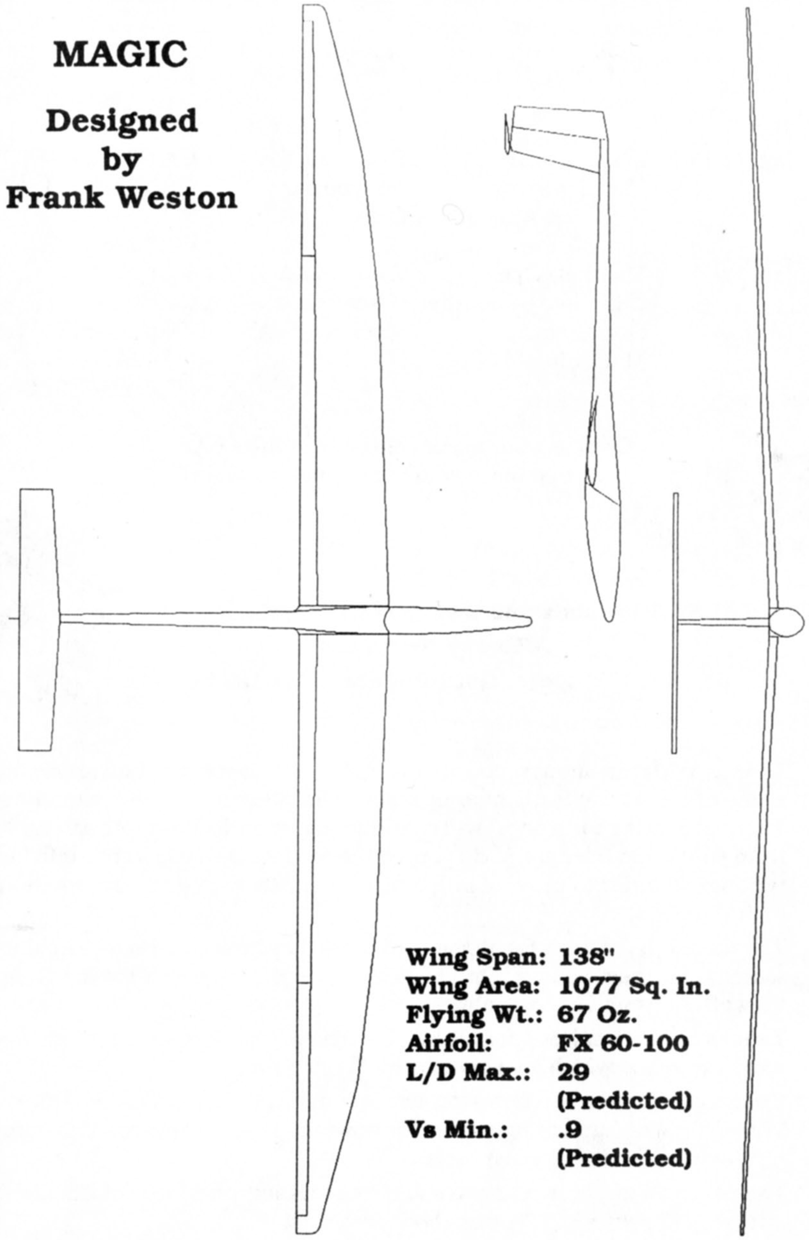
R/C Soaring Digest

December, 1990
Vol. 7, No. 12



MAGIC

Designed by Frank Weston

Wing Span:	**138"**
Wing Area:	**1077 Sq. In.**
Flying Wt.:	**67 Oz.**
Airfoil:	**FX 60-100**
L/D Max.:	**29 (Predicted)**
Vs Min.:	**.9 (Predicted)**

Schedule of Special Events

Date	Event	Location	Contact
Dec. 16	2 Meter & Thermal Unlimited	San Diego, CA	J. Menard (619) 475-0958
1991			
Jan. 11-13	International Modeler Show	Pasadena, CA Inf. - outside:	CA (714) 548-4700 (800) 243-9593
Jan. 19	Barks 3rd Annual Show & Swap	Graham, NC	B. Booth (919) 228-6977
Jan. 19-20	Thermal/Open Unlimited — Southwest Regionals	Casa Grande, AZ	Vern Poehls (602) 945-1957
May 24-26	Slope Race Mid Columbia Cup	Richland, WA	(509) 627-5224 Wil (509) 627-2603 John (509) 525-7066 Roy

Send us your major contest schedules EARLY so that those who travel can plan ahead.

***RCSD* wishes you a very Merry Christmas & A Happy New Year!**

J^2, B^2, Wil Byers, Gordon Jones, Martin Simons

Thanks to Martin Simons, you are the first to see his construction article on a one-of-a-kind PWS-101 quarter scale. His column on "Understanding Thermal Soaring Sailplanes" will continue next month. We appreciate and, from your notes & letters, so do you, all the hard work that has gone into his writings in order to provide sailplane enthusiasts with great information over the years.

Thanks to Bill & Bunny for all the hard work they have done in researching material for their column "On The Wing" over the years and for the plans they offer through B^2 Streamlines.

Thanks to Gordon Jones for all his research work and specifically for his work on servos which is in his column "Winch Line".

Congratulations to Wil Byers on his new monthly column called "Ridge Writer". He's been writing articles for some time and we're pleased to have him write on a more regular basis.

Thanks to all of you who have submitted articles, provided information, advertised or read *RCSD* throughout the years.

Best Wishes for the holidays, J^2

About RCSD...

RCSD is a reader written monthly publication. The articles & letters are contributed to *RCSD* in order to provide: **"The widest possible dissemination of information vital to R/C soaring to enthusiasts all over the world."** All material submitted must be exclusive and original and does not infringe upon the copyrights of others. It is the policy of *RCSD* to provide accurate information. If we print a factual error, we want to make it right. Please let us know of any error in *RCSD* that significantly affects the meaning of a story. Because we encourage new ideas, the content of all articles, model designs, press & news releases, etc. are the opinion of the author and may not necessarily reflect those of *RCSD*. We encourage anyone who wishes to obtain additional information to contact the author. *RCSD* was founded by Jim Gray in January, 1984. Today, he is lecturer and technical consultant and can be reached at: 210 East Chateau Circle, Payson, AZ 85541; (602) 474-5015.

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The Soaring Site

Did your December issue of *RCSD* arrive in better shape this month? We tested the envelopes on the first class subscribers (U.S.A.) in the months of Oct. & Nov. Well, since we didn't get any complaints about damaged or lost issues (first class), we figured that the envelopes must be working so, this month, we put everyone's issue into an envelope. (For those of you outside the U.S., your issue has always been in an envelope because of postal regulations.) Now, this won't speed up the delivery time, but it should help to protect each issue, and we expect fewer issues to be lost in the mail. A special thanks to the subscribers who let us know when their issue was long overdue.

There have been many changes this month. First, congratulations go to Jim Ealy as the new editor of the Bungee Cord. The ad address for Vintage Sailplanes will not change, but Jim can be reached c/o The Peddie School, Hightstown, NJ 08520; (609) 448-8726. Second, approximately half of the ads have changed or are new. For example, the address for NSS has been changed and Scale Model Research has a bigger catalog available.

We are still receiving calls in response to the question on who does custom vacuum bagging or complete foam wing construction and, this month, we're adding Bob Simmer to the list. Bob does foam wings and can be reached at 10895 Redfern Circle, San Diego, CA 92131; (619) 549-4131.

Happy Flying, J^2

R/C Soaring Digest
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Jer's Workbench

T-Tail Control The Start of Something...

Throughout the last few years, I have seen many beautiful T-Tail gliders. Having built a few of them myself, I discovered that they all had one COMMON FAULT.

They all had loose and/or sloppy control systems! Why? I have not been able to find any over-the-counter hardware from which to construct a good, solid T-Tail control system! Believe me, I have spent a considerable amount of time, over the years, trying to overcome this problem.

Anyone who has seen my shop knows that I like to tinker. I also like to keep things simple. So I will share with you how I arrived at my T-Tail Control assembly and, if you have any questions or need any additional help, please give me a call.

In the October issue, I explained how to make a mold to meet your hardware needs. The specific piece of hardware that I constructed using this method was a carbon-filled epoxy bellcrank. In order to construct the T-Tail control assembly, you might want to refer back to my column in that issue before proceeding.

The Mounting Assembly

The mounting assembly is carved, from a piece of hard wood, to fit inside the vertical fin of a fiberglass fuselage. The size of the finished mounting assembly is dependent upon the type of fuselage you are working with. See photo 1.

If you are only going to make one, the hardwood carving will probably do fine but, if you will need another in the future, then now is the time to make a mold of the mounting. I made a mold of my carved assembly so that I won't have to start from scratch the next time

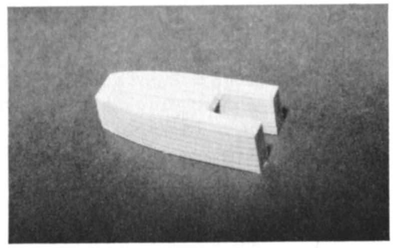

Photo 1 Mounting assembly for bellcrank

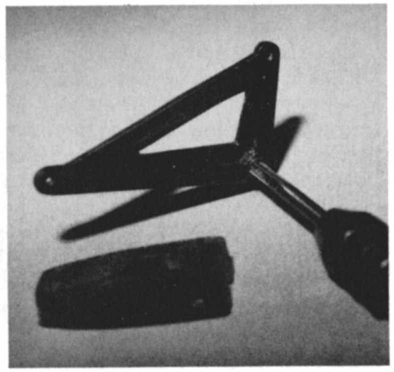

Photo 2 Threading bellcrank

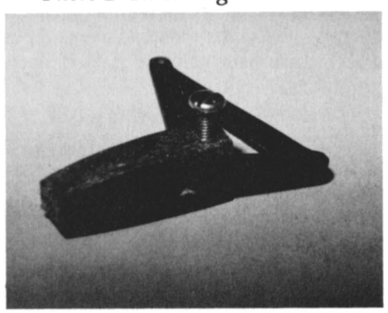

Photo 3 Mounting & bellcrank

Photo 4 Excess screw removed

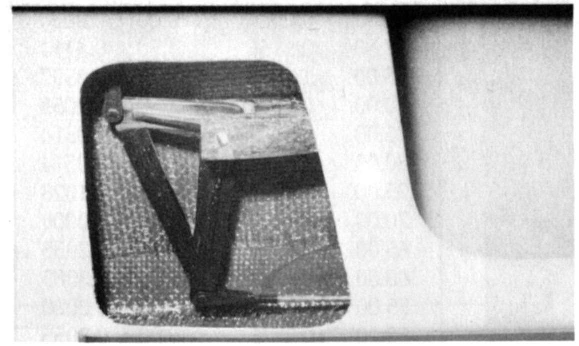

Photo 5 Finished assembly is mounted inside the fin of the fuselage

I need one. Additionally, the molded assembly should be stronger than the hardwood assembly as it is now a carbon-filled epoxy assembly.

I drilled both the carbon-filled epoxy bellcrank that I made earlier and the new mounting assembly using a #29 drill threaded with a 8-32 tap as shown in photo 2. A long 1" or so 8-32 screw fits perfectly. As shown in photo 3, the 8-32 screw makes a nice bearing for the bellcrank. Any excess of the screw should be removed, using a file or hack saw, until it is smooth as shown in photo 4.

The finished assembly is ready to epoxy into the vertical fin of your fiberglass fuselage as shown in photo 5. It works great. No more sloppy control system to worry about. Next month I will share my methods on how to construct a positive mount for your stabilizer.

On The Wing

...by B [2]

A few months back we described an airfoil specifically designed for F3B, the DU 86-084/18. This month we take a look at a section that should be suitable for thermal duration events, the ASM-LRN-007. This section was described in some detail in a recent issue of the Journal of Aircraft [1].

As is now commonplace, the ASM-LRN-007 is a computer designed section. The computer program, by Mark Drela of MIT, is the same used by Michael Selig and John Donovan during the Princeton wind tunnel tests. Please note that the ASM-LRN-007 has not been wind tunnel or flight tested. With a computed $C_L/C_{Dprofile}$ of up to 166 and a maximum C_l of 1.5, however, it appears to be a very high performance section worthy of some experimentation. The ASM-LRN-007 is for conventional tailed aircraft.

The ASM-LRN-007 is the result of a quest for an airfoil capable of high lift with low drag within the Reynolds number regime of 250,000 to 500,000, with minimum laminar separation. The condor and albatross both soar at the lower end of this range; the condor as a static soarer, the albatross as a dynamic soarer. They were thus of great interest

ASM-LRN-007

100.00	0.0000	0.00	0.0000
97.50	0.6166	.50	-0.4111
95.00	1.1305	1.25	-0.3597
90.00	2.5694	2.50	0.2055
85.00	4.0082	5.00	-0.0514
80.00	5.4471	7.50	0.0514
75.00	6.9887	10.00	0.1028
70.00	7.9137	15.00	0.0000
65.00	8.8900	20.00	-0.2055
60.00	9.5581	25.00	-0.3083
55.00	10.0206	30.00	0.0000
50.00	10.2775	35.00	0.2055
45.00	10.3803	40.00	0.7194
40.00	10.3289	45.00	1.0277
35.00	10.1233	50.00	1.3361
30.00	9.5581	55.00	1.7472
25.00	8.9414	60.00	1.9527
20.00	8.1706	65.00	2.1069
15.00	7.0915	70.00	2.2610
10.00	5.6526	75.00	2.1583
7.50	4.8304	80.00	2.0555
5.00	3.8027	85.00	1.8499
2.50	2.4666	90.00	1.4388
1.25	1.5416	95.00	0.9250
.50	0.7194	97.50	0.4111
0.00	0.0000	100.00	0.0000

to the investigators, and the ASM-LRN-007 has several characteristics which reflect this heritage; an undercut front lower surface and relatively sharp leading edge, an undercut trailing edge (aftloading), and a requirement for turbulation. Of particular note is the thickness around 25% chord which gives good spar depth. In fact, the ASM-LRN-007 is very similar to a bird-like airfoil described previously in *RCSD*[2]. The ASM-LRN-007 was designed for a 16% flap capable of both positive and negative deflection.

The undercut front lower surface adds additional positive lift and decreases the airfoil's pitching moment. This narrows the low-drag bucket, but the benefits derived are felt to outweigh this. Aft loading is compatible with full chord laminar flow on the lower surface during high C_L. Reducing the front lower surface undercut and/or reducing the aft-loading would result in a significantly lower

Computed Performance, ASM-LRN-007

Flap Deflection	Reynolds Number	Angle of Attack	Lift Coefficient	$C_L/C_{Dprofile}$
-10	250,000	5.4	.85	87
-10	500,000	5.4	.85	125
-5	250,000	4.5	.96	103
-5	500,000	6.8	1.20	142
0	250,000	6.0	1.37	117
0	500,000	5.2	1.30	160
+5	250,000	5.5	1.50	120
+5	500,000	4.2	1.42	166

$C_L/C_{Dprofile}$. The low-drag bucket, on the other hand, is expanded through the use of flaps. Laminar flow to 67% chord on the upper surface is possible through the use of a zig-zag turbulator strip. Unfortunately, the actual location of the turbulator is not given in the article. The implied location is at about 70% chord. Moving the turbulator on one wing at a time and comparing flight performance (looking for yaw and/or roll) could quickly lead to an optimum position.

The chart was derived from the published polars, the coordinates are as measured from an enlarged drawing.

An added note: Pfenninger and Vemuru suggest that the zig-zag turbulator is more effective than a two-dimensional "trip strip" and can thus be made thinner, with an accompanied drag reduction of significant proportions. (Birds use a series of reversed "zig-zag" turbulators in that their wing feathers form a series of rounded backward facing steps.) Even more effective, however, is turbulation by means of one or several rows of very small suction holes. Pfenninger and Verumu claim this method to have zero drag, and in some cases <u>negative</u> drag! This too might be worthy of some additional experimentation, as the air volume which needs to be moved is extremely small.

[1]Pfenninger, W. and Vemuru, C.S., "Design of Low Reynolds Number Airfoils: Part I", *Journal of Aircraft*, Volume 27, March 1990, pp. 204-210.

[2]Gray, J., "Interesting Airfoil Information", *RC Soaring Digest*, July 1988, pp. 4-5.

Bill & Bunny Kuhlman
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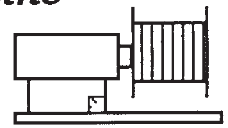
Winch Line



...by Gordon Jones

Choosing the Right Servo

I recently sat down and looked at what I wanted to build next and exactly where I was going as far as aircraft were concerned. The basic parameters were to come up with two open class ships and at least one two meter bird for the coming year. The choice of aircraft was relatively easy, as I already had some things in mind that I wanted to try (an SD7032 airfoil and flaps). Well this was all well and good until I started looking at my inventory of servos. I came to the realization that the current inventory was not going to work very well in the wings for flaps and ailerons; they were all too large. Already owning four micros, I knew that I would need at least eight more to complete the wings for these projects. So, I started looking at what was available with an eye towards size/torque/weight.

I began by pulling out all the brochures and advertisements that I had on hand and going through all the model magazines that contained radio and servo ads. I made a list of the manufacturer, the servo size, available torque, and weight for each type of servo. The accumulation of data was based on the manufacturers advertisements and phone calls to obtain information. I compiled a chart with the available data for comparison purposes so I could look at each and gauge the merits and drawbacks of each type of servo. This worked extremely well and some surprising information was gained through this process.

This process was based on what the average modeler does to reach such a purchase decision. I am somewhat dubious about some of the stated torque values and some sizes don't seem quite right. I think that ACE, for instance, understates their torque specifications, and the size for the Royal Micro didn't seem to fit. I was surprised to find a couple of small servos that have an application in the HLG arena and work quite well for this class of airplane.

I also asked other modelers about their opinions on various servos just to add to the paper data I had accumulated. Most were inclined to favor a particular brand for a variety of reasons. These reasons boiled down to either it was the brand of radio they were using, or it was the one they had heard the most about in magazine articles. Size was the overriding factor in most choices. Torque (or power) did not, in most cases, have any effect on their decision, while servo cost did play a part in about 50% of the modeler's selections. Most were very pleased with their selection and the only negative comment concerned plastic gears and that applied to most servos. I can understand this feeling, as do some manufacturers that are now coming out with metal gear options, or that are including metal gears in their production models.

The chart depicts the information gathered. While it does not include every servo manufactured, it does list the ones that have sailplane aileron/flap application. I did not look at the servos available from the European importers due to the expense and general availability.

What does this all mean? Well, if you are looking for a servo or servos for a particular application then you have a guide of most of the servos available in one spot to look at and compare size, torque, etc. You can also search the advertisements to find the best price once you have made a decision on what you need and further cull the field. There are many different ways to look at this whole process; some will opt for the latest and greatest, and some will look at price. There are many options and this list will make the task a little easier.

Servo Listing

Ace	Bantam Midget 1.125 x .75 x 1.43 18 oz/in 1 oz	WE S-95M 1.2 x .60 x1.3 28 oz/in .67 oz
Airtronic	94401 1.22 x .59 x 1.22 33 oz/in .95 oz	94141 * 1.37 x .60 x 1.27 45 oz/in 1 oz
Cannon	CE-9C .96 x .45 x 1.07 18 oz/in .43 oz	CE-15 1.15 x .75 x 1.50 26 oz/in .90 oz
Futaba	S33/133 Micro 1.06 x .50 x 1.22 27.8 oz/in .6 oz	S135 Mini * 1.21 x .62 x 1.18 36.1 oz/in 62 oz
JR	307 1.14 x .49 x 1.37 28 oz/in .71 oz	311 * 1.14 x .49 x 1.37 30 oz/in .78 oz
	3035 ** 1.2. x .51 x 1.10 41.6 oz/in .88 oz	321 1.2. x .51 x 1.10 31.9 oz/in .86 oz
RCD	Apollo 20 1.2 x .54 x 1.2 20 oz/in .95 oz	Apollo 10 1.48 x .8 x 1.6 40 oz/in 1.55 oz
Royal	Mini 1.5 x .62 x 1.21 27 oz/in 1.1 oz	Micro 1.43 x .68 x 1.43 33.5 oz/in .9 oz
Thunder Tiger	Mini 1.55 x .48 x 1.2 30.6 oz/in 1 oz	Standard 1.65 x .81 x 1.44 34.75 oz/in 1.4 oz

* metal gears ** Dual Ball Bearing

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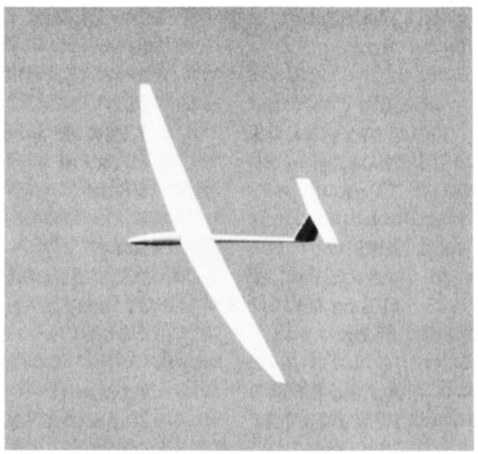
Magic
A Radical Departure from the Ordinary

...by Frank Weston

MAGIC is an Unlimited class sailplane which was designed and drafted entirely by means of CADD and performance optimization software using data from recent Princeton and European wind tunnel tests.

MAGIC makes well-considered use of the latest composite materials and employs unique design and construction techniques. It is available as a finished plane, or can be assembled from a variety of kit options or from plans.



The new ideas and methods employed in MAGIC have resulted in breakthrough performance which has been verified by competition results. MAGIC is radically different from the run-of-the-mill contest ships in most construction methods and materials. Some of MAGIC's features include:

Accurate, High-performance Airfoils

MAGIC wings and tail surfaces are a vacuum-bagged composite of epoxied-glass cloth over 1.5# density extruded styrene foam. Color is imparted to the finished surfaces by means of a white pigment added to the epoxy used in the lay-up. Surfaces have a mirror perfect finish right from the bag and require little sanding and no painting. Labor to complete these wings is about 1/3 that required for a balsa sheeted foam wing. The completed wings are capable of a pedal-to-the-metal launch and zoom in the strongest winds. The wings return launch energy efficiently and weigh about 14 oz. each.

The FX60-100 airfoil with turbulation which MAGIC uses is a great performer, the best by far in Princeton and European tests (better than tripped E-214, SD7032 or SD7037). Because of thin trailing edges and undercamber the FX60-100 is not easily constructed with consistent accuracy by any method other than that employed by Weston Aerodesign and originally used in the TERMINATOR. Because of the difficulty involved in construction of this airfoil, it is not used (to the best of our knowledge) by any other kit makers.

Quality Kit Components

No compromises are made in MAGIC kit materials. Foam used is 1.5# density extruded styrene, NOT the expanded bead polystyrene found in beer coolers and most other kits. This foam is relatively incompressible, sandable, and a light gray in color. Spruce spar caps are kiln dried aircraft grade Sitka Spruce which conforms to MIL-S-6073 and government spec AN-W-2. There is no finer or stronger spruce available. The MAGIC wing rod is a special alloy with a hardness of greater than 44 on the Rockwell C scale. This steel is intended for use as guide rod for large-scale molding operations, and has extremely high yield and tensile strengths. Kevlar-49 with strength three times that of an equivalent weight of E-glass is used in the fuselage and spars. Kevlar is the major structural component of the fuselage, not just reinforcement. Control cables are vinyl clad braided Kevlar which absolutely will not stretch or fatigue. Spars are a composite structure of carbon fiber, Kevlar, Sitka Spruce, and select balsa, assembled with three types of adhesive, each adhesive most suited to the bond combination. The epoxy resin used in kit fuselage construction is the same high strength, heat cured resin used in the construction of canards and fins of high performance military jets. Even the plywood servo trays and bulkheads are exceptional. They are constructed entirely of Finnish Birch aircraft plywood which meets German Lloyd spec GL-2.

Composite Construction Which Can be Scratch-built

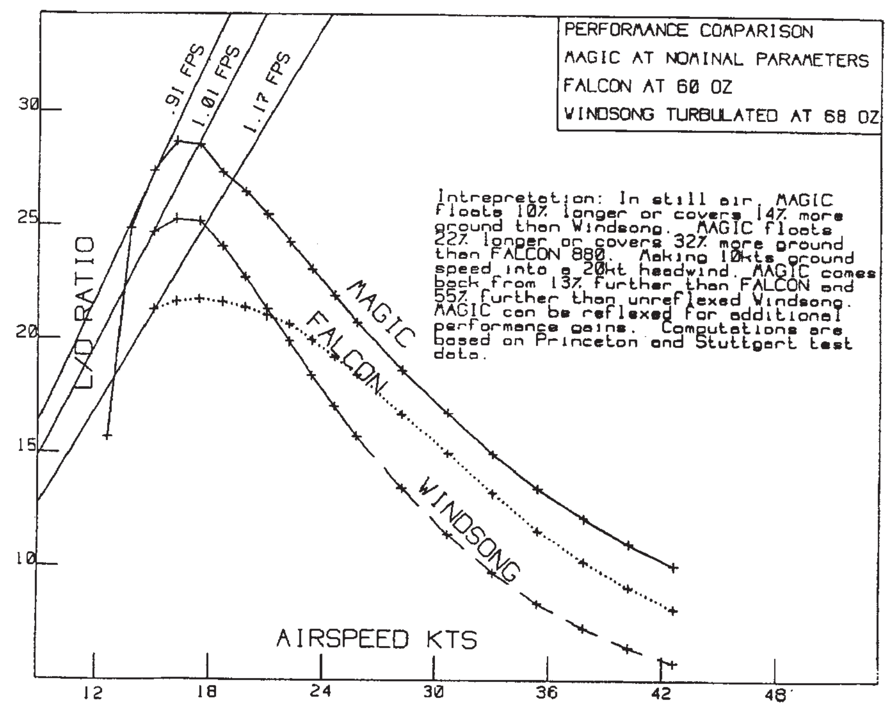
Unique fuselage and wing construction methods used make it possible to build MAGIC, including the Kevlar/glass fuselage, from plans.

Durability

The Kevlar/glass seamless fuselage is both light and extremely impact resistant. Critical areas are carefully reinforced. Easily replaced "sacrificial" pieces make it possible to repair severe damage quickly. A sheared stabilator or tail boom can be repaired in minutes in the field.

High Strength-to-Weight

There are no flat surfaces on the MAGIC fuselage. Structural rigidity comes not only from the Kevlar-glass lay-up, but from the shape of the structure itself. Flat surfaces tend to oil-can and must be built far heavier than a curved surface in order to yield the same stiffness. The MAGIC fuselage is laid up in two parts, the forward section on a male plug, and the aft section, which is a perfect monocoque structure, is laid up around rolled Mylar. The only seam on the fuselage is on the bottom forward third, under the servo tray. Refinement of lay-up schedule, and materials has yielded a very light and strong fuselage. Unfinished fuselage weight is about 5 oz. MAGIC ready for painting and radio installation weighs 3



lbs. and is significantly stronger and stiffer than typical Unlimiteds.

Performance Is First Priority

Typical glass kit fuselages (MAGIC is not typical) are laid up in a female mold and consist of two layers of 6 oz glass. These fuselages use only two laminate layers because using fewer layers saves time. They use glass because glass is about 10 times cheaper than Kevlar and is easier to work with, again saving time and money. Female molds are used because they impart a nice cosmetic finish and are well suited to mass production; however, female molds require that the fuselage be made in two halfs and joined down the centerline. This centerline joint is a serious weak point and a source of additional, un-needed weight.

The MAGIC fuselage is constructed with performance as first priority. None of the above compromises to performance is made.

The MAGIC lay-up consists of five layers of different weights and weaves of Kevlar and glass, each laminate type specifically selected for the job it will do. As noted above there is no centerline seam and the fuselage is laid up around a male plug. The amount of work required to get a cosmetically satisfactory finish is much greater, but the end product is stronger, stiffer, and about three times lighter.

Alignment Problems Eliminated

Unique construction methods make is easy to build a perfectly aligned airplane. Wing and fin alignment is usually so good that no errors can be measured or visually detected.

Separate glass-epoxy wing root moldings are provided. Wings are first aligned to the fuselage. Then, the moldings are aligned to the wings, and then the whole wing/molding assembly is joined to the fuselage for a perfect fit between wing and wing root. The vertical fin is joined to the fuselage after the wings are attached. The alignment between wings, fuselage and fins is adjustable and correctable at each assembly step. The result is a perfectly "square" airplane.

Simplicity

Exclusive of radio gear, there are approximately 60 separate parts to be joined together in the construction of MAGIC, including glass layers as parts. Compare this to over 250 for one of the most popular Unlimited kits. Fewer parts mean less construction time, less weight, and greater reliability.

Clean Lines

Canopies are a pain. A tremendous amount of labor goes into fitting and fairing, and there is no clean, reliable locking mechanism. Nose cones are clean and require little fairing, but they are generally a weak point in the fuselage structure and detract from scale-like lines. MAGIC uses a fuselage strong enough to accept a canopy, but with a slide on nose cone that retains the lines of the design. Since the fuselage has the structural strength, the nose cone can be laid up with very light glass, and weighs less than an equivalent canopy.

Simple Rigging

Elevator and rudder are controlled by means of Kevlar cable linkage with no bell-cranks or control horns or screws and mounting hardware. There are no moving parts other than the cables and the surfaces themselves. These linkages are extremely light, and save all the weight in the most important place - aft of the CG. There are no external horns, clevises or connectors.

Little Balsa, Low Cost

Except for the servo tray, two bulkheads, and the wing spars, no wood is used in MAGIC construction. There is no balsa sheeting. In times of high priced and low quality wood, this is a serious consideration for scratch-builders. Cost of raw materials for construction of MAGIC from scratch is less than $100, and as indicated above, only the best materials are used.

Competition History

MAGIC's competition history is amazing. The first MAGIC flew in competition at the Daniel Boone Classic open soaring contest in Reading, PA on July 14, 1990. This event took place five days after its maiden flight. MAGIC won first overall in this major contest (two days, approximately 75 flyers). MAGIC flew in its second open contest on August 4, 1990, again taking first overall in another major contest. On MAGIC's next outing she finished second, not competing in the second day of a two day contest.

Two MAGIC's flew in the last and biggest East Coast competition of the 1990 season, the CASA Open/LSF International Championships. On day one, MAGIC finished first and fourth. Overall, MAGIC designs finished third and fourth of 104 entrants. MAGIC number 2 was flown in this contest by a pilot with zero hours experience flying MAGIC prior to his first actual contest flight.

What Others are Saying

"MAGIC is by far the best thermal ship out there today." - Josh Glaab, many time winner of the Eastern Soaring League's overall championship, Aerospace engineer, NASA employee and owner of MAGIC number 2.

"It was my idea!" - Jack Cash, nuclear engineer (they let this guy into reactor rooms) who is now scratch building two MAGICs.

"Buy one, I need the work." - Frank Weston, designer, Aerospace engineer, ex-Navy pilot, and owner of MAGIC one.

"Please deliver my MAGIC by mid-October." - Bob Champine, rocket plane test pilot and the World's only LSF level 10.

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The Weston Aerodesign Catalog

...by Frank Weston

The Weston Aerodesign catalog is a serious attempt to provide the composite builder with one source for all hard-to-find materials and tools required to do a first rate construction job. The products offered are those we have used and found to be the best. Nothing is listed just because we think it will sell. Items found their way into the catalog because we used them in our kit construction, liked them and bought them in large enough quantities (in most cases direct from the factory or mill) to get significant price breaks. If you use a tool or material that we don't have listed, and you think everyone should know about it, give us a call. If we try it and like it, we'll get it and offer it. (Hopefully, at a very low price.) If you find something cheaper elsewhere, buy it, but then give us a call and let us know. Weston Aerodesign has or can get on short notice many items not listed in the catalog. If you can't find it elsewhere, give us a call.

Believing In Magic

...by Martin Simons

On my journey through the USA earlier this year I was delighted to meet Frank Weston at a club flying meeting one evening in Maryland. He showed me two of his sailplanes, the 2 metre span Sam I and the Magic.

Both were impressive in appearance and flight. Impressive in another way was the brochure Frank pressed into my hand, describing in great detail the construction methods and materials he has used. There is enough, in this folder, for anyone to build the sailplane from scratch.

Magic exemplifies nearly all the aerodynamic features that will be required in future for success in International F3J class competitions and world championships. It is a development of a previous design, the Terminator, which was larger, with a higher aspect ratio. This produced an outstanding soaring performance. Frank's computed predictions, in fact, so nearly match my own described in articles for RCSD, that we both wondered if one of us had obtained access to the other's results. This, of course, is not so. Standard methods of computing sailplane performance will produce similar figures.

Computational methods have their limitations, especially since we are dependent on wind tunnel test results which are, themselves, always subject to errors of various kinds. The sailplane has to be tested in practice, and many factors which remain, and probably always will remain, incalculable, come into the final reckoning. Among these are the pilot's personal preferences and circumstances. Frank admits, for example, that his choice of wing profile was partly influenced by the aesthetic appeal of the FX 60-100. Perhaps he also responded to the challenge of building an accurate wing with such a thin, cusped trailing edge. If thermals on the east coast of the USA are weaker than in the west, the FX profile may be right for the locality. It would never-the-less be interesting for someone to build a version of one of Frank's designs with less cambered profiles. This might not affect the model's climbing ability noticeably, but would improve its fast glide between thermals. Flaps could be drooped slightly to overcome any lack of ability to use the weakest lift, and for launching.

Frank also, like the rest of us, has to consider his workshop space and the size of his car. The Terminator is about as large as most of us would want to carry around, though still smaller than some European sailplanes that are commonly flown in competitions.

The Terminator turned out to be a little too hot. The longitudinal stability margin was slightly too small which, combined with the high aspect ratio, produced a model which required careful handling. With any efficient sailplane, speed increases very rapidly in a shallow dive. The natural phugoid motion, nose up, nose down, nose up, nose down, associated with the model's stable responses to small disturbances, can easily be exaggerated by the pilot's delayed reactions to become a full scale PIO, or pilot-induced-oscillation. The more efficient the sailplane, the more likely this is to happen. In addition, landing the 4 metre (160 inch) Terminator proved tricky.

The Magic represented the next step. In competitions, it is most important to have a stable sailplane that handles easily, enabling the pilot to concentrate on finding and using lift and landing safely, rather than having to worry constantly about control and trim.

The Magic satisfies these requirements with its smaller span and lower aspect ratio. The performance is a good compromise, the sailplane is easier and pleasanter to fly and, incidentally, requires less space in the workshop and the car. That it has come out right is confirmed by the impressive list of competition wins that Frank Weston can point to.

In Britain, where the F3J class has been in operation now for some fifteen years, models are tending larger and heavier, but it is still unusual to see a model with ailerons and flaps. Most of the contestants still rely on rudder and elevator only, with very powerful airbrakes or spoilers. However, as the models increase in size and weight, up to and exceeding 170 inch span sometimes, ailerons become more desirable and flaps can be of great assistance in adapting the wing to different conditions. Even with hand towline launching, which is the F3J rule, flaps can be of great value to assist the climb to maximum line length. Magic is, in this respect, well up with the field and would be competitive.

What is in the long run probably more important, is Frank's very ingenious use of modern materials and imaginative construction methods. I will not attempt to describe these in detail but it is worth mentioning here the very clever idea of using a rolled mylar tube as a mandrel for making a tapered FRP tail boom. I have myself, for years, used a standard billiard cue for this, and for rolling balsa or plywood tail booms, but the size and shape of the resulting tail cone is constrained by the dimensions of the mandrel. The mylar roll method is much superior, enabling the boom to be of any desired length and cross sectional diameter. I shall copy this and I am sure many others will do the same.

If Frank Weston puts kits on the general market, he will have plenty of customers. What he has already done, generously, is to make his ideas available to everyone and he will inevitably have many imitators. If he wishes to keep in front of the opposition, this conjuror will soon have to pull something even better out of the hat. It won't be easy!

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A Problem & Solution

...from Frank Weston

The progressive modeler wants to build using the latest in composite construction techniques and materials, but doesn't know what tools and materials to use, where to find them, or how to use them. He lacks experience in vacuum bagging and epoxy molding, and doesn't want to waste a lot of time and money learning.

Weston Aerodesign is offering a one day seminar on composite construction absolutely FREE with the purchase of any Weston Aerodesign plan set or kit between now and December 15, 1990. The seminar will cover molding fuselages and small parts, foam cutting, vacuum bagging, tools, materials, and suppliers, design considerations and more. The seminars will be held weekends between now and March 1, 1991. Call (301) 757-5199 24 hours, or write to 944 Placid Court, Arnold, MD 21012 to reserve your position. Seminars will be held in the spacious new facilities of Weston Aerodesign Laboratories in Arnold, MD. Maximum occupancy is 5 persons.

3-View Insanity

...by Gene Cope

While looking through a book or a magazine, you find that aircraft you have always wanted to build, but have never found a kit for. The only option is to build it from a 3-view.

One contemplating building from a 3-view should consult a fellow modeler for a second opinion, as to the sanity of the builder. Building from a 3-view should not be taken lightly, as mental and marital stress can occur at any stage of the procedure.

After all of the options are used up and you decide to build from a 3-view, you will be able to find some excellent equipment out there that will help. some of the common tools of the trade are: an architect's rule, a calculator, plain white shelving paper on a roll, a lot of pencils and an eraser. Above all, the most useful item is a laser copier. To start, take your 3-view to a copier service that can enlarge or reduce your 3-view to one of the scales on your rule. I have had some strange looks from the operators of those expensive copiers. The one I went to had a new color laser copier that could increase or decrease by one-tenth of an inch. I took in my 3-view and said I needed it enlarged so that the wingspan equals 43 feet 9 inches on my rule. She looked at me as if to say, "You want what?", but took my small 3" X 5 1/2" 3-view and enlarged it to legal size in only 20 sheets of paper. The result is a 3-view that can be readily scaled for building. The better the copier, the better the 3-view clarity. I have, in the past, enlarged a small section of a 3-view to actual size for detailing canopies, ribs, and markings, and for decreasing insignias to the appropriate size for my pilots.

Shelving paper can now be spread out on a table or the floor and, with calculator in hand, use the rule and 3-view to draw your fuselage, wing, etc. Now that you have it all drawn out, you can change your mind and not regret it later. If you are still willing to build the aircraft, the next step is to lay out the airfoils for the wing and stab. A computer program or generated airfoil helps, but a trip back to the copier service is in order to reproduce the airfoil for the templates. This can now be used for cutting foam cores or wood ribs. Wings made out of foam make the task easier but, if you build from ribs, double stack the ribs to give a better transition between tapers. If you don't have the capability to cut or have wing cores cut in your area, there are reputable companies that will cut your cores for you. All you need is the chord dimensions and airfoil or you can send in your own airfoil design. It really beats ribs unless it's a vintage ship that had fabric wings. (It's going to be a long time before I build one of them.) Foam won't work and the ribs are the only way to go.

The fuselage can be made from wood, foam and glass, or a combination of both. Your work is far from over, as all sparring, controlling and structural stressing must still be determined. You haven't taken on this task as a first? You have built one or more aircraft? If so, sparring and controls won't be that difficult. The stress factor I have always overdone, increasing the weight of the plane. Some help from other builders and articles have helped. To reduce the stress factor and still maintain structural integrity, don't overbuild.

It also helps to have pictures or, even better, check the aircraft at the airport where you can get hands-on information. It also helps to have friends that can support you when you need it. There are times when two hands and ten toes are just not enough. If you survive the down times, when the aircraft has depressed you into just about quitting, you will have, in time, the aircraft you have always wanted to fly and the time, money, and stress you have put in is justified by the flying of your ship.

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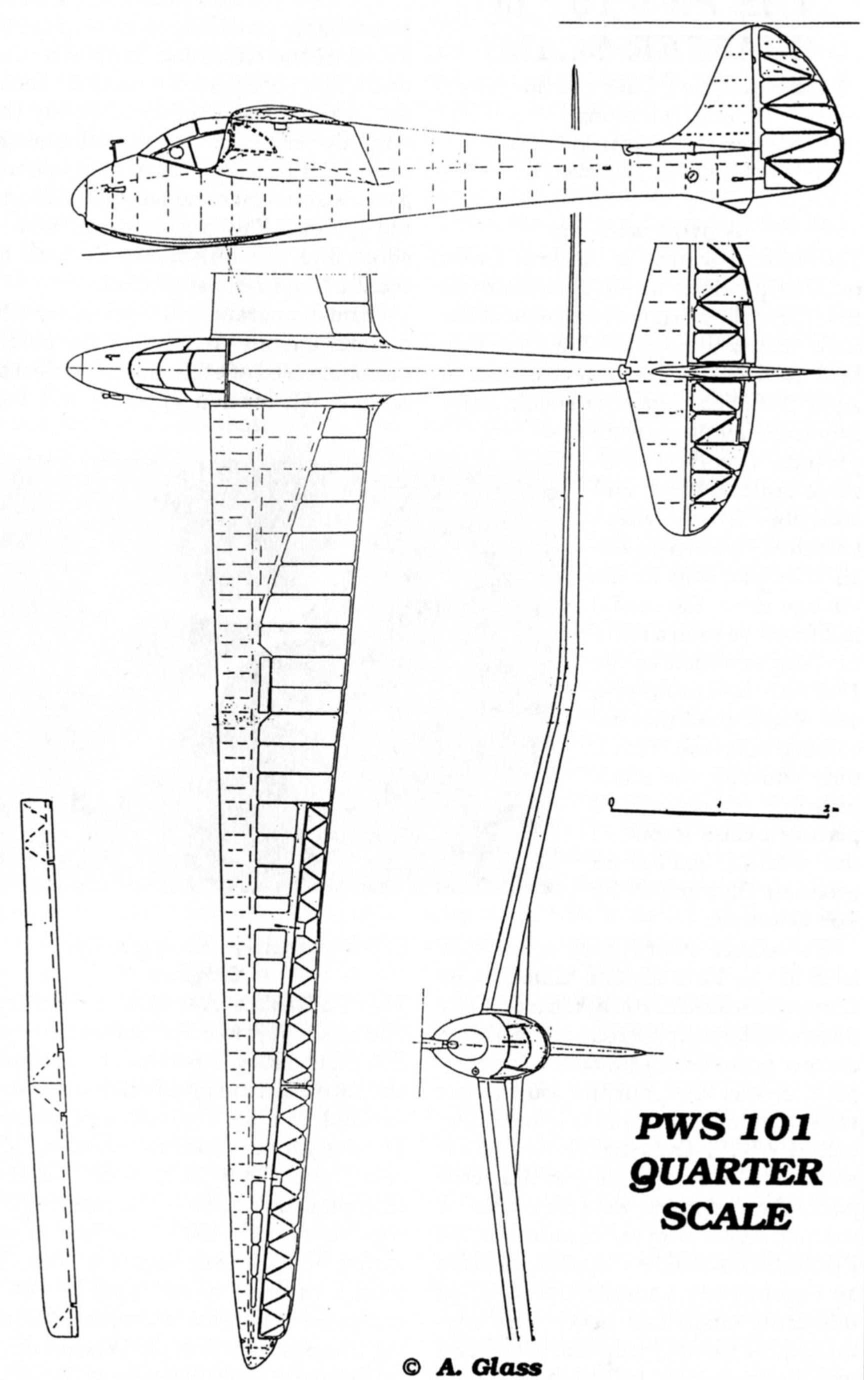


PWS 101 QUARTER SCALE

THE PWS 101 IN QUARTER SCALE

(Model designed, built and flown by Martin Simons)

A prize winner

The model described in this article won two competitions within a month of its first flight. The first success came at the Scale Sailplane Soaring Championship held at Waikerie in South Australia in April 1990. This contest, at which nearly fifty scale sailplanes were present, involved both static scale judging **and soaring** from winch launches. To win the overall championship in the vintage class, the model had to prove itself a faithful representation of the 1937 full-sized prototype, and also a good thermal soaring sailplane. This it did, winning the static judging outright and placing a close second in the soaring, against an excellent Olympia 2b by Rob Goldman.

The second award came a fortnight later at the Constellation Club's Scale Competition held north of Adelaide. Only three sailplanes appeared among a large entry of powered scale models. The competition was keen but the four judges were unanimous in awarding the trophy to the PWS 101. Only models which flew were eligible for judging in the static park, although there were no points for soaring. Again from winch launches, the PWS demonstrated its capabilities in the air impressively. I suspect the judges at this competition had never seen anything quite like this sailplane before and were overwhelmed by its beauty.

The PWS 101 also makes an excellent slope soarer, providing some help can be found if hand launching. In a stiff breeze on a hilltop, one person is needed to hold the fuselage and another to steady the wing tip. The pilot thus cannot manage alone. It is actually very easy to operate alone with a winch and will take off from the ground. This can be done, with a short line, for hillsoaring as well as thermalling from flat ground.

I cannot guarantee first prizes for others, but anyone completing the model can be assured of exciting a good deal of interest wherever it appears, and will find it extremely pleasing to fly.

Origins

The Podlasian Aeroplane Factory, Podlaska Wytwórnia Samolotów or P.W.S., had long experience of powered aircraft design and production when they decided, in 1936, to produce sailplanes. The designer of their first motorless aircraft, the **PWS 101**, was Waclaw Czerwinski. The prototype, carrying the registration SP - 1005, flew first in the spring of 1937 and, together with the second example of the type, SP -1006, competed at the first International Soaring Championships at the Wasserkuppe in Germany in July that year. In SP - 1006 the pilot Mynarski was one of three competitors on the same day achieving the best distance of the meeting, 351 km to Hamburg. (The other two were the Reiher flown by Hanna Reitsch and the Fafnir 2 flown by Heini Dittmar.) Launches were all by bungee from the top of the Wasserkuppe.

Of outstandingly graceful appearance, the PWS 101 showed itself the equal in performance of the best German sailplanes of the time, hardly surpassed even by the very costly DFS Reiher prototype.

Further production continued at the Biala Podlaska factory and great successes followed. Tadeusz Góra was awarded the Lilienthal medal for his national record distance flight of 577.8 km (358.95 miles), which he achieved in May 1938. This was judged by the international jury to have been the outstanding soaring flight in the world for that year. PWS 101 sailplanes dominated the Polish National Championships in 1937 and 38, and in the ISTUS Internationals at Lwow in May 1939, with pilots Plenkiewicz and Góra, PWS 101s placed first and second.

During the Second World War all but two Polish sailplanes were destroyed or looted and no example of the PWS 101 survived. In 1939 Czerwinski had escaped from Poland and went to Canada where, after working for many years in the aircraft industry, he now lives in retirement. Unfortunately he was unable to take any of his drawings or records with him but an article written by him in the journal **Aeronautics**, July 1947, provided much useful background information for the model.

The model plan, on scale of 1 : 4, relied at first on the drawing by Andrej Glass in his book **Polskie Konstrukcje Lotnice 1893 - 1939**. This was also the basis of my own drawing in the book, **The World's Vintage Sailplanes**, published in 1986. These and other references for colour and markings are listed at the end of this article. Construction of the model was well advanced when Andrej Glass discovered, in Poland, an original manufacturer's drawing which showed several inaccuracies in his previous outline, especially the dihedral and the planform of the outer wings and ailerons. Fortunately only minor errors were evident in the parts of the model that had been completed but the wings and wing roots had to be re-designed and modified.

A new set of plans have been drawn to incorporate the more accurate information. Sharp eyed readers will notice some differences between the model portrayed in the photographs illustrating this article, and the revised plans now made available. These alterations will make no difference to the flying performance of the PWS 101. Models built to the new plans will be superior to the prototype in accuracy.

The **wing sections** used on the model are authentic: Göttingen 549 thickened to 16% at the root, tapering to Gö 549 proper at the gull bend, and thence to an 8% thick Gö 549 at the tips, with **6 degrees of washout** as on the original sailplane. Modellers are advised to stick closely to the plans since tip stalling and control difficulties at low speeds are almost certain if the intentional twist in the wing is not built in. As drawn, however, and with the balance point in the position indicated, the PWS is very stable and yet highly responsive to controls.

The divided **ailerons are slotted**, also as on the original (See plans).

The **airbrakes** on the model are also authentic, with the lower surface paddle hinged at the rear so that when open it scoops air in and causes it to pass upwards through the wing to emerge behind the upper paddle. Despite their small area, the brakes are quite effective because of this scooping effect.

Other sketches from Andrej Glass show some of the details included on the model, notably **navigation lights** on the wing tips and fin, the **hand holds** at the wing tips and wing roots. No reliable details of the instrumentation are available but the panel in the model is based on an Askania Instrument Company's advertisement of appropriate date. Many thanks are due to Andrej Glass for his information, and also to Jercy Cynk who also provided photographs and sketches.

Construction

This is a large and elaborate model which should not be undertaken without careful consideration. The structure follows the full-sized aircraft as closely as possible and there are not many short cuts. Although there is nothing particularly difficult about building any large model, there is, as many people have remarked before, a lot of work to be done. The builder will need to dedicate a considerable time to the project and maintain a good standard of workmanship through to the end. The result, however, is very rewarding indeed.

Fuselage

There are several different ways of building a large, streamlined fuselage and experienced modellers may wish to follow a different system from that described here. The method suggested is basically the same as that recommended by Cliff Charlesworth (See **Radio Modeller** for February 1989.) I did try a small variation of this, but if building the model again would revert to Cliff's method, which allows more margin for small errors.

Photograph 1 shows the fuselage formers, keels and cross pieces cut from plywood of appropriate thicknesses. Each former is in two identical halves. If two pieces of plywood are temporarily tacked together, the two halves of a former may be cut simultaneously with a band saw or powered fret saw.

Whenever possible I like to check parts for fitting before beginning to glue things together. Photograph 2 shows how the main formers, the cross pieces and the wing root ribs can be checked for fit. Clothes pegs, elastic bands, bulldog clips etc. may be used to hold them in place. Any errors can be corrected easily at this stage. (On this photograph can be seen the original wing joiner system I intended to use, with two rectangular brass tubes set into the main fuselage frame, one vertically above the other. When the new drawing arrived from Poland this idea could no longer be used because the dihedral angle of the wings had to be altered considerably. A difficult reconstruction job had to be done, but if the builder follows the revised plan this will not occur.)

In photograph 3 the half frames on one side of the fuselage are shown assembled on the central keel. The keel members, spruce strips and plywood pieces, together with the fin leading and rear edge, are pinned down over the plan on the flat building board, then each former is glued in place, checking for squareness. The spruce keel members have to bend slightly in the vertical plane, which may be achieved by steaming or, which I find easier, each strip may be laminated from two half sized pieces glued together edge to edge as they are positioned on the plan. The main longerons and fin spar are glued into the appropriate slots.

The half fuselage is then completed by skinning with 0.4 mm plywood. To give glueing area and reinforcement at each former for the skin, Cliff Charlesworth suggests gluing a ring of balsa wood about 6 mm wide on the face and rear of each former, sanding down to conform to the fuselage shape. This is probably the best method and I used it on the keel members. On the formers, as photograph 4 shows, I used instead strips of the same thin plywood. This also worked quite well but the plywood strips have a tendency to skew slightly out of line, making it more difficult to achieve an accurate fit.

After the formers have been given their balsawood edgings and trued up where necessary, the skin is applied in a series of half rings, as shown. It is of course im-

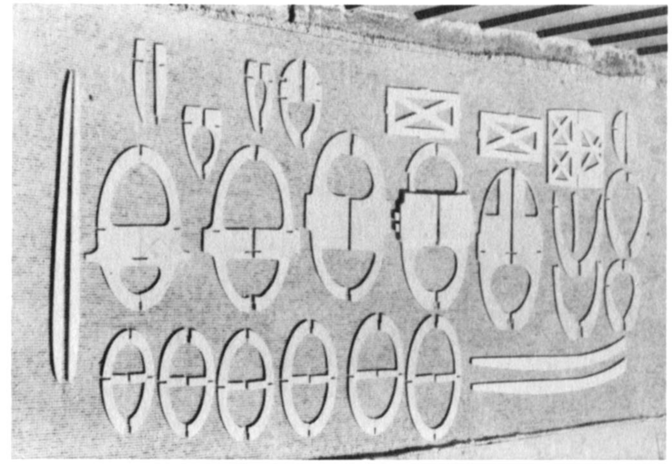


Photo 1 Fuselage formers, keels & crossbraces cut out.

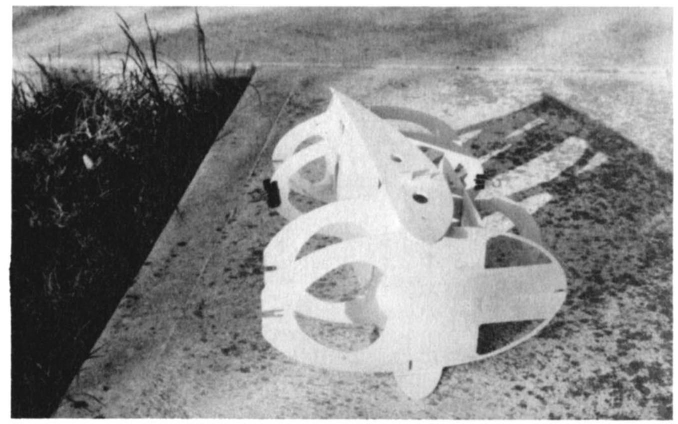


Photo 2 Trial assembly of central formers and root ribs.

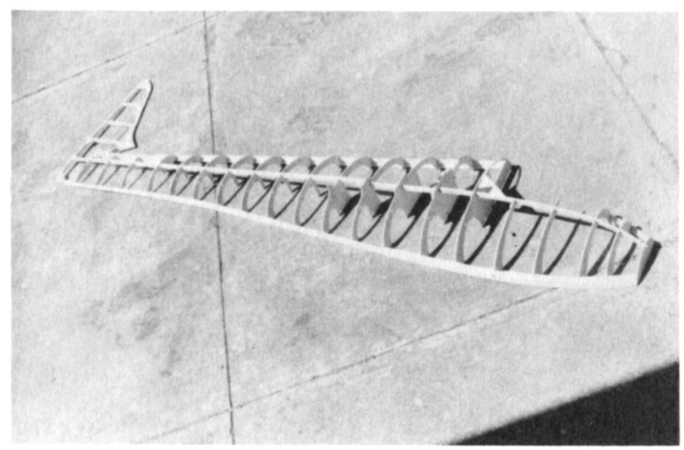


Photo 3 Half formers assembled on keels and longerons in place.

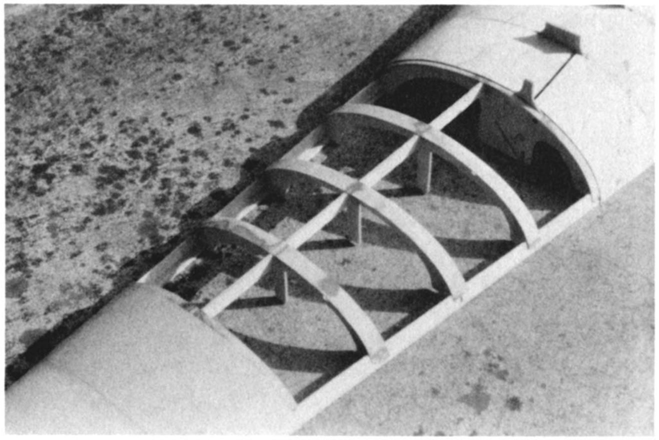


Photo 4 Skinning the half fuselage.

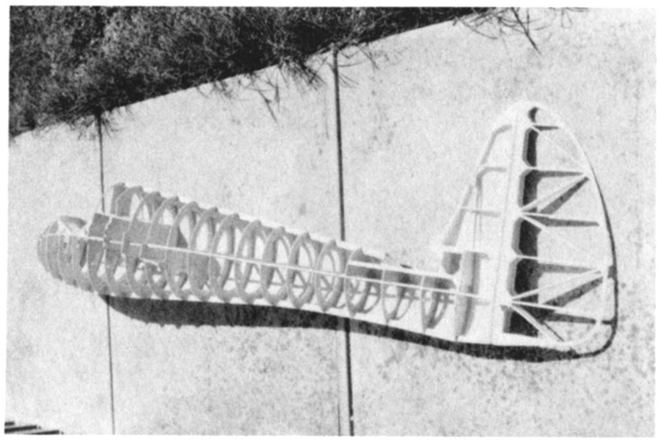


Photo 5 Other half formers glued in place, longerons added.

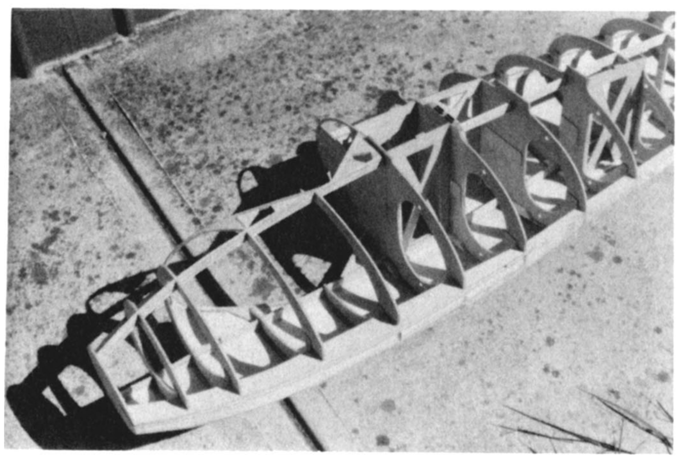


Photo 6 Cross pieces in between main formers. Cockpit coaming added.

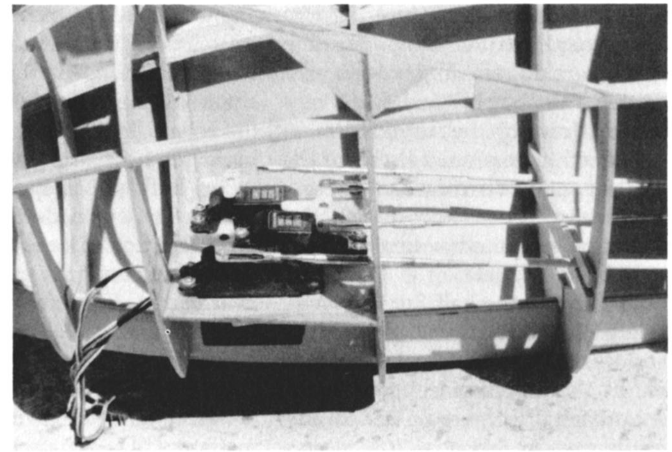


Photo 7 Installation of servos for rudder and elevator, with push rods.

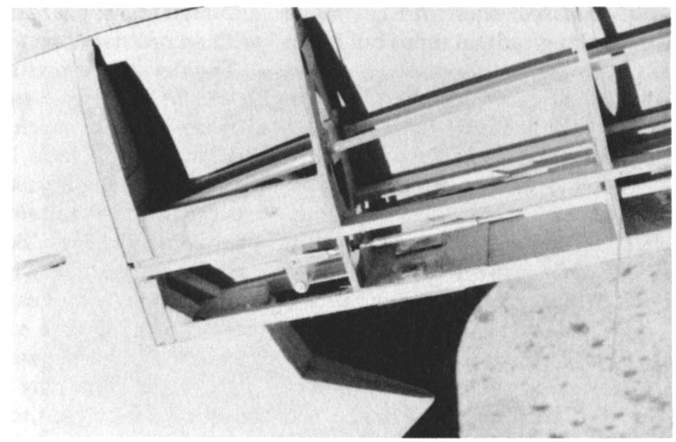


Photo 8 One method of driving elevator and rudder.

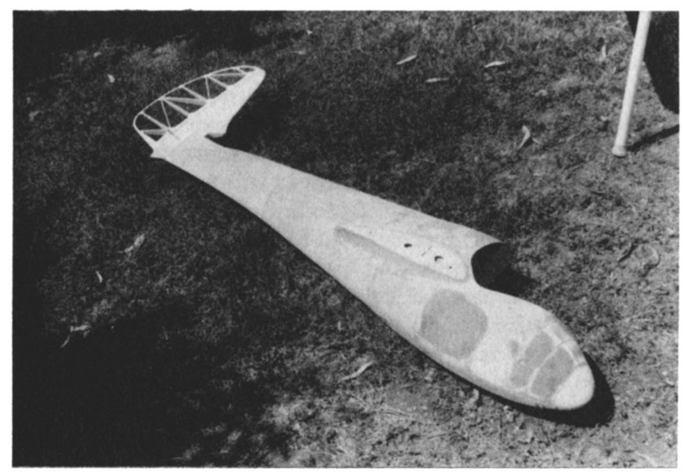


Photo 9 Fuselage skinned, filled low spots with microballons.

portant at this stage to ensure that the building board is truly flat and that the keel members do remain firmly in contact with it. The thin plywood skin is very easy to lay down on the curved formers but will need to be pinned firmly at the keel. Paper patterns are used where any of the ply rings needs to be cut to a special shape, which is required particularly near the nose of the model.

Photo 5 shows the half fuselage shell completed, including the skinning of the fin and the rudder (which is a straightforward balsa job) in place to check for fit. The other half formers are added, and the longerons. At this stage it is important to check repeatedly for alignment. The plywood half shell will not move bow in the longitudinal sense but it can readily be twisted.

The tailplane mounting plate, with the captive nuts very firmly cemented and locked in place, is added now and this, too, checked for alignment and squareness with the fin. It would actually be possible to correct small errors in the tailplane mounting by putting washers on the hold-down bolts, but this should not be necessary. (It is done with full-sized aircraft sometimes.)

The fuselage cross braces are added as shown in photograph 6 between the formers. These not only stiffen the fuselage against shocks coming from the wing roots, but also guarantee correct alignment of the main framework - providing the cross braces themselves are accurately cut.

At this stage the cockpit coaming, which can be laminated from narrow strips of 0.4 mm plywood, may be added, and, as shown in photographs 7 and 8, the control drives, bell cranks and servos can all be fitted and checked for correct operation. The exact location of the servos and radio gear may be varied and will partly depend on how much detail is required in the cockpit. It is recommended, in any case, that a large battery should be used to provide ample capacity to drive at least seven servos. This will be especially important for long duration slope soaring flights. The extra weight in the nose will help with correct positioning of the balance point.

The builder has a choice of elevator drives. The air loads on an elevator of this size are quite large at high airspeeds, so a single standard servo will tend to be overloaded. Either divide the elevator into two and drive each half (synchronously) with its own servo, or invest in a single larger, more powerful servo and keep the elevator in one piece. Either method will be satisfactory. (The rudder too, might do with a more powerful servo, although I have not had trouble in flight with an ordinary one.)

The elevator linkage shown in photo 8 works well. The plan suggests a slightly different layout which will also work, perhaps with a little less friction and permitting easier adjustment of the control throws. I used all steel driving cables of the heavyweight, Bowden type, except for the rudder, which has a closed loop system with heavier cables than would be used on a small model. The inspection panel shown in a convenient place on the plans may be used as it was on the original aircraft, to check and adjust the elevator drive when necessary.

Photo 9 shows the fuselage completely skinned, the root ribs added and faired with microballoons to give a smooth form. Note that wooden sailplanes rarely did exhibit a perfectly smooth skin, since drying out and shrinkage soon produced waves and small hollows.

Cockpit canopy

The original PWS 101 canopy was not moulded in one piece. The techniques for making large transparent plastic mouldings were only just beginning to be developed in 1937. The usual technique for sailplanes at the time was to build a light framework of laminated wooden hoops, or thin tubular steel, to take a number of separate panels of transparent plastic. Probably the PWS 101 used a wooden frame but this is not known for sure. Each separate transparent panel was gently curved in three dimensions by being heated and pressed over a form, so that when these were drilled and screwed or riveted into place the over-all aerodynamic shape was very close to perfection. The joints between the panels were then sealed on the outside, in this aircraft, by strips of aluminium, giving the canopy the appearance shown in the photographs. On SP-1005 the external aluminium strips were also added to the windows behind the cockpit but not on the other aircraft.

The basic shape of the canopy is actually very simple and for the model I was able to find, in a dealer's collection, a moulded canopy intended for a large powered model which, after cutting down, fitted exactly. The frame was built up like the original by laminating numerous strips of 0.4 mm plywood. The cut down canopy was then glued to this, and the aluminium strips were cut from ordinary kitchen foil and stuck on the outside.

The large venturi was turned in wood as a short double cone and wrapped in litho plate, extended to simulate the open ends of the venturi. The pitot and static tubes were soldered up from brass tube. The pitot could be arranged as a jack plug switch for the radio. Pushing the pitot into place switches the radio off, pulling it out switches on. I have not yet had time to fix this up on my model but it has worked very well on others and saves having to remove the canopy to operate the switch.

Tailplane and elevators

Photo 10 shows the tailplane partly built with the elevators fitted, and Photo 11 shows how aileron fork linkages, slightly modified, may be used for the elevator horns. There are other ways of doing this but since it is necessary sometimes to remove the tailplane, it is best if the elevator linkage can be disengaged easily. Make sure that the forked linkages do engage correctly when rigging the tail. What might happen if one of the elevators was not connected, I dare not think.

Three bolts engaging captive nuts, under the platform, hold the tailplane in place. The heads of the bolts should be totally hidden when the model is rigged, since they were not visible on the full-scale sailplane.

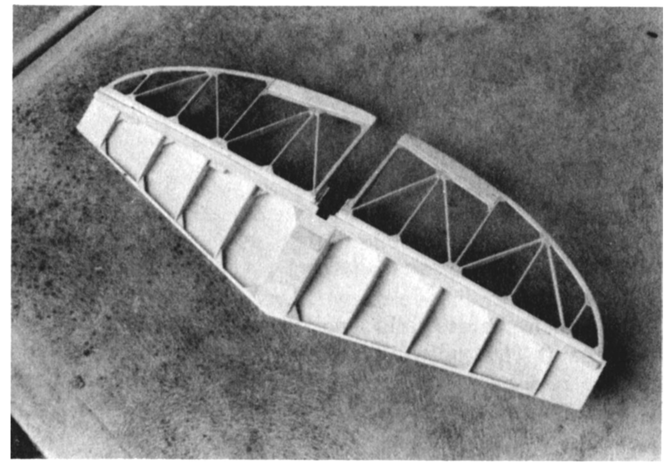


Photo 10 Tailplane partly built, with divided elevator fitted.

The trim tabs on the elevator were, on the PWS 101, actually **anti balance** tabs, linked in such a way that they moved to increase the loads on the stick. That is, when the pilot pulled back on the stick, raising the elevator, the tabs were raised too, tending to push the elevator down again against the pilot's pressure. With such a large elevator the loads must already have been large. I did not attempt to make the tabs work on my model, but it would be possible to do so. I would be inclined, however, to reverse their operation to make them assist the servo rather than resist it.

The wing

Some people seem to think the gull wing form is difficult to build, but these same folk do not hesitate to build a model with polyhedral. The gull wing just goes the other way! However, the bend in a gull wing was always a curve rather than a sharp angle and by far the easiest way of modelling this is to laminate the spar, just as the full-scale sailplane spars were laminated. To do this, a steaming kettle is a valuable asset, and the building board has to be hinged and clamped firmly at the correct angle. Spend long enough on setting up the building board to get the angles right, and then make sure it cannot move. Lay the plan for one wing out carefully, aligning the line of the main spar accurately parallel with one edge of the board. Build the wing up to the final stages, then remove it and without altering the building board, lay out the plan for the other wing, aligning the spar line with equal precision. This will ensure the two wings are accurate mirror images of one another.

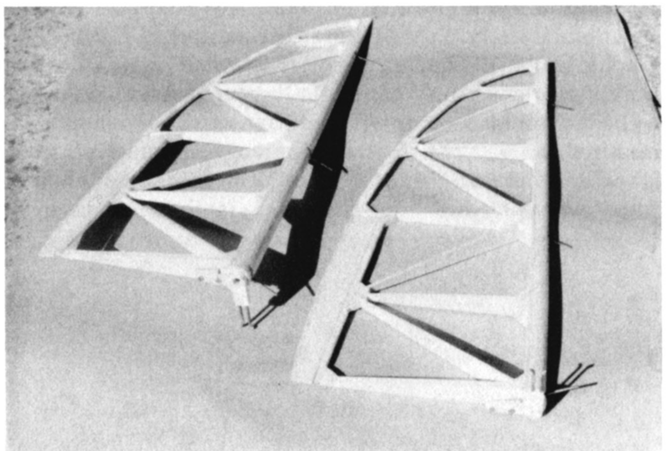


Photo 11 Divided elevator, showing aileron type driving linkages

The outer lengths of the spars, beyond the gull bend, are tapered by careful planing, with a sharp, finely set blade in the plane. This is a fairly tricky planing job but is worthwhile since it considerably reduces the mass of wood out towards the wing tip. Taper only the front face of the spar. Before the bending is done, all four spar flanges can be temporarily clamped together and planed to the taper required as a unit. This ensures all are the same.

There are very few difficulties in laminating spars. It may be necessary to get some spruce specially cut to the sizes shown on the plan. Genuine spruce, from a timber merchant, is quite costly but is lighter than pine or other commonly available timbers found in model shops. Other timbers can be used, certainly, but at some cost in extra weight. It is usually possible to get wood cut to any required size when buying it from a merchant, at some cost. If the modeller has a good, small circular saw, this can of course be done more cheaply at home, but do not attempt it unless the saw is capable of cutting straight and true. Some miniature saws driven by electric drills suffer from what we used to call 'headache'. That is, the saw blade and table wobble slightly in use, producing a very uneven cut which wastes both wood and time.

Begin construction with the lower spar flange. A few minutes of playing a jet of steam from the kettle onto the appropriate area of one of the spruce strips will soften it and allow it to be manipulated by hand into a curve. It may then be simply laid down on the board, over the drawing (protected with a transparent, waterproof sheet) aligned and weighted down. As it dries out it will settle into the required curve quite naturally. A second, shorter strip with a feathered end is treated in the same way, allowing it to dry in place on top of the first strip. Epoxy resin adhesive is best for gluing the laminae together. Care should be taken to align the laminations correctly because a true face will be needed later to accept the plywood webs. Epoxy cleans up better than white glues after setting. (Thinner laminae may be used, but make sure that the finished depth of each spar flange is correct. That is, where the plan shows two layers of 4 mm thick spruce, four layers of 2 mm would be just as good. If the model is never to be winch launched, a somewhat lighter spar could be used but there is not much point in doing this. The model as built will soar in quite weak lift.)

Once the glue is set, the curve in the spar flange will not move again. When the first two laminae are dry, the others near the root, which do not extend to the bend, are added. The whole lower spar flange then is lifted from the board and cleaned up and trimmed as necessary.

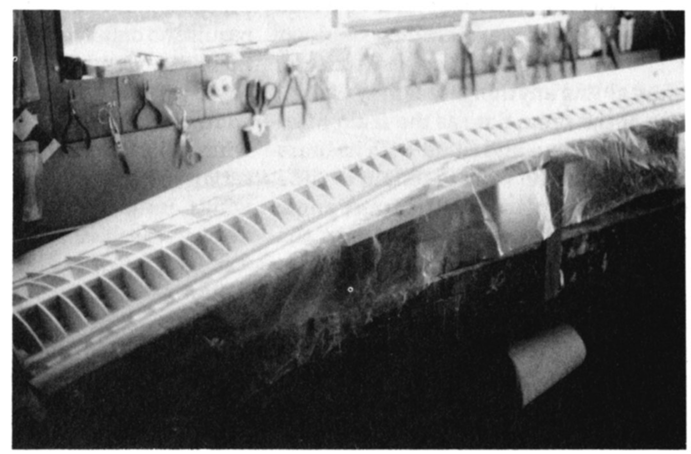


Photo 12 The wing under construction on cranked building board

The finished spar flange is then returned to the board, to be pinned or weighted down.

Note that the washout on this aircraft requires the outer spar to be progressively supported above the building board by the amounts shown on the plan. It is definitely not sufficient to prop up the trailing edge of the wing and hope that the twist this induces in the spar will hold true afterwards. The aerodynamic washout is built into the wing while the spar itself remains untwisted.

The ribs towards the tip are cut with extension tags on the under side, to ensure that they conform to the 6 degree washout as they are glued into place. These tags are retained as long as possible, being removed and sanded smooth only when necessary to finish the wing. Until this time they are used constantly as a reference against the flat surface of the building board, to ensure that the wing twist is correctly maintained.

Cutting the wing ribs might be done by the well-known sandwich method, using templates, but with this model I preferred to cut the ribs individually, this being more economical of wood and enabling the washout alignment tags to be used. I plotted the individual ribs with the aid of a computer (the plan shows every rib so drawn), and then cut out the paper drawings and tacked them to the balsa with spray-on rubber mounting adhesive. Two ribs at a time, left and right, can be cut with a light band saw by temporarily pinning a couple of balsa sheets together. This actually did not take much longer, altogether, than the sandwich method would have done, and certainly created much less mess and wastage.

The sub ribs ahead of the main spar should not be omitted. They will show up as faint humps when the model is finally skinned, which is correct to scale. These small ribs also add stiffness to the wing in torsion, preventing buckling of the leading edge skin. That, indeed, is why the full-sized aircraft required them.

Add the false leading edge and the trailing edges. Shape the aileron spars as accurately as possible to give the aerodynamic slot section, before gluing them in place. This is much easier to do at this stage than later.

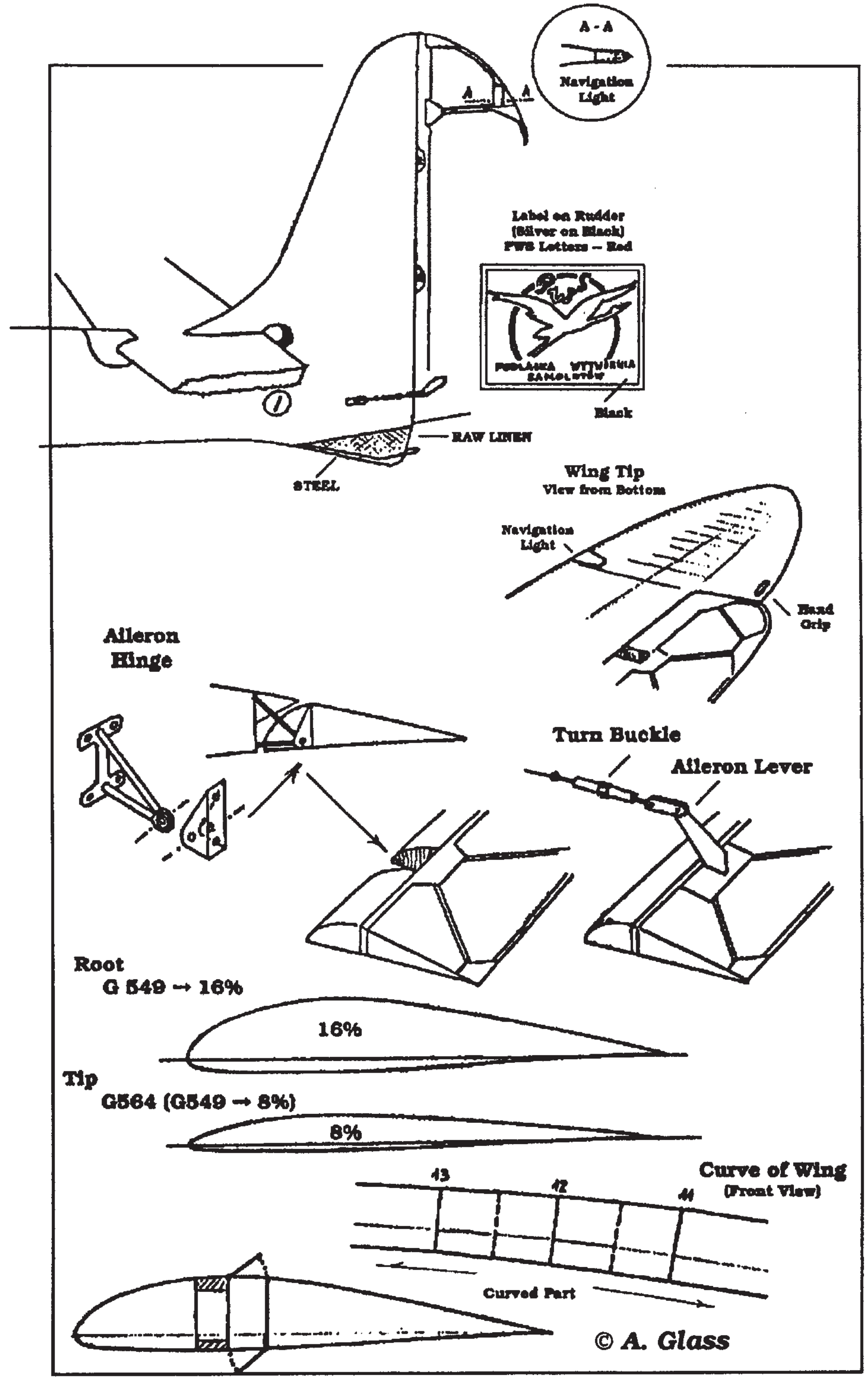
The wing joining arrangements shown on the plan require care, especially since it is easy to misalign the steel strips. It is best to assemble the joiners for both wings and the plywood members they are glued to, and check for accuracy and spacing, before gluing anything. This may well be done at the same time as the main fuselage frame is cut and fitted with its brass tubes, so that the wing is certain to slide correctly into place at the correct angle when the time comes. The steel strip, the heavy plywood web extensions etc., are then glued up and set aside to be treated as a sub assembly and glued accurately into place on the lower spar flange when this is in place. The ribs, of course, have to be cut away to permit this.

It would be quite feasible to design a different wing joining system, perhaps using round steel rod of spring steel and tubes in the wings. An experienced modeller who prefers this should be able to design such a system. Note, however that none of the currently available commercial wing joiner sets, with screw clamps, will fit a model sailplane of these dimensions. This will change if suitable joiner sets come onto the market. I relied on the old fashioned but reliable rubber band method for holding the wings. An extra pair of hooks ahead of the main spar, and more rubber bands, would not be a bad idea, although no trouble has been experienced with wings shifting in flight.

With the ribs assembled and the wing joiners in place, the upper spar flange is treated very much like the lower one, but in reverse order. First the shorter, straight lengths of spruce are cut and laid in place without gluing. Then the shorter curved lamination is steamed and lodged into its place to dry under weights. The second, full-length strip is curved and laid above it. Then all are removed for gluing in sequence and re-laying. Although this may sound difficult, in fact the process is straightforward. Photo 12, taken in rather poor lighting conditions, shows the port wing at this stage.

The rest of the wing construction proceeds along orthodox lines and should require no detailed description. The wing tip block extends inwards a couple of rib bays, to give it more strength than if it were glued only to the end, rather thin, wing rib. It is definitely safe to mount the servos for ailerons and brakes in the wings, rather than trying to drive them through mechanical linkages at the wing root. In any case, ailerons of such area require one servo in each wing to drive them.

The wing skin for the leading edges on my model was 1.5 mm light balsa and all the ribs were capped to bring them up to section. There would be no objection to skin the leading edges with 0.4 mm plywood, with due allowance for the smaller



thickness. The full-scale sailplane of course was skinned with plywood. In any case, the small triangular corner gussets are necessary to imitate the appearance of the original.

Ailerons

The ailerons, with their diagonal ribs, have to be built separately, like small wings, and should be packed up during construction to give them a twist in conformity with the wing washout. The splitting of the ailerons into two was to prevent binding at the hinge line when the outer wing flexed under loads in flight. The plans show how the two parts of the aileron are driven from one servo. A differential drive may be arranged mechanically, or this can be done electronically with a modern transmitter.

The idea of slotted ailerons was to give a form of boundary layer control. Air from below the wing entered the slot and, following the rounded leading edge of the aileron towards the narrow exit, emerged as a thin layer of air moving at high speed across the upper surface. This prevented flow separation over the aileron and improved control considerably, especially when the aileron was deflected down. Some care is needed in shaping the aileron leading edges and hinging them so that the slot does remain open without gaping. The simple, home made hinges suggested for the ailerons (and the elevator) have been found to work perfectly well and are very simple both to make and to adjust during final assembly. On the original model the ailerons are extremely effective and this may be attributed at least partly to the slot effect.

The brakes

The brakes, with their interesting and unusual action, are best driven by the torque rod arrangement shown on the plans. This, if made and aligned according to the geometrical requirements, works very well and the brakes are more effective, when open, than their small area would suggest.

Covering

The fuselage was given a layer of '2 ounce' glasscloth. The wings and tail were covered with SIG 'Koverall', a heat shrinkable polyester fabric which is stuck onto the framework with dope and then shrunk with a hot air gun. Two coats of dope are then applied. The only problem I found with this fabric was that the doping after shrinking softened the adhesive on the under side of the wing where the gull bend formed a concave area. The fabric pulled away from the ribs here but was easily restored to its place by pricking through the cloth and injecting small amounts of cyanoacrylate adhesive.

Colour, finishing and detail

Many Polish sailplanes, including the first two PWS 101s, were painted in red and ivory, approximating to the colours of the national flag. The dark red, according to the chart published by 'Vitocharts', *cervená*, corresponds approximately to the 10A8 sample in the Methuen Book of Colour, but is more vivid. The ivory, *kosc*, matches 3A3 in the same handbook. The disposition of the colours on the first two PWS 101s, and the lettering in black, is shown in the photographs and in Andrej Glass's sketches. The large numbers, 4 on SP - 1005 and 5 on SP - 1006, with the white diamond on the nose, were the contest numbers added for the 1937 Wasserkuppe competition. SP - 1006 did not carry its registration on the fuselage. Other small variations of detail, such as the metallic strip round the rear windows on 1005, are visible on the photographs of the full-sized aircraft.

Later PWS 101s appeared with dark red paint on all the plywood surfaces. The open frame areas were covered in clear doped and varnished cotton fabric (madapolam), and carried large black registrations on the undersides of the wings. An example of this scheme was SP - 1089, which appeared at the Paris exhibition in 1938. Detail of the small PWS trademark on the rudder is shown on the plan.

Cockpit details are not easy to determine, but what is known is shown on the plan in sketch form. The large venturi mounted on the starboard side of the nose was an air suction device which provided power for the gyro turn and slip indicator. This kind of drive worked well until it was most needed: when circling to climb in cloud, the venturi would usually ice up, leaving the pilot without guidance in a critical situation.

My model was first painted in automotive enamels, colour matched to order. The grey primer was sprayed on and rubbed down, and followed with two coats of ivory. After masking, the red enamel, also two coats, was sprayed on.

Flying

The model came out, after painting, weighing 6.5 kg, which seemed enough, giving a wing loading of slightly over 5 kg/sq metre or 17 ounces/sq ft. The first flight was approached with some trepidation. The Waikerie competition was only a week away and there had been no chance to test fly by slope soaring, which is probably a safer way to discover if a model has any deficiencies. We struck a period of nearly calm weather. The first launch therefore had to be by winch and the take off was from the ground.

For the first launches I fitted a pair of open towhooks under the leading edges of the wings just outboard of the fuselage. During construction hardwood blocks had been glued in place with this in mind. A Y shaped extension was attached to the winch line. I felt that the double hooks would aid directional stability at the take off, and the hook position under the wing would help to prevent any sudden rearing up on take off. (My six-year old Kirby Kite climbs very steeply with the towhooks in the orthodox position. This is satisfactory but I felt it was not desirable on a new model for the first few launches.)

The PWS 101 was launched with the wing tips propped up on a couple of bricks with the Y ended winch line attached, and there remained nothing else to do but step on the winch foot switch. The model took off gently, climbed smoothly, came off the line at the top of the launch and gave no trouble whatsoever during the subsequent flight. On the next flight, launched in the same way, a thermal was contacted and the model circled up to a great height. Stability is outstandingly good but the model responds, particularly to aileron, very quickly and positively. (I usually fly with coupled ailerons and rudder.) No trimming or adjustment was required whatsoever, and the controls have been left exactly as they were. The next occasion when the model flew was in the Waikerie contest, where on its fourth flight it again soared away to score a ten minute 'max'. The twin launching hooks were soon moved to a position shown on the plan. No appreciable change in launching behaviour has been noticed and in fact the double hook arrangement also is quite unnecessary once the pilot has become familiar with the model. The model is comparatively heavy and does not climb on the winch as rapidly or as high as the Kirby Kite, which is much lighter, but it is considerably more efficient than the Kite both in soaring and gliding between thermals.

Martin Simons
13 Loch Street
Stepney
South Australia 5069

Readers, the plans for the PWS 101 are available through B² Streamlines.

Classified ads are free of charge provided the ad is personal in nature & does not refer to a business enterprise. They are run on a space permitting basis.

Ridge Writer

...by Wil Byers

Hello! You readers of *RCSD* have certainly seen and contributed to the change that has taken place in this publication over the last year...a change that promises to continue well into the future.

So, when J^2 suggested, very convincingly, that I become a contributing columnist (primarily for Slope and Scale), I was not only flattered but, additionally, I was extremely apprehensive about this peer evaluated task. I have been involved in model aviation since I was about 5 years old and more recently involved in R/C soaring since 1976. I do very much enjoy R/C soaring, and it has become a passion with me and affects almost everything I do these days. Well, almost everything! It is my hope to communicate to you thoughts, ideas, and techniques and I also want to have a whole lot of fun doing it.

That said, now I need to have a bit of help from those individuals out in model glider land who have information that they feel is worth passing along. Yes, I need to hear from you! Because, even though I have a whole lot of past experience in this wonderful hobby, I sure don't know everything there is to know about R/C soaring. Also, I have my built-in biases and paradigms which need to be violated a times.

So, if you have any information which you feel is pertinent to this facet of R/C soaring, please send it to me and I will try and use it in this column to all our benefit. Let me know about your latest and greatest designs, the best of your building techniques, flying methodology, electronics, CAD programs, or anything else that fits. I will attempt to address any issues and maybe some that I feel near and dear to, such as SAFETY. Additionally, I hope to provide sources of material which will help you document, analyze, design, construct, and share in the enthusiasm of R/C soaring.

As many of you already know, the slope soaring format is not one which lends itself to easy planning because events are always wind dependent. But they certainly do not have to be avoided by either participants or planners, because many individuals, in my opinion, would like to have an opportunity to participate in slope soaring on an organized level, even at the risk of no wind. Therefore, if I know about it, we will attempt to promote it, via *RCSD*.

Now for the first bit of technical data to be offered in this new and, hopefully, successful column. Mr. Michael Selig has designed three new airfoils especially with the slope soaring buff in mind. Let's have Michael tell you about one of three airfoils: S-6061. The S6062 & S6063 will be discussed in future months.

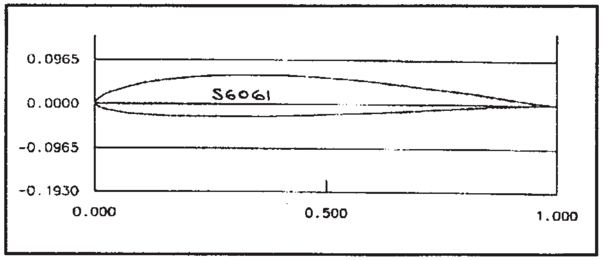
Three New Airfoils Designed for Slope Soaring

...by Michael Selig

At the request of several people I met this past May at the Tri-Cities Scale Fun Fly, I have designed three new slope soaring airfoils which are spin-offs from the SD6060.

It is common to find sailplanes with airfoil names like "modified E205", "E374-9%", or "thinned E374". Certainly any slight modification to the original airfoil will not devastate performance, but the modified airfoil will no longer retain all of the favorable characteristics which were designed into the original airfoil. A typical modification would be to scale all of the airfoil y-coordinates by some fraction in order to reduce the thickness. This simple scaling does not "operate" properly on the airfoil velocity distribution which itself is derived from boundary-layer considerations in the airfoil design process. If a particular airfoil thickness is desired, this requirement is best achieved during the initial design effort in order to retain the favorable boundary-layer characteristics while simultaneously matching the thickness specification.

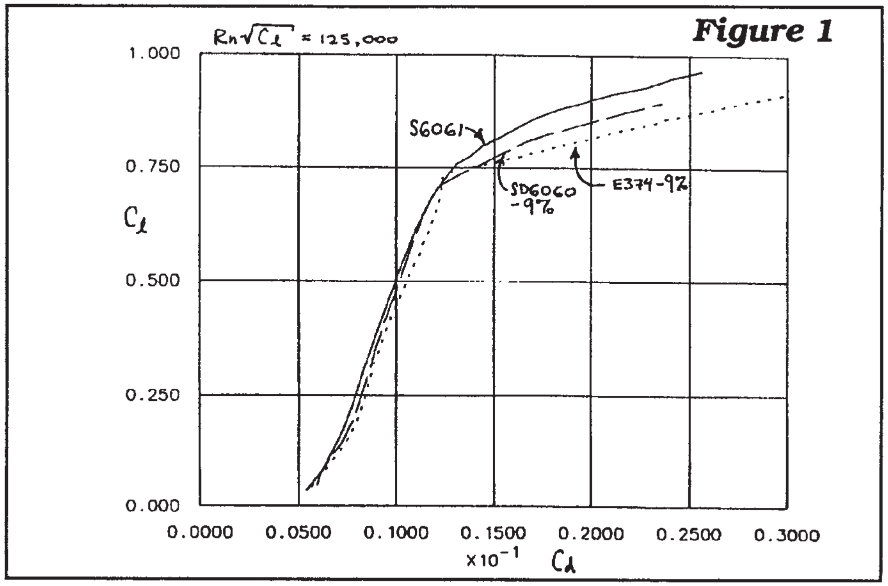
The S6061 is a 9% thick airfoil designed



along the lines of the 10.47% thick SD6060. The new airfoil is compared in figure 1 with a "SD6060 -9%" and "E374-9%". The drag predictions were made using the Drela XFOIL code which is the in-compressible version of the ISES code used to aid in the design of the SD airfoils presented in Soartech #8. Using the Princeton airfoil data base, it was found that the XFOIL code does predict low Reynolds number airfoil performance fairly accurately, and it can be used to compare airfoil designs.

The comparison is made not at a constant Reynolds number *Rn* as is typically done, but instead at $Rn \sqrt{C_l} = 125{,}000$. Thus the Reynolds number varies like $1/\sqrt{C_l}$, so as the C_l decreases the *Rn* increases and visa versa. It can be shown that such a variation in *Rn* follows that of the aircraft in fight. In this case the C_d plotted corresponds to that of the aircraft in flight. Since the constant is 125,000, the aircraft flying at $C_l = 1.0$ would have $Rn = 125{,}000$ which is typical of slope soaring aircraft.

In figure 1 it is seen that the 9% thick S6061 has a broader lift range than the E374-9%, and the drag is practically lower everywhere. The improvement over the SD6060-9% is less dramatic, but it still illustrates the point that simple scaling of an airfoil produces an inferior airfoil.



S6061 9%		0.00135	0.00364
1.00000	0.00000	0.00030	-0.00161
O.99674	0.00022	0.00507	-0.00618
0.98707	0.00100	0.01525	-0.01080
0 97131	0.00255	0.03050	-0.01506
0.94987	0.00497	0.05071	-0.01880
0.92321	0.00829	0.07572	-0.02193
0.89186	0.01244	0.10534	-0.02443
0.85637	0.01728	0.13931	-0.02629
0 81726	0.02264	0.17729	-0.02754
0.77507	0.02832	0.21892	-0.02821
0.73032	0.03410	0.26374	-0.02836
0.68352	0.03977	0.31128	-0.02804
0.63517	0.04512	0.36098	-0.02729
0.58576	0.05001	0.41230	-0.02615
0 53580	0.05427	0.46466	-0.02466
0.48580	0.05776	0.51746	-0.02284
0.43623	0.06032	0.57012	-0.02070
0.38750	0.06185	0.62210	-0.01826
0.34000	0.06231	0.67288	-0.01560
0.29417	0.06175	0.72194	-0.01280
0.25047	0.06018	0.76876	-0.01002
0.20931	0.05761	0.81279	-0.00739
0.17107	0.05408	0.85345	-0.00507
0.13608	0.04961	0.89016	-0.00317
0.10463	0.04431	0.92237	-0.00173
0.07697	0.03826	0.94954	-0.00076
0.05331	0.03161	0.97124	-0.00020
0.03379	0.02455	0.98708	0.00002
0.01856	0.01732	0.99674	0.00003
0.00771	0.01020	1.00000	0.00000

Michael Selig, PENN STATE
233 Hammond Bldg.
University Park, PA 16802

♣ ♣ ♣

Thanks to Michael it is our hope that this type of information will find its way into your hobby and, hopefully, provide you with a winning design or great Sunday flier. Please feel free to call or drop me a line. Also, if you wish to provide me with information on a computer disk, I use a MacIntosh – 3.5" diskette in ASCII format or via a modem. My CompuServe account number is 76104,3605.

Hoping for Wind, Wil Byers
RT. 4 Box 9544
W. Richland, WA 99352
(509) 627-5224 (7:00 PM - 10:00 PM weekdays, after 9:00 AM weekends)

Versions of the Tempest

...by Scott Metze

These are the current versions of the Tempest that are now being built. Each of these designs are mission oriented. In other words, each Tempest has been built for specific flying conditions. The actual plane design takes into account span, aspect ratio, weight, airfoil, tail moment and control surfaces.

Tempest 1.25M - R.E./JC-18

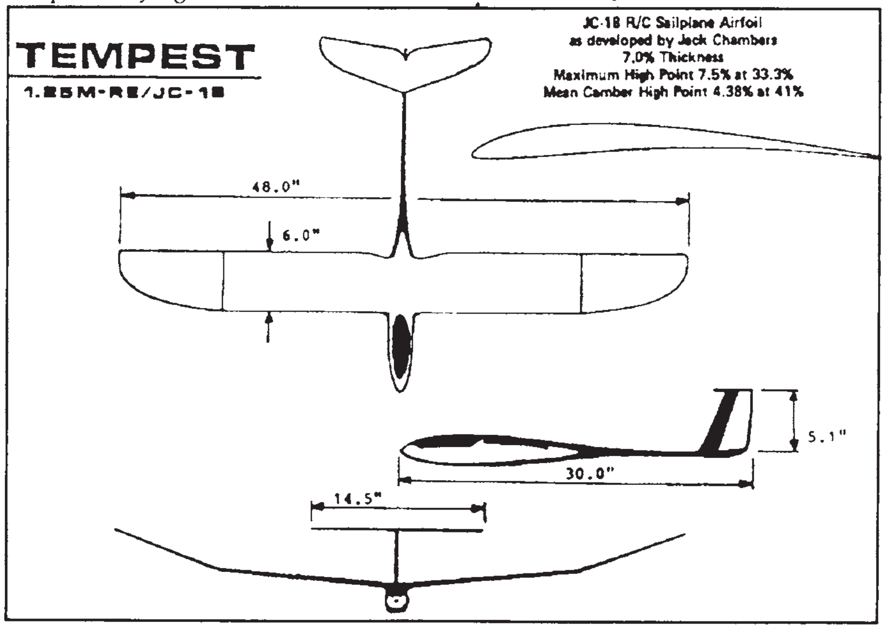
A 50" rudder and elevator Tempest using the Jack Chambers 18 airfoil. It has an aspect ratio of 9 to 1 and an average cord of 5.5". It is designed for hand launch thermal flying or small hill flying. It is available, direct from Scott's Models, finished and ready to cover.

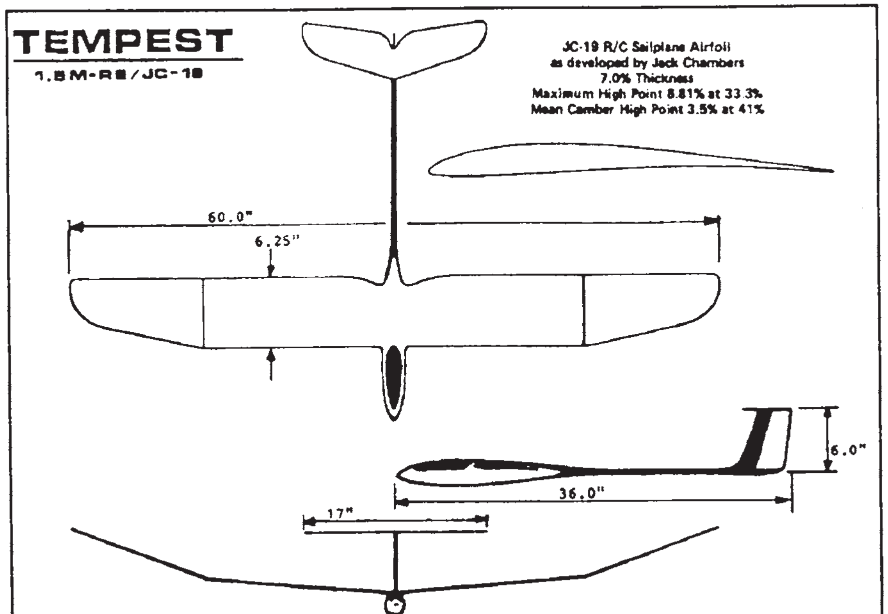
Tempest 1.50M - R.E./JC-19

A 60" or one and a half meter rudder and elevator thermal Tempest. It uses the Jack Chambers 19 airfoil. It has a 10.5 to 1 aspect ratio and an average cord of 5.75". It is designed for small thermal flying or small hill flying. This Tempest will be available in December through Joe Holtzman at Kite Hill in Mission Viejo, California. The wings will be finished and ready to cover.

Tempest 2.00M - R.E.A./JC-22

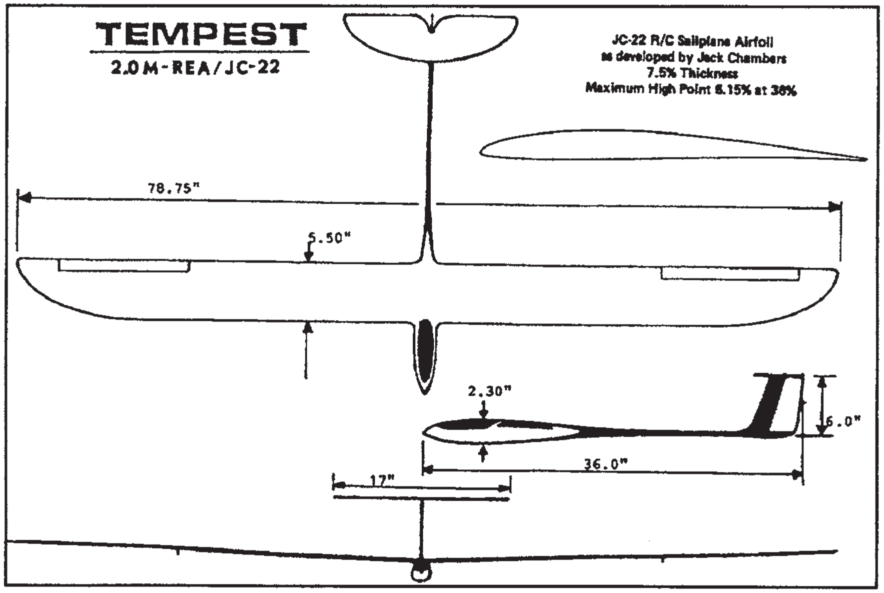
A 78.75" or two meter aileron, rudder, and elevator thermal Tempest. It uses a Jack Chambers 22 airfoil and has a 15.0 to 1 aspect ratio with an average cord of 5.25". It is designed for flat land thermal flying or ridge thermal flying. The two meter Tempest will be available through NSP in Dec. The wings will come finished in two pieces; the fuselage will be finished with the vertical built and installed.

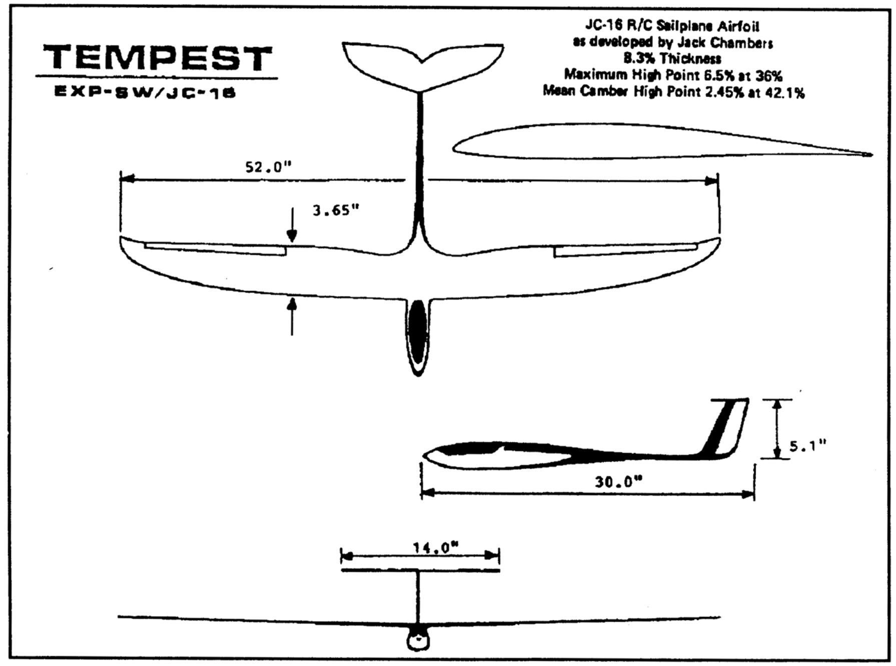


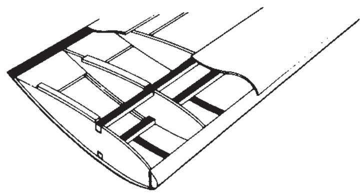


Tempest S.W. Experimental/JC-16
A prototype of the Swallow Wing Tempest, it will have ailerons, rudder and elevator. It is partially designed, and contracted to be built by Lewis Hignite, for the 25 MPH winds and 1000' hills here in Tehachapi.

Scott Metze
P.O. Box 1569
Tehachapi, CA 9358







Video Review

...by Jerry Slates

"Soaring in Mid-America 1990 AMA Nats"

For those of you that were unable to make it to the 1990 Soaring Championships, D.O. has seized the opportunity to provide you with some of the more interesting shots of the event through his new video "Soaring in Mid-America — 1990 AMA Nats".

Both old and new gliders showed up to compete. Competition included hand-launch, scale, 2M, standard, and unlimited plus a bit of F3B. For those of you that attend local contests of 35-50 contestants, going to the NATS for the first time can be quite overwhelming. This tape, of course, shows everyone having a good time which is what it is all about. Of special interest is the way in which D.O. interviewed some of the entrants. His focus helped us see what others are building and flying.

D.O. filmed another tape at the 1990 AMA Nats awards banquet entitled "An Evening with Selig & Donovan". Michael Selig and John Donovan discussed better performing aircraft design and low Reynolds number airfoil results from the Princeton wind tunnel tests. Unfortunately, in an effort to make the tape, there is some background noise that can't be edited out. However, if you're interested in computer theory and have not had a chance to hear John or Michael speak, the tape will give you an opportunity to hear them voice their theories and provide answers that are both interesting and informative. Both tapes are available from D.O. Darnell, Model Construction Videos.

RCSD Database

Lee Murray has dropped us a line to let us know that the "*RCSD* database is available in an improved format for importing into IBM databases." Lee can be reached at 1300 N. Bay Ridge Road, Appleton, WI 54915-2854; (414) 731-4848.

Video Review

...by Jerry Slates

The "Airtronics Vision 8"

I'm sure that all of us at one time or another have seen the BIG GUYS take their airplanes and computer radios into the back of the pit area where they will not be disturbed and where they can do some fine tuning of the controls. So, if this is what it takes to be a winner, then the next logical step is to run right out and buy the same airplane and radio. Well, this doesn't always make us winners.

After the airplane has been built and the servos have been installed, then the controls have to be set according to the manual instructions. Have you seen the new manuals for the computer radios? The terms are new, the servos plug in differently than they have in the past, and the programing is controlled by a menu. There is a lot more to learn today than with the radios of yesterday and, in many ways, there is a certain amount of frustration trying to figure out how do do it right the first time.

John Clarke is offering a video tape on how to program the Airtronics Vision 8. John says, "The tape is a visual step-by-step guide to setting up a modern sailplane. It covers two types of sailplanes: one a simple rudder/elevator/spoiler and the other is an all out aileron/rudder/elevator/flap competition sailplane. There is particular emphasis on the finer points of mixing, and lesser known ways of using the radio. The price is $19.95 plus $3.50 S&H."

Now, John will help you walk through the first control set-ups which should help make your first attempt a bit easier. At the start of the tape, John shows a simple rudder, elevator and spoiler configuration. Then he works into the more complicated elevator and flap mixing, aileron differential, dual flap aileron mixing and a crow set-up. By the time you do all of the above with John, you should be over the fear of pushing buttons and resetting the options and can go on to the many other features that your new computer radio can do. It seems to be a lot easier to do something like programing if there is someone else there to help you at the start.

John currently has another video available. In the May issue of *RCSD* (page 3), Bob Welwood did a video review of John's tape entitled "Foam Wings & Things". This tape is meant for those interested in cutting and vacuum bagging sailplane wings, etc. The tape is available for $10.00 plus $3.50 S&H from John Clarke, 911 Covert Avenue, New Hyde Park, NY 11040.

F3J - USA

A Newsletter for the F3J Community

...from George Burr

In order to promote the development and advancement of the international thermal duration soaring event called F3J, I would like to start compiling and distributing information of interest to the F3J community. I anticipate that people with information to contribute will offer it for publication. Those interested in receiving the information will get on the mailing list. The task of editing and producing the newsletter will be mine. The funds to pay for the production and mailing will be from donations. Because the size and scope of this project will be determined by the amount of interest generated, no standard subscription rate, publication date or frequency can be determined at this time. Should it be decided to discontinue publication or convert the format to a subscription basis or a commercial venture any donated funds would be contributed to a RC soaring organization or the AMA.

If you have an interest in F3J soaring, please complete the form (below) and make a contribution. If you would like to write an article please sit down to your typewriter or better yet your IBM compatible word processor. Send me your manuscript or disk.

What do we want to include in F3J - USA?

- Contest results.
- Airplane designs for F3J.
- Computer design for F3J.
- Discussion of the rules.
- Hand towing experiments including line type and reels.
- Contestant impressions of the F3J event.
- Upcoming contests.
- Construction hints.
- Building a towline tester.

Basically, anything related to soaring that can be used by the F3J community will be of interest. If you have an interest, please take this three step approach.

1. Sign up for the mailing list.
2. Make a small donation.
3. Contribute an article.

Thanks in advance for your interest.

George S. Burr
1614 McCarthy Blvd.
Wausau, WI 54401
(715) 675-9851

F3J - USA
A newsletter for the F3J community.

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Classified Advertising

For Sale

- Fiberglass 4.0M ASW-20, obechi sheeted wings...$500.00 + Shipping
- Lovesong Kit,new in box... $200.00/B.O.
- Great Planes Electric Cub Package, motor, three battery packs, Jomar speed control, flown about 30 minutes...$150.00

Jim Ealy, c/o Peddie School
Hightstown, NJ 08520, (609) 448-8726

For Sale

- MULTIPLEX — Built: LS3, DG-600 retract; In Box: ASW-22, DG-500, DG-300...B/O • Built: DISCUS 4M, TWIN ASTIR 4M; In Box: PILATUS 2M PIVOT WING...B/O

Bob Simmer, 10895 Redfern Circle
San Diego, CA 92131, (619) 549-4131

For Sale

- Robbie ASW-24, 1/4 scale, built, 7 ch. Futaba radio (needs upgrade)...$450.00
- REIHER, Triton Models, 90% completed...$350.00

Ray Cindric, 44 Stockton Ct.
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Original HOBIE HAWK
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Wanted

Central Arizona Soaring League would like to purchase a Davey's Retriever System

Chuck Wehofer,
c/o C.A.S.L.
P.O. Box 2472,
Chandler, AZ
85244-2472

For Sale

- Futaba G-series transmitter modified with "Mixmaster" analog mixer board, originally developed for the Synergy II. This transmitter performs nearly all the functions of an Airtronics Vision radio (Crow, Camber, Aileron->Flap mixing, Elevator->Camber mixing, Launch pre-set) at a fraction of the price. The transmitter will work with any Futaba PPM receivers or compatibles (such as the Platinum, etc.). This is a good way to get all of the functions of the expensive computer radios at a low cost...$150.00 for Transmitter & Documentation or $250.00 for Transmitter & 2 modules on six meters (sold to Hams, only)
- Müller King 85, with 120" natural wood wings, converted for F3E electric with Astro 100 Cobalt motor, Summerauer speed control, folding prop, and 30-cell SCR battery. 12V Astro charger for 30-cell battery. Electric gear may be easily removed and covered with a bolt-on nose cone to make a glider version. The King is ready to bolt in the gear and fly, and if you buy with servos, they are already installed in the wings (metal-geared Becker S400s). A new King costs over $650 these days, and the electric gear is worth over $500. This would be a great starter for someone interested in F3B or F3E....

$400.00 — King with nose cone, glider version (no electric gear, no servos)
$550.00 — King with electric gear, charger, and nose cone (no servos)
$600.00 — King with nose cone and six metal-geared Becker servos (glider version, no electric gear)
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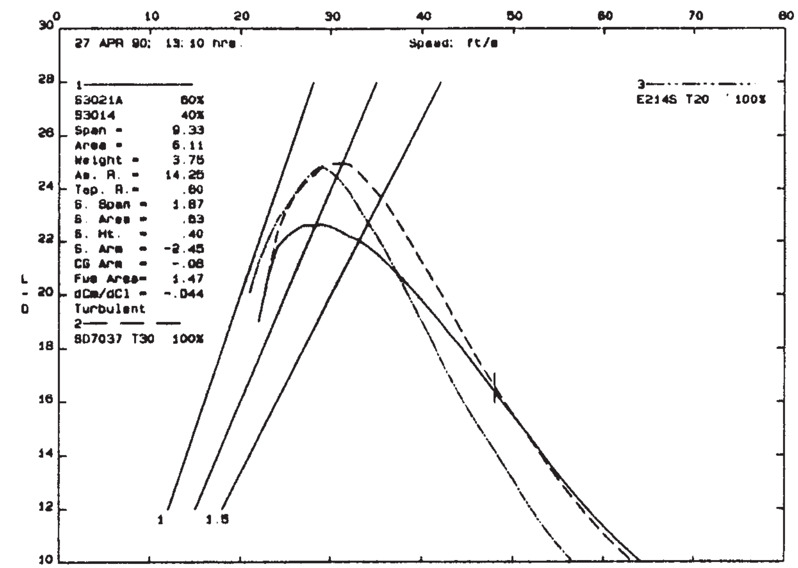

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