SANTA ... PM 31 JUL 1989

Harbor Soaring Society
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FIRST CLASS MAIL

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(The Soaring) Society Column

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"The Oldest Sanctioned Soaring Club In the AMA"
Chapter # 128

August 1989 Volume 26 Number 8

August Club Meeting: The August club meeting will be held on Wednseday, August 2, 1989, 7:30 pm at the Consolidated Water District Office, 1965 Placentia Ave., Costa Mesa, Ca. The Monthly club contest will be on the 6th of August, field conditions permitting.

September Club Meeting: The Sept. club meeting will be held on Wednesday, Sept. 6, 1989 at 7:30 pm at the Water District Office.

MINUTES JULY 1989

The meeting was called to order at 7:30 p.m.

1) The June minutes were read and accepted as printed.

2) New Faces: Jim Parsons, flying a Sagitta; Cecil Sanders, flies slope; Art Wahlstedt, converted power flyer.

3) The Treasurer's report was given by Frank Chastler. He has club T-shirts in sizes Medium, Large, and X-Large.

Old Business:

4) George Joy gave a contest report and tasks for the July contest. He also noted that we have been invited to the Malibu club for a contest in August.

5) Felix gave a progress report on the F3E-7 cell contest. He reports the entries will be about double from last year's. All bills for this contest will go directly to Felix--not the Harbor club.

a) Bob Sliff wants to have a practice session for the timers and help because of the difference in this event compared to regular contests. Felix wants the helpers to help at least a full day (or both) and not part time because of the value of the raffle for the help.

b) The club voted for a 3 day cruise as the prize rather than a Vegas weekend.

6) Field Committee: Voted in as the committee were Frank Chastler, Norm Kutch, and Pete Richardson. Guide lines will be set up for them to follow in dealing with the city. Will Conrad said the city wants something similar to that used by the Torrey Pine Gulls as far as field rules. The committee will see to the making up of a "field rules" sign.

7) John Lupperger gave a summary of the Astro Flight Electric Champs. He thought that more support could have been given by the non-electric fliers.

New Business:

8) The club voted to pay for dollies to help with moving the winches and batteries from the parking area.

a) Dave Nemecek made comments about disarming switches on the winches as he had an accident last weekend.

b) A discussion was held concerning where the winch lines are now located. A committee will get together about the safest placing for the winch lines and landing areas.

The meeting was closed at 8:40 p.m.

Ross Thomas

PROGRAM--ROY REINEMAN

Roy makes models of full size racing yachts and makes showcase models for sale. A model of "The Stars and Stripes" was shown and would cost about $10,000.

Roy showed us the types of molds and forms he used for casting keels and rudders of his models. Stainless steel is used for railings and most metal parts. Stainless steel parts are soft soldered together with special fluid and solder. Parts come out stronger than brass sheet construction. Small parts are laid up like a circuit board and acid etched.

Roy's models are sold to galleries, yacht clubs, and private persons. His primary tools are super glues (i.e. Zap, Hot Stuff) and soft solder.

AMA NATS by George Joy

On the afternoon of July 14th, Ross & Maxine Thomas & Tony Martin in one veichle, myself & my wife in another, started out from here at approx. 1:45 pm, headed for the tri-cities area of Washington State. The trip was uneventful and we arrived at approx. 12:30 July 15th.

We located the soaring field and planted my trailer there for the night. Since we were the first to arrive there was no way of knowing where to park, so we setup next to the street for the night. next morning we located some of the officials and was instructed where to set-up, and since we were the first ones to arrive, we were given the task of informing all others where to park.

We had rain on Sunday afternoon and Monday morning but not heavy. Sunday afternoon was damp and warm. We spent the day checking out the cross country and hand launch field and the slope site. They were about 1 mile away outside of town in different directions. The H/L and X/C were on a grass soccer field with no obstructions for miles. It was a beautiful site. We wondered why it wasn't being used for the soaring events. They said that it wasn't large enough, which I believe proved to be true. The slope site was rough to get to over dirt roads, but was a great place for sloping. The winds on Sunday were very strong and the guys were having ball.

On Tuesday Ross Thomas, Bob Sliff, John Lupperger, Tony Martin and myself went to the H/L event. I had left my transmitter on all night and, of course had dead batteries, though I thought the reciever batteries were bad. So I went to AMA headquaters and bought a new 250 pack. When I arrived back someone asked if I had checked the transmitter, as they had checked the reciever pack and it appeared to be good. So much for having your head where it doesn' belong an what great start for the Nats.

Tony Martin loaned me his hand launch as I was having a problem with mine. On the 2nd launch the verticle fin seperated. As I attemped to save the plane, just before touchdown, slightly inverted and nose down, I gave it full down elevator. The plane came level and struck John Lupperger on the ankle, damaging the leading edge. Larry Jolly, who was throwing for me, picked up the plane, ran over to the truck, and reglued the fin and rudder horn while I taped cardboard to the leading edge. We were back in the air before the 10 min. window was over.

Toni Martin was planning to be slope racing, but it was cancelled for Tuesday. So he showed up to participate in hand launch.

He borrowed a Tossette from Bob that he had never flown and managed to get a 2nd place trophy (ahead of Larry Jolly and behind Joe Wurtz.)

John Lupperger got a 6th place trophy in Hand Launch, even after I ran over his feet, and caught his plane in another round.

On Wednesday was F3B and Scale. The scale fliers started in the morning, while the F3B course was being set-up. The scale event was enjoyable to watch.

I flew in the F3B event with my 100" Cheetah and managed to get a 4th place trophy.

On Thrusday, Unlimited Sailplanes, was the order of the day. With the winds very strong Bob Sliff managed a 7th place trophy. Bob only lost 9 points for the 4 rounds. I was fortunate enough to have help from Larry Jolly to call the air for me and I managed to lose only 10 points for the four rounds. This put me in the only tie in unlimited. I had a fly-off and won it for an 8th place trophy.

On Friday was the Standard class. I managed to get a launch during every sink cycle that came through. I crashed twice, got repaired, thanks to Joe Wurts, and flew every round. In honor of John Aimes, I flew with the Stars and Stripes flying high, as he did on the 4th of July. It was a big hit. Thanks John.

On Saturday was the 2 Mtr. event. Pete Richardson flew a brand new 2 Mtr Gnome, without spoilers, and tied for 8th place. Another fly-off was in order. This time the task was a 5 min. precision (bell curve) and a graduated spot landing. Both pilots launched simultaniously without retrievers. Pete went right and the competition went left. Pete found good lift and skyed-out, while the competition struggled for lift. As the landing time approached Pete came down fast, the competition was still airborn though. as Pete approached landing we saw the other plane make a very good landing. Pete finished the landing very near the center of the circle abt. 3 seconds early. as the cheers went up for both pilots the measurements were taken, the competition got a 94 landing and Pete got a 90. The other plane had landed 8 seconds early. PETE WINS!!! This was the best show of the entire event. Great job Pete. In addition, Bob Sliff placed 6th and Tony Martin placed 10th.

George Joy

A VIEW OF THE 1989 NATS
BY BOB SLIFF

For those of you who did not attend, you missed a very good Nats. In fact, you missed 6 action packed days of competition in weather that was better than it was here in So Calif.

Day One was slope--with a beautiful site, booming lift when the wind was up, and a great landing area behind. The only negatives were: the slope face was rough and rocky, and the valley below was very deep (1,000 ft?). (If one went below the lift zone, it was a long glide down to the bottom.)

Tuesday, the wind was down and handlaunch was up at a beautiful grass field surrounded by lots of open, unobstructed land where thermals were popping up with remarkable regularity. We flew 5 rounds. Each round had several 10 minute slots in which fliers were given 7 launches to make five 2 minute maxes. And, as any flight could continue as long as it started before the end of the 10 minute slot, it was possible to get five perfect maxes. In fact, in one round, both Joe Wurtz and Tony Martin had a perfect round. Even yours truly maxed a good number of times.

Wednesday was Scale and F3B. Though past Nats had been lacking in these areas, that was not the case with over 20 entrants in each event. Several of the scale models were not only beautiful works of art, but were exciting to watch as they were launched and flown. The better F3B models were the glass types we have seen locally, but a number were more conventional models, and these converted models really acquitted themselves well.

Thursday, Friday and Saturday were the Thermal Duration days, with Unlimited on Thursday, Standard Class on Friday, and 2-Meter on Saturday.

Thursday's Unlimited Class started off with some wind (a crosswind at that) which later became stronger. Nonetheless, maxes were very frequent, with the difference between 1st and 10th being mere seconds. So, this day involved early wave soaring that degenerated into blatant sloping off the line of trees that bordered the field and the Columbia River. Yours truly got two maxs working just off the tops of the trees.

Friday was for Standard Class and the wind was replaced by fairly frequent thermals. Here maxes were rather frequent as thermal lift lasted late into the day.

Saturday, 2-Meter day, began with numerous thermals and developed into many more until the last round when they began to be less frequent. I have to admit that they were extremely prevalent as yours truly specked out every round except the last. As George mentioned, Petes flyoff was really outstanding. The other flyoff in 2 meter was something too. (See note below)

Saturday night was the Awards Banquet, with Dr. Paul McCreedy as the guest speaker. The awards then followed with HSS members getting a number of awards. While none of them were 1st's, the placings were really respectable considering the number and quality of the contestants. (There were over 380 entries in the official events).

Placing were as follows for our members:

<u>Slope Racing, F3E</u>:

Over 14oz./sq ft wing loading class--Tony Martin 3nd place

Under 14oz./sq ft wing loading class--Tony Martin 2rd place.

<u>Hand Launch</u>:

2nd--Tony Martin

6th--John Lupperger

9th--Bob Sliff

10th--Ross Thomas

<u>F3B</u>:

4th--George Joy

<u>Unlimited Class</u>:

7th--Bob Sliff   8th G Joy

<u>2-Meter Class</u>:

6th--Bob Sliff

8th--Pete Richardson

10th--Tony Martin

[Note an a side of the Nats experience. The flyoff in two meter for 2nd and 3rd place was between Joe Wurtz and Terry Edmonds. All of us know Joe, of course, but Terry is a fine competitor from Iowa. He has really cleaned houes in some previous nats. To make a long story short, Joe really humbled him here. with a 95 pt landing and a perfect 5 min time. Oh, add a slow roll on final. approach]

Harbor Soaring Society

July Monthly Contest Results
Open Division

	Name	Actual Score	Normal Score	Class	Trophy
1	MARTIN, T	2,739.0	1,000.0	E	E-1
2	HARRIS, P	2,689.9	982.1	E	E-2
3	CHASTELER, F	2,637.9	963.1	E	E-3
4	NEMECEK, D	2,572.0	939.0	A	A-1
5	LOWERY, R	2,522.5	921.0	A	A-2
6	LUPPERGER, J	2,463.0	899.2	E	
7	PANTZAR, D	2,433.1	888.3	E	
8	WHITE, L	2,423.8	884.9	A	
9	RICHARDSON, P	2,380.0	868.9	E	
10	JOY, G	2,183.2	797.1	E	
11	KUTCH, N	1,999.2	729.9	A	
12	THOMAS, R	1,985.9	725.0	E	
13	FINK, S	1,947.7	711.1	A	
14	HURLEY, C	1,857.0	678.0	E	
15	ZINK, D	1,818.4	663.9	S	S-1
16	RITSCHKE, G	1,777.8	649.1	E	
17	DANRICH, D	1,700.0	620.7	S	S-2
18	LAMPRECHT, D	1,380.3	503.9	E	
19	STALLS, J	1,355.1	494.7	A	
20	SMITH, M	1,355.1	494.7	E	
21	BUZOLICH, N	1,198.3	437.5	S	
22	BELL, S	1,074.0	392.1	S	
23	SLIFF, B	833.0	304.1	E	

July Monthly Contest Results
2 Meter Division

	Name	Actual Score	Normal Score
1	HURLEY, C	2,563.0	1,000.0
2	LAMPRECHT, D	2,425.2	946.2
3	WHITE, L	2,405.0	938.4
4	BELL, S	2,302.0	898.2
5	THOMAS, R	2,122.0	827.9
6	LUPPERGER, J	1,887.0	736.2
7	SLIFF, B	1,886.8	736.2
8	KUTCH, N	1,492.0	582.1
9	JOY, G	1,455.0	567.7
10	STALLS, J	854.5	333.4

Yearly Standings - Open Division
Through July

	Name	Score	Contests	Average
1	CHASTELER, F	6,728.7	7	961.2
2	MARTIN, T	6,674.0	7	953.4
3	WHITE, L	6,484.5	7	926.4
4	LOWERY, R	6,349.4	7	907.1
5	PANTZAR, D	6,115.6	7	873.7
6	HURLEY, C	6,066.4	7	866.6
7	HARRIS, P	5,953.8	6	992.3
8	RITSCHKE, G	5,939.6	7	848.5
9	SLIFF, B	5,814.9	7	830.7
10	GARNER, R	5,813.5	6	968.9
11	RICHARDSON, P	5,572.0	6	928.7
12	NEMECEK, D	5,205.1	6	867.5
13	THOMAS, R	5,135.3	7	733.6
14	STALLS, J	4,984.0	6	830.7
15	CONRAD, W	4,657.7	6	776.3
16	JOY, G	4,376.1	5	875.2
17	HENDRY, S	4,139.9	5	828.0
18	CRON, A	4,012.5	5	802.5
19	STOVALL, W	3,915.0	5	783.0
20	BELL, S	3,752.1	5	750.4
21	POULSEN, G	3,552.6	4	888.2
22	LAMPRECHT, D	3,350.3	4	837.6
23	DANRICH, D	3,227.2	4	806.8
24	FINK, S	3,221.8	4	805.5
25	KUTCH, N	3,057.4	4	764.4
26	LUPPERGER, J	2,800.0	3	933.3
27	SANDRONI, H	2,720.5	3	906.8
28	RANDOLPH, W	2,526.4	3	842.1
29	SMITH, M	2,350.8	3	783.6
30	ZINK, D	2,275.0	3	758.3
31	CHASTELER, T	1,537.4	2	768.7
32	ENGER, L	951.2	1	951.2
33	DEE, M	943.8	1	943.8
34	HALL, H	909.5	1	909.5
35	LEE, T	818.6	1	818.6
36	QUISENBERRY, J	689.2	1	689.2
37	EGOLF, D	686.8	1	686.8
38	WEBSTER, D	599.2	1	599.2
39	WENTWORTH, C	552.4	1	552.4
40	BUZOLICH, N	437.5	1	437.5

Yearly Standings - 2 Meter Division
Through July

	Name	Score	Contests	Average
1	WHITE, L	6,588.9	7	941.3
2	HURLEY, C	6,445.5	7	920.8
3	SLIFF, B	6,259.7	7	894.2
4	THOMAS, R	6,229.9	7	890.0
5	CONRAD, W	5,138.8	6	856.5
6	BELL, S	4,311.1	5	862.2
7	JOY, G	4,108.5	5	821.7
8	LAMPRECHT, D	3,816.9	4	954.2
9	POULSEN, G	3,585.3	4	896.3
10	HALL, H	3,503.5	4	875.9
11	STALLS, J	3,333.4	4	833.4
12	KUTCH, N	2,752.5	4	688.1
13	LUPPERGER, J	2,546.1	3	848.7
14	LOWERY, R	1,672.3	2	836.2
15	FINK, S	1,487.1	2	743.6
16	CRON, A	1,270.2	2	635.1
17	QUISENBERRY, J	868.7	1	868.7
18	ZINK, D	814.1	1	814.1

HSS CONTEST DEPARTMENT

George Joy, Contest Coordinator

The following contest schedule is complete to the best of my knowledge.

DAY	MONTH	CONTEST DIRECTOR OR INFORMATION
6	AUG	John Lupperger (HSS Monthly)
19-20	AUG	Felix Vivas (7CELL F3E)
27	AUG	TOSS SC2
10	SEP	Bob Sliff (HSS Monthly)
24	SEP	ISS/SWSA SC2
8	OCT	Dave Nemecek (HSS Monthly)
15	OCT	PSS SC2
5	NOV	________(HSS Monthly)
19	NOV	George Joy/Frank Chastler (HSS SC2)
3	DEC	________(HSS Monthly)

Please Note the blanks--I Need CD's for these.

TOSS SC2 contest

A flier has not been received yet for the TOSS SC2 contest
The date is 27 August, soa flier should bo out soon.
See Frank Chasteler (SC2 President) for further information.

The 7 Cell F3E contest

We will need help with timers and other officials for this contest.
The contest is on the 19th and 20th of this month.
We will have a practice for timers on the Satruday and the Sunday before, the 12th and 13th
Please come out and put in some time. Timer practice is needed!!!
Pilots, this is your chance to get some practice on the course, so bring your planes.
(Note—This will be done along with open sport flying, so come ourt and fly your glider as well as practice for next weekend.) Remember there are some nice prizes for the workers.
For more information contact either Chuck Hollinger or Bob Sliff.

THE AUGUST CLUB CONTEST

John Lupperger, CD.

ROUND 1--900/100

FLIGHT--3 MINUTES DURATION/TIME PRECISION (CALLED FLIGHT ORDER)

LANDING--HALF CIRCLE, NEAREST THE PILOT.

ROUND 2--990/10

FLIGHT--10 MINUTE DURATION/TIME PRECISION (OPEN FLIGHT ORDER)

LANDING--FULL CIRCLE WORTH ONLY 10 POINTS

ROUND 3--800/200

FLIGHT--2 MINUTE DURATION/TIME PRECISION (CALLED FLIGHT ORDER)

LANDING--HALF CIRCLE AWAY FROM THE PILOT.

PILOTS MEETING AT NINE AM SHARP

FLYING STARTS IMMEDIATLY AFTER THE PILOTS MEETING.

SO, BE ON TIME--ARRIVE AT 8:30 AND GET SIGNED UP.

THE SEPTEMBER CLUB CONTEST

Bob Sliff, CD.

TASK--T4. CUMULATIVE DURATION.

3 FLIGHTS FOR 15 MINUTES, NO FLIGHT OVER 7 MINUTES.

WILL USE STANDARD LANDING TAPES FOR LANDING POINTS.

A TARGET TIME WILL BE GIVEN TO EACH CONTESTANT PRIOR TO THE THIRD FLIGHT. (IT WILL BE THE CONTESTANTS RESPONSABILITY TO BE SURE THIS TARGET TIME IS CORRECT--YOU MUST DOUBLE CHECK THE SCORE KEEPERS.)

THE CVRC FALL SOARING FESTIVAL

(THE VISALIA CONTEST)

THE ENTRY FORMS ARE NOW OUT. THE DATE FOR THE EVENT IS OCTOBER 7TH AND 8TH. AS ALWAYS, YOU MUST GET YOUR ENTRY IN EARLY, OR YOU MAY NOT GET TO GO, AS THE CONTEST FILLS UP FAST. ENTRY FEE IS $20.00 (NON-REFUNDABLE/NON-TRANSFERABLE). FIRST 8 FLYERS PER FREQUENCY WILL BE ACCEPTED. NO ENTRY POSTMARKED BEFORE AUGUST 1ST WILL BE ACCEPTED. USE ONLY STAMPS, NO METERED MAIL WILL BE ACCEPTED. LIMINTD TO THE FIRST 150 FLYERS OR FIRST 8 FLYERS PER FREQUENCY. (BBQ ON SAT NIGHT, $8.00 PER PERSON, WITH LIVE ENTERTAINMENT AT THE FIELD.)

IF YOU HAVE NOT RECIEVED THE FORM AND ARE INTERESTED, I HAVE EXTRA COPIES.

BOB SLIFF.

TIDEWATER MODEL SOARING SOCIETY
TECHNICAL JOURNAL #23
EXTRACTED FROM SOAR TECH IV, JAN. 85

SOME IDEAS ON THE AERODYNAMICS OF FUSELAGE DESIGN

Fuselage design doesn't have nearly the effect on overall sailplane performance that some people think it does. Because it's a small effect, you can almost ignore the aerodynamics of the fuselage and still get pretty good performance from any reasonable thermal-soaring type sailplane. In fact, I've seen a few models over the years where I was sure that the designer ignored aerodynamics when he designed his fuselage! Some of them flew pretty well too.

My personal interest in the subject was triggered about a year ago by Preben Norholm of Denmark when he wrote me that Ralf Decker (current world champion) had designed what he (Preben) thought was exactly the best fuselage. Preben had even written an article on the subject for the Danish model magazine which he sends to me. Sorry to say, I couldn't get much out of the article (Boy! Talk about language barriers) but I did give a lot of thought and a bit of study to the subject. More recently, I was contacted by Ray Olson of Mesa, Arizona who (working with Lee, laser cut airfoils, Murray of Appleton, Wisconsin) was trying to design a new optimized sailplane fuselage. This is getting to be a bit of a cosmopolitan project as you can see. I predict that if this fuselage becomes available, you'll hear a lot more about it.

For a conventional model design, there is one big area of TROUBLE in the aerodynamics of the fuselage. The airflow interactions between the wing and the fuselage are ALWAYS bad. The boundary layer sweeping up over the nose of the fuselage thickens and slows until, when it encounters the wing, it's in bad shape–unable to follow the complex curves and interactions around the canopy, fuselage, and wing root fillet. This results in wedge shaped separations over the top of the wing as higher pressure, slow moving air spills out into the low pressure lifting low . over the top of the wing.

Bob Champine solves this problem by putting the wings of his Red Bird on a high pylon so that the leading edge is flying in clean, undisturbed airflow and the top of the wing has no fuselage intersections to spill bad air into the lifting flow. He gets more drag from the pylon, and its intersections with the fuselage and wing bottom, but he still is probably more efficient. Ray McGowan, from Napa, California, and Eugenio Pagliano from Italy (and others) have built and flow noseless designs where the front center of a swept back wing is the nose of the plane. Here again, the wing is entering clean air–but there are losses due to the swept wing and here again there is both gain and loss.

If, however, you really want a conventional looking design, how would you try to handle the aerodynamics to minimize the losses? Smooth curving fillets at the wing fuselage joint is the conventional approach. By avoiding sharp corners and tight curves the airflow has a better chance of being able to follow the surfaces. That still doesn't work very well and, to get the best results, you have to give the air itself more "sticking power". A freshly formed turbulent boundary layer sticks to the complicated contours and intersections better than any other kind of airflow. For that reason alone we want to keep the boundary layer over the whole nose completely laminar. Then, just an inch or so before the flow gets to the area of the wing root, we must positively trip it into turbulent flow. The inch is to let the separation bubble form, transition the flow, and then reattach ahead of the wing.

To do this you have to have a laminar flow body with no seams or projections all the way back to the trip point. Further, the laminar body must continue to increase in diameter back to that point. Then, at the right place, there must be a definite turbulator to make the boundary layer change to turbulent at that point. Notice that the laminar flow that's preserved over the whole nose isn't to reduce friction drag, but only to be sure that the turbulent transition starts where we want it. This is a real problem to manned sailplanes because they <u>must</u> have a canopy–but we don't. That's right, the canopy seam (no matter how tight it is) trips the boundary layer in the wrong place. That's why Preben liked the Decker nose so much. In case you didn't notice, the Australians had a one piece removable nose like that too.

Now, with the flow transitioned to turbulent just an inch (or a bit more) ahead of the wing, those smooth fillets and intersections have the best chance of keeping the airflow attached through the wing root area.

Behind the wing there is a strong field of downwash. That means the fuselage behind the wing has an airflow with a top to bottom velocity component. To get the best flow around the fuselage it should be a bit airfoil shaped itself with the leading edge at the top and the trailing edge at the bottom. Most designers just make the cross section elliptical with the long axis vertical and the short axis horizontal. This part of the plan should be narrowed to the maximum possible (structural strength and stiffness requirements take over here) to reduce friction drag.

Few people realize that there is a similar field of upwash ahead of the wing. It is there, though, and it's about as strong as the downwash. For that reason, the nose of the plane is much to droop, it is a bit complicated. At slow speeds (high angle of attack) the upwash is at its strongest, while at high speeds it almost goes away. Therefore, a plane that's designed for optimum performance at high speed has less droop than one that's set up for thermalling. Nature helps a bit here, though, because the droop angle is set up to the wing's zero lift angle which is much higher (negatively speaking) for a highly cambered thermalling airfoil than it is for a low camber airfoil used for high speed designs. Just set up the nose droop so that it's about 3 to 4 degrees below the wing chord line and the airfoil you choose for the plane's designed purpose will take care of the rest.

Drooped symmetrical laminar flow body for a nose cone extending almost to the wing; intentional turbulator ringing the aft end of it; smoothly filleted wing root area contracting in cross section to a thin tapering boom just aft of the wing. Just a bit different than anything you're likely to see at the field, but certainly not radical. The smooth skidless nose will make a bit of a problem on landing (unless you make it strong enough to STICK-IT). You will have another problem if you try to build one of these. The low drag laminar flow body designs will all have too small a nose radius to meet the FAI requirement. It'll have to be enlarged and great care taken to assure that it meets the nose body smoothly. Any sharp change of radius in this area can cause the boundary layer to transition too soon. You might also like to look at the earlier Tech Journal article on the vertical fin and rudder. It suggests extending the boom to the aft end of the rudder.

M.A.R.C.S.
NATIONAL SAILPLANE SYMPOSIUM
EXTRACTED FROM NOV.12, 83

COMPOSITES FOR STRENGTH WITH LOW WEIGHT

by Keith Scidmore

The use of composites in building both model and full scale aircraft is an art that has been around as long as flight itself. The earliest composites used in building aircraft were made by using adhesives to apply paper or silk to the surface of wood structures for added strength and rigidity. The word "composite" is not specific to any particular group of materials, but instead refers to a wide variety of compound materials incorporating any combination of structural elements--from the bricks made of mud and straw used in 100 B.C. to the exotic composites used in building the Space Shuttles.

When the modeler uses high performance composites of carbon, Kevlar, or glass the composite is used in one of two ways. Either the composite is used as the sole material from which a part is manufactured, or a composite skin can be applied over an existing wood (or foam) structure to form a new three-material composite of fiber, resin and wood (or foam). In addition to adding strength and rigidity, a composite skin stabilizes wood with respect to heat and moisture, reduces tendencies to warp, adds dent and puncture resistance, hides joints, and fills the grain.

Glass Fibers

Glass cloth is by far the most common and inexpensive material available for our general use in modeling. The advantages of using glass rather than more exotic materials like Kevlar or carbon fiber are the low cost of glass, the facility of its use, and its availability in a wide variety of weights, weaves, mats, and tapes. Glass cloth is easily obtained in weights ranging from 1/2 oz/sq.yd. to 8 oz/sq.yd. or more. The weights if 1/2 to 2 oz. are preferred by most models for their flexibility in following contours. These lighter cloths can be layered with weaves running at 45 degree angles to provide better torsional rigidity and a more tear resistant and uniform surface than is provided by a single layer of a heavier cloth.

There are two types of glass which are appropriate for use by the modeler. The first type, "E" (electrical) glass (silicon dioxide, aluminum, boron and magnesium oxides plus lime, with traces of several other compounds) is by far the most commonly used glass in a wide variety of applications, including modeling. The second type, "S" glass differs slightly in chemical composition, is slightly lighter than E glass, but has a 30% larger tensile strength than E glass as well as being 20% stiffer (higher elastic modulus). S glass is commonly used in construction of high performance structures such as full size aircraft parts. The glass commonly sold through modeling catalogs for used by the modeler is E glass. S glass is about twice the cost of E glass and may be obtained through some of the suppliers listed at the end of this article. With respect to tensile strength, S glass outperforms both carbon fiber and Kevlar, but it weighs considerably more.

Both E and S glass cloth are excellent for general reinforcement or for the molding of parts. While the strength to weight ratio for fiberglass is not as high as for Kevlar or carbon , the machineability and cost of glass makes it the preferred material for almost all modeling applications. In all but the most high performance models the actual weight savings realized through carbon or Kevlar will usually not justify the added cost nor headaches involved with their use.

Kevlar

Kevlar is a trade name for a group of aramid materials developed originally by DuPont for use in radial tire belts. Kevlar 49 is the specific name for the high elastic modulus, high tensile strength form of Kevlar that has gained popularity in numerous aerospace, electrical and marine applications. Many forms of Kevlar are sold having varied physical properties. For example, Kevlar 29 is used for its toughness to make bulletproof vests and armor, bomb squad equipment, protective gloves for metal and glass handling and many other applications. There are many other forms of Kevlar which are designed for specific applications where a tough, high strength, high modulus material is needed. For full size and model aircraft uses, Kevlar 49 is usually the preferred type of Kevlar and hereafter is the variety referred to when the word "Kevlar" is used.

When incorporated into a composite the (tensile) strength-to-weight ratio of Kevlar is outstanding. Kevlar fibers are about 40% lighter than glass fibers but yield composites with tensile strengths about halfway between S glass and E glass. Kevlar has a higher elastic modulus (is stiffer) than both types of glass but nowhere near that of carbon.

One of the most interesting properties of Kevlar is that it is somewhat ductile, much like metals when overstressed in bending or compression. Under extreme compression or bending Kevlar can become permanently deformed and will not completely regain its shape. This is not, however, the case when undergoing a purely tensile stress. (Remember tensile forces act to stretch a material; to be contrasted with compression.)

Each of the materials discussed here has some weakness. Kevlar's weakness is found in its poor compressive characteristics. In compression Kevlar composite will generally have about half the compressive strength of glass and less than 1/3 that of carbon. This can be an important factor to consider when designing load carrying structures made of Kevlar.

As an example of an engineering question raised by Kevlar's relatively low compressive strength, let's look at an aircraft wing. Normal load on a wing will be compression on top and tension on the bottom. There have been arguments made to the effect that wings or other surfaces of a model are most likely to fail in the compressive mode rather than in the tensile mode due to the wing geometry and the fact that the materials used are stronger in tension than in compression. To test this hypothesis several wing spars were made and broken to see which side would fail first. The result was that regardless of the spar material used (spruce, carbon, or Kevlar) the compressive side would always fail before the tensile side! The conclusion one would make from this is that Kevlar may not be the best material to use in wing construction without some other material to provide compressive strength to the composite. Although many of Kevlar's properties suggest that it can be used almost anywhere glass can be used, working with Kevlar can be a frustrating experience. It is probably for this reason that Kevlar has not already replaced glass as the preferred material for general use.

The first problem the modeler will have is cutting the material. Heavier cloth weights of Kevlar are virtually impossible to cut with scissors, and even the lightweight cloths can be a problem. (One successful method is to use a straight edge and an X-acto blade and bear down with repeated cuts.) Cutting Kevlar is just a minor problem compared to Kevlar's greatest disadvantage which is that it is virtually impossible to sand the finished composite. The tough, flexible fibers of Kevlar do not break off like glass or carbon fibers when sanded, but instead they frizz and leave a surface similar to crushed velvet. There have been various methods suggested for solving this problem which range from burning the exposed fibers off with a torch (risky) to layering glass cloth on top of the Kevlar to provide a sandable surface. Of course if you are using the Kevlar in conjunction with a reliable and well polished mold, the composite will need only a superficial sanding and the problems of finishing are greatly reduced.

Carbon Fiber

Carbon fiber is exactly what the name implies. Carbon fiber can be manufactured in a number of different ways with the resulting fibers often having very different properties. Fibers made from resins or pitches are cheaper to manufacture but do not have the quality of the more expensive (and more common) fibers made from polyacrylicnitrile (PAN) or rayon. When precursor fibers or PAN or rayon are heated to around 400 degrees Celsius in the absence of oxygen it drives off the hydrogen oxygen, and nitrogen in the original fiber compound to leave behind the backbone molecules of almost pure carbon. These fibers are then stretched and heated to about 2000 degrees to achieve their maximum tensile strength. To achieve greater stiffness (higher elastic modulus) the fibers can be stretched and heated further to as much as 2800 degrees Celsius. The high modulus (HM) fibers will, however, have a lower tensile strength than the high tensile strength (HT) lower temperature fibers.

What is truly phenomenal about carbon fibers composites is their stiffness. In fact, it is this high modulus of elasticity that has made carbon an important rival to glass. A carbon fiber composite will typically have an elastic modulus three to six times that of glass and about twice that of Kevlar.

Another characteristic of carbon fiber is its high strength-to-weight ratio. While carbon composites are only slightly higher in tensile strength than E glass composites, they are considerably lighter. For a given volume a typical carbon composite will weigh about 20% less than a glass composite (of equal resin content) and will weigh only slightly more than a composite of Kevlar.

As with glass and Kevlar, carbon does have some faults. While carbon composites are stiff and light-weight they are temperamental with respect to localized stress. A carbon composite under load may tend to fail at specific locations where the stresses are concentrated just as a sheet of window glass will break on a scored line. For this reason, construction with carbon is not as straightforward as with other materials. Notches, punctures, dents, scratches, and any designed-in sources of localized stress must be avoided. The engineers who use carbon take the properties of carbon composites into consideration and choose geometries and applications accordingly. Special resin systems are often used with carbon in order to fully utilize the capabilities of the material. Furthermore, the professionals will not simply replace metal parts with carbon parts nor will they frequently use composites of carbon alone. Instead carbon is combines with glass, or Kevlar in an "engineered" composite of more than one fiber type. It is for these reasons that the efficient and effective use of carbon composites for molded parts is beyond the capabilities of most modelers (including this one) in all but the simplest of applications. The modelers use of carbon in molded parts should undoubtedly be limited to simple geometric shapes whenever parts are expected to undergo considerable stresses. Carbon fiber wing spars probably illustrate such a safe and efficient use of carbon by the modeler.

Another consideration in choosing carbon as a building material is its cost. Carbon fiber is expensive to manufacture and currently is in high demand. The manufacture of high performance carbon fiber products is in its infancy and the possible uses of carbon are far from being fully explored. Experimentation is underway by many researchers in an attempt to find cheaper, easier ways to manufacture carbon.

Carbon fiber cloth is very expensive ($11 to $48/sq yd) and is not readily available for use by the modeler. Carbon fiber "tapes" are, however, available commercially. These taper, or "tows" as they are correctly called, are a loosely associated group of fibers with all of the individual fibers running lengthwise. They are not woven fabrics as are most of the commonly available fiberglass tapes. Carbon fiber tape is used mainly in modeling for reinforcing specific problem (weak) areas in structures such as wings in areas of high stress. Incidentally carbon fibers are a good conductor of electricity and some shielding of a receiver antenna may occur where much carbon is used, especially if an antenna is run inside of a carbon fiber fuselage.

General Application

For the sport flier or semi-competitive modeler, E glass is undoubtedly the preferred material for general composite reinforcement or for the molding of parts. Either epoxy or polyester resins can be used, with epoxy being more difficult to used but resulting in a stronger final product. A composite of polyester generally provides only 80 to 85% of the tensile strength of an epoxy composite of the same fabric.

For the competitive flier building a model where weight is of great importance, Kevlar or carbon may be used because of their high strength-to-weight ratios. The builder should, however, be aware that using these two materials to replace glass cloth will not necessarily result in a stronger structure. In fact, owing to Kevlar's low compressive strength and carbon's brittleness the resulting structure can actually be weaker than glass in some respects. A blending of both Kevlar and carbon fabrics into a single composite may help to offset the faults of these materials when used alone owing to the fact that a weakness of one material is usually a strength off the other.

Comparative Composite Properties of "Typical" Samples of a Unidirectional Composite

The following data comes from a number of sources and is indicative of the approximate relative properties that can be expected from the composites named. The properties of any particular composite layup will vary according to the manufacturer, resin system, resin to fiber ratio, any many other factors.

Tensile strength (Ultimate linear strength per cross sectional area.)

E glass	XXXXXXXXXXXXXXXXXX
S glass	XXXXXXXXXXXXXXXXXXXXXXXX
Kevlar 49.	XXXXXXXXXXXXXXXXXXXXXX
Carbon (HM)	XXXXXXXXXXXXXXXXXXXX

Modulus of Elasticity (Stress to strain ratio of stiffener per cross sectional area.)

E glass	XXXXX
S glass	XXXXXXX
Kevlar 49	XXXXXXXXXX
Carbon	XXXXXXXXXXXXXXXXXXXXXXXX

Compressive Strength (Ultimate compressive strength per cross sectional area - compressive strength is largely a function of the fiber-to-resin bond strength.)

E glass	XXXXXXXXXXXXX
S glass	XXXXXXXXXXXXXXXX
Kevlar 49	XXXXXXX
Carbon	XXXXXXXXXXXXXXXXXXXXXXXX

Density (This reflects the weight of fabric plus resin for a given volume of a typical composite.)

E glass	XXXXXXXXXXXXXXXXXXXXXXXX
S glass	XXXXXXXXXXXXXXXXXXXXXXXXXXX
Kevlar 49	XXXXXXXXXXXXXXXX
Carbon	XXXXXXXXXXXXXXXXXX