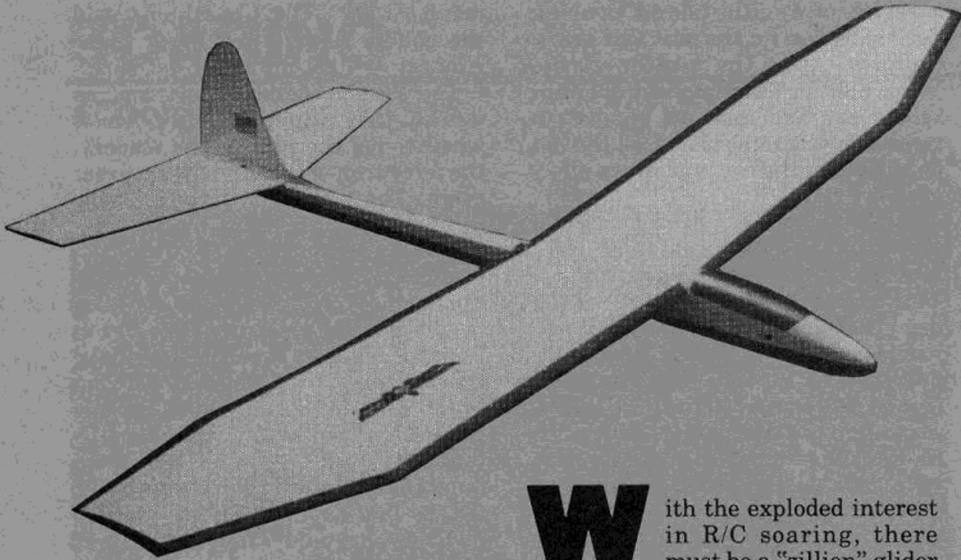


SOARER

With the exploded interest in R/C soaring, there must be a "zillion" glider designs available today. Many of them, are highly developed and obviously excellent machines. The 2-Meter class seems most popular, especially outside of competitive circles. You probably have one or two in your stable. If so, you realize that this size restriction gives a real cause to search for superior aerodynamics. Comparative research would show that the "boys" have boiled the aerodynamics down to a most successful formula; using this proven data, most 2-Meter gliders have become very similar.

With this story, still another 2-Meter glider is offered. The "Soarer" is obviously a well-proven design, otherwise the effort to produce this article would be stupid. A more positive statement would be that its characteristics and performance have been admired by glider experts --- **it is** a competitive machine.

The objective of this article is to offer you a **different** design. If your mood would be to try a different approach, the "Soarer" offers the opportunity with confidence. In short: "If you have tried the rest, try this one next, you might learn something interesting."

For sure you should never "charge into" something just to be "different." So that you will understand, the "whys" of the design should be explained.

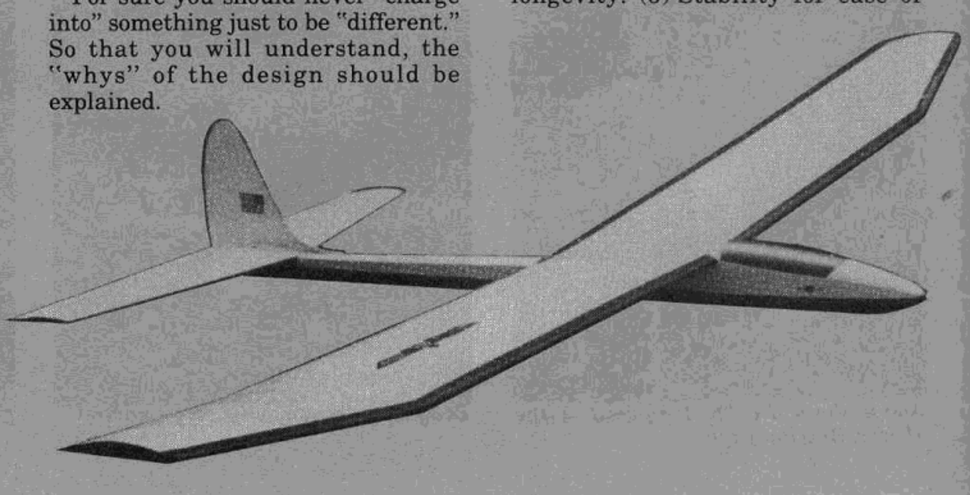
Forty years ago the Sun rose in the morning and set at night. There was an atmosphere and the Sun shown. Many things have changed, but not the things which affect the flight of our models. Modelers were searching for long flights and found them just as hard to come by as they can be today. Maybe the problem was even more severe with those very weak engines and no "hi-starts" or "winches." Perhaps with the shortcomings of those days, we modelers had to depend more upon nature's laws than we do now, with our fine mechanical assists. Perhaps aerodynamics were most important because we had little else to work with.

After watching the local glider group enjoy the sport for some time, an urge grew. First, to join the fun; second, to find out if some of the "old concepts" might work just as well in today's **light lift** conditions as they did back then. The "Soarer" is the result of that urge and is providing much enjoyment --- let's check it out . . .

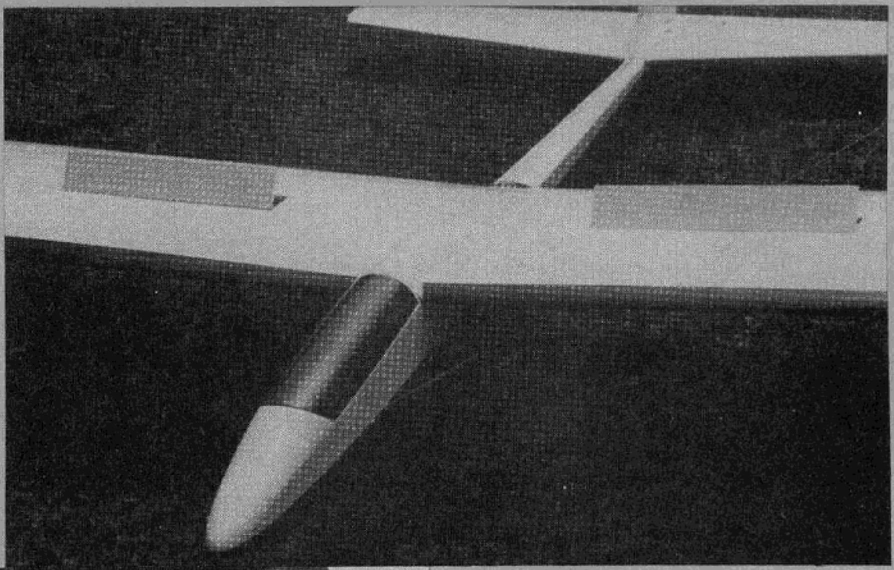
In those days little was known of "model aerodynamics," but quite a few modelers were experimenting and investigating. Much like today's "Free Flight Society," modelers were working together with people like Frank Zaic, accumulating the fundamental data. This author was in the midst of it and applied the learning to produce some very successful designs. It is those theories which formulate the "Soarer" design and which we will discuss.

Objective: To produce a non-powered aircraft which can be used to search out rising air and sustain flight as long as possible using it; especially under **light lift** conditions which are so common over most of our country and during the time available to us for flying.

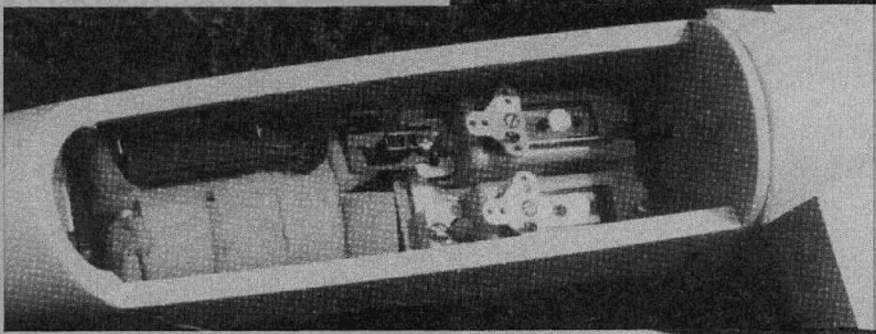
Design parameters: (1) A low rate of sink for duration. (2) Ability to perform in moderate winds. (3) Penetration, ability to search for lift. (4) Strength to successfully use launching methods and to provide longevity. (5) Stability for ease of



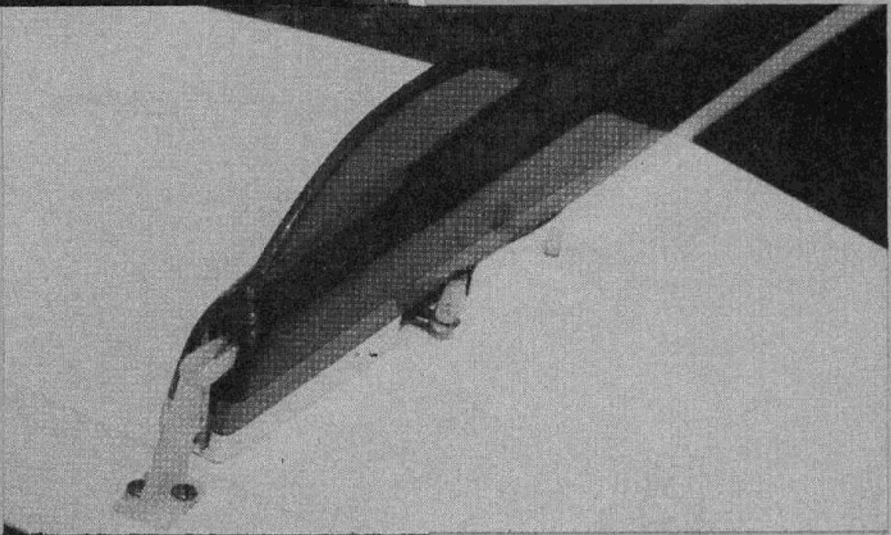
By
Hal
DeBolt

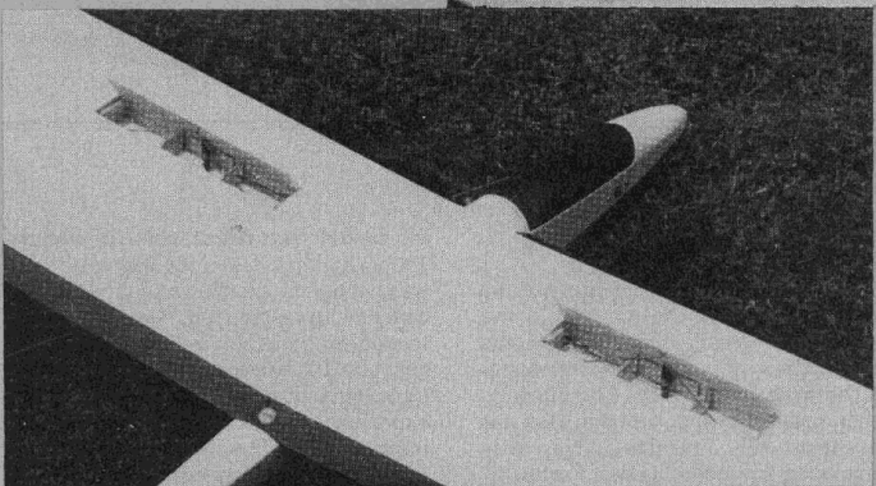


Pappy DeBolt applies a bit of free-flight design philosophy to his 2 meter Soarer

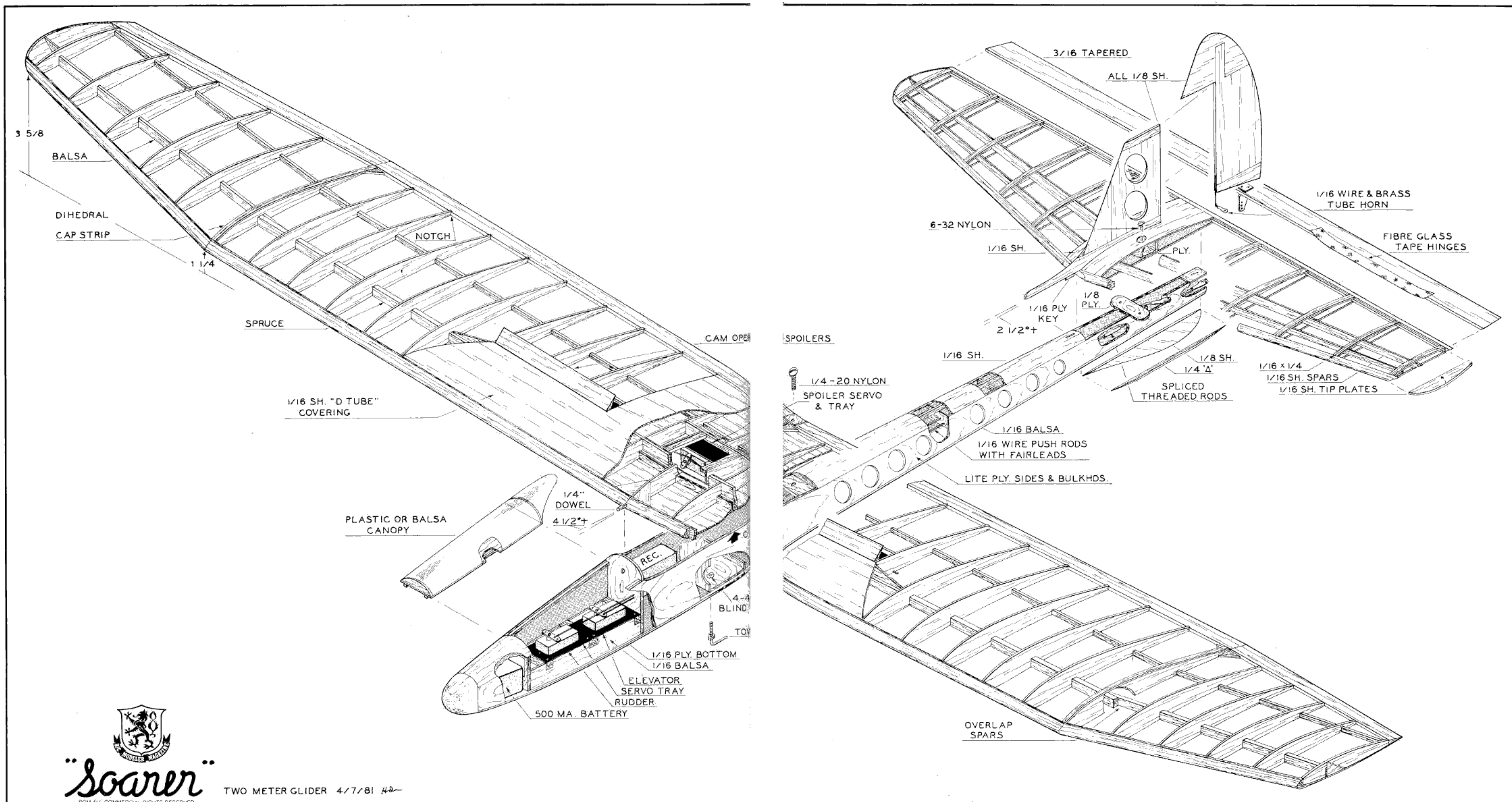


SOARER
Designed By: Hal deBolt
TYPE AIRCRAFT
2 Meter Sailplane
WINGSPAN
78 Inches
WING CHORD
9.85" Avg.
TOTAL WING AREA
768 Sq. In.
WING LOCATION
Top of Fuselage
AIRFOIL
Davis Formula
WING PLANFORM
Constant Chord Center
Tapered Tips
DIHEDRAL EACH TIP
Center Panel 1¼" — Tip 3⅝"
O.A. FUSELAGE LENGTH
45¼ Inches
RADIO COMPARTMENT SIZE
(L) 13" x (W) 1⅞" x (H) 2"
STABILIZER SPAN
30 Inches
STABILIZER CHORD (incl. elev.)
6½" Avg.
STABILIZER AREA
195 Square Inches
STAB AIRFOIL SECTION
Flat Bottom Lifting
STABILIZER LOCATION
Top of Fuselage





VERTICAL FIN HEIGHT
10 Inches
VERTICAL FIN WIDTH (incl. rudder)
5" Avg.
REC. ENGINE SIZE
NA
FUEL TANK SIZE
NA
LANDING GEAR
NA
REC. NO. OF CHANNELS
3
CONTROL FUNCTIONS
Rud., Elev., Spoilers
BASIC MATERIALS USED IN CONSTRUCTION
Fuselage .... Balsa & Lite Ply
Wing .... Balsa, Spruce & Ply
Empennage .... Balsa
Wt. Ready To Fly .... 36 Oz.
Wing Loading .... 6.75 Oz./Sq. Ft.



PLAN NO. 857②

FULL SIZE PLANS AVAILABLE — SEE PAGE 203

piloting and flight. (6) Controlability — the ability to go where you wish, when you wish. (7) Utility — simple to assemble and with space for common equipment.

These objectives and needs should be met to have an excellent glider, no matter what method might be used. The "Soarer" does it nicely in the following manner.

CONSTRUCTION

Wing:

Any aircraft design should be developed around the wing; it is the heart of the craft. The heart of the wing is the airfoil. The airfoil chosen is of the high lift variety. Fortunately, when properly used, this one also has comparatively low drag. This was developed from the "Davis Formula" for model free flight used in about 1938. At that time its introduction was very, very exciting and it had to be quickly investigated. Comparative tests immediately indicated that if offered a 10% increase in dead air time over the popular 6409. Further experience with it offered even greater improvement. The Davis was and still is an excellent airfoil for duration used.

It is no secret that at our Reynolds numbers, airfoil efficiency increases drastically as chord width is increased. The average glider chord is right in the minimum range as far as serious efficiency loss is concerned in this respect.

Area produces lift and duration. With a span limitation, area can only be increased with chord or multiple wings. With gliders, aspect ratio is widely used to increase wing efficiency. Increasing the chord **reduces** the efficiency. Increasing the chord **increases** the efficiency with the Reynolds effect. Obviously, a trade off is possible here. Increase the chord to get the needed area and let the two efficiency factors balance each other out. The Soarer thus uses a moderate aspect ratio of 8:1 which offers exceptional wing area for a 2-Meter glider. History would tell us that very successful free flights were used with aspect ratios of only 5:1, hence 8:1 is no big deal.

A further note is that lower aspect ratios tend to be more stable and have greater maneuverability --- also nice characteristics to have. Polyhedral is used to have as little lift loss as possible from the dihedral effect. It also enhances the ability to turn with rudder control.

The wing is set at a 4½ degree angle of incidence and is flown at this same angle, for two reasons. First, note that at this angle the forward 1/3 of the Davis airfoil is entering the air stream with a "symmetrical" shape. At this angle, this airfoil is in its lowest drag condition, offering exceptionally low drag for an undercambered style foil.

Secondly, a scientific investigation showed that a gliding model achieved its lowest rate of sink when the wing angle of attack was 5 degrees. With the wing incidence close to this angle, we are assured of being able to fly at this desirable angle of attack without excessive fuselage drag.

Additionally, this wing angle allows the remaining portion of the design concept to be practical, as you will see when the tail is discussed.

Structurally, the wing uses a progressive structure to achieve the needed strength. Note that the highly stressed center portion uses the reliable "D Tube," which progresses to common spruce spars and on to simple balsa in the lightly loaded tips. This is a serious attempt to achieve lightness plus strength. The spars are kept flush with the lower surface to facilitate attaching the covering.

Fuselage:

As always, the fuselage simply is a place to carry the equipment while creating the needed moment arms for stability. At the slow glider flying speeds, as far as drag is concerned, there is always the probability that "cleanliness" will do just as well as streamlining. Hence, in the interest of simplicity, the "clean lines" concept was used.

A fuselage structure which can use plywood for the sides immediately creates close to the ultimate in structural simplicity. The excess strength eliminates the need for additional parts such as doublers, reinforcements, and mounts. The lower weight of "Lite Ply" makes this concept most attractive.

Horizontal Tail:

If the rate of sink is controlled by the amount of lift available, then the greatest possible amount of lift seems advantageous. Lift is created by the airfoil, area and speed. If you desire a docile, easy to fly craft, you do not use speed which leaves only area and the airfoil to work with.

Fundamentally, the horizontal tail is required and used to create stability. The more tail, to a maximum amount, the more stability. An additional factor is that the tail can be used to generate lift as well as stability.

Tails of up to 1/3 of the wing area have proven usable. A practical amount has proven to be 25%. The choice here was 25% using a rather high lift airfoil. Perhaps something more could be gained by using a more precise airfoil, but simplicity and **lightness** dictated the use of the capstrip ribs.

For stability purposes, the balance point was established at 50% of the wing chord, even though setting it further back could take even greater advantage of the available tail lift.

The needed lift proportion between the wing and tail required a stabilizer incidence angle of 2½ degrees. That makes a good lift angle for this type of airfoil. This also allows the glider to cruise nicely "up on the step" so to speak, reducing the chance of a stall when encountering sudden changes in air speed.

With the wing and tail lift being proportional, good longitudinal stability is present over a wide speed range. This can be an asset in penetrating strong winds. Level flight is automatically assured and a bit of down trim can create the power needed when greater penetration is desired.

Perhaps we should further explain this penetration design feature. Penetration is prevented by a design's inherent drag and/or the lack of power to overcome the wind force. The available power is created by gravity and is fixed by the model's weight. Model weight is detrimental to soaring ability; hence, the ability to add weight (ballast) only when needed is an asset. While the use of ballast may reduce soaring ability, additional power may be more important in some cases if greater penetration is desired.

Thus, it would be advantageous not to use ballast in competition when others have to use it. If we can enter the wind with the least possible amount of drag, we can delay the need for ballast. If we can also enter the wind with a level or nose down model attitude, we will have maximum or above power without the addition of ballast.

With this design there is a constant lift balance between the wing and tail. As the airflow speed changes, the lift generated by both components changes proportionately. If the model attitude is flat and level, it will remain so throughout all airflow speed changes. Thus, on entering a strong wind, no trim is required to maintain the level flight, least drag, attitude. No trim also equals less drag. If this level flight also produces maximum lift, and you are in lift conditions, some of the lift can be sacrificed by trimming for a slight nose down condition. In that attitude some power is gained to further aid the penetration.

In short, aerodynamics can be used to increase the inherent penetration ability delaying the need for ballast. If the aerodynamics work well enough, ballast may never be needed in tolerable wind conditions --- yet, you still have have ballast as an "ace in the hole."

Conclusion:

It should be obvious that the features of the "Soarer" are different from most current designs. Then too, it would be questionable whether the use of **any one** of them would offer an advantage. It is the **combination** of the factors working together which creates success. But that was what the research of 40 years ago taught us!

Assembly:

There is only so much which can be done with the space available for an article. This time the design story seems much more important than would be the "glue A to B" sort of thing. This structure is a simple one, the drawings are extremely detailed. There are no new or mysterious methods used. With the info given on the drawings, any accomplished builder should have no problem with the assembly.

Flying:

What to expect:

(1) The initial test flights of the prototype were made in 20 mph winds. Much flying has continued in strong winds as well as calm. Don't expect miracles; penetration is tough in real strong wind, yet very good in moderate wind. Obviously, flight is as expected in anything less. The point is that you do not need to remain "grounded" by any tolerable wind condition.

(2) The "Soarer" tows "straight," easily, with any type of launch. Maximum "hi-start" power is handled neatly. Any amount of "winch power" considered normal creates no problem. The available lift will easily carry the line to the apex assuring maximum possible launch height. The thought has been that adding another 50' of line could be an asset.

(3) Control: Do limit the elevator to the amount indicated. Rudder trim is very insensitive. Rudder action is good under all conditions. The spoilers are extemely effective — too much so on the prototype. The width has since been reduced. Simply "cracking" them open has been effective on landing approaches. Do be **cautious** when using any greater amount.

(4) Adjusting: The wing setting and C.G. location should be checked and then left alone. No ballast should be required. The desired flight path should be flat and level, not nose up. Any lift encountered will "bump" the model up telling you it is there. If the model should not fly "on the step" or flies "nose down," compensate with stabilizer incidence changes as

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