



CADSPORT

**If You Have Been Thinking About Getting Into Giant Scale,
Here's A Good Ship To Get Started With!**

By David Doehlen

**CAD, CAM, CIM,
the buzz words of the late 80's.**

Cadsport was conceived as a way of learning how to use AutoCad® and an opportunity to design my own airplane. I am a firm believer that you learn by doing. An excellent way of learning is to have a specific purpose in mind rather than just doing exercises. Designing my own R/C airplane was something that I wanted to

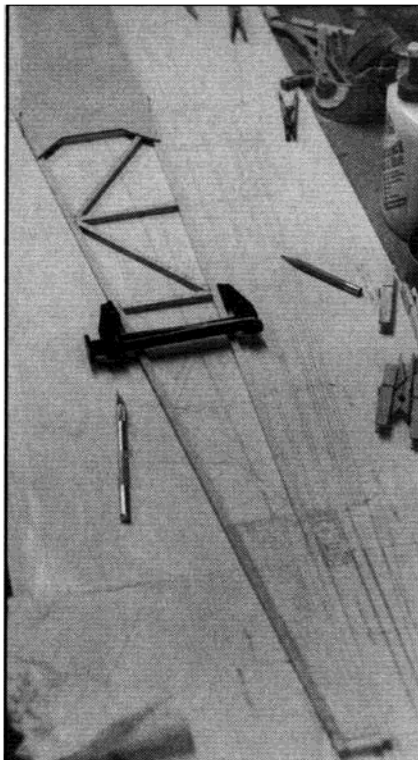
try as well as learning how to use a CAD program. The result was Cadsport.

I've scratch-built several .40 size planes without too much difficulty. The "Giant Size" planes are impressive and reported to be easier to fly. So the decision evolved to design a giant size sport plane.

Light planes are supposed to fly better, so open frame construction was used on the fuselage. Built-up balsa construction was

used for the wings rather than fiberglassed balsa sheeted foam in order to save weight. Strength verses weight is the battle designers have waged since the Wright Brothers. Ample spruce spars are used in the wings and for the fuselage longerons. The empennage features both sheeted and ladder-type construction. Since the elevator servos are located in the tail, the tail construction had to be light but not to the point of sacrificing

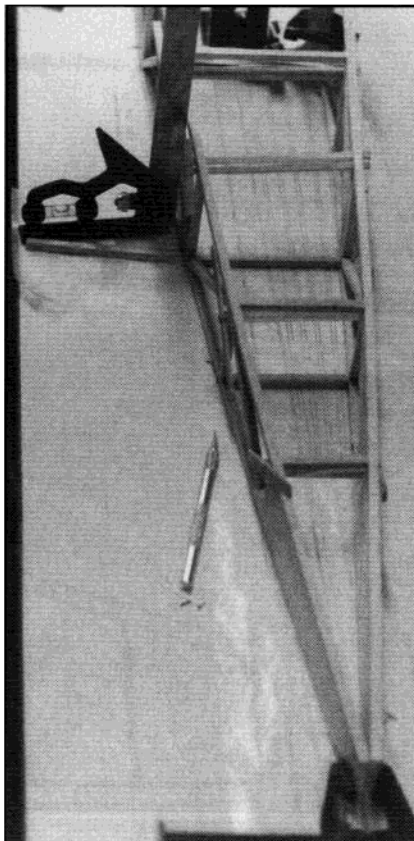




Build the fuselage sides on the plans. Note fuselage ply doubler has been installed.

strength. The stab is sheathed with 1/16" balsa over balsa spars. The rest of the tail surfaces are ladder construction, 1/16" balsa sheet with half thickness spars and ribs on each side. This makes for a very strong yet lightweight member.

The design started with the wing. Rectangular constant chord wings are fine for trainer-type aircraft, but are not aesthetically pleasing. Tapered wings look like they belong on airplanes. A P-51 surely would not look right with barn door wings! There are numerous design guidelines for model aircraft, aspect ratio (wingspan to chord), weight per sq. ft., fuselage length to wingspan, stab area to wing area, aileron area to wing area, etc. Most of CadSport's design values fall in the middle of the recommended range. The major exception is the fin. Fin size has increased in recent times. Compare the



After installing fuselage formers, install top and bottom cross members in sequence forming curved sides.

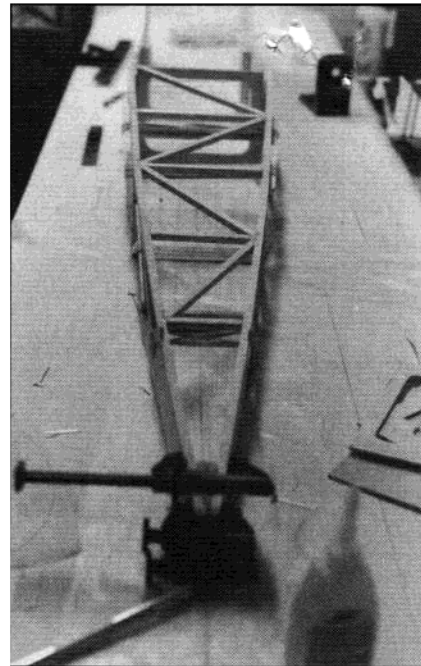
fin on a P-40 or Spitfire to a P-51's fin. Then look at the tail feathers on the current crop of high performance aerobatic aircraft like the CAP 21, Extras, TR 260, Super Chipmunk, Sukhoi, and the Ultimate.

Some general construction notes might be helpful before starting. I made most of the parts by sticking the part drawing on the wood with Scotch® 377, roughly cutting out the part and then sanding to final shape. When two identical parts, such as the wing ribs are required, they were tacked together with #377 and the part drawing stuck on top.

CONSTRUCTION

Fuselage:

Begin by splicing two pieces of 1/4"



After installing balsa diagonals on the bottom, the tail filler is glued into place.

square spruce for the top longeron. Don't butt splice this. Taper the splice at 30° to increase the gluing surface area. Pin this down on the plans. Add the three 1/4" balsa fillers from the fire wall back (watch the direction of the grain). Then install the 1/4" balsa wing filler. The bottom longeron can now be glued to the wing filler. The 1/4" sq. vertical and diagonal braces can now be installed.

Take care to accurately match the joints! The more wood to wood contact, the stronger the joint will be. After installing the filler at the tail, add the plywood fuselage doubler. The fuselage can now be assembled upside down on the top/bottom view on the plans. After installing formers F-2 to F-6, the sides are bent into an arc by installing the cross braces from F-6 to the tail in sequence. Install the diagonal braces, wing bolt plate, bottom sheeting, and fillers to complete the bottom. Flip the fuselage over and add the top pieces; turtledeck formers F-6A to F-10A, turtledeck stringers, cockpit, and cowl sheeting to

CADSPORT

Designed by:

David Doehler

TYPE AIRCRAFT

Sport

WINGSPAN

89-5/8 Inches

WING CHORD

14 Inches (Avg.)

TOTAL WING AREA

1250 Sq. In.

WING LOCATION

Low Wing

AIRFOIL

Symmetrical (15%)

WING PLANFORM

Double Tapered

DIHEDRAL, EACH TIP

2-1/8 Inches

OVERALL FUSELAGE LENGTH

62-1/2 Inches

RADIO COMPARTMENT SIZE

Ample

STABILIZER SPAN

30 Inches

STABILIZER CHORD (inc. elev.)

10-1/2 Inches (Avg.)

STABILIZER AREA

302 Sq. In.

STAB AIRFOIL SECTION

Flat

STABILIZER LOCATION

Top Of Fuselage

VERTICAL FIN HEIGHT

13 Inches

VERTICAL FIN WIDTH (inc. rud.)

10 Inches (Avg.)

REC. ENGINE SIZE

2.0-3.0 Cu. In.

FUEL TANK SIZE

16 Oz.

LANDING GEAR

Conventional

REC. NO. OF CHANNELS

4

CONTROL FUNCTIONS

Rud., Elev., Throt., Ail.

C.G. (from L.E.)

4-7/16 Inches (At Fuselage)

ELEVATOR THROWS

3/4" Up — 3/4" Down

AILERON THROWS

11/16" Up — 5/16" Down

RUDDER THROWS

1-3/16" Left — 1-3/16" Right

SIDETHRUST

1-1/2 Degrees

DOWNTHRUST/UPTHRUST

N/A

BASIC MATERIALS USED IN CONSTRUCTION

Fuselage Spruce, Plywood, Balsa

Wing Spruce, Balsa, Plywood

Empennage Balsa

Wt. Ready To Fly . . . 308 Oz. (19 Lbs. 4 Oz.)

Wing Loading 35-1/2 Oz./Sq. Ft.

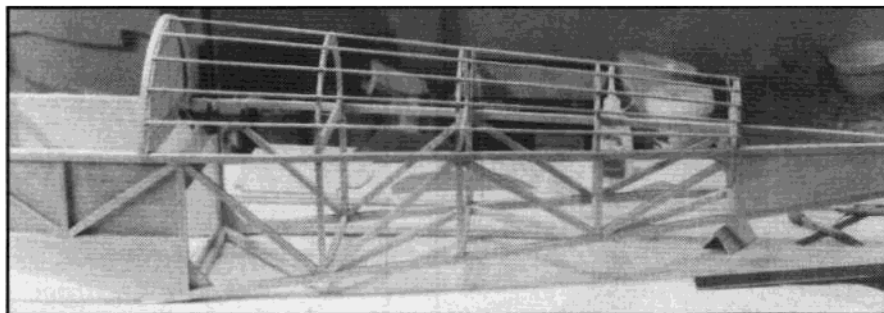
complete the top. F-1 is about the last item to install on the fuselage, prior to building and fitting the cowl in place.

Empennage:

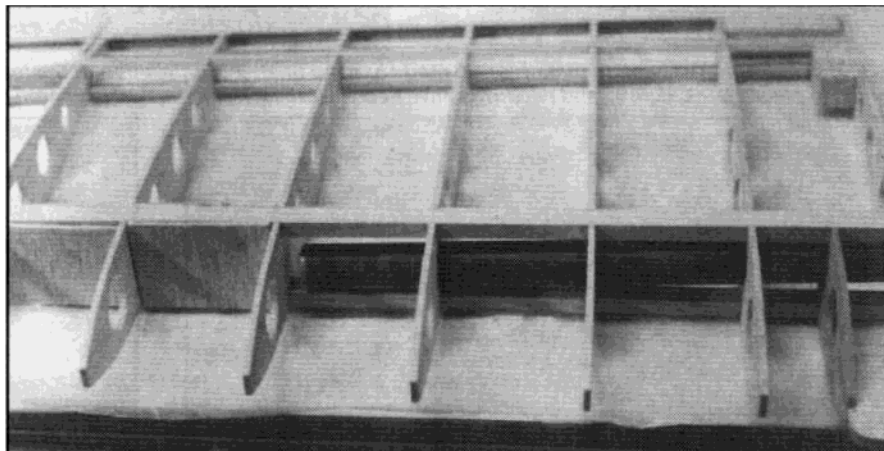
The horizontal stabilizer is built-up using hollow core sheeted construction. Spars and ribs are 5/16" thick and the sheeting is 1/16" balsa. Tack glue your 1/16" balsa sheets together with #377 and cut them to the outline on the plans. Separate the sheets and glue on the spars and ribs. There are centerline tics on the drawing to align the ribs. Add the top sheet and sand the leading edges round. The vertical fin assembly is built-up using 1/16" balsa sheet as the core, with ribs and spars added on each side. Again, cut one 1/16" sheet to the outline of the fin. Pin the sheet to the plans. Glue the 3/16" spars and ribs in place as indicated on the plans. Tic marks are on the plans outside of the outline to line up the centerline of the ribs. Flip the assembly over and glue the second half of the ribs, spars, and filler blocks to the other side. Round the edges and you're about ready to cover. The rudder and elevators are constructed in a similar manner.

Wing:

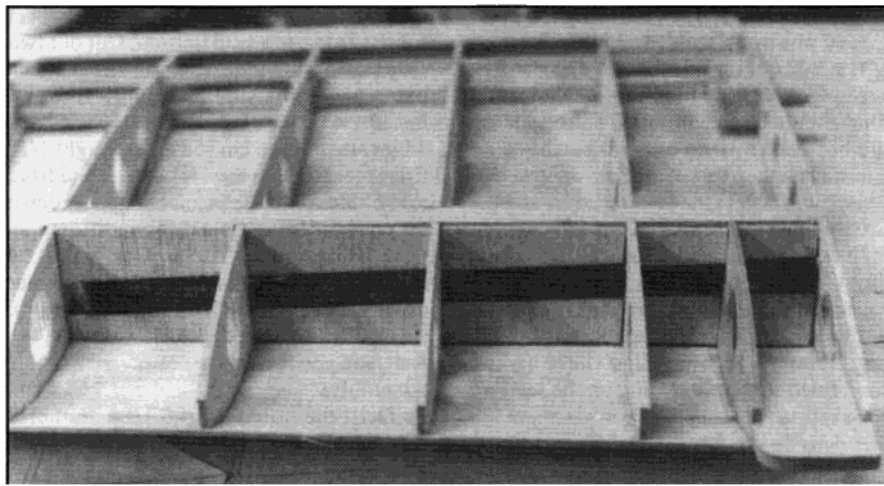
Built-up balsa/spruce construction was used instead of sheeted foam for two reasons. Built-up balsa is lighter and stronger. After cutting out all the ribs, identify each rib in the upper portion. The right wing is constructed upright and the left is constructed upside down. Even though the airfoil is symmetrical, the first four ribs must be installed correctly, up for the right, down for the left, in order for the wing joiner tube to fit properly and produce dihedral. Make the rib alignment jig from 1/4" x 3/4" x 48" balsa as noted on the plans. This or a wing jig is necessary in order to build a straight wing with tapered ribs. After pinning down the main spruce spar and the alignment jig, the ribs can be glued to the bottom spar. Use the angle template for the first rib. This assures a close fit between the wing halves. Add the top main spar and the back 1/4" square spruce spar. Epoxy the phenolic wing joiner tube to the ribs. Glue the shear webs to the main spars. The top



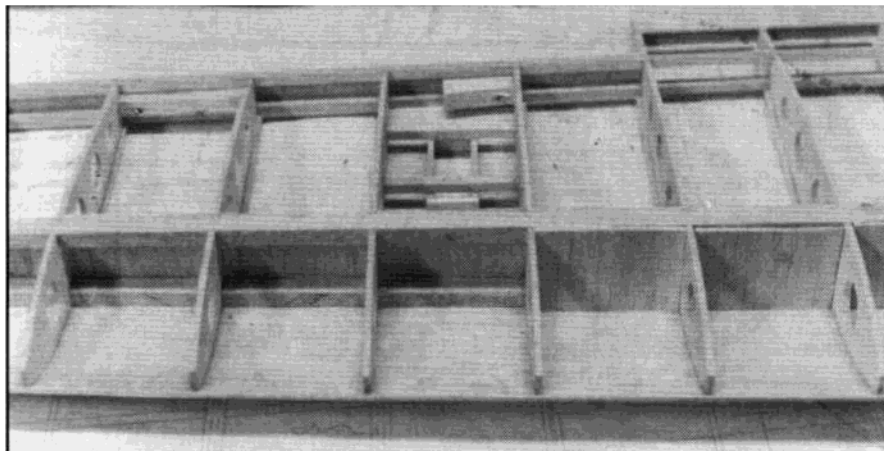
Turtledeck formers and 1/8" dowel stringers make it begin to look like a fuselage.



Wing joiner socket installed. Note: Tube is not parallel to main spars due to the dihedral of the wings. Shear webs have been installed up to socket.



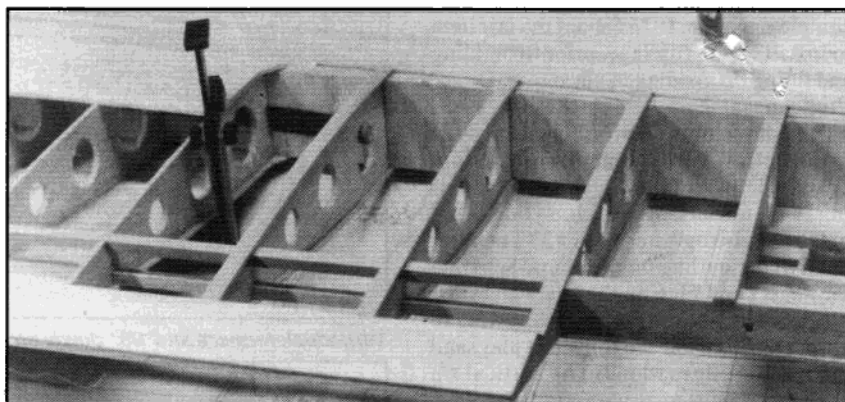
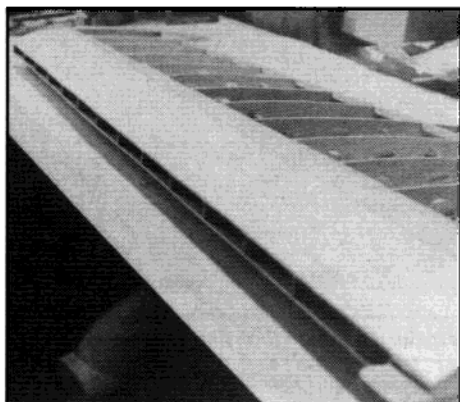
Joiner tube shear webs epoxied in, bottom sheeting in place ready to install the top leading edge, trailing edge, center sheeting, and rib capstrips.



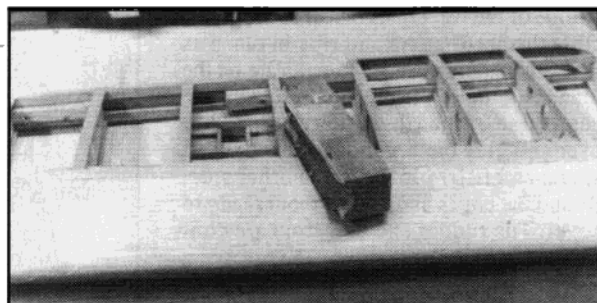
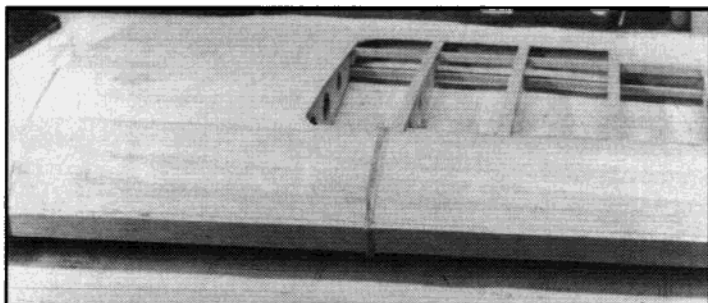
Servo mount has been installed. Note: This is the right wing right side up. The aileron has been removed and the wing framed out in that area.

CADSPORT MATERIAL LIST

- 4 — 1/2" x 3/8" x 48" spruce, main spar
- 4 — 1/4" x 1/4" x 48" spruce, rear spar
- 5 — 1/4" x 1/4" x 36" spruce, longeron
- 12 — 3/32" x 3/8" x 36" balsa, capstrips
- 2 — 1/8" x 1/2" x 48" balsa T.E., trailing edge
- 5 — 1/4" x 1/4" x 36" balsa, fuselage vertical & diagonal
- 3 — 1/4" x 3/4" x 48" balsa, leading edge & jig
- 2 — 1/8" x 12" x 24" birch ply, fuselage formers
- 1 — 1/4" x 6" x 12" birch ply, fuselage formers
- 5 — 3/32" x 3" x 36" balsa, center sec. sheeting
- 8 — 3/32" x 3" x 48" balsa, wing sheeting
- 4 — 1/8" x 3" x 36" balsa, wing shear webs
- 7 — 1/8" x 4" x 36" balsa, wing ribs
- 2 — 1/4" x 3" x 36" balsa, fuselage filler
- 6 — 1/16" x 3" x 36" balsa, tail
- 2 — 1/16" x 4" x 36" balsa, tail
- 1 — 5/16" x 3" x 36" balsa, tail
- 3 — 1/8" x 3/16" x 36" balsa, tail
- 3 — 1/8" x 5/16" x 36" balsa, tail
- 2 — 5/16" x 1/2" x 36" balsa, tail
- 4 — 3/16" x 1/2" x 36" balsa, tail



LEFT: Leading edge sheeting installed and ready to sand flush for installation of the leading edge. **RIGHT:** Top center sheeting being glued in place after L.E., T.E., and capstrips have been installed. Note: Framed in aileron cut out.



LEFT: The large wing requires innovative clamping. Number 64 rubber bands hold the leading edge in place for gluing. **RIGHT:** A concave sanding block and a little elbow grease finish off the 1/4" x 3/4" leading edge.

leading and trailing edge sheeting can now be glued in place. Turn the wing over and install the rear spar, and glue formed 1/8" x 1/2" trailing edge in place on the T.E. sheeting. The wing bolt reinforcement and filler should also be installed before adding the bottom trailing edge sheeting. The aileron can then be cut out, the aileron ribs trimmed to accept the leading edge, and the tip ribs added. The aileron cut-out opening in the wing can also be finished up at this time. The rest of the fillers, reinforcements, capstrips, and leading edge sheeting can all be done now. Leave the leading edge to the last. Trim the leading edge sheeting and sand flush to the ribs. Glue on the leading edge and sand to shape.

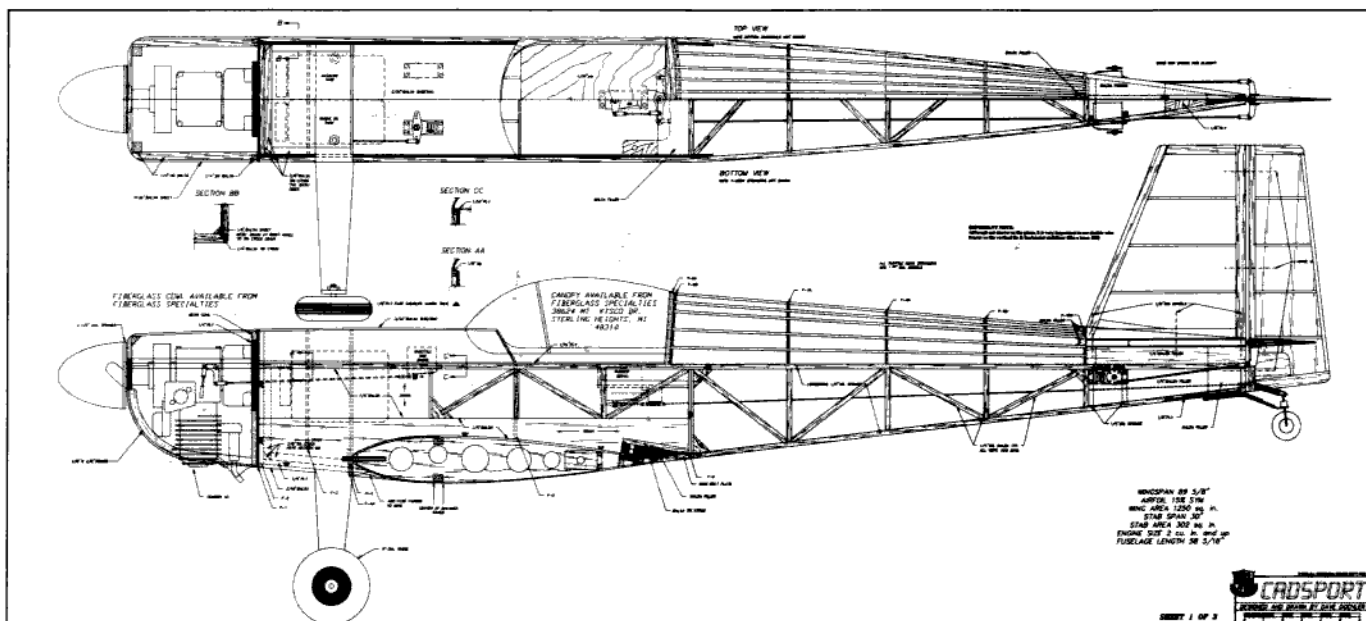
Cowl:

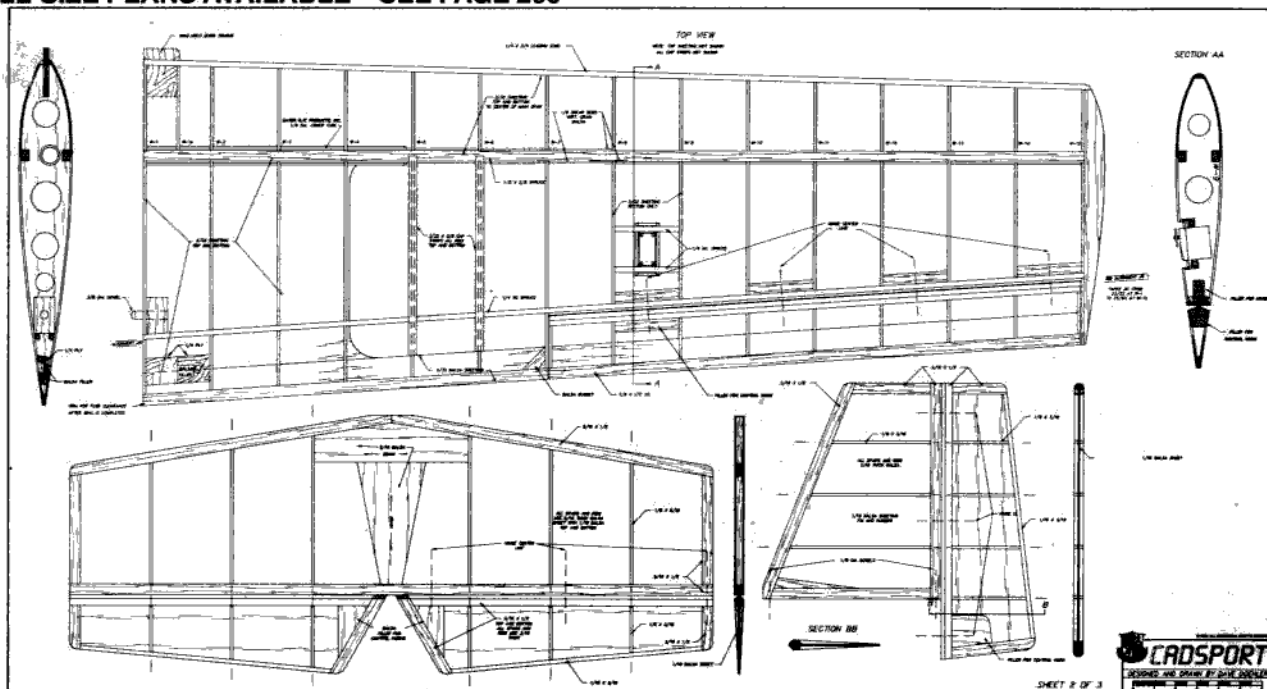
The cowl is made with 3/32" balsa sheet for the sides, top, and bottom. Cut out two sides using the side view on sheet 1 as a pattern. Cut the side at the split line and install 1/4" square balsa on the top and back edges. Install the curved and straight 1/2" filler pieces. Glue the 1/4" balsa cowl front to the sides with the assembly upside down on your building board. The bottom can now be sheeted. The top is made by installing 3/32" balsa to the front and rear cowl pieces made from the patterns on sheet 4. Round the edges, screw it to the fire wall, and you're ready to cover.

Assembly:

Drill the holes for the 1/8" diameter

dowels in the stab and fin. Align the stab to the fuselage and drill the dowel holes into the fuselage. Glue the stab to the fuselage using the dowels to locate it. Install the fin by epoxying in the 1/8" dowels from the fuselage, through the stab, to the fin. Add the tail filler pieces. Join the wings and fit to the fuselage. You may have to trim the inside bottom of F-4 to get a proper fit to the wing tongue. Align the wing to the centerline of the fuselage. Mark the bolt hole location on the fuselage wing hold-down plate using the bolt holes in the wing. Drill and tap the wing hold-down plates for hold-down bolts. The wing fairing can now be installed on the bottom. The servos and radio gear should be fitted and set up. After





covering, the engine can be installed. The original installation used well nuts through the fire wall to secure the engine and provide some vibration isolation. Final balancing after covering was achieved by moving the location of the battery pack.

Flying:

I set the initial control surface throws, per Dave Patrick's recommendations at 8°-10° on the elevator, 6°-8° on the ailerons, and 20°-25° for the rudder. These throws do not produce fun-fly maneuvers, but smooth graceful loops and rolls that require full throw on the joy sticks.

The first test was to start the engine after

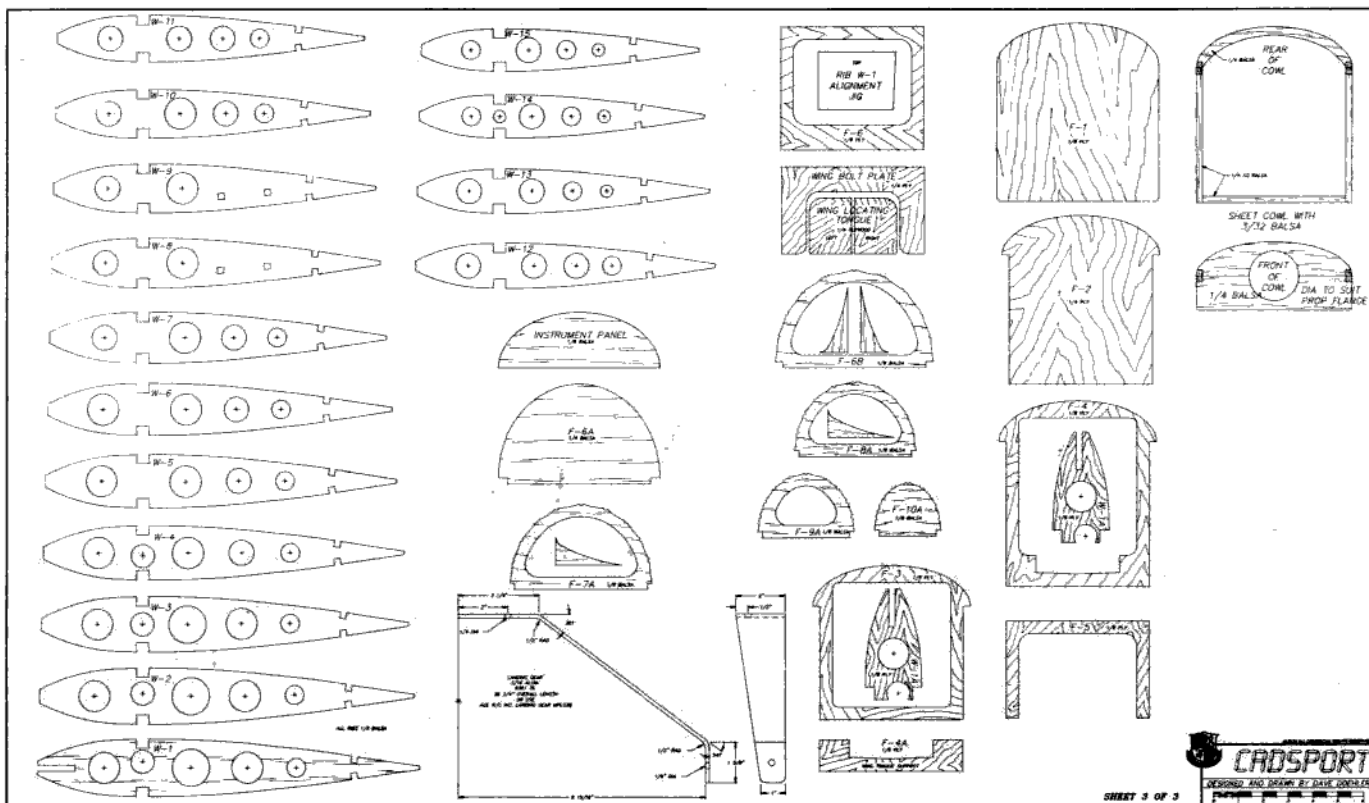
it had been installed inverted. After some fiddling around, the engine started and was run in the backyard. This test run showed up loose muffler bolts. The second test was taxiing at the flying field. After some trouble

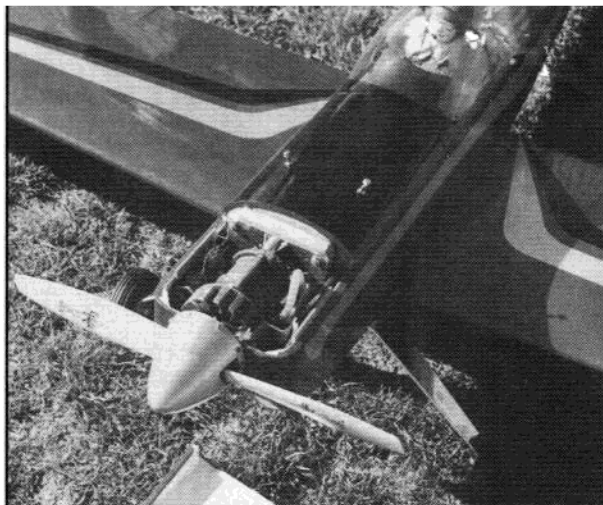
"The second test was taxiing at the flying field... On several occasions the tail came up and the plane actually got about a foot off the runway. Cadspport really wants to get into the air."

starting the engine, the ground handling was completely checked out while chasing gophers around the field. The ground handling was good with typical taildragger

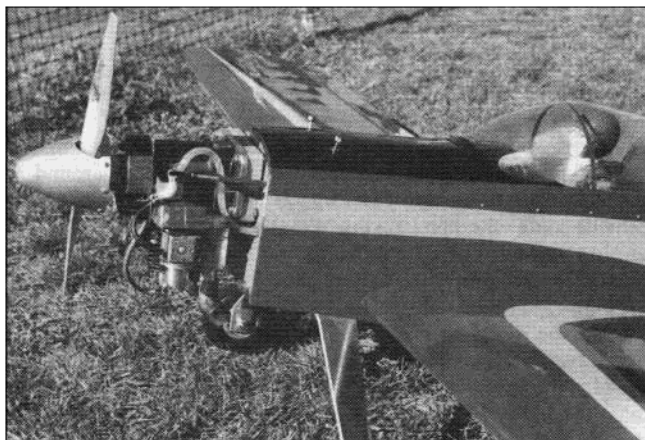
characteristics of the tail wanting to swing around. However, the rudder was more than adequate to offset engine torque. On several occasions the tail came up and the plane actually got about a foot off the runway. Cadspport really wants to get into the air.

After a week of rain and windy weather, the day arrived. Light variable winds and warm, partially sunny weather mandated the maiden flight! After loading up the family van, the drive to the field was 15-minutes of doubting questions. Did I calculate the aileron area correctly or is it half of what it should be? Is the stab area the right proportion to the wing area? Is 7° of dihedral





LEFT: Full cowl in place. The split joint for removing just the top is visible. RIGHT: Top of the cowl removed by removing screws on each side that screw into the lower cowl. The two fittings on top of the fuselage are vents for the gas and smoke oil tanks.



LEFT: By removing four screws in the lower cowl, it can be removed by lowering it around the exhaust pipe extensions. The magneto has been replaced by computerized battery ignition on the left side of the engine. RIGHT: The cowl is totally removed without touching the spinner and prop. The engine is mounted to the fire wall with well nuts and spaced from the fire wall by a piece of 3/4" pine. The carburetor side of the engine gets crowded with throttle linkage, fuel tubing to the carb, and impulse tubing to the smoke oil pump.

enough for stable flight or is it too much for inverted flight? With all these doubts swirling around in my head, I arrived at the field.

Assembly at the field is quick. Slip the wing together, put it close to the fuselage, connect the aileron servo leads, and install the two wing bolts. Preflight the controls, fuel it up, start the engine, and it was ready to taxi out. Smooth, even application of the throttle while applying right rudder is a must. The tail comes up quickly, so wait a little and build up speed before pulling back on the elevator. Once airborne Cadspart climbs with authority. The prototype was powered by a Magnum II 2.5 cu. in. gas

burning 2-stroke. The first flight was far better than my wildest fantasies. It was smooth and stable. By the fourth flight of the day, loops, rolls, split S's, stall turns, vertical rolls, and Immelmans were all tried with confidence and completed successfully.

All my landings are approached with anxiety, and Cadspart did not help. Even when the approaches were close to what they are supposed to be, the plane would get into ground effect and would not touchdown. The engine idle speed may have been too high to allow the plane to slow down enough to drop through ground effect. One bounce-and-go aborted landing impressed the pilot spectators

enough to cause them to applaud. On the fourth landing, I pushed the throttle trim all the way down before touchdown and managed to keep the plane inside the boundaries of our field. What a day! Cadspart performed every maneuver that I wanted, smoothly and effortlessly. Rolls looked better without elevator correction. Vertical rolls held to hanging the plane on the prop, and then kicking the rudder over to a stall turn. What more could you want on the first flights? Adjust the idle speed down, set up the smoke system, and Cadspart is ready for the next sunny day at the field, and so is the designer/builder/pilot!



LEFT: Prior to first flights, Cadspart looks ready to go. Magnum II engine has been exposed to help with starting. RIGHT: The author on the sticks trying to bring Cadspart in close so photographer John Gavasso can get a shot of a slow fly by.