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Swept wings: the breakthrough to modern aviation

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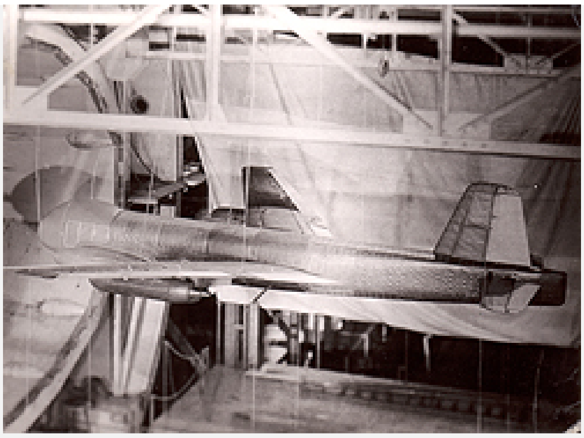
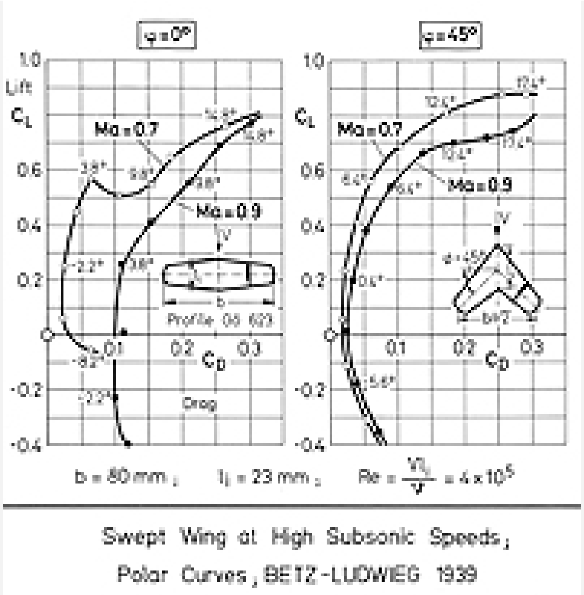


First aircraft with swept wings: Ju 287

The fact that intercontinental air travel with acceptable flight times is an everyday occurrence today is due to an apparently simple idea: the swept wing. Seventy years ago, the advantages of a swept wing in comparison to an unswept or straight one was experimentally demonstrated for the first time at the Aerodynamics Research Institute (Aerodynamische Versuchsanstalt; AVA) in Göttingen, the precursor of today's German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR).

In the 1930s, the fastest aircraft of the time hit an invisible limit: the sound barrier. As soon as aircraft came anywhere near this barrier, they became increasingly difficult to control. The rudders stopped responding, the wings began to vibrate and the whole aircraft was thoroughly shaken up. Aircraft frequently crashed as a consequence. Because of this, many researchers believed that sustained flight speeds of 800 to 900 kilometres per hour, commonplace today, were impossible.



Measurement of the swept-wing effect

Significance only recognised in Germany

In 1935, Adolf Busemann, who studied under the Göttingen aeronautics research pioneer Ludwig Prandtl, presented the idea of the swept wing at a congress in Italy. However, the suggestion of this 34-year-old, unknown in the scientific community, was ignored: "He was very young for a scientist and his idea of supersonic flight was considered to be impossible, even by leading researchers," explains Prof. Hans-Ulrich Meier, for many years a Head of Department in today’s DLR facility at Göttingen.


Adolf Busemann

In his book 'Die Pfeilflügelentwicklung in Deutschland bis 1945' (The Development of the Swept Wing in Germany until 1945), Meier describes how the significance of the new invention as the basis for high-speed flight was only recognised in Germany. "One reason for this was undoubtedly the search for superior weapons systems for the impending war," Meier says. The new wing promised German fighter aircraft a speed advantage in comparison to their opponents.

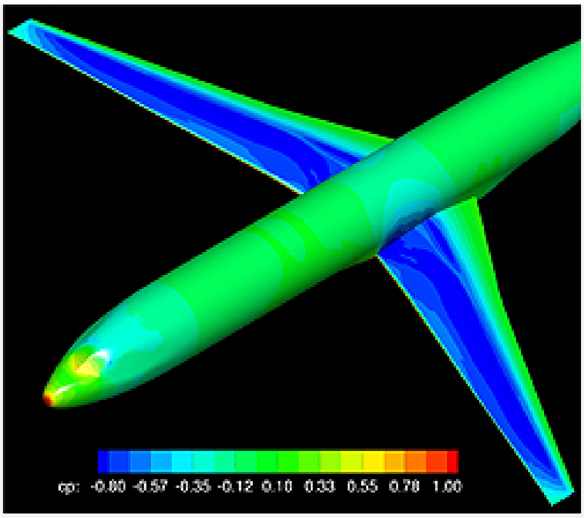
Faster with swept wings

Hubert Ludwieg

In late 1939, Hubert Ludwieg carried out the first swept-wing measurements at AVA. Busemann had, in the meantime, become head of the new German Institute of Aviation Research (Deutsche Forschungsanstalt für Luftfahrt; DFL) in Braunschweig. Ludwieg's measurements confirmed the correctness of Busemann's theory for the first time. A swept wing allows an aircraft to fly faster because the drag is reduced.

If, then, the swept wing was the prerequisite for high-speed and supersonic flight, the jet engine provided the necessary power. In 1939, the first jet aircraft in the world took to the skies in the shape of the Heinkel 178. Swept wings and jet propulsion were combined in an aircraft for the first time in 1944, in the Junkers 287, based on the research undertaken at Göttingen. Interestingly, the latter had wings that were swept forward – a concept that has only been recently revived, due to its difficult flight characteristics.

An old concept revisited: the swept-forward wing



EU NACRE project

DLR has been conducting research into swept-forward wings at its Braunschweig facility as part of the EU New Aircraft Concepts REsearch (NACRE) project. Aerodynamic drag is to be reduced using what is known as 'laminar technology'. For long-distance aircraft in particular, the swept-forward wing combined with laminar technology produces a clear fuel saving: "Such an aircraft could fly just as fast but use less fuel, and thus fly more cleanly, than conventional aircraft," says Dr Heiko Geyr von Schweppenburg from the DLR Institute of Aerodynamics and Flow Technology (Institut für Aerodynamik und Strömungstechnik; IAS) at Braunschweig. As a result of this potential, such a configuration is now being investigated in the DLR LamAir project.

Knowledge-transfer to the USA

In contrast to jet propulsion, the swept wing was not used during the Second World War. Models such as the legendary first operational jet aircraft, the Messerschmitt 262, did not have swept wings. This was because this new wing shape also produced many problems. Lift and stability are worse than for unswept wings.

Messerschmitt 262

At the end of the War, the Allies secured the knowledge acquired in Germany for themselves: thousands of tons of documents were shipped to the USA, Britain and the Soviet Union. The German researchers were obliged to commit everything they knew to paper. This knowledge is documented in the 'Göttingen Monographs', still of significance today, and has been translated into English. "A thousand pages, dealing only with the best possible way to integrate the engine into the swept wing, went from Göttingen to the USA and Britain," says author Meier. Many researchers emigrated to the victorious powers. Adolf Busemann, the inventor of the swept wing, went to the USA, where he continued his research, first at NASA and then as a professor at the University of Colorado in Boulder.

Basis of modern aviation

Forerunner of modern passenger jets: Boeing 707

The discoveries made in Germany became the basis of modern aviation. The Americans combined the results in the B47 jet bomber. This in turn was the precursor of the Boeing 707, which introduced the age of civilian jet travel. All of today’s giant civilian airliners are based on the B707. A direct line can be drawn from Busemann’s swept wing idea via the Junkers 287 to modern aircraft such as the Airbus 380.

Today, the former wartime enemies are working together in the field of swept-wing research. In an international project to test modern computational techniques, the aerospace research institutions of the USA, France and Germany (NASA, ONERA and DLR) have recently created a comprehensive experimental database for a wind tunnel model of a commercial airliner. The aim of the database is to help enable the development of further improvements in wing shape in the future.

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