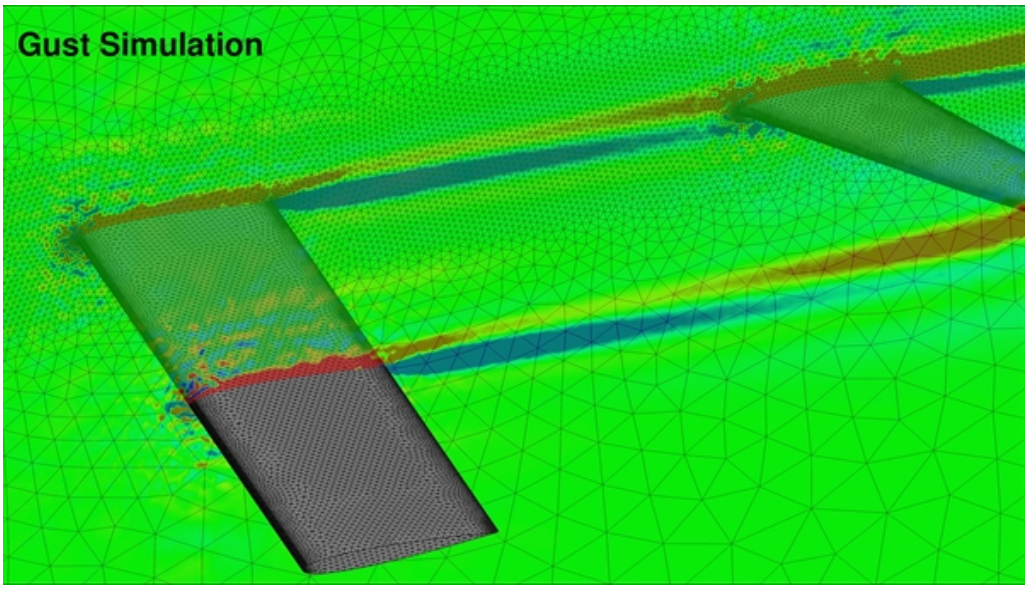
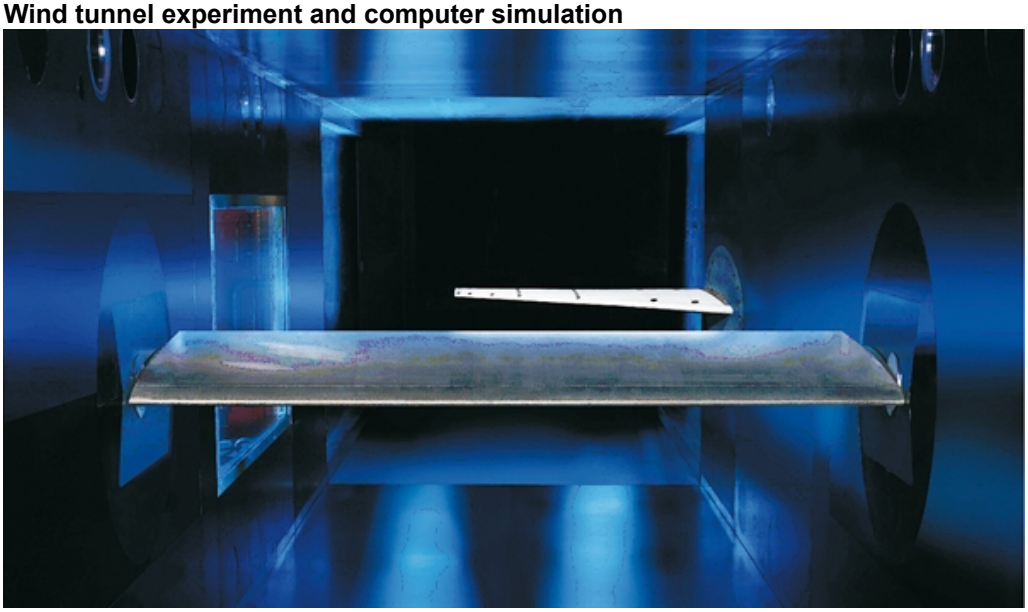
Turbulence simulation



Computer simulation of the turbulence around models of a wing and horizontal stabiliser, as would occur during a gust of wind. The red areas show strong vortices, the blue shows areas with opposite rotation.

Wind tunnel experiment and computer simulation



Air flows around a rectangular wing in the 50-metre-long transonic wind tunnel at Göttingen. The wing is then caused to oscillate, as can happen during flight. This leads to turbulence in the airflow, which impacts another, smaller aerofoil that also begins to oscillate.

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