Lightplane Wing Design

NASA ANTISTALL TECHNOLOGY IMPROVED THE SAFETY AND PERFORMANCE OF A NEW HOMEBUILT AIRPLANE

The airplane pictured is a two-place Venture, a "homebuilt" assembled by the buyer from a kit of components designed and manufactured by Questair, Greensboro, North Carolina. It is a high performance lightplane that can cruise at more than 250 knots and climb at 3,000 feet a minute. Additionally, it has excellent low speed characteristics and enhanced safety due to NASA technology incorporated in its unusual wing design.

The Venture has a high aspect ratio wing, long in span in relation to its chord, with relatively high lift and low drag. For that reason, it was selected as the airplane to be employed in a joint NASA/North Carolina State University (NCSU) research project involving new techniques for preventing aircraft stall at high angles of attack (the angle between the wing and the air through which it is moving).

A stall, which can cause loss of control, occurs when the airplane loses lift due to disturbance of the smooth airflow over and under its wing. At high angles of attack, the airflow breaks away, or "separates" from the wing surface and causes stall.

The standard industry method of countering separation is the addition of "stall strips" that fence and direct air to improve the wing's stall characteristics, but this technique involves some loss of wing lift. NASA had developed another solution that employed drooped wing leading edges to bar separation; experimentation, however, was incomplete. The method had been tested extensively on conventional moderate aspect ratio wings but much less work had been done on high aspect ratio.

NCSU, in the form of graduate students Holly Meyer Ross and Bruce Owens, advised by Dr. John N. Perkins, associate head of the Department of Mechanical and Aerospace Engineering, joined with Langley Research Center to advance the database of the antistall technology and extend it to aircraft with high aspect ratio wings.

Ross, Owens and Perkins, together with NCSU lecturer Robert J. Vess and Langley engineer Long P. Yip, spent seven months of 1987 working on the Venture project. They performed wind tunnel and radio controlled model tests at Langley, analyzed the results and recommended a wing modification for the Venture.

The modification consisted of a droop in the leading edges of the wings near the tips, plus two "slots" cut into the leading edge of each wing. The slots create small whirlpool-like airflows called vortices that add energy to the airflow and prevent separation. Wind tunnel tests showed that the NCSU/Langley droop/slot combination delayed airflow separation and improved control, thus providing more usable lift than the stall strips. Flight tests with the Venture confirmed the effectiveness of the droop/slot configuration.

The modification was adopted on the Venture prototype, which was further tested by the company; the airplane subsequently set 10 world speed records for small single engine aircraft. The homebuilt is now in production and commercially available. Questair officials state that the NCSU/NASA work enabled the company "to establish a new standard in stall departure/high angle of attack flying qualities for general aviation aircraft. ●