# undertaker

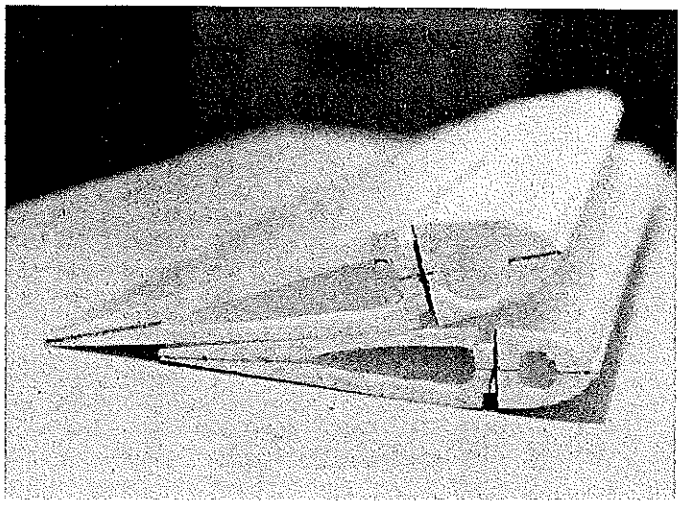
**Making it through a full season of Fast Combat flying calls for an airplane that's highly maneuverable yet rock steady, sturdy enough to survive minor knocks, and quick to build and repair (unless you like to spend all your free time building!). This plane brings all these attributes together, and it has laid to rest many opponents.**
**■John Thompson**

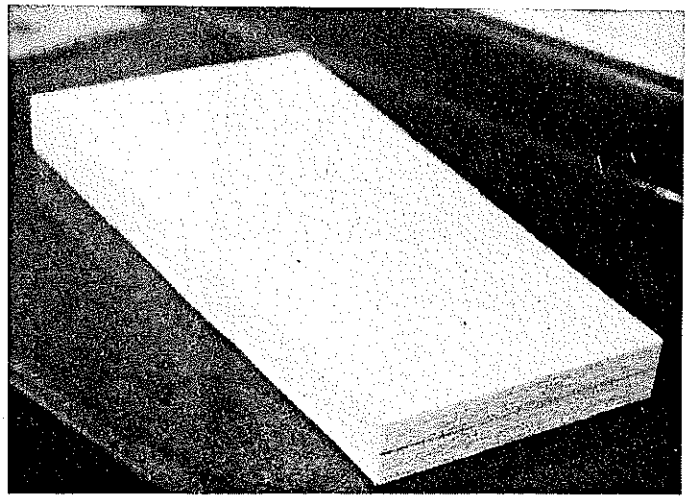
THE GRUELING environment of AMA "fast" Combat requires a special kind of airplane. It must be fast and dazzlingly maneuverable. It must have a solid feel on the lines and a flight stability that allows "eyes-off" piloting. It must be sturdy enough to withstand rough handling in the pits, minor midair collisions, and incidental whacks on the ground. The design/construction must be sufficiently simple to allow mass-production without draining the flier of the energy to survive a busy season of travel and competition.

That's a tough order. Many airplanes have been designed that meet some of these qualifications, but few have managed to do all of them. Some are incredible aerobatic performers, but are fragile, extremely sensitive to warps and other trim-adjustment problems, or are just too complicated to build in the large quantity needed for a whole season of competing. Others are simple to build, but they fly poorly.

The Undertaker, designed in 1983 and refined throughout the 1984 Combat season, is a melding of the two key concepts of good performance and simplicity of construction. It is the result of my personal search for satisfaction in AMA Combat. A busy non-modeling schedule and an enjoy-

Our author's latest Undertaker flies right out of the hands of Bill Varner on its first ever flight. Pilot-friendly characteristics are one of its strong suits. Thimpleby, Gayle Rapp, others, author.





**Left: Foam blank ready for cutting the wing cores. Foam construction does much to reduce the building time. Right: Examples of the wing panels already cored—outboard panel on top, inboard on the bottom. See the text for details on how the coring is actually done.**

ment of other kinds of modeling require that the Combat planes I build must be easy to produce quickly. In addition, I demand that the planes I fly be in tune with the state of the art as practiced by my opponents.

The Undertaker can be mass-produced in six hours or less per airplane, and it is an excellent performer. The design evolved from influences of a number of other Combat planes and their designers. Essentially, I took the best features of a number of airplanes and combined them into one that met my own personal specifications.

**This article is purposefully** as much on the concept of Combat models and flying as it is on the specific airplane. Construction techniques I use could be adapted by Combat fliers to their own particular favorite layouts. Though I believe the moments and dimensions of the Undertaker are almost ideal, other fliers (after building one) may want to experiment with different airfoils, wing planforms, or materials to meet their own preferences.

I began AMA Combat flying in about 1978. Like all beginners in a new event, I went through a period of searching for the plane that suited me. I started with a variety of all-balsa designs and then moved to foam wings when I was captivated by the incredible performance of foamies with high-aspect-ratio wings. However, after two years of alternating exhilaration and frustration, I retreated from that concept and came up with my own (first) design. I temporarily gave up on tapered-wing foamies because of their susceptibility to line-tension problems and their general unpredictability when they were the slightest bit out of trim.

My first design, the Ax, was a balsa-based airplane with a foam leading edge. The foam LE was essential to be able to snag the streamer leader string and get that now-standard "wing kill." The plane had a rectangular wing planform with a fairly thick airfoil, copied from an early design by Phil Granderson. Construction of it was influenced by designs by Gene Pape and Norm McFadden.

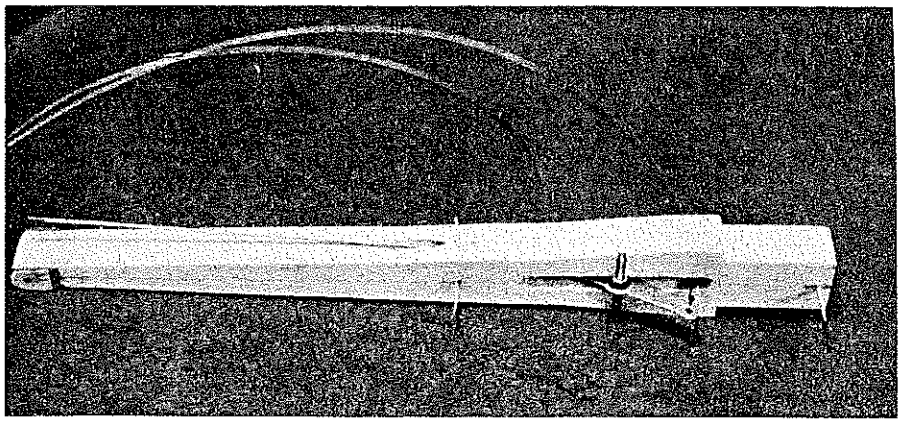
Once sorted out, the 42-in.-span Ax met my flying specifications. It was absolutely predictable in all flight attitudes, flew immediately from the launch no matter the wind direction, turned well, and would fly acceptably even if warped by poor trimming or damage. It was also quick to build.

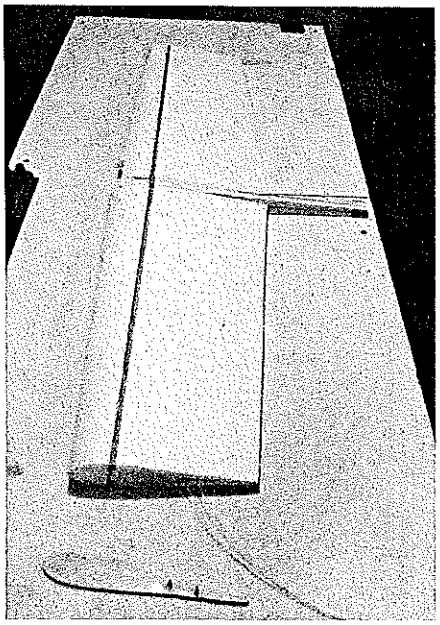
Still, the Ax had a serious flaw. In my efforts to simplify and lighten the airplane as much as possible, I had created a design that simply wasn't strong enough. Though it withstood flight stresses, it would explode on contact with another airplane or the ground.

It was back to the drawing board for me. I wanted a plane that would fly and build like the Ax but also be sturdy enough to withstand minor bumps and bruises. I also wanted an airplane with many parts that could be recycled and reused after crashes or collisions. I began to look again in the direction of foam wings for strength, while also looking at the ultra-simple concept of Gene Pape's Dogfighter—which had emerged as a popular beginner and quick-build Combat plane in the Northwest.

In thinking-out the Undertaker, I tossed into the "blender" the concepts of foam for strength and wing kills, a tapered wing planform and moderately-high aspect ratio for good turning, the airfoil and moments of the Ax for predictable flight response, and the simplicity of the Dogfighter's construction.

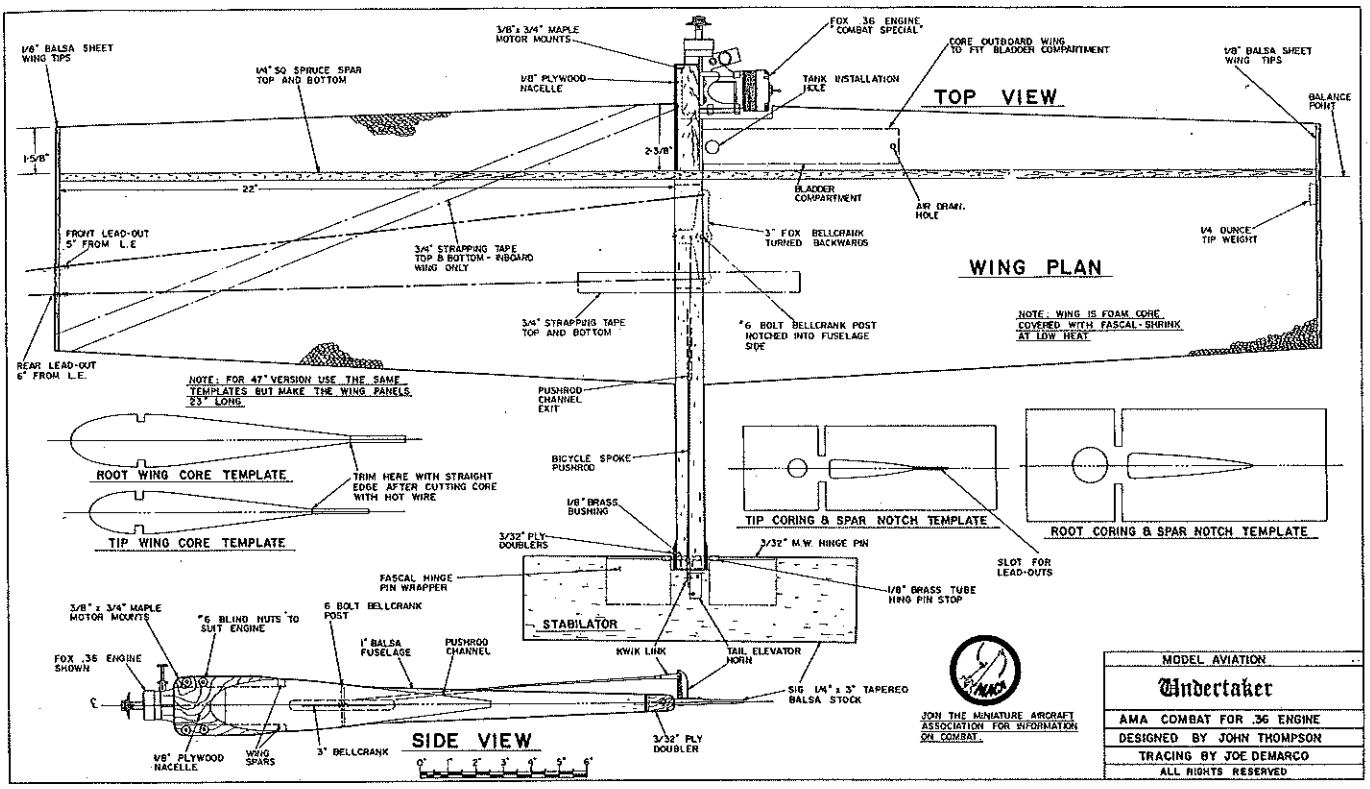
The resulting airplane was absolutely satisfactory in its first prototype. Since then, the only change I have made was in building a larger version for the 1984 Reno Nats. I am pleased with both the original 45-in.-span version and the Reno 47-in. version and have not settled on which I prefer to fly. For that reason, this article contains instructions for both. In construc-

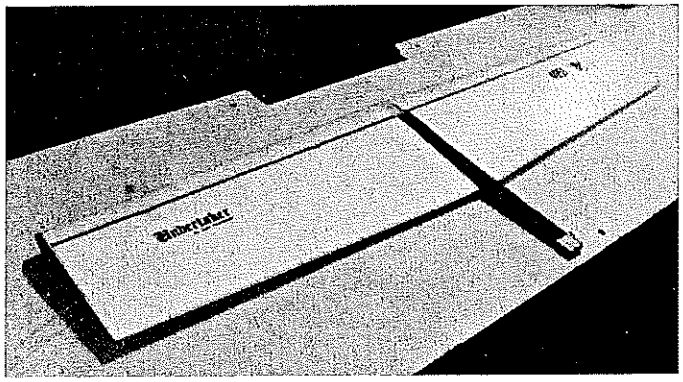


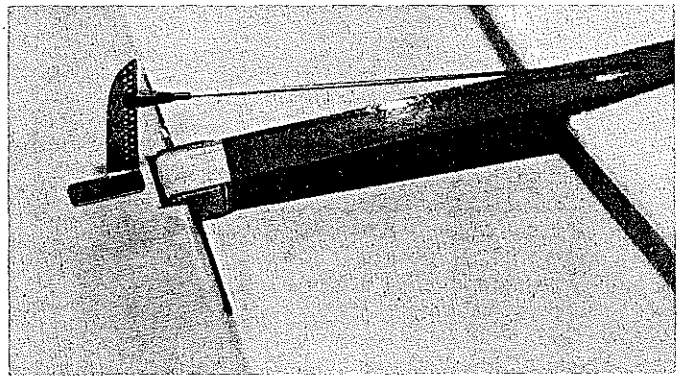


**Left: The fuselage after installing the controls, tail boom doublers, and toothpick alignment guides. Right: A view of the wing as it nears completion. Outboard tip weight, spars, and inboard lead-out guides have already been installed; installing the wing tip is next to do.**

**Full-Size Plans Available . . . See Page 164**





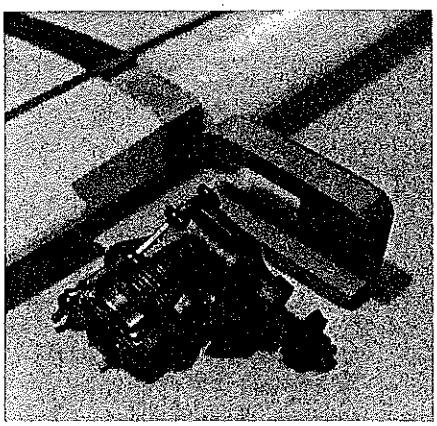
**Left: The wing/fuselage assembly after covering. Keep the finish as light as possible, as light weight is the key to a good Combat flier. Right: Tail assembly details. Note the wire hinge, tall elevator horn (this one a DARE unit), and center-fuselage pushrod emergence.**

tion, the only difference is to add an inch to each wing core for the larger version.

Properly built, the Undertaker is stable in level flight, and it is also quick and tight-turning. It pulls hard on the lines for a good feel at the handle; it is easy to control either upwind or downwind. It has virtually none of the bad habits related to line tension, bobbing, wobbling, or warp-sensitive control loss often associated with high aspect ratio designs having thin airfoils.

It is strong enough to survive most minor crashes and collisions, and it is frequently repairable even after serious damage. Even when the plane is not repairable, the fuselage/tail assembly and controls are usually reusable (unless it's center-punched by another plane). Addition of new wing cores —easy to do because the spar channel is not hidden under the engine mount where it would be difficult to clean out—often results in a virtually new airplane in a couple of hours' work.

Careful construction and selection of the best materials will result in Undertakers that weigh around 21 oz., including the engine, prop, and bladder tank. With extra attention to detail, the weight can be brought down to 20 oz. The cost of materials should be less than $10 per plane, and building time, including cutting the parts, should be no more than six hours once you know the technique.



**The engine mount with the author's Fox Combat engine alongside. The mount is first assembled and then glued to the fuselage where needed for balance. The fact that the spar channel is not hidden beneath the engine mount reduces wing replacement time to only about a couple of hours.**

**Construction.** Start by collecting together or making up the following components that will become the "kit" for this plane. Refer to the plans for any detailed dimensions that are needed.

Plastic or paper bladder tube. Plastic tubes can be ordered for 25¢ each from Will Naemura, 16320 S.E. Division, Portland, OR 97236.

Outboard wing panel with front core section enlarged for the bladder tube. Inboard wing panel. Wing panels are 22 in. for the 45-in.-span airplane, 23 in. for the 47-in.-span version.

Two ¼ x ¼-in. spruce, fir, or pine spars.

Fuselage with controls installed. Controls include standard lead-outs, Fox 3-in. bellcrank, No. 6 bolt hinge pin, and bicycle spoke pushrod. Spokes are available from bicycle shops for about 10¢ each. A Kwik-link metal threaded coupler completes the horn end of the assembly.

Two fuselage tail doublers (3/32 plywood).

Two toothpicks.

*Continued on page 154*

"Indoor flying sure affords a lot of advantages, i.e., no noise, no fumes, no real dangers, very low expense, no sunburn, no wind, no rain or dust. Indoor flying has a really big future, so make sure you jump on the wave and become an expert before all those little boys and girls discover the fun and swamp the entry."

Tony, we should be so lucky.

## Undertaker/Thompson

*Continued from page 67*

Two ⅜ x ¾-in. maple engine mount beams.
Nacelle, ⅛-in. plywood.
Inboard wing tip with eyelets installed.
Outboard wing tip
Lead wing-tip weight, ¼ oz.
Stabilator (made from ¼ x 3 x 36-in. Sig tapered balsa stock).
A 6-in. hinge pin of 3/32 music wire.
Two ⅛-in. O.D. brass hinge pin stops.
Hinge bushing of ⅛-in. O.D. brass.
Large elevator horn. Use Kraft RC tall horns, or order stainless steel fine-adjustment Combat horns from Dark Ages Racing Equipment, 200 W. Franklin Ave., Astoria, OR 97103. Don't be tempted to use the easier-to-find standard-size control horn; it is too small.
Blind nuts for your favorite-size engine attachment. I recommend No. 6 blind nuts and bolts.

**Sequence.** Cut the wing panels with a hot-wire cutter and the templates shown on the plans. After the panels are cut out, use the rectangular templates to core-out the cavities. Enlarge the front outboard cavity, and install the bladder tube. Use a 1¼-in. drill bit or sandpaper wrapped around a large dowel for enlarging the hole. (If using a drill, jig it and guide the core to prevent the hole from wandering.) (An excellent reference work on how to cut foam wing panels is Gene Pape's article on the FAWF AMA Combat plane in the April 1980 issue of *Model Aviation*.) Save the part of the foam block you cut the core from, as it will be used later as a jig for assembly.

Saw the fuselage, tail, tail doublers, tips, and engine mount pieces. Put centerlines on both sides of the fuselage, and locate the toothpick guide holes. Groove the fuselage for the bellcrank post.

Assemble the control system by mounting a Fox bellcrank on the No. 6 bolt, using nuts on the top and bottom to hold it in place. Bush the lead-outs with grommets or brass tubing, and put the bicycle spoke, keeper down, in the inner bellcrank arm hole. A long piece of brass tubing cut jagged on one end serves as a good drill bit for the long pushrod exit hole through the fuselage. Some adjustment may be needed to get the hole just right for the pushrod to clear the bellcrank, or possibly the rod can be bent a bit to obtain clearance. Once you are practiced, you should be able to drill the hole so that the entire system operates freely right off.

Attach the fuselage and doublers with cyanoacrylate (CyA); sand, drill, and install the brass tube bushing. Make sure to get the hole straight; use a drill press if possible.

Install toothpicks in the fuselage holes for wing-alignment guides. Attach the wing cores with 5-min. epoxy. Use the part of the foam blanks that you cut from the wing as a jig to hold the assembly straight while gluing. Using the centerlines on the fuselage as a guide, make sure the panels are on straight. The back of the wing spar notch should line up with the front of the fuselage cutout so that the spar lays across the fuselage and butts up against the back of the cutout.

Glue in the spars with a white glue. (I prefer Pica Products Gluit, as it sands easily.) The spars can be held in place while the glue dries by returning the cores, spars and glue in position, to the blanks (lined with wax paper) from which they were cut; weight the "sandwich," and let the glue dry.

Attach the wing tip weight to the outboard tip, and install both tips, threading the lead-outs through the inboard tip eyelets. The templates are designed to slot the back of the panel to allow the lead-outs to travel through their proper channels. Don't tamper with the line rake—it's the key to good line tension.

Run a strip of ¾-in. strapping tape diagonally from the front root to the back tip on the inboard side, top and bottom, to prevent flexing. A short piece spanwise across the fuselage at the center, top and bottom, as far back as it can go and lie flat, will significantly strengthen the center section and avoid damage in minor crashes.

Put your AMA numbers on the plane as

required by the AMA Safety Code, and cover the cores with FasCal (using a low-heat setting).

Attach the tail using the music wire hinge pin. Glue the brass hinge pin stops to the hinge pin with CyA to prevent a sideways sliding of the elevator. CyA-glue the hinge pin to the elevator (a little baking soda may help secure it), sand the joint, and then wrap the pin area with FasCal scraps. Cover the whole tail with FasCal, which can be done with a single piece wrapped around.

Install the elevator horn (if using a Kraft horn, put a 1/32 plywood plate underneath to prevent it from lifting under stress). The DARE horns don't need the plate. Finish the tail boom with FasCal or other plastic covering.

Connect the pushrod to the elevator horn with a Kwik-link. Very little movement is needed, so start out with the horn near the top of the Kraft horn or about five holes down on the DARE horn.

Glue the maple engine bearers to the plywood rectangle nacelle, and cut out the center to fit the assembly to the fuselage. The rear of the beams should butt up against the spar. Shape the engine mount (taper at the rear of beams, round them at the front).

Rubberband your engine (with mounted prop and the engine bolts) onto the engine mount. Plug the mount onto the plane, and move the engine forward or backward until the plane balances at 25% of the wing chord, which is about on the spars. Mark the engine mounting hole locations, and drill for and install the blind nuts.

Attach the engine mount with slow-cure epoxy, and fill in any gaps later with 5-min. epoxy. Finish the mount and exposed parts of the fuselage with 5-min. epoxy.

Drill access and drain holes in the bladder tube, and fuel-proof the holes. Securely tie the lead-out ends.

**Flying.** You should find your new Undertaker is under control right out of the launch. Some Kwik-link and horn adjustment may be needed to equalize turns in both directions and to find the proper turn radius. Resist the temptation to adjust for too much elevator travel. Too much travel will induce a stall and set up the plane for an easy kill by your opponent. If a large amount of travel seems necessary to get the plane to turn, it is balanced nose-heavy. Within limits, that can be corrected with tail weight. If the plane is "nervous" and won't fly level, it is tail-heavy, and elevator travel will have to be minimized.

Once your Undertaker is in the air and flight-trimmed, the only thing standing between you and victory in Combat circles is plenty of practice and lots of Combat flying.

## CL Aerobatics/Fancher

*Continued from page 68*

Objective III, items 2 through 8).

The worst waster of line tension is roll. If the airplane is banked toward the pilot, a portion of the wing's lift is vectored