NASA RESEARCH FINDS AIRCRAFT SURFACE GROOVES MAY TAME TURBULENCE

Barely visible grooves, on the surface of an airplane, may help to tame drag-producing air turbulence and increase fuel efficiency, NASA research has shown.

The grooves, shaped like tiny "v's" with the angle pointing forward on the fuselage, might be no more than two-thousandths of an inch deep. But they would be deep enough, NASA thinks, to favorably alter the turbulent flow of air that forms over the surface of a moving airplane.

On today's airplane surfaces, most of the air flow is turbulent. Within this flow are violent eruptions called bursts that begin at the surface which are responsible for most of what aerodynamicists call "skin friction drag" and nearly half the total aerodynamic drag on an airplane. If the intensity of these bursts can be reduced, the reduction in drag would translate directly into lower fuel consumption or an increase in aircraft speed.

Reducing skin friction drag has been targeted by NASA's Langley Research Center, Hampton, Va., as a research goal of the 1980's, with a major focus on understanding and control of turbulent bursts.

Experiments at Langley have shown that small "v" grooves with equal height and spacing can reduce net turbulent skin friction drag up to 10 percent, compared with
ungrooved smooth surfaces. The grooves, also called "riblets," were machined into flat aluminum samples and tested in wind tunnels.

A turbulent drag reduction of 10 percent would translate to a fuel savings of about 2 1/2 percent, a potentially hefty $200-300 million annual savings for the U.S. commercial airline fleet, estimates Jerry N. Hefner, a researcher in Langley's High-Speed Aerodynamics Division. The division's long-range goal, he says, is to double the demonstrated drag reduction to 20 percent, providing a five percent savings in fuel.

"When we change a flat smooth surface into small riblets of the size we're studying," says Hefner, "we're really talking about v-shaped valleys the size of scratches. Although these precise little grooves are small, they obviously have a pronounced effect on the turbulence and skin friction drag."

Confidence is rising that these relatively small-scale results can be repeated under flight conditions on a full-sized air transport. If the concept continues to prove itself in ground tests, the first flight test could come in 18 to 24 months.

An item published in NASA's "Tech Briefs," a magazine devoted to transfer of technology to U.S. industry, prompted the 3M Co. of St. Paul, Minn., to design and produce test specimens of riblets in tape form. The company determined it would be simpler to take a lightweight extruded film with adhesive backing and press it into place, rather than groove the metal skin.

In Langley tests, these grooved plastic films are reducing turbulent drag as well as, or better than, machined aluminum surfaces with the same groove sizes and shapes, reports Michael J. Walsh, principal researcher in Langley's riblet work.

Some surface areas may not benefit from riblets. Where the flow of air over the airplane is not turbulent, a smooth ungrooved surface would be best; in highly complicated flows over wing and tail surfaces, further research is needed to determine if riblets will significantly reduce skin friction drag. Even with these exceptions, a majority of the fuselage — representing about half the area of the aircraft — remains a
good candidate for riblets.

Repair of damaged riblet surfaces is not expected to be a problem on an airplane with plastic film. The old sheet would simply be pulled off and a new sheet, cut to fit, would be applied in its place. In much the same way, plastic or some similarly grooved film could be applied to existing aircraft as a relatively economical retrofit measure.

Recent observations indicate that projections on the skin of fast-swimming sharks resemble riblets. Called dermal denticles, the projections are made of the same material as shark's teeth and typically have four or five very small grooves on what looks, to the unaided eye, like tiny flat surfaces. Slower sharks also have grooved projections, but the grooves do not line up to create the effect of continuous v-grooves.

Research at Langley identified the riblet concept and its precise v shape before this clue from nature was found. The concept was derived by NASA from research indicating favorable flow characteristics of water through triangular pipes. The idea of adding sharks data came from an effort in the Soviet Union to uncover secrets from the animal world to aid in the more efficient propulsion of airplanes, ships and submarines.

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