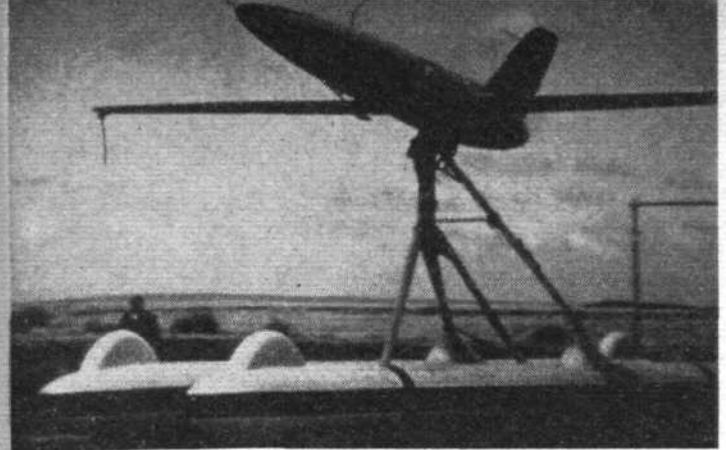

Several years ago Vickers conducted free-flight trials of variable-sweep test vehicles operated from a trolley on the airfield at Predannack, Cornwall. These photographs are taken from a 16mm colour film which is the only record to have been passed for publication

shapes, he showed plan views of the podded delta-wing Hustler ("which can fly at Mach 2 for a *very* short time"), the cancelled Avro canard bomber and a "RAE bomber" layout. (This last was the conventional missile-like design with engine pods on the tips of tiny straight wings illustrated by Sir Arnold Hall in a lecture four or five years ago.—J.H.S.) Indecision in layout, said Dr Wallis, is because people are trying to make the wrong sort of aeroplane altogether.

The right way to achieve high supersonic L/D is to use a slender delta, so that every part lies behind the high-density air of the Mach cone, and to cut away the backside—which is almost useless for lift but contributes much drag because of the separated flow in supersonic flight. It is not surprising that nobody had thought of using it before, since it would be impossible to take off or land without a 20ft high undercarriage.

Dr Wallis then showed slides and films of the "Swallow" and its wartime forerunner the variable-sweep "Wild Goose," both of which were flown as large models from Predannack Aerodrome near the Lizard.

The "Wild Goose" project was a laminar-flow body, a slender ovoid with variable-incidence wings set well aft and a highly swept fin, which was launched at 100 mph from a carriage with a swivelling head to cater for cross winds. Co-ordinated and differential changes of sweepback provided three-axis control. There was no autopilot. The system of radio pilotage was curious, with a "pitch (height) pilot" at the end of the runway and a broadside "roll pilot." It was, said Dr Wallis, difficult to keep the clean aircraft within the aerodrome perimeter—a Security requirement. Perhaps the most surprising feature of the "Wild Goose" film was the steadiness of the flight (one circuit was shown from a camera under the belly) since the pilot, as much as two miles away, had to recognize attitude changes through binoculars and so he tended to over-correct. There was no sign of slithery, yawing turns, which might have been expected from the unconventional method of modifying the forces of equilibrium.

Association of ideas connected the early project with variable sweepback for control, to the solution of the low-speed problems of the cut-out delta for lowest drag at high supersonic speeds.

By a sadly human slip-up the "Swallow" model was lost on its first flight; because, in the excitement of the moment, the pitch pilot forgot to switch off, so that the roll pilot could not gain control to bring the model into the circuit and it flew out into the English Channel. It should have floated for some time, but the coastguards said the tide would drift north, whereas the Channel current must have taken it south, for it was never seen again. Shortly afterwards, the Ministry of Supply, having spent well under a million on the project decided "enough of this nonsense" and support was withdrawn. (One understands that the project, although dropped in May 1957, has again been under consideration since February last with substantial financial support from NASA.—J.H.S.)

This free-flight subsonic "Swallow," apparently of about 30ft span, was powered by two small rockets and had tip fins and elevons. The film showed that it took off at high incidence necessary to obtain the lift contribution from the triangular body/wing, in addition to that of the main surfaces, the "swallowtails," which were set approximately normal to the centreline. Having climbed to a moderate height, the model assumed a slightly nose-up position for level flight. It was markedly steady and, particularly since the consumption of rocket fuel would have modified its weight considerably and rapidly, it is apparent that sufficient pitch stability is obtainable from the lift of the delta portion of the surface, while the oblique leading edges and general side area satisfy roll and yaw needs. The high aspect ratio of the wings in the forward position would give low induced drag and high take-off lift coefficients without flaps.

Supersonic models of the "Swallow" have been successfully flown, but permission to show RAE films of these was not forthcoming.

To get an idea of proportions, the seemingly slender swallowtails of the demonstration model at the lecture appeared to have a thickness ratio of about 15 per cent (structurally) in the forward position, which must have been reduced to something like 4 per cent (aerodynamically) in the line of flight when swept at about 80°. Thus there is no lack of structural depth to give strength in bending, while the narrow chord must keep torsional loads low.

In the "Swallow," wing sweep is co-ordinated and not used for flying control, the greatest problem being to maintain a steady c.g./c.p. relationship during the geometrical changes. One would expect the aeroplane to accelerate automatically as the wings move back and reduce both frontal area and wave drag, so that it would probably chase its M_{crit}, as this value rose with the increasing sweepback. The wing pivots, which are obviously the key secret of Dr Wallis's exceptional mechanical genius are, he says, "something like that used for training a gun." This suggests a fulcrum and lever, possibly with an arcuate (irreversible) rack-and-pinion.

One slide showed fuel tanks in the greater part of the swallowtails and along each flank of the body/wing. Dr Wallis said that the engine nacelles were placed far out as an aid to the c.g. problem—the c.p. moves aft with the sweepback angle and there must be a compensating rearward shift of weight. The engines have to be swivelled to maintain them in the line of flight and from this point "you may as well make them tiltable in pitch as well so that they act as elevators, ailerons and rudders." The areas of the twin nacelles are large and they evidently act aerodynamically, possibly with a little assistance from the deflected jet thrust lines. The nacelles suggest moderate size afterburning turbojets, pivoted well aft so that the weight of the engines can act as mass balances. The pylons of the nacelles are vee-shaped, the apices being next to the wing surface, to give clearance for movements in pitch. One would imagine that the problems of rigidity and suppression of feedback and flutter of the all-ways moving nacelles would be considerable even with power actuation, but Dr Wallis thrives on mechanical problems! Control of the nacelles as aerodynamic surfaces would be from conventional stick and rudder pedals.

Some changes from the original layout drawings are noticeable in the demonstration model. Most marked is the downward curve of the nose to meet the rising airflow produced by the wing lift.

On each side of the body/wing are two long strakes, just about where one would expect the main wheels to be. Published results of tunnel tests on narrow deltas mention severe vortex separation at high incidence and these strakes may be fences.

There is also a small tail projecting aft from the centreline, which one might guess contains a precautionary ground bumper rather than having any aerodynamic significance. One is strengthened in this surmise by Dr Wallis's words when explaining how the original laminar-flow fuselage of the "Wild Goose" came to be flattened into a narrow delta body/wing: "All wetted surfaces produce drag, therefore flatten the fuselage and cut out the tail."

A supersonic aeroplane of this type would have a wing loading of about 40lb/sq ft, not 100lb/sq ft, and would take off at 100 mph in two or three hundred yards. In conversation, Dr Wallis referred to a new Ministry of Aviation design contract for a 50,000lb naval version, possibly with Bristol Siddeley Orpheus engines, which would be able to patrol subsonically for hours with its wings spread and accelerate rapidly to high supersonic speed as its wings went back. He thought that such military development was essential for the financing and pioneering of a revolutionary project. A 60-passenger long-range airliner would weigh about 100,000lb, would have a span (spread) of 130ft and a similar overall length with the wings swept.

A rather controversial statement is that it would be possible to operate a daily return service to Australia with one Swallow—flying time for the return flight would be about 10 hours.

Dr Wallis's closing words to his young audience were undoubtedly the text of his own career: "In the course of your work you will make many friends, but you will also meet many obstructors—then never, *never* give up!" J.H.S.