TAILLESS, CANARD, & CONVENTIONAL DESIGNS... A DISCUSSION OF PERFORMANCE POTENTIAL

From TWITT's (The Wing Is The Thing) Newsletter #28, October, 1988:

NOT A TAILLESS FAN

Victor Mead Saudek of Los Angeles writes:

...I shall make a few comments on your TWITT movement at this point: It has been very well established that nothing in the way of sailplanes can be cleaner than the conventional tail-in-the-rear configuration. To claim otherwise is to allow emotions to overcome hard won knowledge. With the prospect of making even incremental gains in performance giving one manufacturer great increases in sales you can bet the farm and your family that G. Weibel, Klaus Holighaus and others have examined this field very diligently. It is true that some features have recently been discovered - such as Les(?) Schueman(?) who figured out the double sweep back near the wing tip - and Holighaus now builds the Discus, but this is a small advantage. You should realize that when racing sailplanes are costing $45,000 in the US, there are great incentives to examine every possible detail to get an advantage.

Recall the idea of tail-first concepts by Burt Rutan and how they were advertised as being "stable" and "clean." Well, it isn't so and Technical Soaring for July 1988 has an article on the subject: "Canards: the Myths and the Realities" by Albert W. Blackburn. Any way you cut it, the forward surface should be several times the aft surface area for performance. The reasons for this have long been known. And the tailless designs are inherently poorer than tailfirst! All-wing aircraft have tails - the reflexed trailing edge of the airfoil - but this is too close to the lifting part of the wing and must always reduce that lift. With a smaller surface further aft, the tail can balance the overturning (tendency to dive) moment of the airfoil with a light downward load and little drag while the wing can have an optimum low drag airfoil.

To increase L/D of sailplanes one can reduce the waviness of airfoil surfaces (see Soaring, Dec 1987), use endplates on wingtips (carefully) and minimize interference drag at the intersections (wing-to-fuselage). The next big step will be active boundary layer control (using solar cells?) which should give L/D of 100 or so. If I haven't convinced you, I am not surprised or sad unless you invest too much money in the chasing of the tailless "Will of the Wisp."

Vic Saudek

TWITT Editor's Comments:

It seems naive to advance non-use as proof of lack of merit. I must candidly confess my ignorance of the intricacies of sailplane design, but areas of technology with which I am familiar - and there are a few of those - are littered with meritorious ideas which are simply left unused. Some are very complicated to analyze (e.g. free-piston engines) while others cannot leap the retooling barrier; others are neglected out of sheer ignorance. In this connection, the high cost and low sales volume of high-performance sailplanes would seem to provide a *dis*incentive to innovation; I know of no practical way to squeeze "great increases in sales" from a miniscule market. There is no **technical** reason to discount tailless sailplanes *a priori*; the induced drag argument fails to consider the aircraft as a whole when considering the conventional layout. It is the downwash distribution in the wake of the aircraft - **due to the entire aircraft** - which determines whether the aircraft will have minimum induced drag. Optimum downwash gives optimum induced drag, **regardless of how it is achieved.** There is good reason to believe that a tailless design could have *better* induced drag, at equal span, than a conventional machine. If a wake displacement is taken into account, the advantage of the tailless airplane would seem to increase at off-design lift coefficients. The lower skin-friction drag of the tailless, and the near absence of crossflow drag in curvilinear flight, seem to favor it even more. It is not clear to me why Mr. Saudek mentions canards in connection with flying wings, as they have little in common. The basis for his claim that flying wings are somehow "worse" is equally obscure. The record of the Horten machines in international and national competition suggests very strongly that the big problem of tailless sailplanes is not aerodynamic at all - they have atrocious ground handling qualities and are vulnerable to damage during out-landings. It would actually be easier to apply boundary layer control to a tailless machine, and the availability of power for suction raises the intriguing possibility (which certain TWITTs are investigating) of using **active stabilization** as well, allowing operation with the cg behind the neutral point of the aircraft.

Marc DePiolenc

And a comment from Klaus Savier, as well, in Newsletter #29:

In engineering it is simply performance and cost which rule. If one configuration consistently shows better performance than others, it is wise to accept the fact that this configuration is better. Aerodynamic performance cannot be evaluated adequately by looking at skin friction drag and induced drag alone; there is more to the story.

Most canard configured airplanes generate a drag problem during turning flight, and thus are not a good choice for an airplane which is required to turn 80% of the time, i.e. sailplanes. This problem does not disqualify canards when they are evaluated on a broader spectrum. For the past seven years, general aviation aircraft performance has been meticulously measured and evaluated at the CAFE race in Santa Rosa, CA. CAFE stands for Comparative Aircraft Flight Efficiency, and we score:

$$\text{mph}^{1.25} \times \text{payload}^{0.75} \times \text{mpg},$$

which can also be written

$$\text{mph}^{2.25} \times \text{payload}^{0.75}/\text{gph}.$$

As you can see, speed and efficiency are of greatest value. The airplanes are flown at or near gross weight around a 400 km course - climbing, descending and turning around pylons. There is no doubt that low drag is highly desirable in this event, yet it has always been won by canard configured airplanes. I entered the CAFE race four years ago. Since then the three top places in the two-seat category have always been taken by canards! This year Gary Hertzler (VariEze), Gene Sheehan (Q200) and I scored within 3% of each other. Fourth place went to Mike Maxwell and co-pilot Ray Cote in Mike's meticulously race-prepared Lancair. Its score was 25% lower!

I would like to invite all believers in the "old configuration" to perfrom in the CAFE race or fly your old configuration nonstop, unrefuelled around the world. My hat and goggles to you if you win. Until then: put up or shut up.

Klaus Savier

All of the above information concerns full sized aircraft, particularly the powered type. We feel, however, that much of what is said is applicable to the improvement of our R/C sailplanes. Of particular note are the topics of boundary layer control, drag measurement, and CG location. We're hoping that you will be able to pick up a few other enticing tidbits and incorporate something new in your next project.