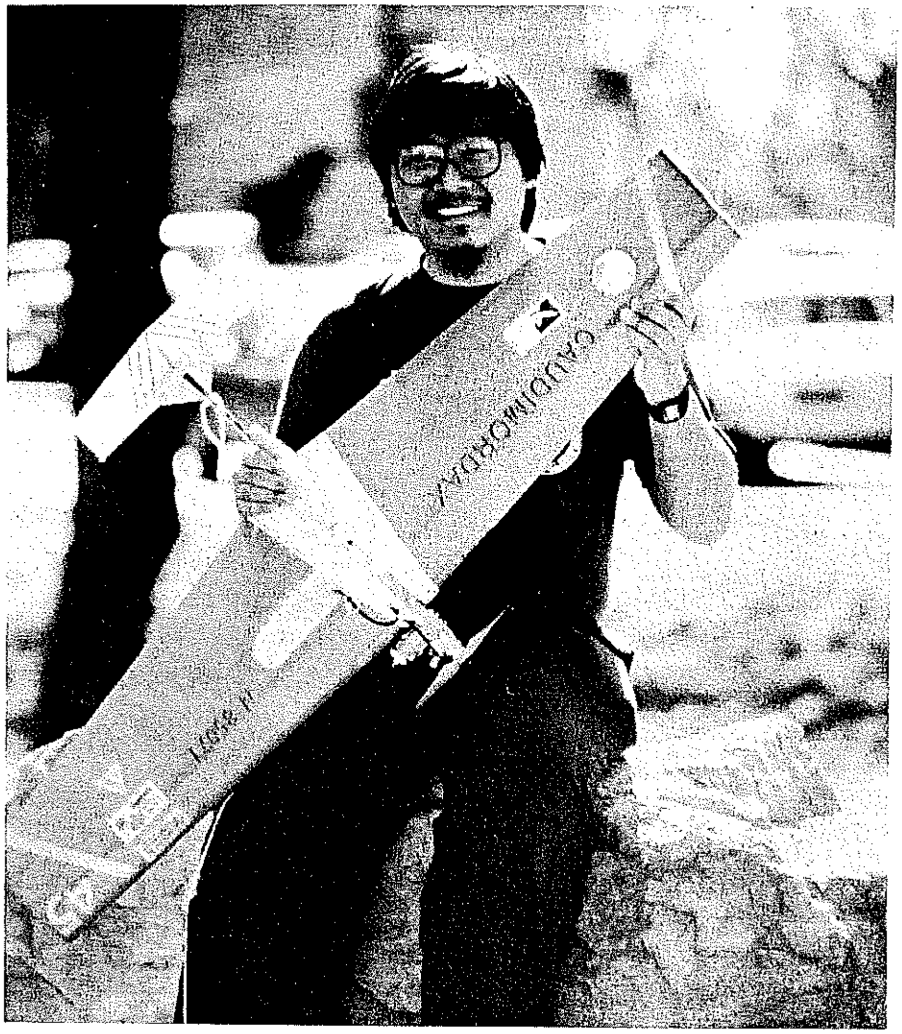
Caudimordax

Fast Combat with smaller engines? It works! Three ounces of fuel can last up to five minutes. Your shoulder stays in one piece. A slower, tight-turning ship gives you an edge over your opponent—and the engine costs a lot less!

■Iskandar Taib

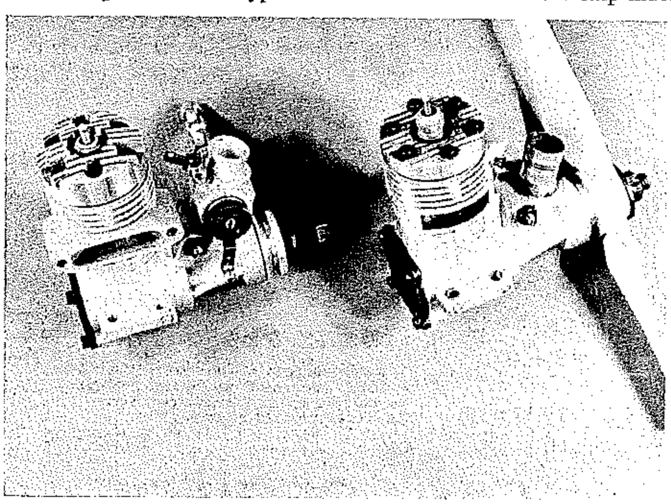


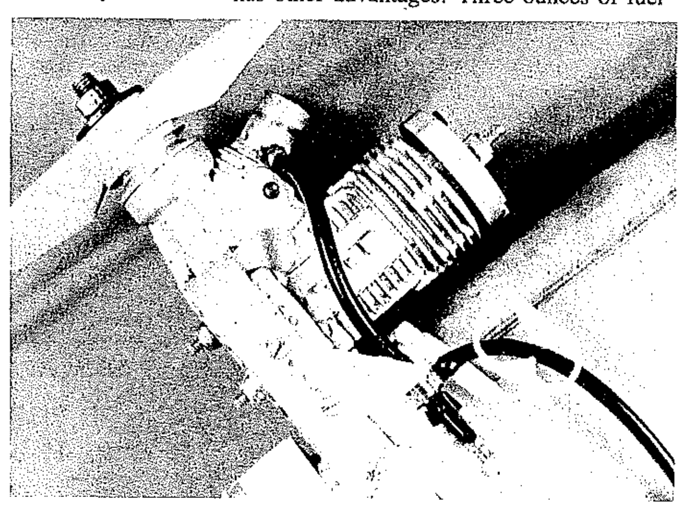
Author/builder Iskandar Taib holding his Caudimordax, a thoroughly designed Combat plane. It gives up some top speed (typically 10-15 mph), but it makes up for it by barely slowing in the corners. Light weight, along with special modifications to the engine, make this possible.

AMERICAN COMBAT design philosophy has traditionally favored speed over turning ability. Note the large sums of money spent on Hoffelts and custom Foxes, many of which are bolted onto 300- to 400-sq.-in. airplanes weighing 21 oz. What these engines share, besides their enormous power output, is their weight. Most of them weigh in at about 9½ oz.

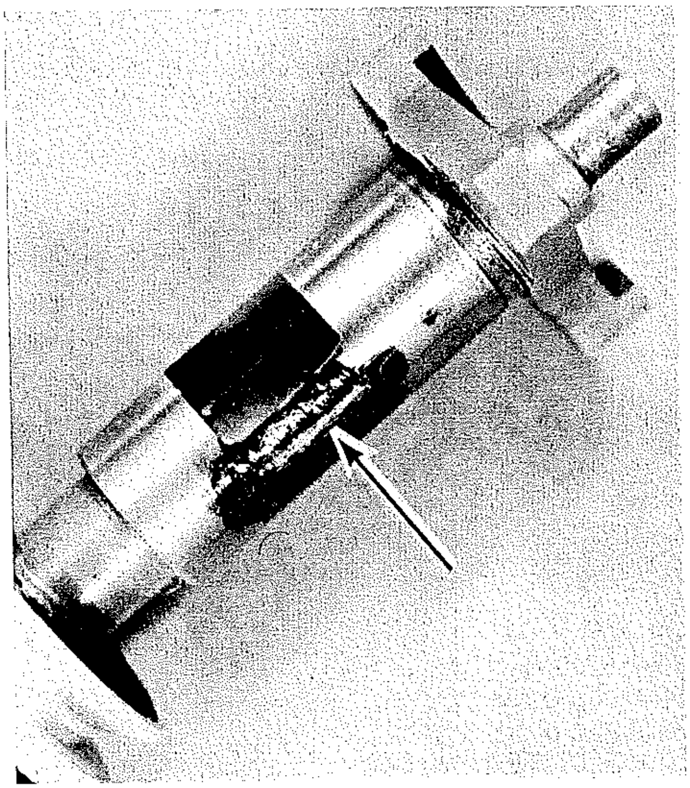
Caudimordax is a design that takes another approach. A high rate of turn and small turning radius are given top priority, and these qualities are achieved by using a light engine and a high aspect ratio wing. The compromise is speed. Caudimordax with a Brat .28 flies 10 to 15 mph slower in level flight than the typical Fast Combat job. It makes up for it in the turns, though, which are much tighter and actually slow down the ship much less than they would a heavier model.

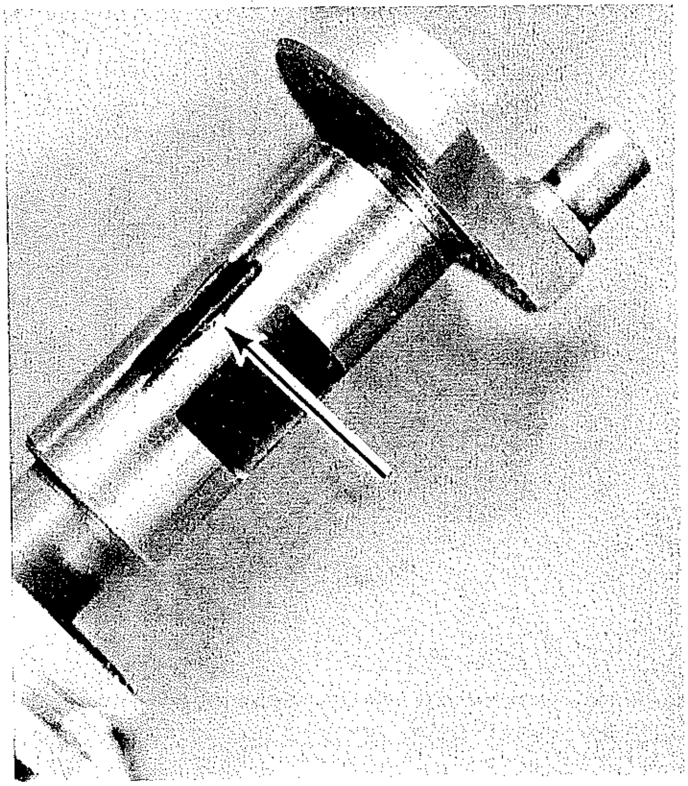
Flying Fast Combat with smaller engines has other advantages. Three ounces of fuel



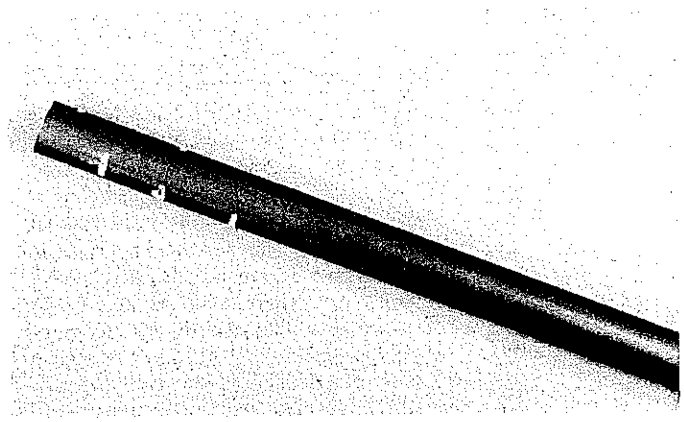


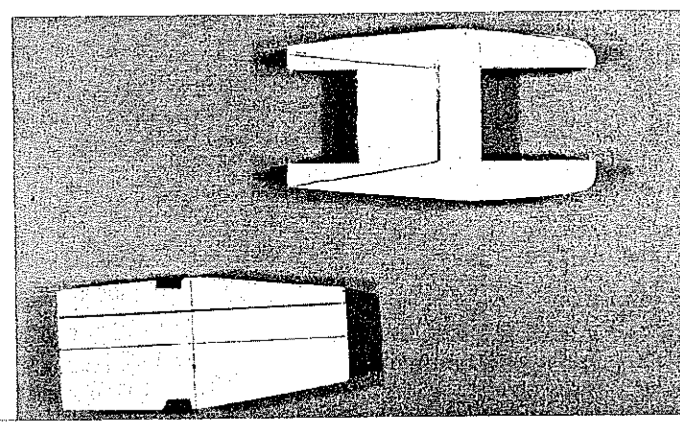
Left: On the left is an unmodified Brat .28 still sporting its RC carburetor (the author has several to give away). On the right is a modified Brat .28. Note the missing metal around the exhaust port, thinned head fins, homemade venturi, and the 7 x 6 Taipai prop. Right: Close-up view of the remote needle valve assembly. A unit from an O.S. .10 FSR RC was used. Note the short length of tubing slipped over the end of the needle valve to prevent leakage. The plastic clip on the fuel line is available from the author.



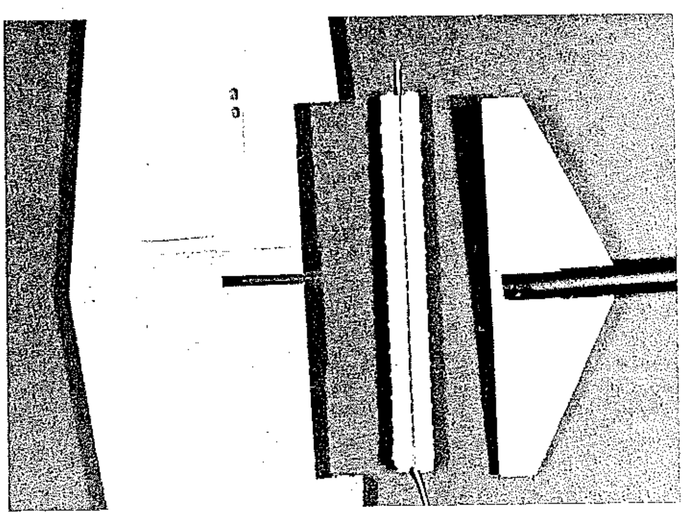


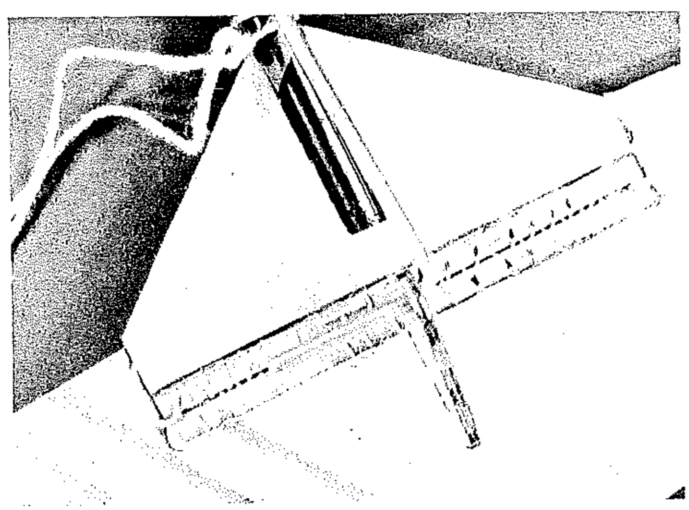
Left: Mark made on the crankshaft at the intake port's closing side. Right: Mark made on the opening side. Note the amount of metal that has to be removed. Brats have very conservative timing, which befits its sport RC roots.



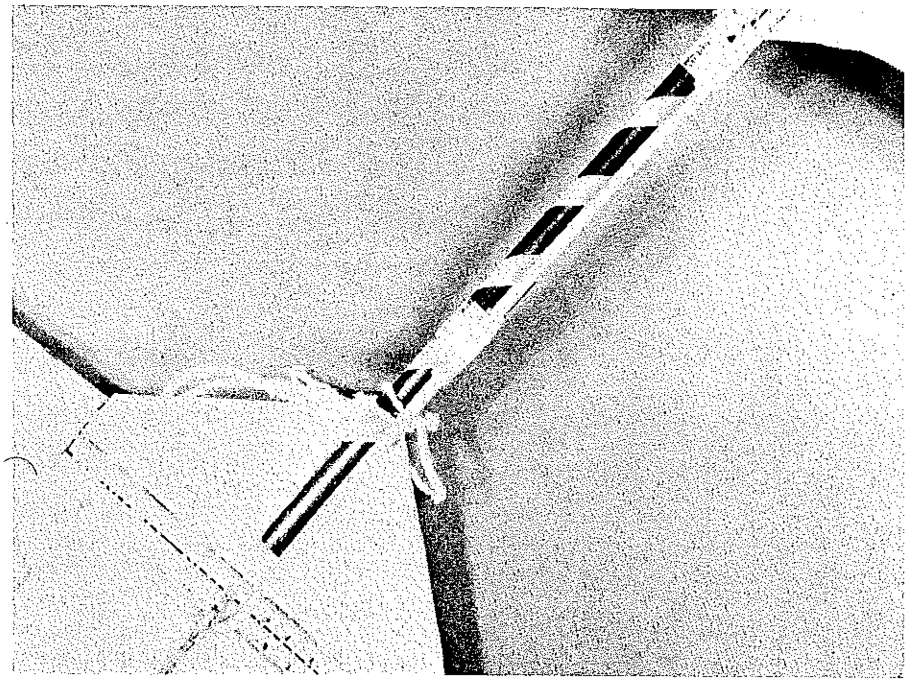


Left: Front end of tail boom. Note the shallow cuts that were made in the aluminum for the epoxy to grab. Small holes may be drilled instead. Right: Engine mount assembly and center rib. Mount is marked for sawing, using front of center rib as a pattern.

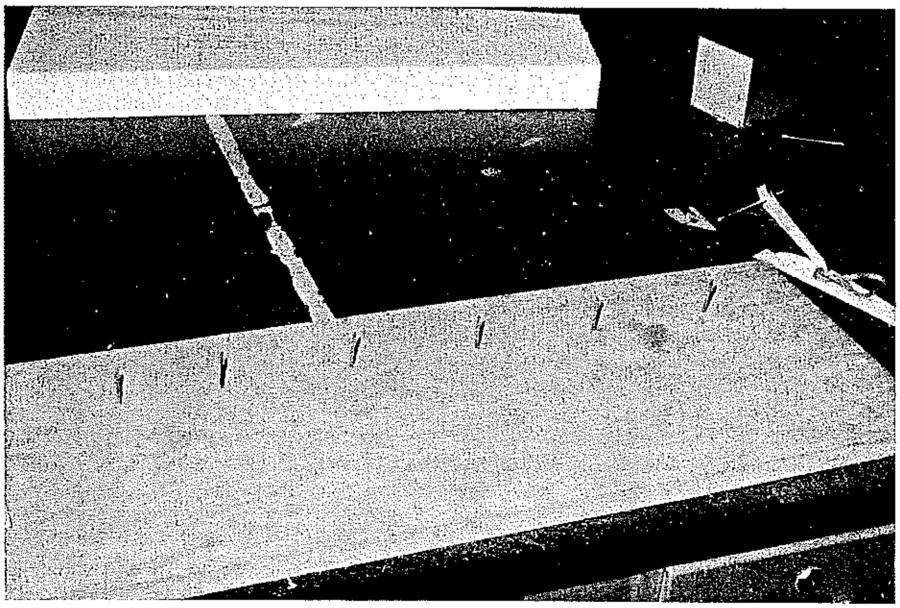




Left: Components of the horizontal stabilizer. Start by epoxying the arrow shaft to the stab anchor. Glue hinge assembly to the stab anchor, then cover the horizontal stab (⅛-in. medium balsa) and glue it to the stab anchor. Right: The completed tail assembly. Notice how the hinge is built: String is wrapped in a figure-eight pattern around two $^3/_{16}$ dowels.



Pushrod braces are made from outer Sullivan Ny-Rod. Filament tape wraps them to tail boom.



The bed of nails. This particular piece was made out of a straight section of chip-core board.

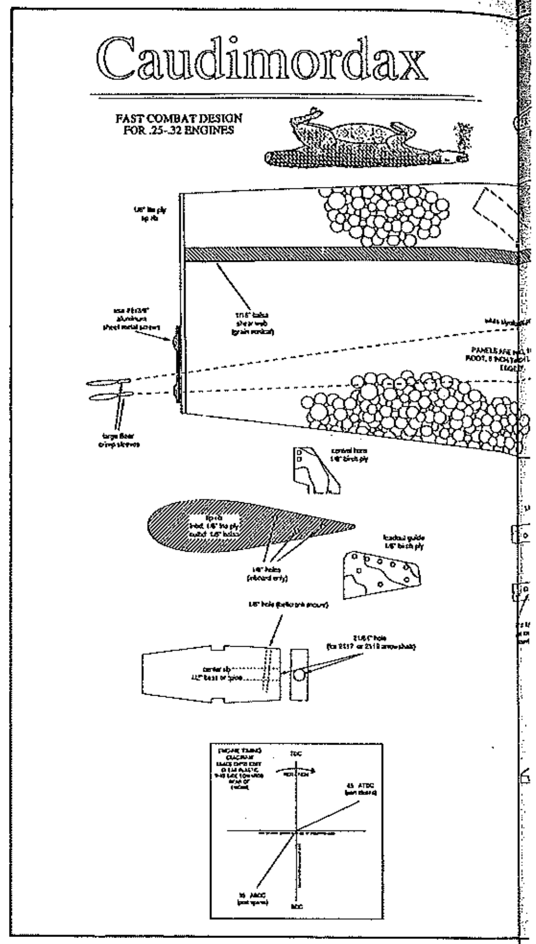
will last five minutes. The airplane doesn't dislocate your shoulder, and it's not so fast that you can't keep up with it. A slower, tight-turning airplane can also be hard for your opponent to line up on. I have gotten several kills when the other guy overshot in the attack. Perhaps most important of all, the engines cost far less than their bigger counterparts.

Caudimordax can also be used in the Outlaw FAI contests which are sprouting up all over the Midwest. Rules typically specify Fast (or Slow) rules, .15 engines, and 52-ft. lines, with no restrictions on engine or tank setups or nitro content of the fuel.

Most Schnuerle-ported, double ball bearing .15s weigh about six ounces, ¾ oz. less than a Brat .28, so the only modifications needed are to use a slightly smaller (typically 1⅛ in.) engine bearer spacing and to mount the engine slightly further forward.

The Caudimordax design goes back several years, evolving slowly to its present form, and admittedly incorporating features that are currently in vogue. External controls, for instance, are now being used by many top fliers (including the Russians), and save much building time by allowing the use of solid wing panels. Another great time-saver is the simple cutout for the bladder tank, which replaces the more common rocket tube. The arrow-shaft tail boom, although it requires a little extra building time, allows easier rebuilding and saves a little weight.

The agility of Caudimordax is attributable to its high aspect ratio wing and thick airfoil. The high aspect ratio reduces the tip vortices that cause induced drag, and the thick airfoil delays the onset of high-speed stall. The thick airfoil also lends lateral stability to the design, which helps to control the snap rolling associated with high aspect ratio designs.



Induced drag. Just what is induced drag, and why is its reduction so important in Combat design? Drag is generally divided into two types, which are often confused.

Parasitic drag is caused by the friction of air on the surface of the airplane and is therefore proportional to the surface area of the wing. Also included in this category are the drag of the lines and the drag caused by protuberances on the airplane, such as the pushrod and engine cylinder. Streamlining serves to reduce parasitic drag.

Induced drag, on the other hand, is related to the lift produced by the wing. When the wing is producing lift, the pressure of air on the bottom surface of the wing is greater than the pressure on the top. These pressure differences cause air above the wings to move outward toward the wing tips and air below the wings to move toward the root. At the tips, there is nothing to prevent air below the wings from curling around the tips and pushing down on the top surface of the wing, reducing the actual amount of lift produced.

The airflow around the wing tip also produces turbulent vortices, often visible as vapor trails emanating from the wing tips of jet fighters during high-G maneuvers. The energy needed to drive these vortices is ultimately linked to drag, and it is the drag associated with these vortices that is described as induced drag. The greater the lift

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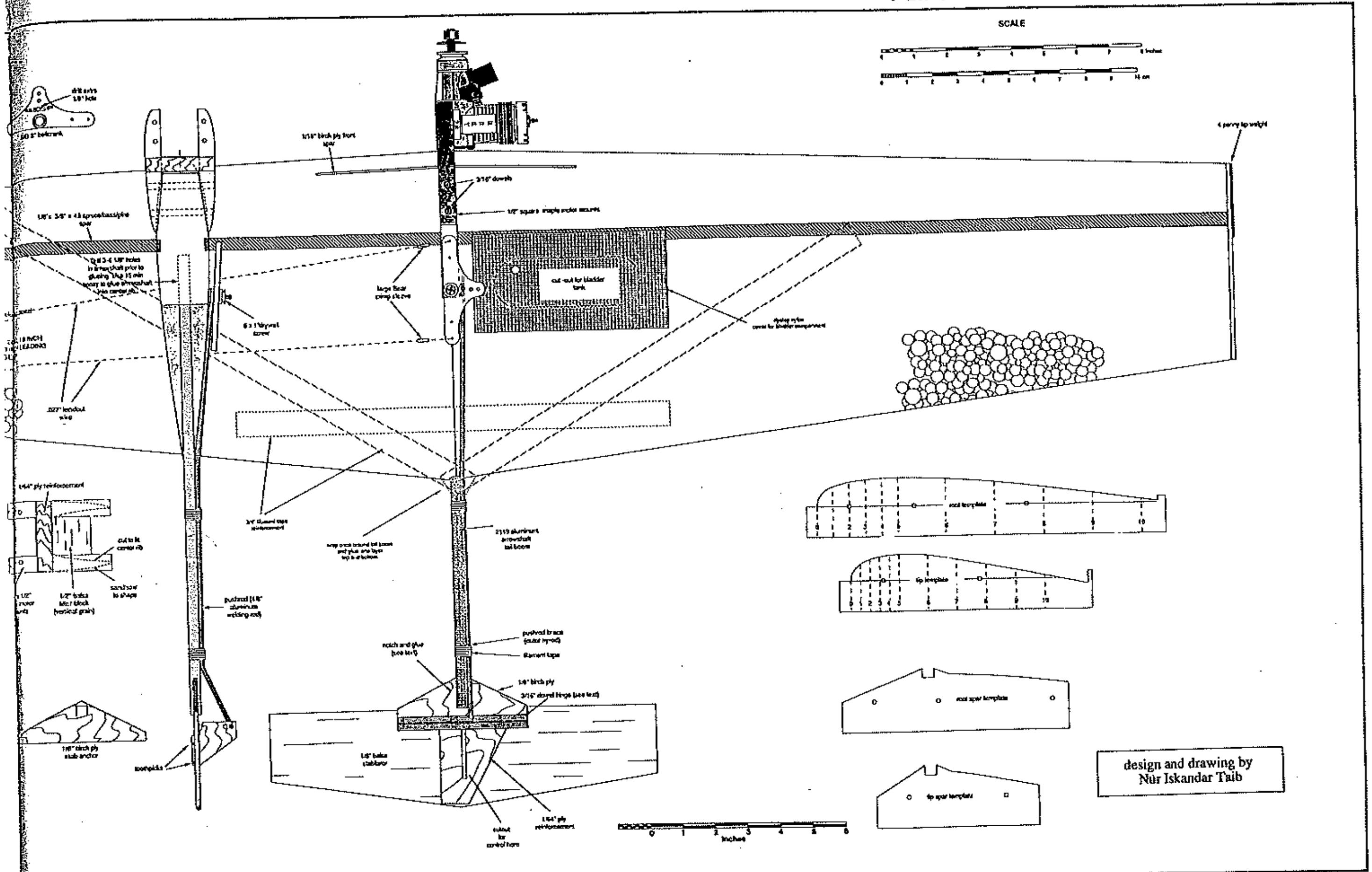

produced by the wing, the larger the vortices.

Several strategies exist for the reduction of tip vortices. Tip fences, for instance, will impede the air flowing around wing tips. Low aspect ratio wings would benefit most from tip fences. (Ed Brzys, are you listening?) They've been seen on full-scale airplanes with low aspect ratio wings such as the pretty Racing biplane Sorceress. Hoerner anti-vortex tips are a variation on the tip fence, and are shaped to force airflow at the tips counter to the direction of the tip vortex. However, these only work while the airplane experiences positive Gs. Flip the airplane on its back, and the anti-vortex tips actually add to the problem.

Forward sweep of the wing causes the airflow to move toward the root, where it cannot spill and cause a vortex, but forward-swept wings have to be extremely rigid to withstand aeroelastic twisting forces, which increase as the wing twists (technically known as aeroelastic divergence).

Another way to improve the efficiency (lift/drag ratio) of the wing is to use a smaller wing tip. Wind tunnel experiments have shown that the Schuemann planform (shouldn't it be called the George Perryman planform?) currently in vogue with glider pilots has the least amount of induced drag for a given amount of lift. The elliptical planform (e.g., the Spitfire) is almost as good. A wing with no taper is only 60% to 65% as efficient as an elliptical wing of the same aspect ratio. A wing with a tip chord that is 60% to 65% of the root chord is 90% to 95% as efficient. In a turn a tapered wing produces a lot less induced drag than a non-tapered one.

High aspect ratio wings have smaller amounts of tip spillage than low aspect ratio wings (less wing tip length per unit area). Glider wings have high aspect ratios for this very purpose. High aspect ratio wings have their own problems, however, a main one being the added bending stresses put on the

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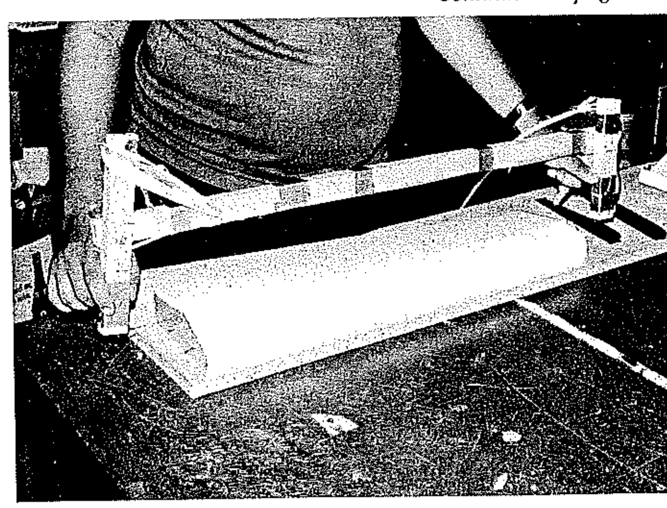

Left: Cutting top surface of wing core. Core is held tightly to the board, which is embedded with nails. Note how bow is held. Right: Cutting the spar slot. Slot is cut in a single pass: down, back, and up. Author gives complete directions for foam wing cutting, something rarely done.

great idea.

I can't resist quoting Mr. Stahl's comments in the opening paragraph:

"Overemphasis of strictly flying designs in contests throughout the country in recent years has brought about an unwarranted condition of neglect in the building and flying of Scale and semi-scale models. Much of the favoritism must be attributed to the desire for maximum performance, since little need be said of the relative appearance of a neatly built Scale ship and the usual contest design."

SAM Italia: Dr. Ferdinando Gale of Baveno, Italy recently sent me a most interesting handbook about Eastern bloc engines written by Cesare de Robertis. Well illustrated with unusual model power plants and text (in Italian), it is available from Gale at Via Marconi 10, 28042 Baveno (NO), Italy.

More and more interesting material and designs are emerging from SAM Italia, including several magnificent construction drawings for beautiful Italian Gliders of the pre-WW II era. These are available from B² Streamlines, P.O. Box 976, Olalla, WA 98359.

RC Pylon/Hager

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were no mediocre planes at the event. In fact, they were all so well done that I don't know how pilots selected which one they would show from the two or three each had brought along. I would still be out there trying to decide if I'd had a vote! The collection was absolutely beautiful.

"The takeoff area was too narrow to support four planes up, so all of the heats were three-plane blasts. Plans have been made and things are in the works to widen the takeoff area so four-plane heats can be accommodated next spring.

"The top 10 finishers for Saturday were: 1) Randy Rich, 1:14.80; 2) Richard Oliver, 1:17.01; 3) Red Cranfield, 1:21.89; 4) Phil Bussell, 1:17.42; 5) Jim Young, 1:18.59; 6) Bill Hager, 1:15.39; 7) Hubert Wills, 1:19.05; 8) Norm Johnson, 1:14.73; 9) Dub Jett, 1:14.87; 10) Sam Womack, 1:16.56.

"Just to keep everyone's attention, there were two midairs on Saturday, both occurring just out of turn number three. Poor Bob Greer was a participant in one of those little high-speed tangos with Dave Layman. Bill Hager and Jerry Small tried to trade a little paint in flight and wound up getting their planes all dirty, if easier to transport (under the seat).

"Sunday's action was just as hot and heavy. To make sure that he had the moves down pat, Bob Greer provided all those present with what had to be the most violent midair collision since the invention of the prop. It happened about 20 ft. directly behind and above my head as I stood in the cage at turn number one. The pilot in my lane had not made the clock, so I was locked on to the action when it happened. I felt bad for the pilots, but the crash itself was right out of the movies. There was another midair just out of turn number three, but it was tame by comparison with the Bob Greer/Hubert Wills fiasco earlier and I completely forgot to get the names of the pilots involved. (*Yours Truly, Bill Hager, and Jerry Small—BH.*)

"Top five finishers on Sunday: 1) Dub Jett, 1:16.85; 2) Red Cranfield, 1:19.44; 3) Phil Bussell, 1:20.59; 4) Bill Hager, 1:16.14; 5) Montie Montcrief, 1:16.20; 6) Clay Gary, 1:15.09; 7) Dave Layman, 1:13.81; 8) Norm Johnson, 1:14.15; 9) Randy Ritch, 1:15.29; 10) Sam Womack, 1:27.72. Fast time for the meet was a 1:10.90 turned in by Jerry Small.

"There was a lot of really good close (and tight) racing action on both days, and I can personally vouch for the quality of the food that was available. I heard nothing but praise for the condition of the field—its size and its location. I think the two quotes heard most often were, 'Y'all have the best racing facilities around,' and, 'For a grass field, it is in absolutely fantastic shape.' Those nice words made me feel kinda proud of our field and proud to have been a small part of the core of club members who come out to work this event. I got to meet some super-nice guys, see some beautiful planes doin' some really competitive racing; and besides all that, Bob Greer, I'll be a long time talking about that Sunday midair of yours!"

Take it from me, the guys put on a first-class race and the field was in great shape.

See you next month.

Caudimordax/Taib

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wing by lift that is being generated farther out from the root. Very high aspect ratio wings demand extra strength and, consequently, added weight in the spars at the root.

Each particular application will demand an aspect ratio that provides the best combination of weight and efficiency. For Caudimordax, an aspect ratio of 6:1 was chosen. This allowed for a convenient wingspan of 48 inches (Styrofoam comes in 2-ft.-wide sheets—just right for one wing panel) and a mean chord of eight inches. This allows a 10-in. root and 6-in. tip (a 60% tip/root percentage). Such a wing core is not too difficult to cut. The trailing edge is swept forward three inches, while the leading edge is swept back one inch, producing a net sweep (on the quarter-chord) of zero.

Experiments with a straight leading edge produced airplanes with unpleasant snap rolling tendencies. A swept leading edge also allows easier placement of the spars and greater lead-out sweep.

Eliminating high-speed stall. Turning an airplane too tightly causes the wing to stall. The wing is forced to produce more lift than it is capable of producing; and to produce more lift, the angle of attack must be increased.

Beyond a certain angle of attack, the airflow along the top of the wing separates from the wing's surface and becomes turbulent, causing a sudden increase in drag. Most Combat fliers adjust their controls to limit the turn radius in order to avoid stalling. Another approach is to use a thicker, blunter airfoil that stalls at higher Gs than a thin one does. The drawback to this approach, of course, is that the thicker airfoil has a greater parasitic drag and top speed is reduced accordingly.

For Caudimordax, the root section is a thick 15% and the tip an even thicker 25%. The relatively thicker tip airfoil ensures that the root will stall first in a turn, thus reducing the airplane's tendency to drop a wing tip. This tendency causes the lateral instability common to high aspect ratio Combat wings.

Longitudinal stability. An airplane that does tight, fast turns is absolutely no use if you can't make it go where you want it to go. A common problem with Combat wings is a lack of longitudinal stability. A turn, once started, will tighten up of its own accord. This makes the airplane unpointable and therefore useless in Combat. The airplane should also be able to fly straight while unattended. An unstable airplane will tend to tighten, or to wander into or out of a turn if the pilot glances away even for an instant.

A common misconception is that the stabilator (or elevator) is there only to make the airplane move up and down. If that were true, a designer could reduce the stabilator area on an airplane that's overly sensitive or unstable. Actually, the opposite is true. The stabilator provides stability by opposing the downward pitching moment produced by the wing. The larger the stabilizer, the larger the airplane's stability margin, since the stabilizer doesn't have to work as hard. Similarly, a longer tail moment increases stability by providing a longer moment arm for the stabilizer to act on.

The Spitfire was an airplane that had too small a horizontal stabilizer. The earlier marks had had a very small acceptable range for CG (center-of-gravity). When additional equipment was added aft of the acceptable range, the aircraft's stability decreased. In fact, several structural failures were traced directly to aircraft that tightened into turns due to instability.

Later in the war, when longer range fighters were needed as long-range bomber escorts, CG became an issue again. One way of extending the Spitfire's range (especially with the bigger Griffon engines that were used in later marks) was by situating additional tanks behind the pilot. Eventually, larger horizontal (and vertical) stabilizers were incorporated to allow for a more rearward center-of-gravity. In addition, the larger tail surfaces helped to control the 2,000-plus horsepower output of the big Griffon engines.

With the 12 x 3-in. stabilator shown on the plans, Caudimordax is longitudinally stable. It will fly large loops if you want it to without tightening up. If set up to do so, it will turn as tightly as needed, even to the point of stalling. Earlier versions with a 9 x 3-in. tail were not as predictable.

Construction. The center rib, tip ribs, stabilator, lead-out guide, bellcrank plate, control horn, and engine mount assembly are best cut on a scroll saw or band saw to ensure accuracy and a good fit.

Final shaping can be accomplished with a belt or disc sander. Be sure to set up all tools to cut or sand at a perfect 90° angle.

I prefer a band saw to a scroll saw. Most scroll saws don't seem to have the power to cut through maple, and vibration tends to obscure the guide marks. Band saws, by comparison, are powerful, and very smooth. They can be used for resawing balsa and pine (Have you ever worked with 1/2-in. pine for Slow fuselages?), cutting aluminum sheet, and even sawing exhaust lugs off engines. A really nice 10-in.-throat, three-wheel band saw can be obtained from Sears for little more than the cost of a Dremel scroll saw. Wait until they're on sale if you can, or get one for Christmas. Life was terrible before I got mine.

The engine mount assembly is first glued together with a very thick CyA (cyanoacrylate glue) like Special-T (What would we Combat fliers do without our super glue?). Make sure that the grain of both the balsa spacer and the 1/64 ply side plates is vertical.

The balsa spacer and 1/64 ply plates may look insubstantial, but with two dowels through the maple and center rib, I've yet to have one of these assemblies fail. Trial fit the engine, and mark and drill the holes. Each engine mount assembly must be fitted individually to its intended center block when marking and making the diagonal cuts in the maple. Remember to allow for the 1/16 ply front spar. Loose-fitting engine mount/center rib combinations can be corrected by adding 1/64 ply spacers where needed during final assembly.

The aluminum arrow-shaft tail boom can be cut to length on a band saw. The size I use is 21/64 O.D. and has .019 walls. They are marked "2117" and ought to be available from a good sporting goods store. The shafts I use are cutoffs from arrows that had been shortened, and they only cost me a quarter each. Other sizes, as well as graphite shafts (which are hard to come by in southern Indiana), will work just as well.

Use a drill press or a jig of some sort when drilling the hole in the back of the center rib. Crooked tails get laughed at. Drill bits are available in 1/64-in. increments, so finding one the right size shouldn't be a problem.

Cut the notch on the rear of the boom using the band saw. Drill two or three holes in the front inch or so as an epoxy anchor before gluing the boom and block together. Shallow notches made with the band saw will work in lieu of holes. Stuff some tissue paper into the front end of the boom to prevent the epoxy from flowing into the boom. Use slow-curing epoxy. *Make sure the notch on the back end is horizontal!*

Cutting foam cores. Most Combat construction articles will tell you to look elsewhere for foam cutting instructions. Not this one! This method for cutting foam was first developed by Doc Passen, and is the easiest method I've tried yet.

The cutting bow is assembled using 1 x 2-in. furring strip. The cutting wire is .015 braided control line. The power source must be able to supply 12-13 volts at 3-4 amps. A Variac will work, but does not come cheap; or use a car battery. Phil Cartier uses a light dimmer switch in series with a 200-watt light bulb. Write to him at The Core House (760 Waltonville Road, Hummelstown, PA 17036) for details.

Root and tip templates are made out of 1/8-in.-thick Formica. The edges must be sanded as smooth as possible. Candle wax rubbed into the edges also helps with straight cuts. Note that the centerline of the templates is 7/8 in. from the bottom. This is to compensate for the fact that foam is rarely exactly two inches thick and also for the 1/16 in. or so lost when the foam is cut.

Put the guide marks on the templates as shown on both sides as well as on the top (guiding) edge. The template patterns are at the edge of the plans to make for convenient Xeroxing. Paste the Xeroxed patterns onto the Formica.

A cutting surface is prepared by driving nails through a *flat* piece of plywood or particle board. The nails, which serve to hold the foam down flat during the cutting process, should penetrate by about one inch.

A jig should be made for cutting blanks. Two vertical templates are needed at the edge of a table, 27 in. or so apart, with enough space behind to accommodate 8-ft.-long foam sheets. If you're really into mass production, make these jigs two feet high and cut a dozen blanks at once!

Hold the layers of foam together with bamboo shish kebab skewers. These skewers are also useful for holding stacks of cut wings (in their beds) together for storage.

The templates are held in place using double-pointed pins made from 1/8-in. aluminum (or brass) welding rod. Nails with their heads cut off can also be used. This allows the templates to be removed and flipped over without removing the pins.

Foam is obtained from the local lumberyard. Ask for 2-in.-thick "bead-board." Don't ask for Styrofoam. You'll get heavy blue extruded foam, and your airplanes will fly like furniture. Cut the foam into blanks the size of the wings (10-in. root, 6-in. tip, 1-in. leading edge sweep) with the cutting bow and the aforementioned jig.

Press a blank down onto the bed of nails with the leading edge away from you, and attach the templates to the root and tip. Adjust the wire temperature so that the bow cuts without sagging in the middle. Only experience (and a few ruined cores) can teach you the right wire temperature. Holding the ends of the bow in either hand, start cutting from the leading edge back, pulling the wire towards you, and being careful to keep the wire down on the templates. The cutting speed along the root template is faster than across the tip template. Use the marks on the templates to coordinate the cut (the marks should be on the edge as well as on both sides of the templates); i.e., make sure that mark No. 1 is reached simultaneously at the root and at the tip. Note that the cutting speed is not constant at the tip. Up to and slightly behind the high point, the cutting speed is almost the same as at the root template.

Remove the airfoil templates, and replace them with the spar slot templates. Cut out the top spar slot.

Turn the wing over, keeping the leading edge away from you, and stick it onto the bed of nails together with its core bed. Flip the templates upside down, and cut the other surface.

Replace the airfoil templates with the spar slot templates, and cut the bottom spar slot. Repeat the process for the other wing panel—and voila, a set of wings!

Assembly. Drill a 1/8-in. hole for the bellcrank mounting screw. Assure that the cores will fit to their intended center rib, then cut the slot in the foam for the front spar using a long-bladed utility knife. Don't omit this front spar! It holds the entire front end of the airplane together, allowing the foam to support the wood. Only after cutting the slot do you remove foam to actually fit the core to the center block. A 1/4-in. slice of foam should be removed from each panel as far back as the center block extends. Use sandpaper wrapped around a dowel to carve a semicircular channel where the tail boom fits.

Glue the front spar to the front of the center rib with thick CyA, making sure that everything is square. Glue the inboard core to the center rib and front spar. All wood/foam joints are made with yellow wood glue (e.g., Titebond). After the glue has "grabbed," glue on the outboard core in the same manner. Again, allow the glue to grab before proceeding. Use copious amounts of masking tape to hold things together; but remember to leave some untaped gaps, or the glue will not cure. Glue in the spars, again using short lengths of masking tape.

While waiting for the wing to dry, assemble the stabilator. Glue on the 1/64 ply reinforcement, and, if using the plywood horn shown, cut out the slot on a band saw.

Cover the stabilator with your favorite covering, and install the horn.

The hinge assembly is made with two 3/16 dowels tied together with heavy stranded nylon fishing line (two strands of Cox Dacron control line will also work) in a figure-eight pattern with the ends glued down. The anchor stub for the stabilator hinge is made out of 1/8-in.-thick birch ply. The rear dowel is glued to the stabilator and the front dowel to the stub with thick CyA. These hinges are really easy to make and are reasonably strong.

After assuring that the wing is completely dry, remove the masking tape. Remove the melted styrene from the surface by lightly sanding the entire wing with 100-grit sandpaper. Brush off as much dust as you can (do this outdoors!).

Cut the slots at the tips for the shear webs. These can be scrap 1/16 balsa or scrap 1/32 ply. Make sure they are firmly glued to both spars. Glue on both tip ribs. The inboard rib is 1/8-in. Lite Ply; the outboard rib is 1/8-in. balsa.

Cut out the hole for the bladder tank. Fuelproof the inside of the hole with thinned wood glue (1:1 with water). Also brush thinned white glue onto the foam, extending it one inch on either side of the center rib.

When dry, epoxy nylon cloth over the hole. Lightweight upholstery vinyl can also be used for this purpose. Make sure the epoxied glass cloth extends at least one inch around the hole.

Use 3/4-in. filament tape for reinforcement where shown. Wrap the tape once around, and glue it to the tail boom.

Covering and finishing. At this point the wing, tail, and engine mount assembly are essentially complete. Before final assembly, cover the wing. I used to use Graphic Plastofilm, available from Triangle Hobbies. Seal Lamin is essentially the same stuff, as is GBC laminating film. You can also use Fas-Cal or Solarfilm if you have the money.

Graphic Plastofilm can be smoothed down with an iron, but don't try to shrink it afterwards with a heat gun. A strip of clear packing tape over the leading and trailing edges will prevent the covering from coming off. Iron over the tape to secure it (just like Fas-Cal). Don't cover over the center rib in front of the spars, but do cover behind the spar.

I recently switched over to a film called Clearphane. It's available in two thicknesses and six gorgeous colors. Use the one-mil-thick film in 50-ft. rolls. I get it from a crafts supply store. Dan Rutherford supposedly uses a similar film, except that his has a floral pattern. A spray adhesive (e.g., 3M 77) is sprayed onto the covering. After waiting a minute or so, iron the covering onto the foam and shrink it in the normal way.

Glue the tail assembly into the notch in the tail boom using 15-minute epoxy. Notches cut into the tail boom and stab anchor serve to lock both parts together. Make sure everything is straight.

Use very thick CyA to glue on the engine mount assembly. Loose fits can be cured by shimming with 1/64 ply. Drill two 3/16 holes through the engine mounts and center rib, and install the dowels.

Fuelproof all exposed wood with your favorite polyurethane, or simply brush on white glue.

The control system is next. Use 30-in.-long .027 braided wire for the lead-outs. Drill an extra 1/8-in. hole into a Sig bellcrank in the top hollow of the "S," between the "S" and the "I" in "SIG."

I use a piece of 1/8-in. aluminum welding rod for the pushrod. Bicycle spokes also make good pushrods. Bend the pushrod as shown on the plans. The pushrod should lie close to the tail boom so that braces can be used to prevent flexing. The braces are made out of short pieces of outer Nyrod taped to the tail boom. Slip them onto the pushrod before bending. Make the final bend at the control horn end accurately.

If the lead-outs are the same length, the stabilator is set at neutral when both lead-out ends are held together, and all your line sets have lines of the same length, you will never have to adjust your handle again. Test the pushrod by pulling on the *down* lead-out while trying to push the stabilator *up*.

Modifying the Brat .28. The inexpensive Brat .28 (the Polk Bluebird .28 is the same engine) makes an excellent lightweight Combat engine. In its final form, it weighs no more than 6.75 oz.—scarcely more than some H.15s. It costs far less than similar engines (O.S. Max .25 FSR and .28 F, SuperTigre

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S29, Magnum .28 FSR, Royal .28). It seems to be as well made as my .25 FSRs and a far cry from earlier Taiwanese engines. Its light weight is partially due to its AAC piston and liner.

As the Brat was originally intended for RC sport flying, its induction timing is quite conservative. For Combat use, it is necessary to retime the induction port and replace the RC carburetor with a large-diameter intake stack (also known as, but not really, a venturi). It also helps to trim off all excess weight.

The head fins don't contribute very much to cooling and get in the way when changing glow plugs. The fins can be ground off before disassembling the engine. Remove the glow plug, and plug the hole with pieces of paper toweling. Also, plug up the air intake and exhaust. Grind off the fins using a disc or belt sander, leaving the last 3/32 in. or so intact. Wash off all the filings with detergent and water before removing the paper towel plugs.

Disassemble the engine. The cylinder liner fits very tightly in the case and must be removed carefully. Don't remove the bearings.

Stuff the case with paper toweling before grinding off the muffler lugs. Make sure to stuff some toweling down the exhaust port. A disc or belt sander is a good way to start. A file can be used in the more inaccessible places. A stone on a Dremel tool also works, but it will clog and needs constant dressing. Wash the filings off with detergent and water before pulling out the paper toweling. With care, none of the filings will enter the engine. To

OFFICIAL AMA SAFETY CODE—January 1, 1991

Model Flying Must Be In Accordance With This Code In Order For AMA Liability Protection To Apply

GENERAL

1. I will not fly my model aircraft in competition or in the presence of spectators until it has been proven to be airworthy by having been previously, successfully flight tested.

2. I will not fly my model higher than approximately 400 feet within 3 miles of an airport without notifying the airport operator. I will give right-of-way to, and avoid flying in the proximity of full-scale aircraft. Where necessary, an observer shall be utilized to supervise flying to avoid having models fly in the proximity of full-scale aircraft.

3. Where established, I will abide by the safety rules for the flying site I use, and I will not willfully and deliberately fly my models in a careless, reckless, and/or dangerous manner.

4. If my model weighs over 20 pounds, I will only fly it in accordance with paragraph 5 of this section of the AMA Safety Code.

5. At air shows or model flying demonstrations a single straight line must be established, one side of which is for flying, with the other side for spectators. Only those persons essential to the flight operations are to be permitted on the flying side of the line; all others must be on the spectator side. Flying over the spectator side of the line is prohibited, unless beyond the control of the pilot(s). The only exceptions which may be permitted to the single straight line requirement, under special circumstances involving consideration of site conditions and model size, weight, speed and power, must be jointly approved by the AMA President and the Executive Director. The maximum permissible takeoff weight of models is 55 lbs.

6. I will not fly my model unless it is identified with my name and address or AMA number, on or in the model. Note: This does not apply to models flown indoors.

7. I will not operate models with metal-bladed propellers or with gaseous boosts, in which gases other than air at normal atmospheric pressure enter their internal combustion engine(s); nor will I operate models with extremely hazardous fuels such as those containing tetranitromethane or hydrazine.

8. I will not operate models with pyrotechnics (any device that explodes, burns or propels a projectile of any kind) including, but not limited to, rockets, explosive bombs dropped from models, smoke bombs, all explosive gases (such as hydrogen-filled balloons), ground mounted devices launching a projectile. The only exceptions permitted are rockets flown in accordance with the Safety Code of the National Association of Rocketry or those permanently attached (as per JATO use); also those items authorized for Air Show Team use as defined by AST Advisory Committee (document available from AMA HQ). Note: A model aircraft is defined as an aircraft with or without engine, not able to carry a human being.

9. I will not fly any model using turbojet power (axial or centrifugal flow) unless I have obtained a special waiver for such specific flights from the AMA President and Executive Director and I will abide by any restrictions imposed on such flights by them. (Note: This does not apply to ducted fan models using piston engines or electric motors.)

RADIO CONTROL

1. I will have completed a successful radio equipment ground range check before the first flight of a new or repaired model.

2. I will not fly my model aircraft in the presence of spectators until I become a qualified flier, unless assisted by an experienced helper.

3. I will perform my initial turn after takeoff away from the pit or spectator areas, and I will not thereafter fly over pit or spectator areas, unless beyond my control.

4. I will operate my model using only radio control frequencies currently allowed by the Federal Communications Commission. (Only properly licensed Amateurs are authorized to operate equipment on Amateur Band frequencies.) Further, any transmitters that I use at a sanctioned event must have a certified R/CMA-AMA gold sticker affixed indicating that it was manufactured or modified for operation at a 20kHz frequency separation (except 27MHz and 53MHz).

FREE FLIGHT

1. I will not launch my model aircraft unless at least 100 feet downwind of spectators and automobile parking.

2. I will not fly my model unless the launch area is clear of all persons except my mechanic and officials.

3. I will employ the use of an adequate device in flight to extinguish any fuses on the model after it has completed its function.

CONTROL LINE

1. I will subject my complete control system (including safety thong, where applicable) to an inspection and pull test prior to flying.

2. I will assure that my flying area is safely clear of all utility wires or poles.

3. I will assure that my flying area is safely clear of all non-essential participants and spectators before permitting my engine to be started.

make sure, wash out the case thoroughly. An old toothbrush helps. Thoroughly dry, and then oil the bearings.

As stated earlier, the intake port on the crankshaft must be opened up to increase the angle at which it remains open.

Before retiming the crank, scratch the timing diagram shown on the plans onto a piece of transparent, rigid plastic using a scribe. Thin Plexiglas should work well.

Insert the crankshaft into the case. Slipping on the drive washer and the prop nut will help hold the shaft in the proper position.

Holding the engine nose down, lay the timing diagram onto the rear of the engine. Line up the cross hairs with the bottom of the mounting lugs and the mold flashing on the centerline of the engine.

Referring to figure 1A, rotate the shaft until the middle of the crankpin lines up with the opening line. While holding the crankshaft in this position, insert a hard metal scribe through the intake stack and make a mark on the crank. Use the bottom edge on the *left* (looking from the rear) side of the intake port in the crankcase as a guide. If you've set this up correctly, the port should be totally closed off by the shaft while doing this.

Do likewise for the closing side of the intake port, referring to figure 1B. This time, make the mark on the *right* side of the port.

The intake stack can be made from ½-in.-O.D. aluminum, nylon or brass tubing. The wall thickness should be 1/32 to 1/16 in. Wrap Teflon tape around the tube to ensure a good seal. If you intend to use a remote needle, drill and tap for a 6-32 Du-Bro pressure fitting ⅛ in. above where the stack slips into the case.

The remote needle is made from an O.S. RC needle valve assembly. It is mounted on the engine bearers using a nylon control horn and 2-56 sheet metal screws.

Wash all engine parts using hot water and dishwashing detergent. Dry off the parts using paper toweling. Oil all the parts with WD-40 or Break-Free, and reassemble the engine.

Flying. Caudimordax flies best with the CG in line with the spars, using about four or five pennies for tip weight (approximately 13-16 grams). Attach a streamer for all test flying. Line rake is usually set at maximum (the two rearmost holes in the lead-out guide).

The Brats seem to like 7 x 6 Taipan props. I use 25% Red Max fuel with half castor and half synthetic oil. The back-flipping chicken-stick technique described by Charlie Johnson in his Combat column seems to work best for quick starts.

When flying an airplane for the first time, check for warps. Fly level upright, and note whether either wing appears to be flying high. If the outboard wing is higher than the inboard one, very carefully flip the airplane onto its back. If the outboard wing flies low, you have a warp. If it still flies high, add tip weight. If the outboard wing flies low when upright and high when inverted, you have a warp the other way. Don't do tight turns with a warped airplane. Take it home, and use a heat gun to shrink the covering where needed to eliminate the warp.

When flying against a faster opponent, use Caudimordax's superior turning radius to your advantage. Follow your opponent through the turns; the advantage in level speed is negated. I have actually been able to fly up others' tail pipes on occasion. Always be on the lookout for a leading edge kill. When your opponent makes a pass at your streamer, more often than not it sets him up to overshoot, and that's when the leading edge kill can be accomplished.

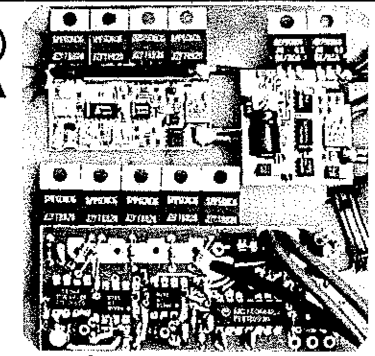
The name Caudimordax (Doc Passen calls it "Quasimodo") comes from Tolkien's book *Farmer Giles of Ham.* Naming Combat designs after weapons named in Tolkien's better known book *Lord of the Rings* is an old tradition in Combat circles: Orcrist and Anduril were English FAI designs, for instance. Glamdring, Guthwine and Aeglos are still up for grabs, while Sting would make a good name for a ½A. Anglachel, though, wouldn't be appropriate for an airplane you hope will not fly in at you!

Caudimordax, however, is uniquely appropriate for a Combat airplane. The sword was also known, "in the vulgar tongue," as Tailbiter. It had the habit of leaping out of its sheath whenever a dragon was near. The tradition at the time was for knights to kill dragons, cut off their tails, and serve them as a delicacy at court. The sword was given to Farmer Giles, who put it to good use.

Further development. As with all Combat designs, Caudimordax is anything but static. Combat designs evolve faster than most due to the high rate of destruction. Don't be afraid to try out different airfoils, different tail moments, different construction techniques, Perryman tips, "Ford Taurus" styling (as in Steve Hills' Arrowplane). If you won't, I will.

You can even stick a Fox .36 on the nose (but, please, use at least ¾-in.-thick wood for the center block and ¾ x ⅜-in. maple for the engine mounts). Even if you never build a Caudimordax, this article (and others) ought to give you a few ideas on how to improve another design, or design your own.

Nearly all the construction techniques used in this airplane were filched from others, and I'd like to thank them, too, for their ideas used in this design: Terry "Doc" Passen (foam cutting and engine retiming techniques, tail hinge, bellcrank mount and pushrod), Phil Cartier (arrow-shaft tail boom techniques, bladder compartment, the idea of using smaller engines in the first place), and Richard Wilkens (front spar and foam cutting bow).



CL Scale/Boss

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Ontario, Canada. CL Scale was judged on June 30th and flown on July 1st.

Mike reports a disappointing CL Scale entry of only five. Two were Canadians, while the other three were from the U.S. It's surprising that more of our U.S. modelers from the north central area of the country weren't on hand for this competition. The contest site is about three hours from Buffalo, NY, about two hours from Detroit, MI, and well within a day's drive of several north central states. *Continued on page 178*