Note:
The Sky Sailing Duo Discus is a Duo Discus XL, which has some differences from the model tested in this report.

A Flight Test of the Du

Richard H.

N117GV on TSA's long and wide N/S grass runway. Note the sailplane's graceful lines and distinctive polyhedraled and swept back wing tips.

SUMMARY

The Duo Discus is a new two-seated high performance composite sailplane being produced by the well-known Schempp-Hirth sailplane factory in Germany. It was modeled after the highly successful single-seated Discus Standard Class racing sailplane that has been in production at Schempp-Hirth since 1985. Being a two-seater, its wing span was increased from the single-seated Standard Class 15-meter span to a full 20-meter almost Open Class span. The wing is sensibly divided into four sections with the inner panels comprising 15-meters of the span, and the outer panels adding the final 5 meters of span. That way the wings fit into a trailer that is not much longer than a standard 15-meter sailplane's trailer. This two-seated enlarged model of the Discus was created to provide the sailplane market with a safe and easy to fly high-performance two-place that was not as complicated as the modern flapped Open Class competition sailplanes.

INTRODUCTION

Figure 1 shows a three-view drawing of the Duo Discus sailplane. With its multiple swept wing leading edges and polyhedraled wing tips, it certainly has modern and graceful lines. The retractable main landing wheel has a generously sized 6.00 inch wide by 5 inch diameter hub that supports a 14.5 inch diameter tire. In its extended position, the wheel provides moderate but adequate ground clearance for the fuselage. The wheel is equipped with a hydraulic disc brake that is connected to both the squeeze grip on the cockpit control sticks, and the final portion of the airbrake handle actuation.

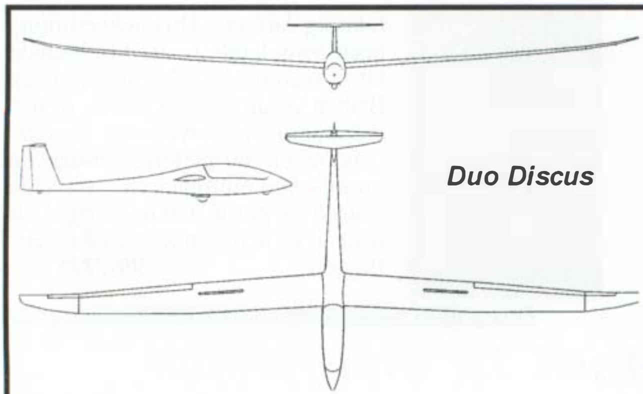

FIGURE 1-Three-side view.

The wheel brake is powerful, but one does not have to worry about putting the sailplane up on its nose during heavy braking because the fuselage nose is equipped with a non-retracting 3.00 by 4 by 9 inch diameter wheel placed there for its protection. The sailplane main wheel is located well ahead of the Duo's normal flight C.G.; therefore, it normally rests with its tail down when on the ground, unlike the more common Grob and Schweizer trainers. The tail wheel is a standard 200 by 50 mm pneumatic unit that is 6.75 inches in diameter.

The Duo Discus carries one water ballast tank in each wing, each capable of holding about 99 liters (218 lb). The wing ballast tanks are integral types that have internal baffles to limit ballast shifting when partial water ballast is carried. Relatively large one inch diameter conic water ballast dump valves are provided in the under surface of each wing. The dump valves are located about two meters out from the fuselage, and are easily accessible for sealing with grease or wax. The tanks are filled thru top surface fill ports located about mid-span on the wing, using standard funnel techniques. A small water ballast tank is provided in the fuselage tail fin such that the sailplane's center of gravity can be optimized, just as it is with the single-seated 15-meter Discus models. It is an excellently designed water ballast system!

The wing is equipped with 1.4-meter long top surface-only Schempp-Hirth type airbrakes that are easy to operate, and they perform well. Their effectiveness is fairly high, and full deployment combined with a sideslip provide adequately steep descent angles. All of the controls connect automatically upon assembly, and that is certainly commendable.

The wing airfoil was said to be designed by Horstmann & Quast, who are well-known sailplane airfoil designers in Berlin. As will be shown, they have succeeded in designing the outstanding HQ-31-A/XX airfoil.

AIRSPEED CALIBRATION

When the TSA Partnership of Jacobs/Park/Smith/Voltz and Voltz received their beautiful new N117GV recently, they kindly offered it for flight testing and I naturally welcomed the opportunity. First a moderately high tow was made to calibrate its airspeed system. Those test data are shown in Figure 2. A standard trailing

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View of the front and aft cockpits, with the right side hinged, one-piece canopy open.

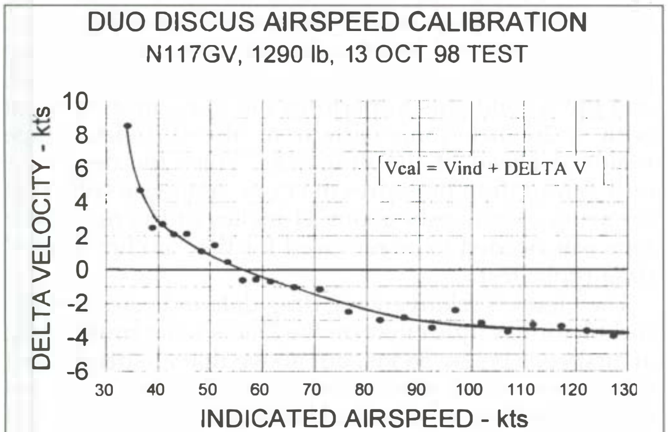


Figure 2

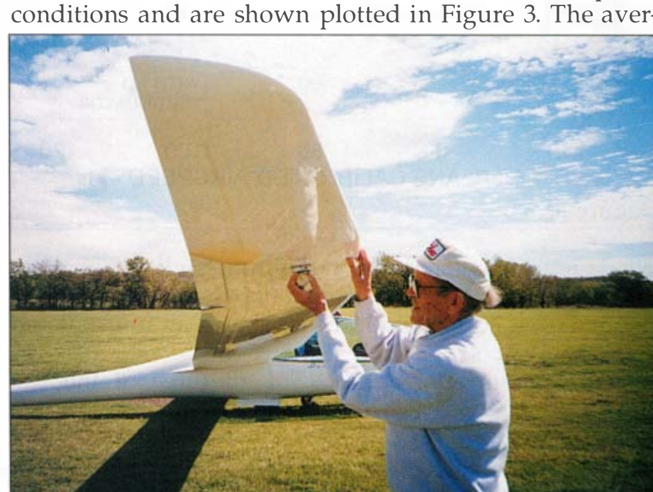
"bomb" was used for an accurate static pressure source, and a Kiel tube was temporarily taped to the side of the canopy for the accurate pitot source. The sailplane's pitot is located on the vertical tail fin. Its airspeed system static source utilizes four flush orifices that are manifolded together; two of which are located on the sides of the fuselage under the wing, and the other two are located well aft on the fuselage sides.

That manifolded multiport static pressure port system is similar to that successfully used with the Ventus 2 (Reference A). The Ventus 1's use airspeed system static sources that are located on the fuselage sides below the wing alone where they are reliable and well protected from clogging by both rain and water ballast dumping, but suffer from relatively high static system pressure errors (Reference B). Static sources located on the aft fuselage sides have always shown very low pressure errors, but they often clog when dumping water ballast or flying in rain. By manifolding the under-wing and the aft-fuselage static sources together, a highly reliable airspeed system static source is achieved with only moderate pressure errors. Obviously the pressure errors will approach the Ventus 1 values if water clogs the aft fuselage static ports, but the airspeed system should still remain functional.

Note that at the low speed end of the Duo Discus airspeed system calibration curve, the error reaches about +8.5 kts at an indicated airspeed of about 33.5 kts. That was about as slow as I could get the Duo to fly with two persons onboard, and it resulted in a calibrated airspeed of about 33.5 + 8.5 = 42 kts. The +8.5 kt measured airspeed system error is likely due to a combination of high static pressure on the under wing static ports at high angles of attack, and fuselage wake blanketing of the tail fin mounted airspeed system pitot. The airspeed system errors approach zero at about 56 kts, and at airspeeds above 90 kts indicated the calibrated airspeed appears to be only about 3 to 4 kts less than that indicated.

SINK RATE TESTING

The Texas air was relatively calm (winds less than 15 kts up to 12,000 ft) on the 13 and 14 of October 1998 and three high tows to 11,000 ft were made to measure the Duo's unballasted polar with two pilots aboard. Those data were corrected to sea level standard atmosphere conditions and are shown plotted in Figure 3. The aver-



The author performing chordwise waviness measurements with a 2 inch long wave gage on N117GV's wing lower surface near its swept back wing tip.

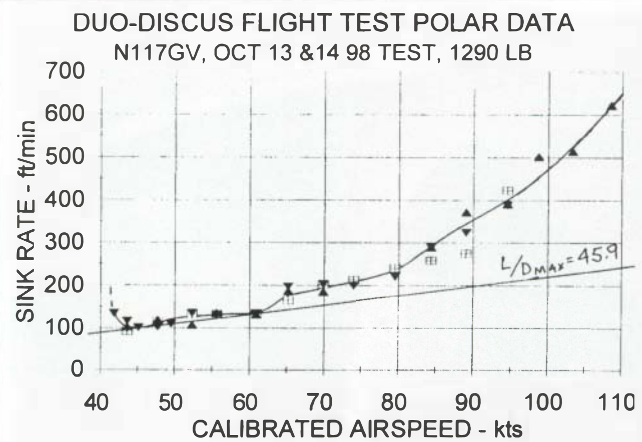


Figure 3

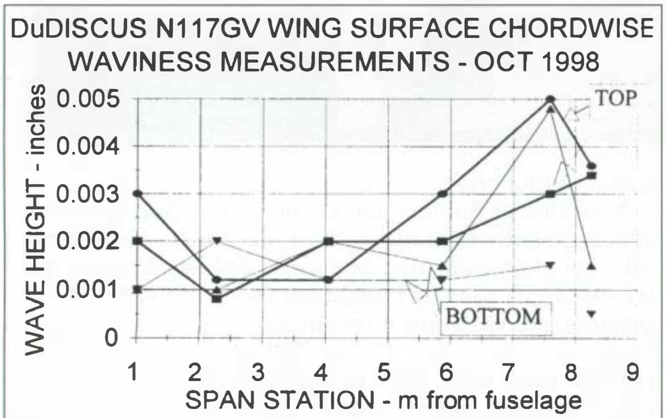


Figure 4

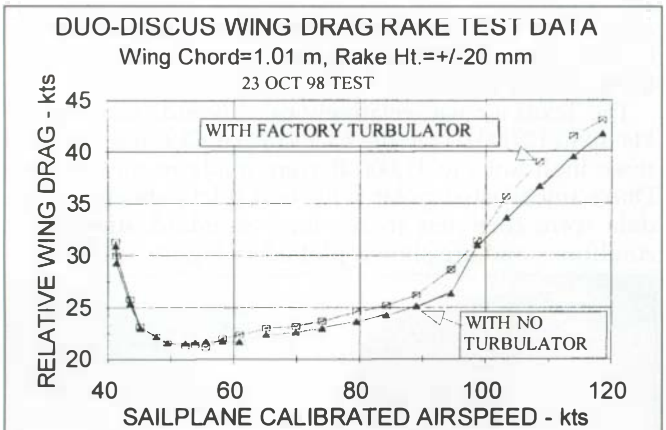


Figure 5

aged Figure 3 data indicate a minimum sink rate of about 100 ft/min at about 44 kts, and a maximum glide ratio of about 45.9 at both 45 and 61 kts. That is an unusual and remarkably good polar!

One common characteristic of all three of the test flights is the remarkably low drag (low sink rate) shown at 61 kts, followed by a substantially higher drag (higher sink rate) at 65 kts. The reason for that drag knee in the polar is uncertain, but it is likely due to some quirk in the wing's airflow at those airspeeds. This will be discussed further in the wing drag rake and oil flow testing paragraphs.

WING CHORDWISE WAVINESS MEASUREMENTS

Our test sailplane was new from the factory and it was beautifully finished with a Vorgelat T35 gelcoat. The magnitude of N117GV's wing surface chordwise waves were measured with a standard two-inch wave gage at six spanwise locations on each wing panel, and those data are shown in Figure 4. The magnitude of those waves were remarkably low, averaging only about .002 inches peak-to-peak. It will be interesting to observe how long these outstandingly smooth wings will be able to maintain their smoothness levels after baking in the hot Texas summer conditions for a year or two. I will keep my wave gage handy and check on that periodically.

WING DRAG RAKE TESTING

To better understand the Duo's wing profile drag characteristics, a +/- 20 mm high drag rake (described in References C and D) was taped to its left wing panel trailing edge about 1.2 meters out from the fuselage side. Then two 5,000 ft high tows were made during 23 October to measure the wing relative drag pressure values over a calibrated airspeed range of 42 through 119 kts, and those data are shown in Figure 5.

The Duo Discus came from the factory with a .5 mm high zig-zag turbulator attached spanwise to the wing lower surfaces at about .73 chord aft of the leading edge. The first tow was to measure the wing relative drag pressure values with the factory turbulator installed, and the second was to perform the same measurement with a 26 inch long section of the turbulator tape removed ahead of the drag rake. Since the drag rake only senses drag pressures over one spanwise section of the wing chord, only about 24 inches of the turbulator tape was needed to be removed for this "no turbulator" drag probe test.

The Figure 5 relative wing drag data indicates that the turbulator has little effect on the Duo's wing profile drag at airspeeds below 58 kts, but above that airspeed about one to three kts of relative wing drag pressure increases (drag increases) are shown. That indicates that we could likely measure somewhat lower sink rates at airspeeds above 60 kts had we removed the turbulator entirely from the wing surfaces and repeated our sink rate testing. That testing has not yet been performed, but possibly will be at a later date.

The typical laminar bucket shape of the "no turbulator" data curve indicates that the Duo Discus wing

The test Duo Discus being prepared for a test flight at the TSA Gliderport.

achieves considerable laminar flow from about 45 kts up to about 95 kts with our two pilots aboard but in unballasted flight test condition. Above that airspeed the wing drag increases rather rapidly, which is typical for a well designed laminar airfoil coming out of its optimum angle of attack region. The factory turbulator appears to be particularly harmful to the Duo's 95 kt laminar bucket edge region.

OIL FLOW TESTS

To determine how much of the Duo's wing chordwise surface actually achieved low drag laminar air flow (at our rake test station), and if a harmful laminar separation bubble existed with the turbulator tape removed, one 24 minute test flight was performed at about 55 kts with darkened (well used) 10W-40 motor oil applied to the aft .6 chord regions of the wing top and bottom surfaces at the drag rake test location. After landing, photos were taken to document the chordwise extent of the laminar flow and to show if any laminar separation bubbles were present. The Duo's wing did not appear to have any significant laminar separation bubbles anywhere in the oil test region, even where the turbulator tape was removed. A turbulator added to a wing that does not have a separation bubble problem is of no benefit to the performance and is likely to result in increased drag, as our drag rake data shows at airspeeds above 58 kts.

GENERAL CHARACTERISTICS

The single piece, side-hinged canopy provides excellent visibility from both cockpits. The cockpits are well shaped to comfortably support the pilots; however, neither cockpit is provided with a urinary relief funnel and drain tube system. The front seat instrument panel is well sized and it is capable of holding about five full sized instruments plus two smaller ones. The front pilot can comfortably reach the tow release that is mounted at the base of the instrument panel, provided that the adjustable seatback is positioned far enough forward. A second tow release handle is provided in the aft cockpit, as is a second landing gear actuation handle. The aft cockpit instrument panel is capable of holding about four large plus two small instruments. In-flight adjustable rudder pedals are provided in both cockpits. The front pair adjust over a moderately large 7.25 inch adjustment range, and the rear cockpit rudder pedals adjust over a smaller 5.35 inch range.

The landing gear retraction handle is nicely located on the right hand side of the cockpit floor, and it is equipped with both up and down positive lock detents. It takes a moderately strong force to pull the handle aft when retracting the gear, but its relatively long 9.5 inches of travel is a bit farther than some pilots can provide with their right arms alone, but I had no difficulty with it. Because our test sailplane was equipped with a nose tow hook, it was quite stable during aero tow. The left cockpit side mounted elevator trim system works well, so even during aero towing it is often possible to momentarily release the control stick while finalizing the landing gear retraction if that is needed.

The aileron control is quite good, and it is not necessary to extend the airbrakes during takeoff to achieve good roll control; as is a common procedure needed with many modern Standard Class sailplanes. +/- 45 degree rolls at 50 kts require about five seconds. The aileron control forces are fairly low for a 20-meter sailplane, but the relatively large inertia of the long wings require a some-

Another view of the wing bottom surface oil flow patterns after the 55 kt test flight.

The author using an ordinary paint brush to apply darkened 10W-40 motor oil to the aft 60% of a 42 inch wide section of the wing bottom surface, before the oil flow test flight.

The as-brushed bottom surface oiled section of the wing before takeoff. Note that the factory installed spanwise turbulator at .73 chord extends about eight inches into both the inboard and outboard portions of the oiled area. Also that a 26 inch long section of the turbulator in the central part of the oiled area was removed to see if any separation bubble did indeed exist in flight.

what longer acceleration period to start and stop their motions. A similar inertia effect is noticed with the rudder in the yaw plane.

The stalling characteristics of the Duo Discus are remarkably gentle. The level flight indicated stalling speed of the unballasted Duo Discus at our 1,290 lb flight weight was difficult to determine because of the large airspeed system errors near stall. I could not find a sharp stall point and had to settle for just wallowing and buffeting. Although buffetting started at about 38 kts indicated (about 42 kts calibrated), I could manage fairly steady level flight while indicating about 32 kts, which still calibrated to about 42 kts! I do not consider the 6 kts difference in those indicated airspeeds to be a true stall warning margin; but since the stall is so gentle, it probably does not mean much anyway. Even during turns, there was not much tendency for a wing to drop. The flight handbook specifically forbade any spins or other aerobatic maneuvers, so we did not investigate any of those. However, I could not resist doing a few gentle chandelles.

The 7.5 meter inner wing panels of N117GV each weighed about 215 pounds; the 2.5 meter long wing panels each weighed about 15 pounds. We found it handy to just remove the light outer panels when temporarily storing it in the limited space of the TSA closed hangar.

CONCLUSIONS

Overall, the Duo Discus is beautifully constructed and a very satisfactory sailplane for general sport and cross-country flying. Its current delivered price of about $108,000 with full instruments and trailer makes its ownership affordable to only a few clubs and private owners, but with syndication (group ownership) it is quite attractive. Since it does not have wing flaps and is relatively easy to fly, it does not require world class piloting skills to fly it safely. Also, adding a second pilot generally does enhance flight safety, and it can lead to some interesting discussions! Thanks go to the Texas Soaring Association for providing high tows needed, to its tow pilots who endured the cold winter skies in unheated Pawnees while making the tows (Jan Martin and Dick Mockler in particular), and to the five member TSA syndicate who kindly provided the test sailplane and assisted and recorded data during the testing.

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About the author: *An eleven time winner in U.S. National sailplane contests and long-time contributor to* Soaring Magazine, *Mr. Johnson continues his excellent work in the area of sailplane test evaluations. He has BA and MS degrees from Mississippi State University and Stanford and currently resides in Dallas, Texas where he remains active with the Texas Soaring Association.*

The one piece canopy and lowered nose provide the pilots with excellent visibility. Note the fixed nose wheel, and the large retractable main wheel and doors under the wing. The tail wheel exists, but is buried in the runway grass.

AN INSTRUCTOR'S THOUGHTS ON THE DUO DISCUS.

By Dean Carswell

The 20-meter/65.2 feet span Schempp-Hirth Duo Discus is, according to its flight manual, a sailplane for advanced training and cross-country flying. To go along with his Flight Test Evaluation, Dick Johnson kindly asked me to write up my impressions of this superior sailplane from an instructor's standpoint.

On first impression, this two-place sailplane appears big when approached; perhaps this contrast is heightened if you are more accustomed, as I am, to similarly configured Grob G-103s and Schleicher ASK-21s. The cockpits also appear high, with very deep seat pans, no doubt to limit the risk of 'submarining' in the event of a too-sudden stop. Having climbed in, I noted that the 'four point trapezoid wing' stretching away to either side again places emphasis on size. I also found the handholds beside the rear instrument panel a welcome assistance when it came time to climb back out of the deep hole.

Getting into the rear seat, I had to check my seating position carefully to ensure a good view forward. This could be helped by putting a firm pad or cushion behind my parachute and moving the rudder pedals forward to compensate. If part of the solution is to put a pad in the seat pan, then it should be the high density variety to limit compression injury in the event of high vertical deceleration. Rather surprisingly, the seatbelts were the four-point (rather than five-point) kind. The seating position is comfortable for a long flight, and view ahead reasonable.

Nominal empty weight of the test article (s/n 181) was 926 lb/420 kg which leaves a large potential disposable weight in the cockpit of 529 lb/240 kg. Adding water ballast in the wing gives a maximum gross weight of 1,543 lb/700 kg. The Manual specifies wing ballast of up to 52.3 U.S. gal/198 liters or 436 lb/198 kg. At maximum gross, wing loading is 8.7 lb/sq.ft/42.7 kg/sq.m. Up to 2.9 U.S. gal/11 liters or 24 lb/11 kg of water trimming ballast is permitted in the tail. When this is used, the manual emphasizes thoroughly checking the actual quantity used and referring to the appropriate loading chart to ensure that the aft c.g. limit is not exceeded. The water ballast dump control is incorporated in the front cockpit only. Lead ballast can be fitted below the front instrument panel, with additional (optional) ballast attached to the front control column mounting frame. Together, this compensates for a 66 lb/30 kg reduction in the front seat occupant's weight. All of this should be clear warning to the pilot to apply with care his/her CB SIFT CB or other pre-takeoff checklist to ensure safe loading.

On takeoff, the Duo Discus has good lateral control. Even in a light headwind, coarse use of aileron was sufficient to keep the wings more or less level as speed down the runway increased. However, the rather low maximum demonstrated crosswind component of 11 kt/20 km. hr may mean considerably more attention is required as that limit is approached. I did not have the opportunity to see whether this prediction was actually true. As we left the ground, the ship's near silent qualities became immediately apparent. Airflow noise was as low as in any sailplane I can remember. The tow itself was most biddable, with surprisingly little adverse yaw – a feature later confirmed in free flight by its easy coordination. The lever controlling the spring-actuated tailplane trim felt stiff and lumpy to operate. However, perhaps increased familiarity and use would change that impression.

Coming off tow, we raised the landing gear which is controlled by the front seat pilot. Although a back-up lever in the rear seat allows for physical assistance, the lever itself is quite heavy. The landing gear cannot be operated from the rear seat alone. Consequently, to avoid risk of sympathetic PIO inputs, one should not try to raise the landing gear until the Duo Discus is off tow.

In pleasant contrast to its two-place Schempp-Hirth predecessor the Janus, the Duo Discus control harmonization is very natural and sweet, which makes it a joy to fly. Rate of roll is surprisingly good for a 20m ship, and the Manual-specified rate of 4.6 seconds for a 45°/45° roll at representative thermaling speeds was borne out. But it gets even better! Once established in a thermal turn, the Duo Discus goes around as if on rails. Speed control is easy. All you have to do is watch out for the other sailplanes you will likely be passing on the way up. This of course is greatly helped by the very low min. sink rate confirmed by Dick's evaluation.

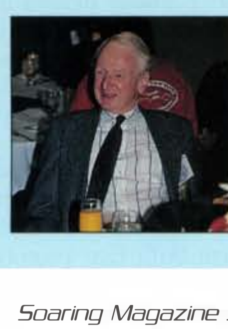
Other handling needs little specific comment. In the U.S., the ship has an approved type certificate in the utility category. Presumably because of the two-piece wings, 'no aerobatic maneuvers are permitted, including spins and steep turns'. No guidance is given in the manual as to what turn may be considered steep. The stall straight ahead was preceded by a gentle vibration; and at 38 kt/70 km.hr a sudden and rapid airspeed drop was indicated, followed by oscillation below that value. Extrapolating from Dick's analysis, this occurred around 42 kt/78 km. hr TAS at our weight of 1,280 lb/581 kg. Things were so gentle that it was never clear whether the glider was stalled or not. The same characteristics were present during a turning stall. Probably these maneuvers can be best described as the aircraft nodding and just carrying on flying. While the amount of stall warning should be categorized as 'very little', the Duo Discus appeared sufficiently docile to make the absence immaterial. Although prohibited, the manual declares that at aft c.g. a steady spinning motion is possible. Because of the stated limitation, we did not try this, but apparently recovery is easy and straightforward.

Slipping was easy and relatively effective. It became quickly apparent that the airspeed indicator was particularly sensitive to yaw. This was obvious not only during the slipping tests, but any time that even a little yaw was inadvertently allowed to develop. The airbrakes were relatively effective, with little trim change. Operation of the airbrakes with moderate sideslip should provide a steep enough descent for all practical purposes.

Performance, penetration, or whatever you want to call it, is difficult to discern sitting in the cockpit, and one is often left with subjective impressions which are not confirmed by quantitative measurement. The Duo Discus certainly gave the impression of good performance, judged by height lost when flying on a parallel course to other sailplanes. I can say with certainty that its ability to cover the ground gave me confidence that this was a sailplane with fine long legs, even without having had the opportunity to try it with water ballast aboard. Dick's flight test polar showing a best L/D of 45.9 bears this out. The Duo Discus is a ship for big cross countries!

In conclusion, the Duo Discus is a beautifully handling two-place sailplane with serious cross-country ability. Its two seats, and ability to carry water ballast, make it an excellent ship for cross-country instruction, particularly as it has the instrument panel space in both cockpits to carry all the bells and whistles you expect to see in a state-of-the-art sailplane. I am sure that it will find its niche as a very capable cross-country trainer, without forgetting its role as a very satisfactory (and satisfying) mount in its own right for one or two pilots going cross-country without the need for instruction. In addition, its tail dragging configuration, retractable gear and general handling should make it a useful tool for converting low time pilots to Standard Class and similar ships without flaps. Its size, docility and cost, however, probably make it less suitable for general training, which can be better accomplished by a ship which has fewer maneuvering restrictions and a substantially greater ability to demonstrate the major part of the regime encompassing flight at minimum control airspeed, stalling and spinning. And, I think I would have just a little trepidation in sending a student on first solo in a $110,000 sailplane.

Thanks to the five-person Duo Discus syndicate at TSA who are fortunate enough to own this super ship, and generous enough to let me carry out the flights necessary to make this evaluation. In particular, my thanks to syndicate member Glenn Park who accompanied me on all the flights and suffered me pushing his new ship around all the corners of the sky. Finally, thanks to TSA for donating the tows necessary for the tests.



About the Author: *Dean Carswell holds a Gold Badge with two diamonds, and has been instructing in sailplanes since 1963, having made over 7,000 instructional flights. He is presently the chief flight instructor of Texas Soaring Association.*