A-B-C TOOTHPICKS

Big brother (sister?) of the 1980 NFFS Model of the Year—½A Toothpicks—is designed for AMA Power with .19—.36 engines. Well thought out construction gives maximum strength with minimum weight. Author's observations on when to fly are important to FF competition fliers of all persuasions. ■ Gil Morris

PROBABLY the least explored but potentially the most rewarding area of Free Flight Gas is the combination of lightweight models matched to the power of Schnuerle-ported engines. This challenging area forces us to use the best in flight character and structural strength. A-B-C Toothpicks was designed with that in mind.

This model is an enlarged version of the ½A Toothpicks (published in the June 1979 *Model Aviation*) but with the wingspan and tail moment arm stretched. The longer wingspan and fuselage produces sweeping power turns, instead of sharp angular ones, and this permits greater engine power without sensitive trim adjustments. A-B-C Toothpicks is the most spirited and easy-to-fly plane I have ever had.

At its best—in a super-fast climb, aided by autostab. Ability for an engine to start quickly is important in contest flying—otherwise, launch likely will miss the thermal.

The technique of building strong and light requires placing structural members where they will count, omitting or minimizing them otherwise. As a general rule, the greatest bending strength comes from concentrating materials at the outer edges. A good example of this is the I-beam used extensively as major support members of buildings and bridges. When the I-beam is bent in the direction of its web, one flange is in tension while the other is in compression; the web between serves only to hold the two flanges parallel so that the flange in compression doesn't buckle. The greater the separation of the flanges, the greater the strength and stiffness of the beam.

In the same manner, the box spar in Toothpick's wing places the top member in compression, with the bottom member in tension (reverse this at the instant of a dethermalized landing). The side shear webs simply hold the top and bottom members rigidly fixed to one another, so neither can buckle. Note that the box spar is at the thickest part of the airfoil for maximum separation and strength; the top member is thicker than the bottom one, since balsa is stronger in tension than in compression.

Although I didn't take the time to do it, the ribs (therefore, the wing) can be further strengthened with little added weight by cap-stripping. This adds material to their outer edges, strengthening the ribs against bending. The same line of reasoning can be extended to the fuselage, where the material is concentrated at the outer edges (the corners in this case) with struts in between to maintain a fixed relationship, one corner to the other. Diagonals also resist twisting.

Wing torsional twisting is reduced significantly by covering the wing with silkspan, because the random filament arrangement allows little stretch in any direction. It becomes the outermost edge of strength. This covering is followed by a protective cover of ½-mil Mylar. 339

Strips of Mylar tape are criss-crossed over the silkspan on the top and bottom of the wing, and the Mylar covering is then cemented to the tape. This is to break up the Mylar covering into small patches, rather than large sheets. The shrinking force, corner-to-corner, of large Mylar sheets

Author peaks out the engine prior to launch. Note that tweaking is being done in climbing attitude. For maximum rigidity, wing is covered with silkspan, then with ½-mil Mylar.

would have much more leverage to cause warps than that of the many small patches so created. For the same reason, it is important to cement the Mylar, which is applied to the fuselage and the stabilizer, to all of the structural members it comes in contact with: formers, diagonals, ribs, and spars—rather than just around the edges. The torsional forces on the fuselage and stab are not great enough to warrant the use of silkspan and its increased weight.

One of the hazards of building light is the possibility of going too far and building too weak. The lighter the plane is, the faster it will climb when under power. Since lift and drag are proportional to the square of the velocity, and stress is directly proportional to the lift and drag, stresses will increase with the square of the velocity. Simply then, the lighter the plane is, the stronger it needs to be.

But the rewards for successfully building light are substantial. For example, a 20-oz. plane accelerates upwards 50% faster than the same plane weighing 26 oz. (based on 60-oz. thrust), not to mention the slower rate of glide descent.

How do you recognize critical flight stresses? The wing is most vulnerable, because most of the plane's lift and drag forces are acting on it. Flexural and torsional flutter singly or in combination, or a fixed divergence, can occur. The flexural motion is a change of dihedral resisted by the wing spars, whereas the torsional motion is a twisting action resisted by geodetic ribs and the covering material.

The trailing half of the airfoil is inherently weaker than the leading half, because it is thinner. Therefore, the neutral bending axis generally is not parallel to the chord line, but it is downwardly inclined to the front somewhat; as the wing flexes toward more dihedral, it tends toward washout as it bends on the neutral axis. This will cause a diving tendancy at high speed. Every wing flexes to some degree, but if the stabilizer also flexes a like amount, the effects of one neutralizes that of the other, and a constant angular difference is maintained. Therefore, the wing and stab should have approximately matching stresses.

Since the forces on the stabilizer are relatively low (stab lift and drag per square inch of area is less than half that of the wing), the stab construction should be made very light as compared to the wing. The light stab helps in other ways, too. This permits a short nose moment, with the engine pulled up under the leading edge of the wing for good stability under power. Also, the light stab (and tail end, in general), reduces the plane's moment of inertia to improve the glide—through responsive maintenance of a constant angle of attack even in choppy air.

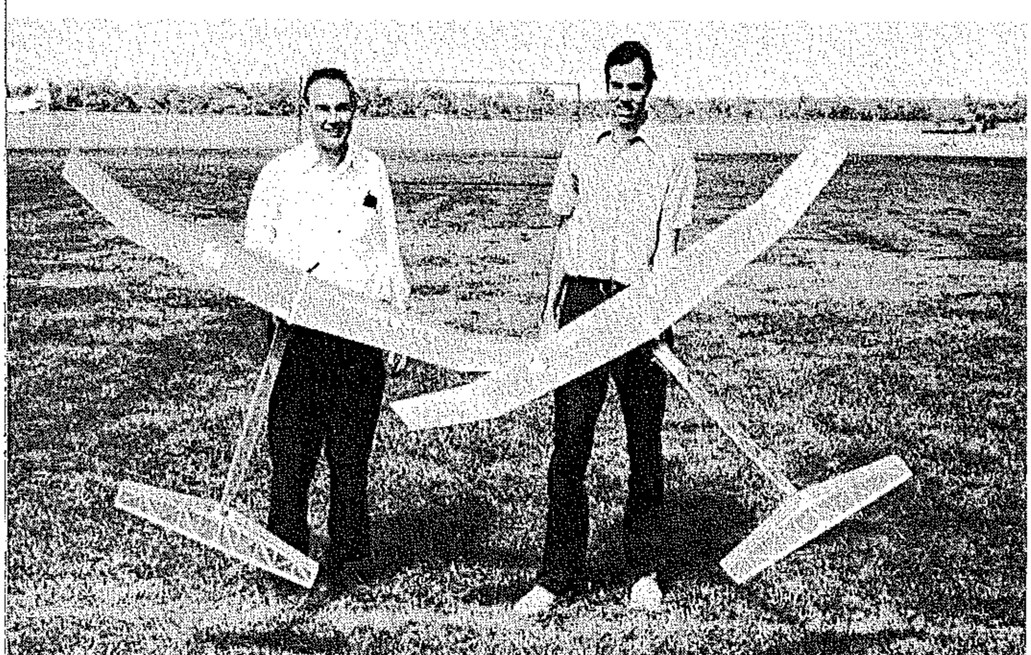
Construction. The wing is built in two halves, with the top piece of the box spar and turbulator spars left off the inboard panels. Also, leave out the five center ribs. Note that the two halves are joined by two diamond-shaped 1/64 plywood pieces, one at the top and the other at the bottom. Epoxy the two halves together at the proper angle, with the lower 1/64 plywood piece in place. After this has set, add the five center ribs, the ⅛-in. center webs, and the upper 1/64 plywood piece. Finally, add the top pieces of the box spar and the side webs to complete the box.

Cover the wing with medium-weight silkspan and three coats of dope. It is best to build in the washin and washout, but if you are like me, this doesn't get done. I confess that I rig the wing with bent paper clips and string tied to the workshop ceiling, and then I twist the wing with weights while doping the silkspan. After the dope has cured, criss-cross the top and bottom of the wing with ½-in. Mylar tape, following the pattern of the geodetic ribs.

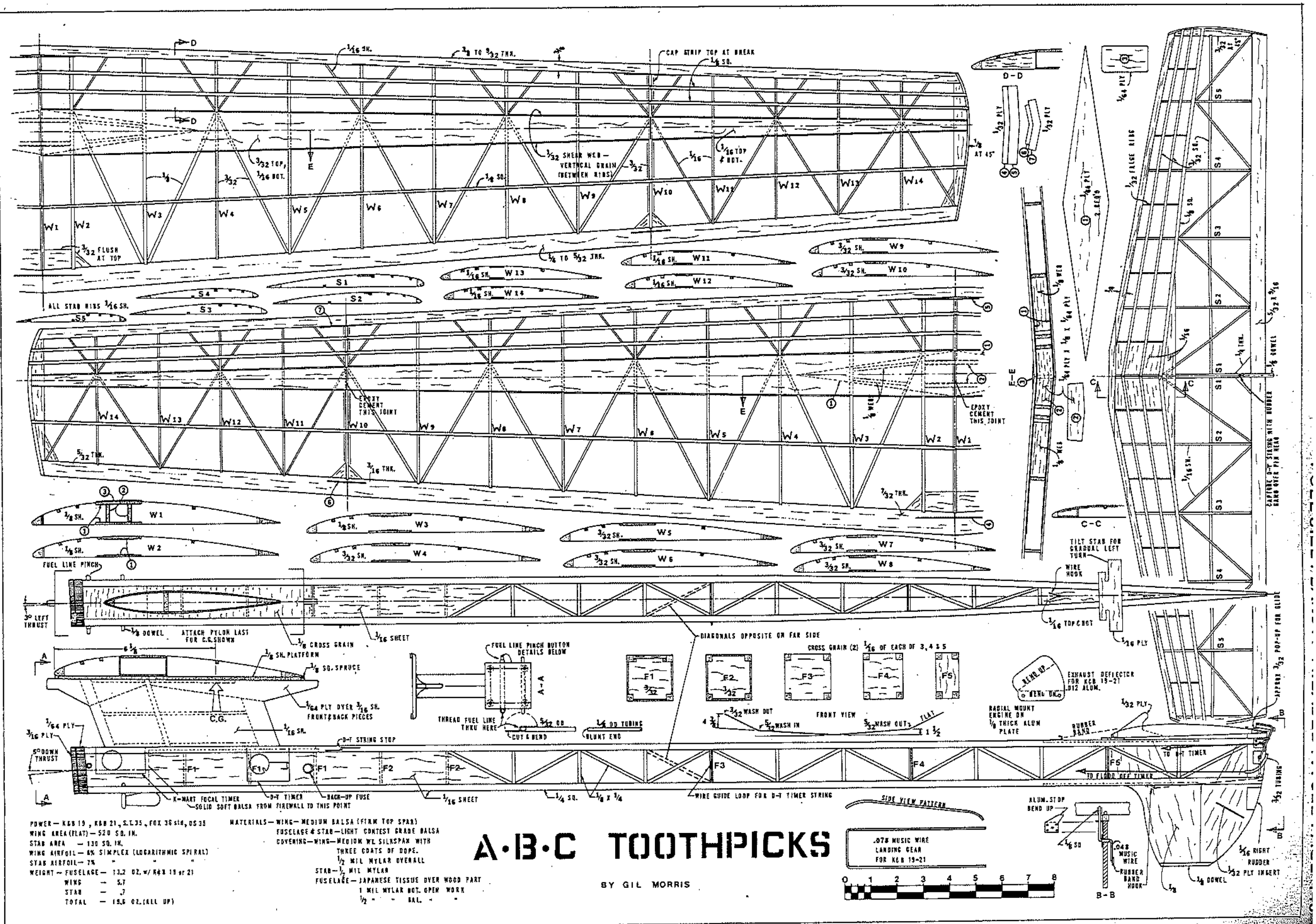
Now, cover the wing with ½-mil Mylar. Stick it to the wing outline and to the criss-crossed tape. I use Quik Stik brand contact cement made by Coverite for this purpose. Be sure to overlap the Mylar onto itself by ¼-in. at the seams. Put about a dozen pin pricks in the top and bottom of the wing to relieve the hot air when shrinking the Mylar.

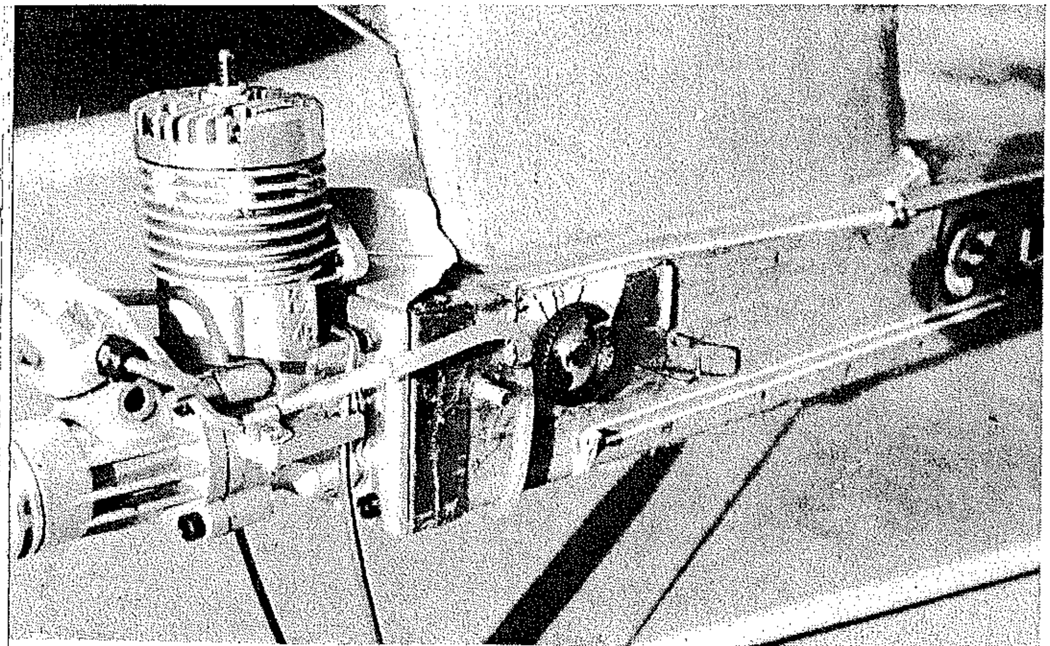
I've had best results by doing the shrinking job in steps, using a heat-sealing iron—90% the first day, and the balance over a two-week period. Set the warps as you go, with the shrink of the Mylar. Periodically thereafter, check the warps, and pull them back to where they should be if there is drift. The wing will take a more permanent set as it ages.

Spray the front one-third top of the wing and stab very, very lightly with a fast-drying enamel to give some turbulation roughness to the Mylar. Spray from several feet away so the spray particles are partially dry before landing; this will give a somewhat rough finish. This is a light, slow-gliding plane, and the top boundary layer may need to be energized a bit—as provided by the paint texture.



Two A-B-C Toothpicks—the author at left, and son Jim at right. The author took first in Class B Open at the 1979 Nats, and first in Class A Open at the 1980 Nats. Article has valuable tips.


A·B·C TOOTHPICKS
BY GIL MORRIS
POWER — K&B 19, K&B 21, S.T.35, FOX 36 std, OS 35
WING AREA (FLAT) — 520 SQ. IN.
STAB AREA — 130 SQ. IN.
WING AIRFOIL — 6% SIMPLEX (LOGARITHMIC SPIRAL)
STAB AIRFOIL — 7% " " "
WEIGHT — FUSELAGE — 13.2 OZ. w/ K&B 19 or 21
WING — 5.7
STAB — .7
TOTAL — 19.6 OZ. (ALL UP)
MATERIALS — WING — MEDIUM BALSA (FIRM TOP SPAR)
FUSELAGE & STAB — LIGHT CONTEST GRADE BALSA
COVERING — WING — MEDIUM WT. SILKSPAN WITH
THREE COATS OF DOPE.
1/2 MIL MYLAR OVERALL
STAB — 1/2 MIL MYLAR
FUSELAGE — JAPANESE TISSUE OVER WOOD PART
1 MIL MYLAR BOT. OPEN WORK
1/2 " " BAL. " "
K-MART FOCAL TIMER
SOLID SOFT BALSA FROM FIREWALL TO THIS POINT
D-T TIMER
BACK-UP FUSE
1/16 SHEET
DIAGONALS OPPOSITE ON FAR SIDE
CROSS GRAIN (2) 1/16 OF EACH OF 3, 4 & 5
FRONT VIEW
WIRE GUIDE LOOP FOR D-T TIMER STRING
SIDE VIEW PATTERN
.078 MUSIC WIRE LANDING GEAR FOR K&B 19-21
EXHAUST DEFLECTOR FOR K&B 19-21 .012 ALUM.
RADIAL MOUNT ENGINE ON 1/8 THICK ALUM PLATE
TILT STAB FOR GRADUAL LEFT TURN
CAP STRIP TOP AT BREAK
ALL STAB RIBS 1/16 SH.
EPOXY CEMENT THIS JOINT
ATTACH PYLON LAST FOR C.G. SHOWN
FUEL LINE PINCH BUTTON DETAILS BELOW
THREAD FUEL LINE THRU HERE
CUT & BEND
BLUNT END
3° LEFT THRUST
5° DOWN THRUST
C.G.



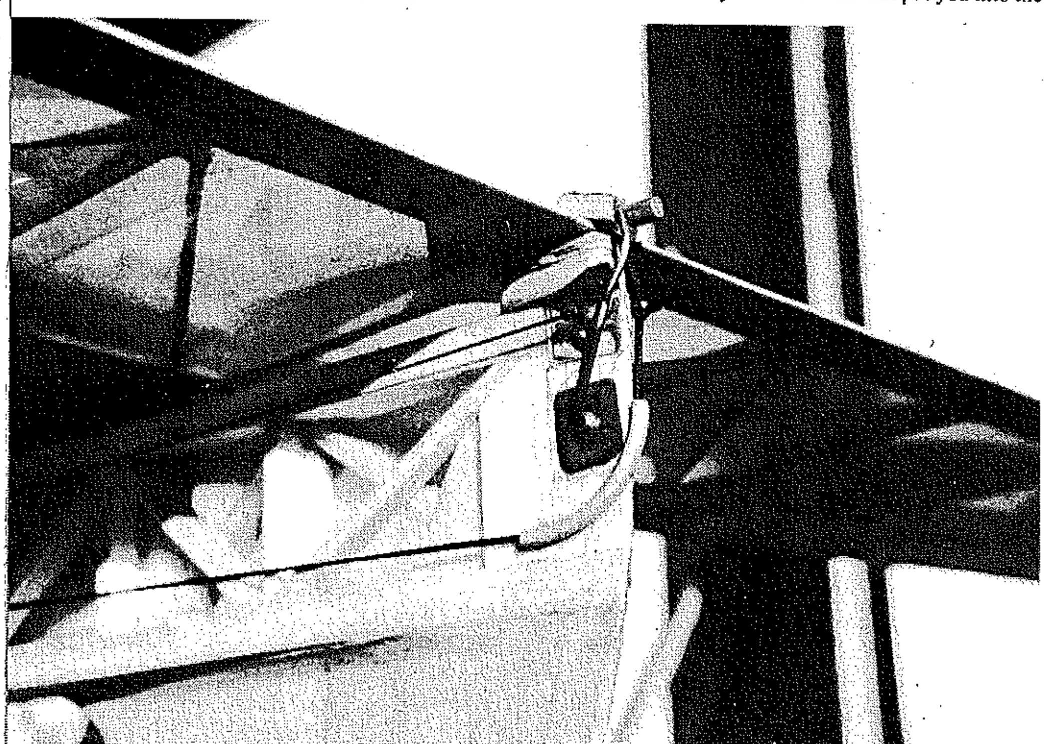
Button ahead of the flood-off timer pinches fuel line on opposite side when pushed—handy for quick starts. Landing gear is captured between engine and the backplate—and through the beam mounting holes. Upper rubberband, released by engine timer, holds string going to stab dowel. Lower rubberband holds the dethermalizer timer switch in the "on" position.

Build the bottom fuselage surface first, pinned directly to the plans. Then add the formers. Off to the side, cut the top two longerons, taper the ends where they join in the rear, and cement them together there. Place this sub-assembly onto the formers, pulling in the longerons to conform with the same contour as the bottom, and cement them to the top corners of the formers. All of the diagonals can be put in last after the assembly is removed from the board.

Use epoxy (slow curing kind) to cement the wing center section together, to fasten the firewall and the 1/64 plywood shield around it, the 1/16 plywood stab rest, and the ⅛ dowel on the back of the stab. All other cement work is done with model airplane glue. I don't key the wing or stab for alignment, preferring to eyeball these before each flight. With the K&B 3.25 or 3.5, I use an 8 x 4 Zinger (old style) or Master Screw prop and 60% nitro fuel.

Flying. Note the trim adjustments shown on the plans. The plane should go almost straight up, with a gentle twist to the right, and transition at the top into a gradual left glide turn. It should transition perfectly even with only a 3-sec. engine run. Best results are had by delaying the auto-stab lift by one or two seconds after the engine cutoff.

The airplane is important, but so is the engine and your flying style. An engine that starts easily within a couple flips is an advantage. Invariably, a stubborn engine will upset your timing and cause a delay in launch that will put you into the down air of the back side of a thermal.



Bottom string, holding stab dowel, is released by engine timer to allow the stab to lift to glide position. Top string, holding the auto-stab arm, is later released by the dethermalizer timer to allow the stabilizer to swing up to the dethermalized position. Stab covered with ½-mil Mylar.

Odds are against maxing between the hours of 10 and 12 a.m. I have been stung by too may downers during these hours for it to be coincidental. I theorize that, on a normal day, thermal activity progresses something like the following.

During the night, all temperatures equalize so that, in the early morning hours, there are no temperature differences to produce vertical air movement. The air is cool, dense, and favorable to maxing without thermal assistance. (Get your first flight in as early as possible.)

However, as the sun heats the earth's surface, temperature differences are generated, starting thermal activity. (By this time, you should have maxed out and are ready for the flyoffs, but be patient.) Open fields, highways, and runways readily absorb the sun's rays. Areas with foliage, such as woods, cornfields, soybean fields, and heavy grass-covered fields, are effectively insulated from the sun's rays; therefore, they absorb heat more slowly than the open fields—such as the one you most likely are flying on.

What this means is that the surfaces of the open fields remain cool (as the sun's heat is easily absorbed into the mass of the earth) and the top surfaces of the foliage of the foliage-covered areas heat up quickly (because the heat is not readily conducted away). Standing thermals form over the foliage-covered areas, and standing downers prevail over the open fields. This is the condition that persists roughly between 10 and 12 o'clock.

This isn't to say that there are no thermals over the flying field from 10 to 12. Thermal bubbles from neighboring fields will be blown over during this time, but superimposed on them will be the standing downer which makes air picking particularly tricky and statistically unfavorable. I suppose that, if you were enterprising, you could win consistently by flying over cornfields and woods during these hours.

Finally, the surface of the open fields heat up as the earth's crust has heated. Its temperature approaches that of the surfaces of the surrounding foliage-covered areas. At this time, say between 12 and 2, a different picture develops. Dark and rough areas, such as macadam and freshly plowed fields, still absorb heat—while lighter areas, such as concrete runways and light tan, hard dirt fields, are up to temperature and are now heating the surface air and producing thermals. (Barring other weather factors, now is the time for those flyoffs, starting at about 1 o'clock.)

From about 2 o'clock and later, the process is much in reverse of what it was from 10 to 12. The surfaces of black-top areas have become hotter than anything around, and the foliage areas are still not fully up to temperature, as the sun's heat is being slowly drawn away to the still-cool earth underneath. Therefore, in the afternoon, the flying field tends to produce standing thermals, and the surrounding areas tend to produce standing downers. This condition becomes particularly apparent in the late afternoon and evening—up to perhaps midnight—when the hot fields give up their stored heat to the cooling air, and the foliage-covered areas have less stored heat to return to the atmosphere.

This discussion is somewhat idealized, because it ignores larger air movements from fronts, cloud coverage, etc., but when the contest day dawns clear, and the forecast is fair and calm all day, watch for these conditions to occur. Even if the forecast is otherwise, these static conditions will develop but be less apparent as other dynamic weather factors are superimposed to confuse the

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on 3½ ounces of fuel, rarely needs a plug, and runs on any kind of fuel. I've tried all sorts of synthetics and castor, with nitro percentages from 5-60%. My engine seems to prefer around 20% oil (15% Klotz, 5% castor) and goes faster with the addition of more nitro. This is not the case with some engines, where more nitro means sensitive needle settings, blown plugs, and sometimes less power until head clearance/shape is changed. Maximum power of my motor is limited because it still has the rather small stock venturi.

Just what you always wanted, the Monoboom SP. The SP stands for "Speed Pattern." The event might even catch on some day. It's been tried in various parts of the country already. A fixed series of loops, eights, and level flight, where your total elapsed time is what counts (think of trying to do the AMA Stunt Pattern in about two and one half minutes!). The SP plane will be larger and be set up for rear exhaust engines like the K&B and Tigre .40 with straight pipe. We're talking lots of horsepower, like 130-mph-producing horsepower. Proponents say that it is "the" event of the future, a non-destructive measure of pilot skill and model/engine performance. Whatever happened to lady luck?

How come the FAI Combat Team Trials aren't at the Nationals like the other CL events? I guess the main reason (amd the one I tell people) is that the Combat program was so well organized that we were locked in before the Nats location became a real possibility. Stunt/Team Race/Speed had nothing firmed up so were able to change to the Nationals location and time. (Editor's note: Since this was written, the Stunt finals have also been moved from the Nats—to Dayton, OH on the Labor Day weekend.) Let's hope all the planning and great facilities in Nashville make up for the extra travel expense. A bonus in having the Combat portion separate is the added publicity that Combat will receive.

Charlie Johnson, 3716 Ingraham St., San Diego, CA 92109.

A-B-C Toothpicks/Morris

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picture.

Speaking of weather forecasts, there are certain old almanac and folklore sayings that are generally true and helpful. Here are some that I like:

"Red at night, sailor's delight. Red in morning, sailors take warning."

"Rain before 7 ends before 11."

"When smoke descends, good weather ends."

"Sharp horns (meaning unusually clear points on a partial moon) do threaten high winds."

"Rain long foretold, long last; short notice, soon past."

Fair weather guides: Rising smoke indicates high barometric pressure—thus, a clear day. Dew is a sign of a fair day. No matter how ominous they appear, high clouds won't rain.

Foul weather guides: Sun or moon halos indicate a coming rain. When leaves turn over and show their backs, rain is on its way. If storm clouds appear in the west or northwest, it usually indicates a storm that will reach you. Storms to the south go past.

Put it all together: plane, engine, and flying style—and you are bound to be a tough competitor. However, this is a slow process. Allow a year or more to bring a new plane up to full potential.

Happy landings!

FF Scale/Warner

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The model we flew at the 1981 Astro-Flight/Model Builder Champs has a 3/16-in. aluminum tubing drive shaft going back to the prop from the motor in the cockpit area. Bits of thin Teflon sheet from a surplus store were punched out to the tubing O.D. and bracketed with Ambroid glue at the places the tubing passed through the bulkheads on its way rearward. This took the vibration out of the shaft very nicely.

Glue won't stick to the Teflon, but will hold it in place if smeared all around and over the edges of the squares, cut just a little larger that the 3/16 hole in the center. We probably could have eliminated the break for a bronze bearing halfway back on the shaft, used in an attempt to steady it. It didn't do the job of eliminating vibration—but the Teflon did.

A few planes with props halfway back in the fuselage, such as Joe Tschirgi's famous DuFaux, amaze many people who can't see why the whole rear of the plane doesn't revolve, too! Our Vancouver, B.C. correspondent and artist, Dick Allen, gives away the secret with his electric-motor-driven conception of how it's done. Quite simply, the long stationary shaft ties the front and back of the fuselage together while the prop shaft is really a free-spinning tube which fits over the non-moving structural member. It is spun by a belt or with gears. A great job for electric!

If you are thinking of a shaft-drive plane, just remember to keep it as light as you can, try and support the drive shaft at intervals to keep shake out, and try and keep the shaft and motor in line. Minor bends in the drive line can be accomplished using the Hungerford method, a wound music wire spring at the point of direction-change to provide the needed flexibility. Having used this