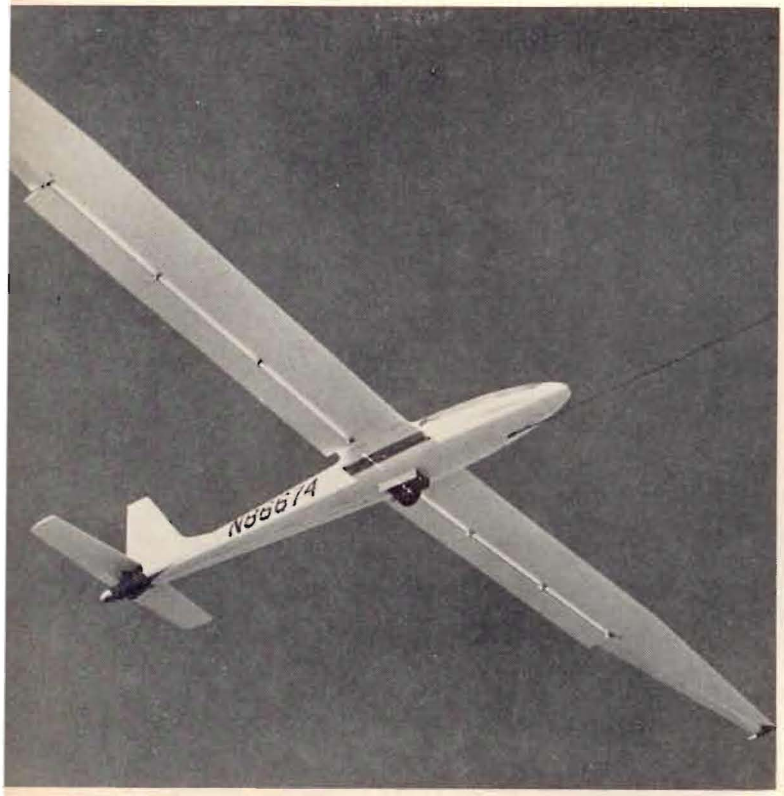

Zefir Two, photographed on tow by George Uveges.

VARIABLE-GEOMETRY GLIDERS

by Frank G. Irving, MEng, DIC, AFRAeS

The variable-geometry wing is certain to play a very large part in Project Sigma, the British Gliding Association's endeavor to develop an ultra-high-performance sailplane for the next world championships. In this article, reprinted by kind permission of Flight International, Mr. Frank Irving, Chairman of the BGA Technical Committe, explains the technical background of the project.

THE time inevitably comes when a significant improvement in the characteristics of any technological device can only be achieved by a fundamental change in the concept. Biplanes have been succeeded by monoplanes, and piston engines by turbojets. The design of gliders is beginning to undergo an analogous change, because there is relatively little worthwhile improvement to be made to the fixed-geometry machine.

Progress in the 15 years or so before the last war was quite rapid but since then it has slowed considerably, despite the wartime and postwar developments in low-drag wing-section design. The Dart 17 of today is about 27 per cent better than the Weihe of 1938 in terms of best lift/drag ratio, so the average annual rate of improvement has been about one per cent. Undoubtedly, there are further gains to be made, but we are well into the region of diminishing returns.

The purpose of this article is to show how a significant advance is possible by adopting variable geometry. Of course, this is not an entirely novel thought: several types of gliders have been designed with camber- and/or area-changing flaps, recent notable types being the D-36 (Germany) and the BJ-2 (South Africa). But it seems useful to review the possibilities of variable geometry for operation in temperate-climate thermal conditions.

The only really novel feature of the possible gliders discussed here rests on the assumption that quite large changes of wing area are mechanically feasible. The history of aviation suggests that, if there is a sufficiently strong requirement for a structure or mechanism to do a particular job, then somebody will produce a solution. Another implied assumption is that the weight penalty will not be large. This is not very fundamental so far as the general conclusions are concerned: if the weight penalty is noticeable, the gliders will just have to be rather bigger.

High performance gliders are generally intended to travel at the maximum average speed which is possible under the prevailing weather conditions. This is the only type of soaring flight considered here, since it represents the normal contest or record-breaking situations. At intermediate levels, there may be a demand for gliders which stay up and earn money: these are not considered specifically, although they emerge as a by-product.

The usual starting point when considering glider performance is to contemplate an idealised cross-country flight. We assume a still-air situation, and subsequently superimpose any wind on the final result. We also neglect the effects of the beginning and end of the flight. In some conditions these assumptions are not valid. For example, a 100-km triangle has a beginning and three final glides which occupy a large proportion of the total flight. So we are only concerned with fairly long flights consisting of a series of climbs in thermals followed by straight glides between them. The ideal situation assumes thermals of uniform strength, and then there exists a simple construction for finding the best speed to fly from one to another (Fig. 1).

In practice, the thermals are rarely of uniform strength, but the pilot is not given powers of foresight—or not very much—when forecasting future thermal strengths. So he tends to optimize each climb-glide sector of the flight unless there is a good reason for doing otherwise (e.g. positive evidence that the next thermal is a long way ahead, so that it will pay to fly for best range rather than maximum speed.) Also, there exist other ways af organizing a flight, so that the chance of completing it is improved.

Obviously, the maximum chance of arriving (unless darkness intervenes) is obtained by flying at one's best gliding angle between thermals. For the fastest flight, one's chances of arriving (assuming a Gaussian distribution of thermals) are noticeably diminished.

But, for the present purposes, we will consider the simple climb-glide sequence, and the corresponding construction which gives the best speed to fly between thermals together with the average speed. This, of