Dornier Do 335

Building Guide

The finished Do 335

Plans by Al Masters
Short Kit by Gary Hethcoat

Aviation Research
P.O. Box 9192, San Jose, CA 95129 USA
Email: gary.hethcoat@gmail.com
Phone: 408-660-0943

Al Masters has designed and built nine different Do 335s over a period of 35 years. You might say he has a thing for this plane! I've always been fascinated by it as well. When he stopped offering his Do 335 designs in 2002, I took up the mantle because I couldn't stand seeing one of the great R/C designs vanish into the history books!

The Monogram Book on the Do 335

Monogram "Monograph" #2 on the Do 335, it is without a doubt the definitive work on the 335. It contains the most comprehensive coverage to date, including many color photographs of the restoration of #102 VG+PH, which is the ID I chose for my Do 335.

Title: *Dornier 335 Arrow, Monogram Monarch - 2*
Authors: Smith, Creek and Hitchcock

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Monogram Aviation Publications
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USA

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The cost is about USD $50. It is 8.5 x 11 inches, hardbound.

Development History

The Do 335 was the fastest production piston-engined fighter of the war -- 472 MPH at 21,000 feet. Its push-pull twin engine layout wasn't new, but this was the first time it was developed to its full potential. Had it not been eclipsed by turbojet powered aircraft, it could have set a new standard for the design and performance of piston-engined fighters.

The unusual tandem-engined layout of the Pfeil was first patented by Dr. Claude Dornier in 1937, but it was not until the end of 1942 that permission was given to build the first prototype. Perfecting the Pfeil proved to be a long and laborious task and was probably delayed by the skepticism of authorities toward its unusual design. Overheating in the rear engine was but one of the early development problems. The small production run included 3 versions--a single-seat fighter (335A-1); a 2-seat night fighter (335A-6); and "heavy" fighter (335B- series). Toward the end of the war, a night fighter was also produced. Take-off weight was 21,160 pounds, a little less than P-38's 21,600 pounds. First production version A-1 appeared in late 1944, but the course of the war prevented further development.

Let's get started!

Some general notes:

Construction Sequence You can begin with either the fuselage or the wing. The areas of interface between the two should be kept in mind, however. You won't be able to position W1 precisely, for example, until the fuselage is framed up and (F10) is in place.

Landing gear: Be careful in the selection of retracts. The length of the landing gear legs should be planned carefully to achieve the proper 'sit' of the model on the ground. You want it as close to flying attitude as possible. A nose-down sit will make it hard to get off the ground on take-off. A nose-up attitude may make it want to fly prematurely. This may sound like basic stuff, but it is easy to get lost in the complexities of this model and forget the basics.

Engines: We chose to install four stroke engines in our Do 335. The main reason for doing this was for scale-like sound. This was only partially achieved since the rear propeller makes a whining sound due to its close proximity to the elevators' rear edge. The Do 335 sounds very different from other twin four strokes that we've heard. It's quite possible that the full size Do 335 also made a similar sound.

We've heard that it might be possible to mount an engine midships and use an extension shaft to the rear propellor. We've never seen this successfully done, but it might be possible if a flexible shaft were used and the engine placed low in the rear fuse so it could get cooling air from the rear scoop. I'm told such flexible shafts are available and used in R/C boats. If some enterprising soul attempts this, we would like to hear the results. It would definitely make for a lighter, better flying Do 335.

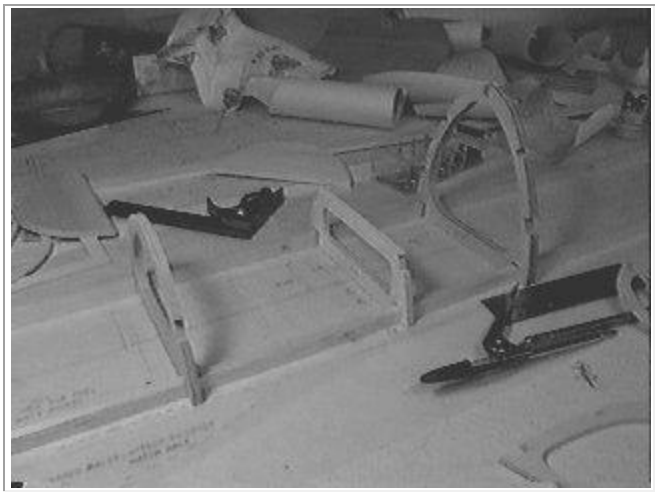
General: Save *all* parts cutouts. You may want some of them to be partially or fully filled in later.

Construction Details

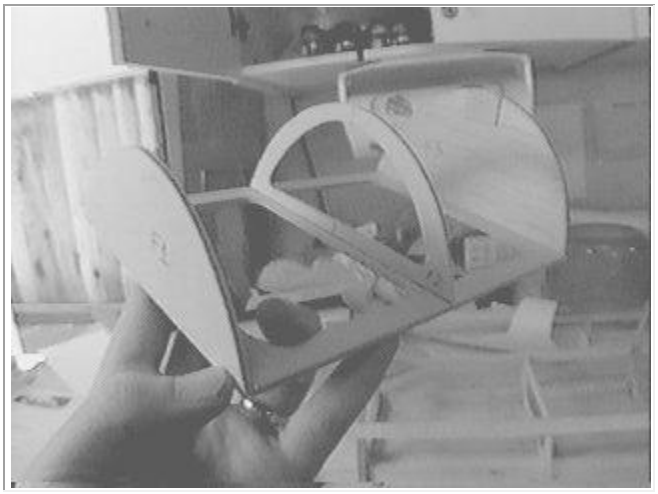
The photos here are of the 70" Do 335. The differences between it and the 81" version are very minor.

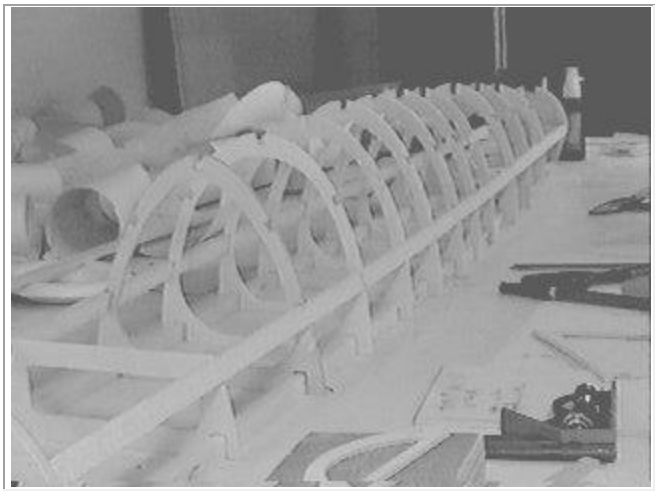
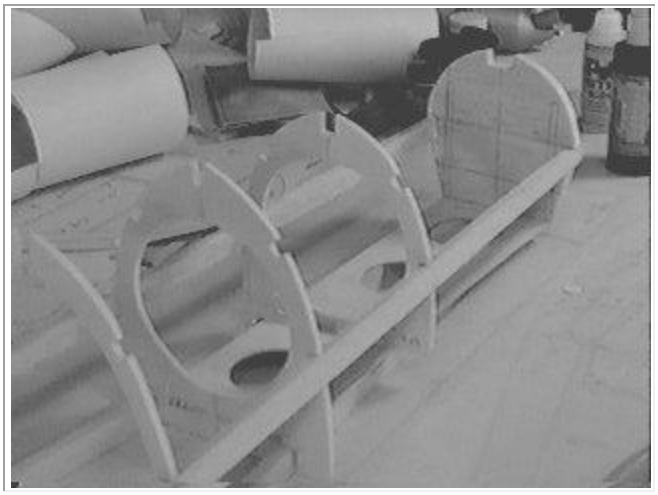
Fuselage Construction, Part I

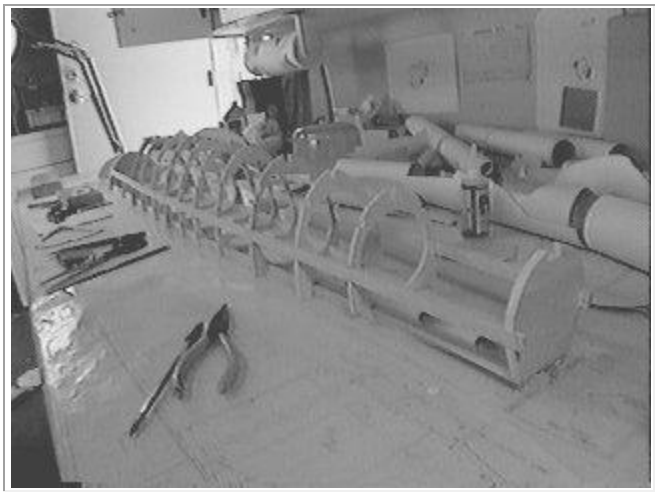
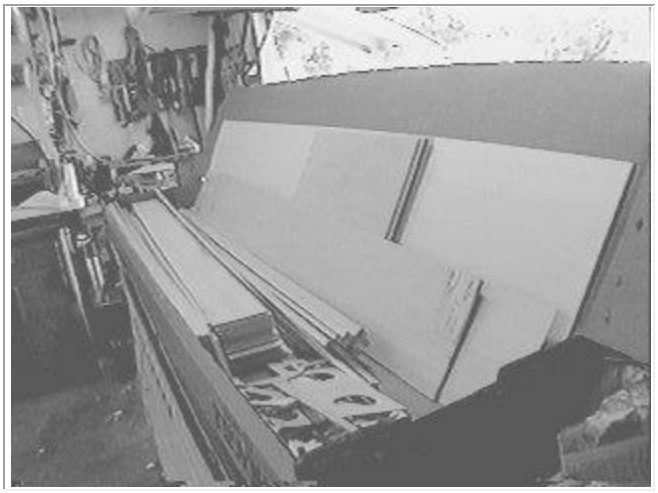
We'll start with the fuselage, moving from the firewall to the tail. The first thing we do is pin the 1/4 x 1/2 crutch down over the plans.

	Here is the crutch pinned down, with a few formers test-fitted on top. The crutch serves as a guide when placing the formers, it ensures that the fuselage is built with straight and true alignment. We will build the top half of the fuse over the crutch, partially sheet it, then remove it from the building board.

The Forward Fuselage Hatch

	Here is the framework for the upper fuselage hatch. This will house the receiver and battery. It butts up against the firewall in front and the removable canopy section in the rear. This is the view of it from the front. Former F1 is at left and F3 is at the right.
	This is the hatch from the rear. Note the 1/16 ply doublers. These will hold the blind nuts for the hatch hold-down screws.

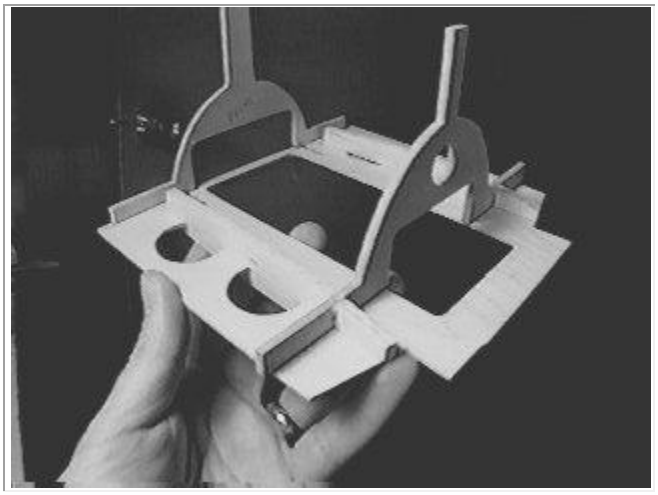
	Here is the hatch in place on the crutch. All the upper fuselage formers are now in place, as are the first two stringers (1/2 x 3/16).
	The rear part of the fuselage showing the formers and stringers.
	The rear fuselage. The tail will go between the last two formers at the right (F19 & F20). The rear firewall will be glued to the rear of F20. The 1/16" platform resting on the crutch (with the three round holes cut into it) is the rear tank support.

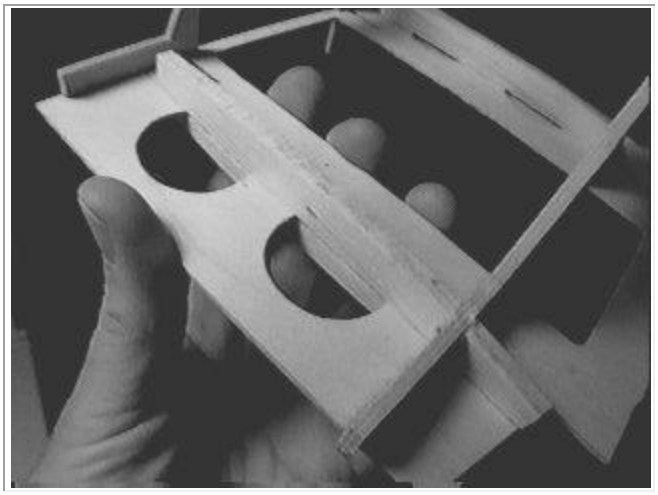
	The upper fuselage, view from the rear. Now we're getting somewhere!
	We acquired stick and sheet from Superior Balsa & Hobby Supply. We've had nothing but good experiences ordering from them.

Removable Upper Tail Section

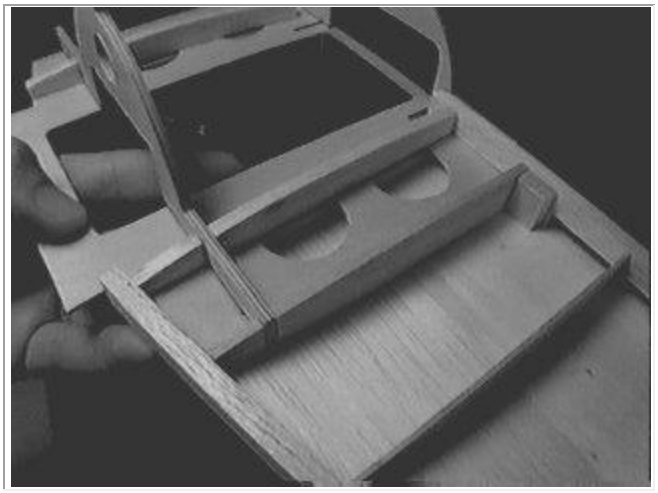
At this point in the project, I visited the Paul E. Garber Facility of the NASM and saw the last remaining *real* Do 335 in the world.

The Tail Section

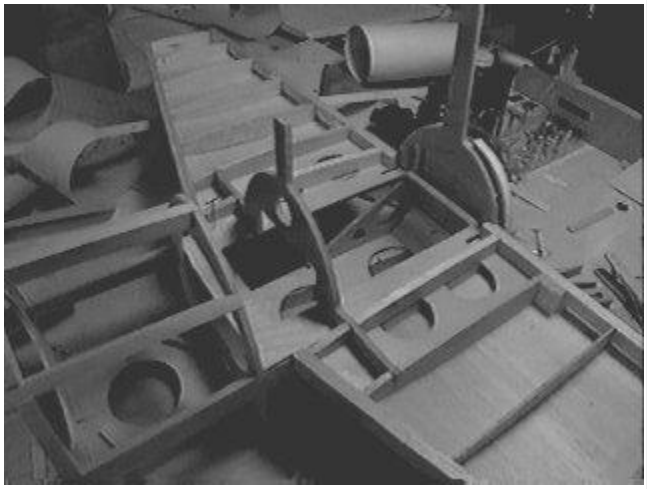
	This is the right half of the stab, top-side facing up. It was framed up on the building board upside-down, then the bottom was sheeted. You can see the notch for F19B can be seen on rib #2. The leading edge and spar were shimmed up from the building board to get the proper rib position.
	The finished upper-tail center section. The three sections of rib #1 are glued directly to the 1/16" ply plate, and to the upper tail post and F19B.



Here is a closeup of rib #1 glued to the center section.

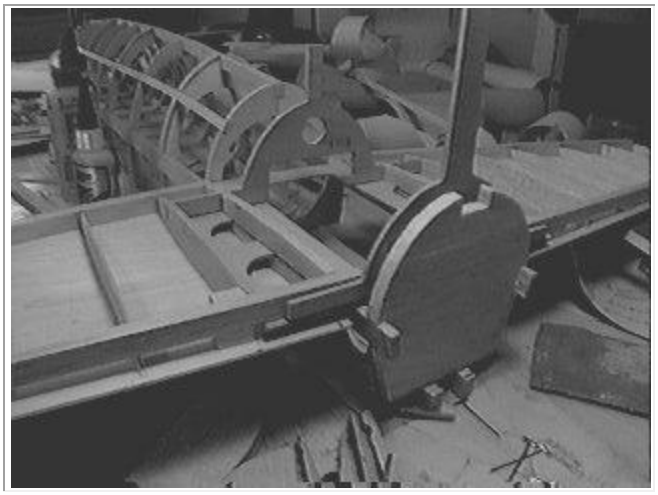
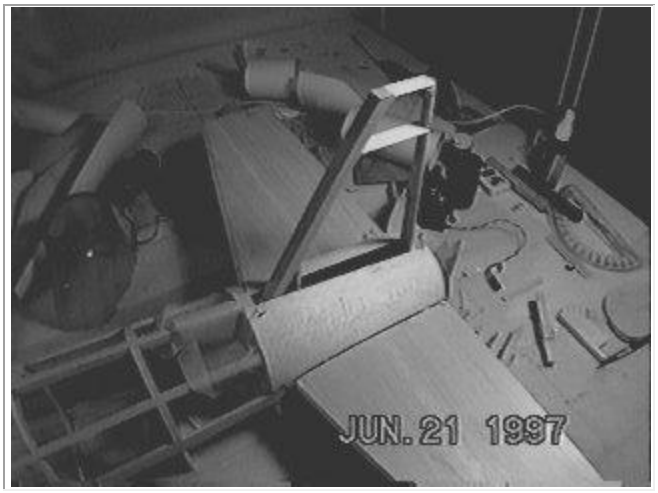
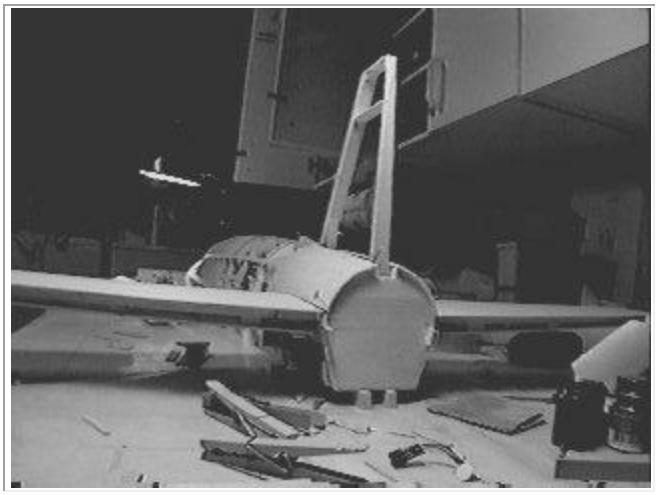


Here is the left stab attached to the center section. Note how F19B fits into the notch in rib #2 and the rear spar fits against the plate.



Here is the whole assembly set in place on the rear fuselage. Now the final alignment is done. I had to shim up the right saddle 1/16". The stab halves needed to be held in the correct position while the top sheeting was glued on. They tended to warp after being glued to the center section. I used some blocks underneath the tip of each one, then shimmed the leading edge to get the proper incidence. Once the top sheeting is glued on the stabs become rigid.

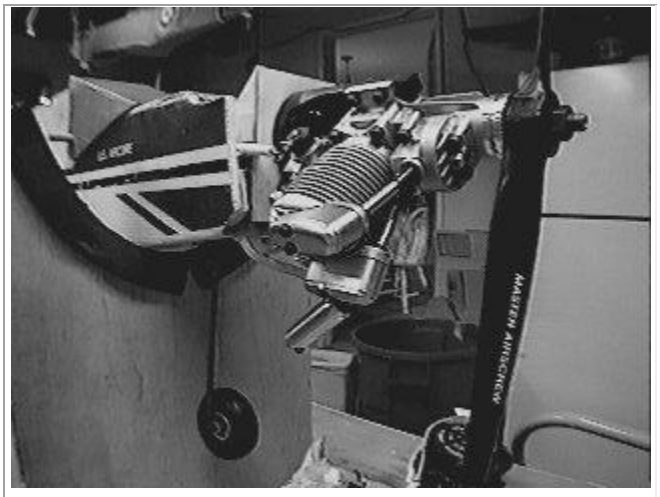
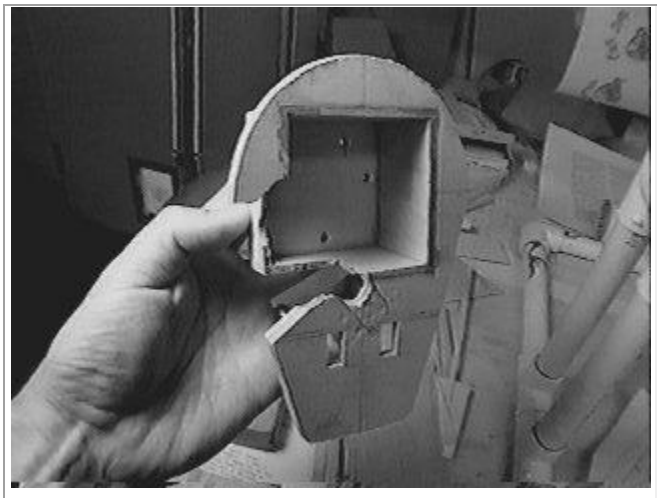
The stab may come out with a slight amount of dihedral. The drawings of the full size Do 335 seem to show some slight dihedral in the stab.

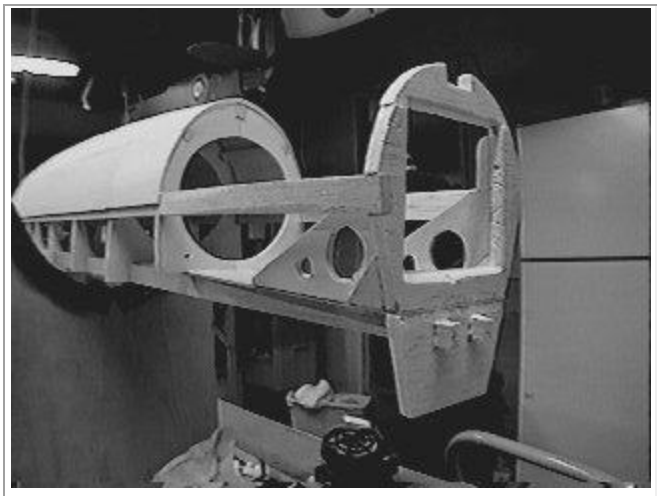
	The assembly viewed from the rear. You can see how the rear spar, the upper fin post, and the rear stab spar fit together here. Actually, the rear spar and side-tab of the fin post did not quite come together. I put a piece of 1/20" balsa in between to fill the gap.
	Now the stab is sheeted and the fin construction is underway. The 1/8" sheeting on the curved fuselage-part is also glued in place.
	The tail assembly from the rear. Note that the sheeting is not glued to F20, which is the rear fuse former visible in this view. The aft firewall will be glued directly to F20 after the fuse is removed from the building board.

Fuselage, Part II

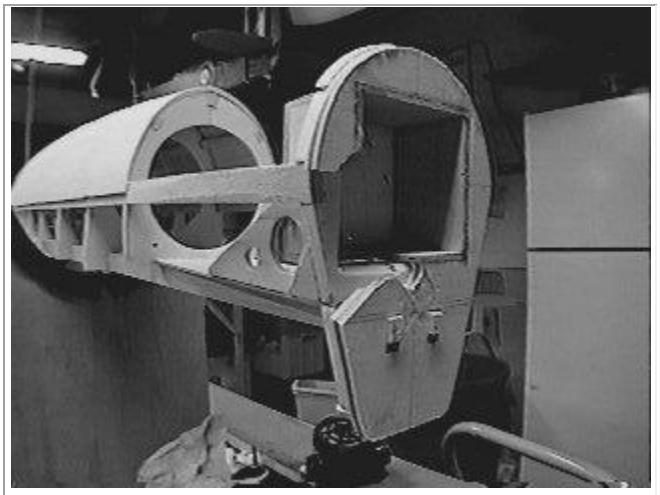
It's starting to look like an airplane now. We decided to use four strokes in our Do 335. For those of you who have never heard twin four strokes in flight, let me tell you, it is a religious experience! The first time for us was when a club member built a P-38 powered by two OS .46 Surpass engines. The sound that thing made on a low pass, it was enough to make your heart skip a beat! We chose to put a Saito .90 in the nose and a Saito .50 in the tail.

FOUR STROKES!!!

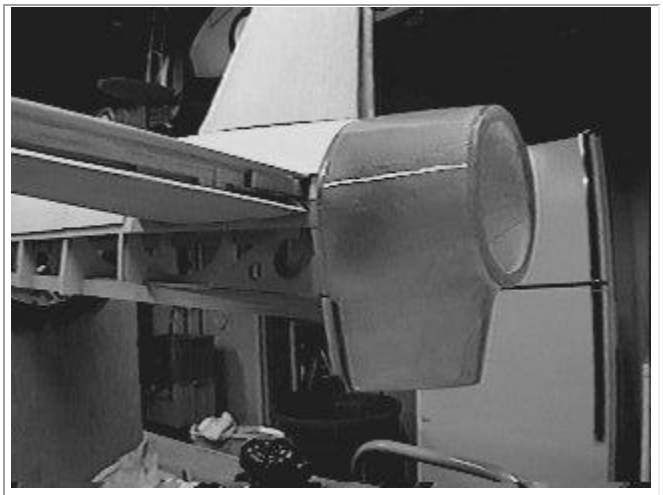
	The Saito .50 mounted on our testbed plane, a US Aircore .40. We broke it in that way, flying it in the same orientation it will be mounted in the Do 335. Concerns about whether it would need on-board glow turned out to be unfounded. It ran fine as-is.
	This is the rear firewall, modified to accept the Saito .50. One thing is clear, the plane will be heavier! The engines are heavier, the supporting structures are heavier, and some workarounds will also cause extra weight.



The modified tail section, with a hole cut into F20 to accept the backset firewall, which *just* fits between the firewall braces. Note the protruding ends of the crutch.

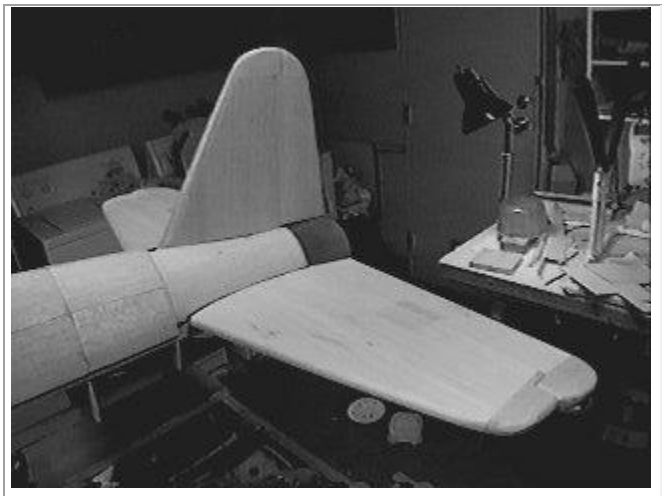


The new firewall in place. Notice that alot of F20 and the left firewall brace will have to be cut away. We were a bit concerned about this but it turned out OK.



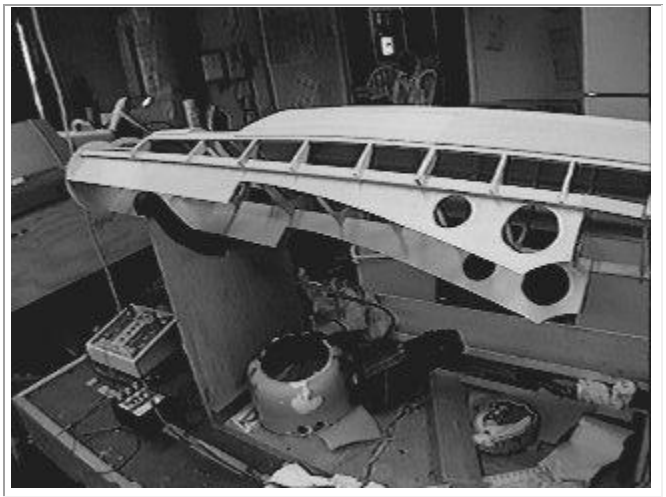
The rear cowl in place. Trimming and fitting it turned out to be pretty easy.

The Tail Section is Finished

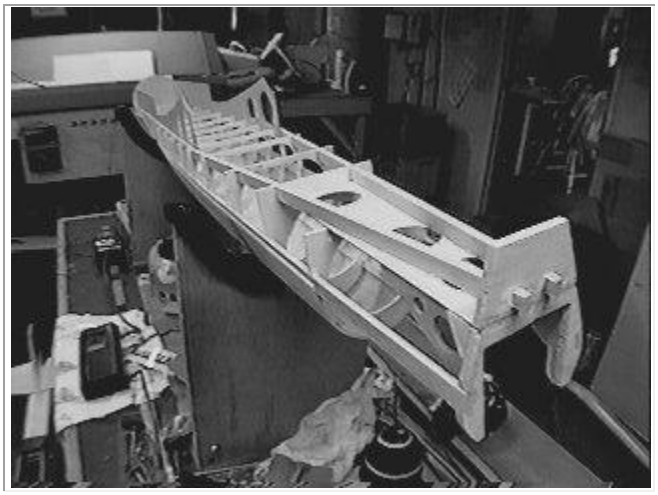
	The completed tail section with rear cowl in place.
	The tail section from the rear. It's starting to look like something!

The Fuselage Comes off the Building Board

With the 1/8" sheeting in place on the upper fuse, it can be removed from the building board. Once off the building board, the 1/16" ply lower stiffners are glued into the slots between the formers and the crutch. The lower formers will now be glued over these frames. The forward firewall is just temporarily set in place, I haven't glued it yet. It will have to have a backset firewall like the rear engine to accept the Saito .90.

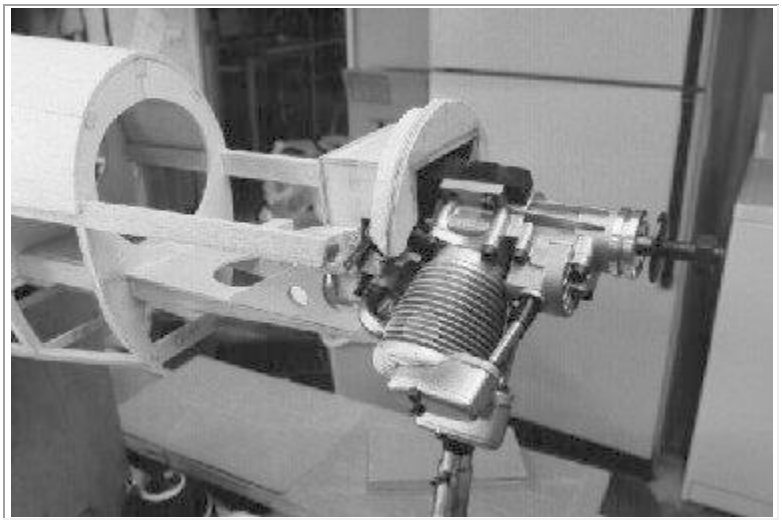


A better view of the 1/16" ply stiffners.

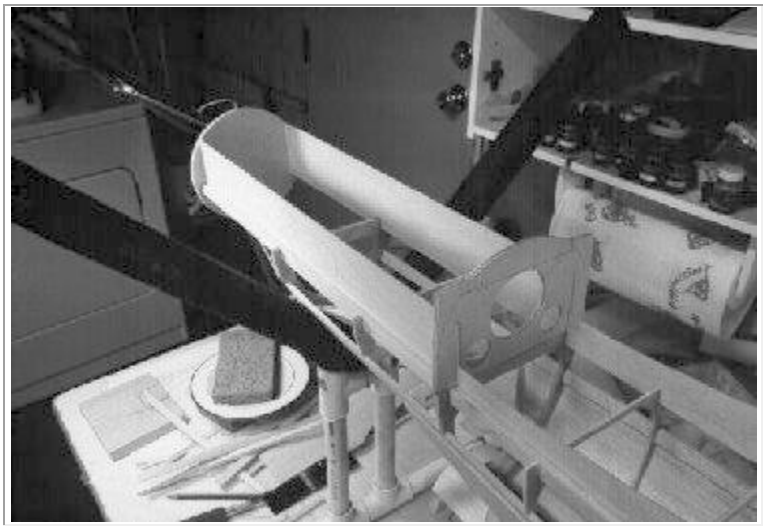


Here's a view we couldn't see before - the bottom of the upper fuselage.

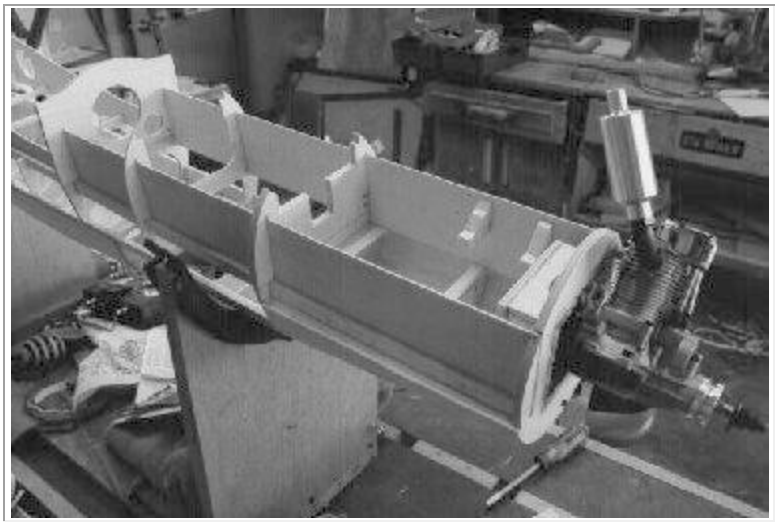
Fuselage, Part III



Here is the rear engine (Saito .50 in this case) mounted in the rear firewall. This is a non-standard installation. You can see that alot of structure had to be cut away to clear the carburetor area.

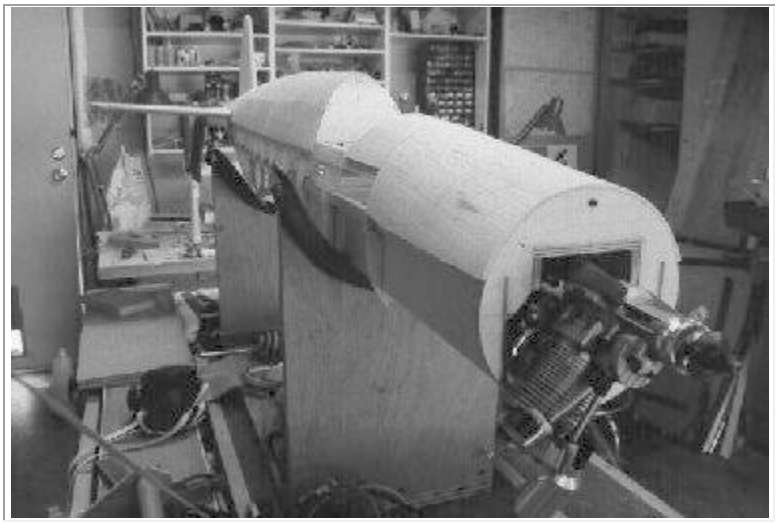


Here is the lower forward fuse with F1, (F10) and the 1/16 ply lower fuse frames.



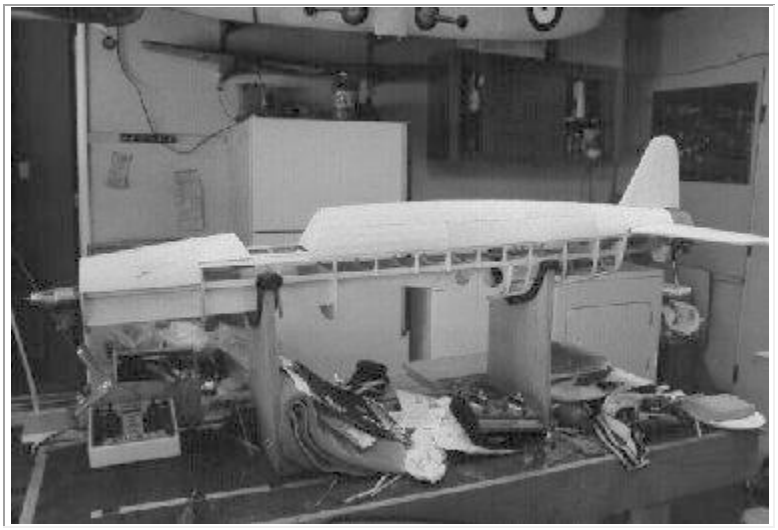
Here is the same area with (F4) and (F8) installed. The former numbers with parenthesis, by the way, are the lower halves of these formers, so for example, F4 is the upper part, (F4) is the lower part below the crutch.

Note also in this picture the mounting blocks for the throttle servo.

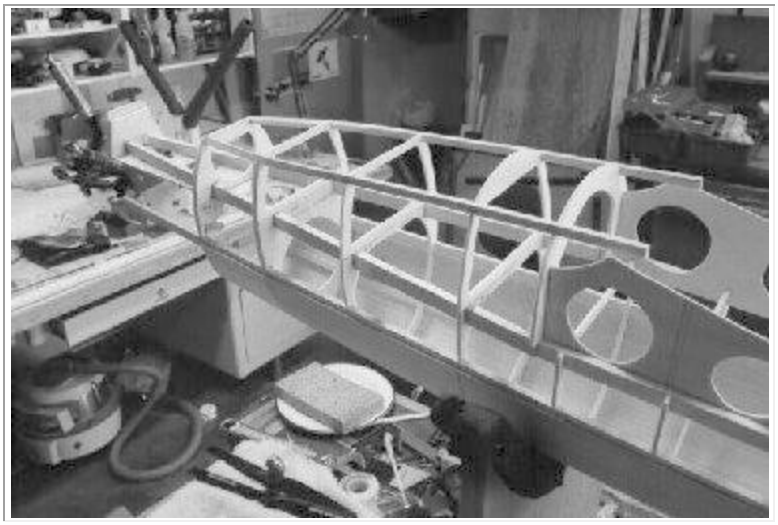


Upper front fuselage. Note the .010 styrene sheet plastic on the rear cockpit bulkhead. I'm using this in the cockpit area to prevent having to fill the woodgrain when finishing this area.

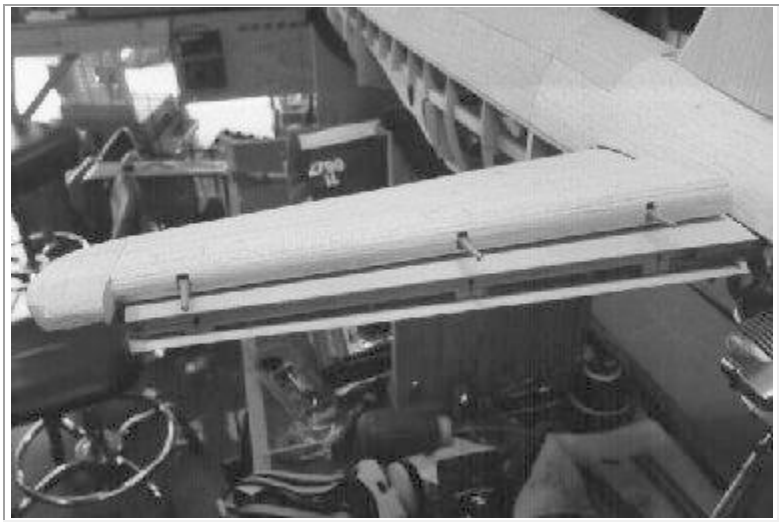
Note also here the completed front hatch. It is held on with two 4-40 screws front and back.



Overall view of the fuse with both engines mounted.



Close-up of the lower rear fuse with all lower formers and stringers in place. It's best not to go much further with this area until the wing is ready for mounting.

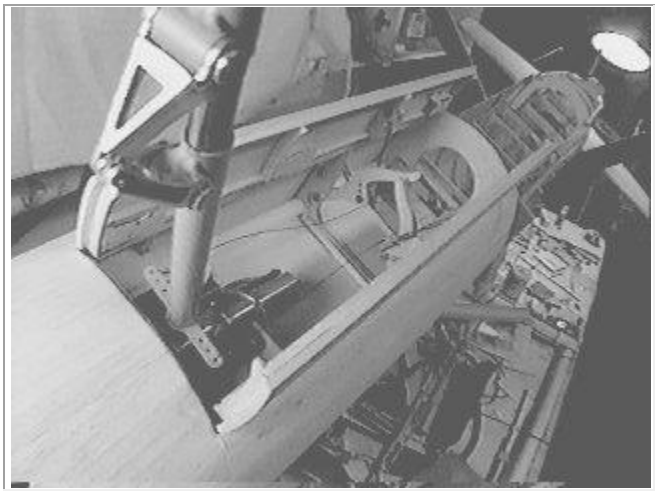


Shown here is an optional scale-type hinge, as apposed to the more standard bevel type called for in the plans. It achieves a much better look and scale operation. It really isn't all that much work either. Robart hinge-points are used throughout.

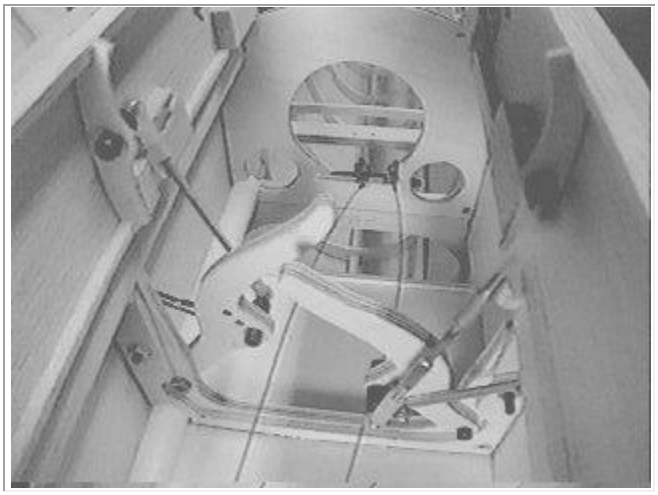
Nosegear Installation

Here's the forward fuse with nosegear installed.

Used here is a Robart 640 series steerable nosegear unit with a 7/16" diameter forked strut. The nosegear retracts through an angle of 105 degrees, which is 10 degrees less than the scale retraction angle of 110 degrees. I special ordered it from Robart and it took forever for them to get it to me (about 8 weeks) but I'm very pleased with the product. We also used 640 series retracts for the mains, 85 degree, straight struts.



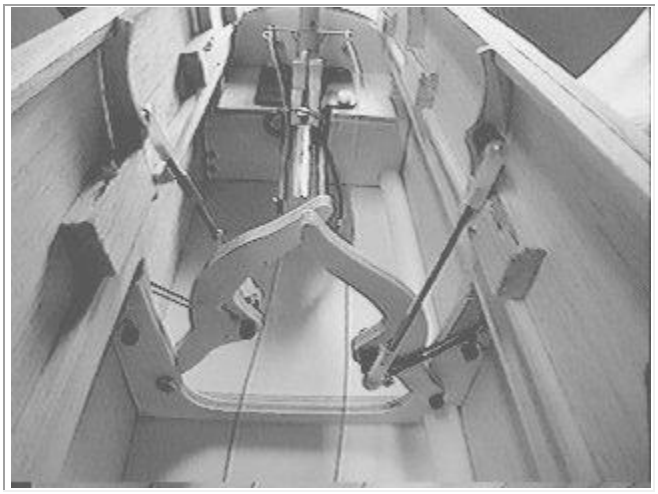
Here is the nosegear well. You can see the steering arms and air cylinder. The nosegear doors are attached with 4 Klett hinges. A piece of music wire is pushed through all 4 hinges, making for a nice crisp action.



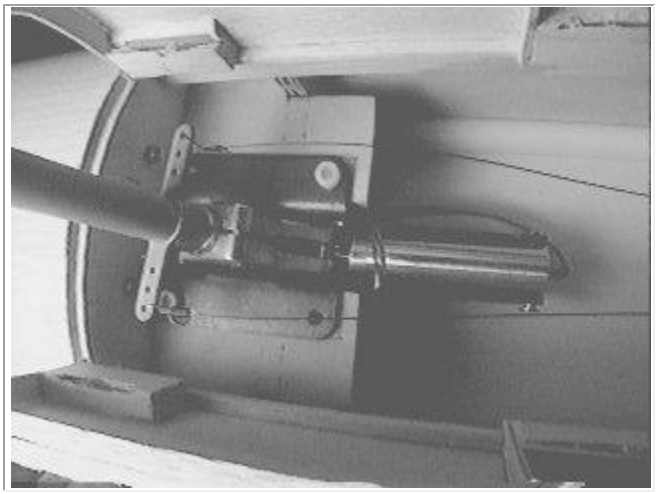
Here is a closeup of the door actuation mechanism from the front. F10 is visible in the background.

I had to rework the actuators, the ones on the plans were too short to catch the strut on the way down. Note the rubber bands that hold the doors in the open position.

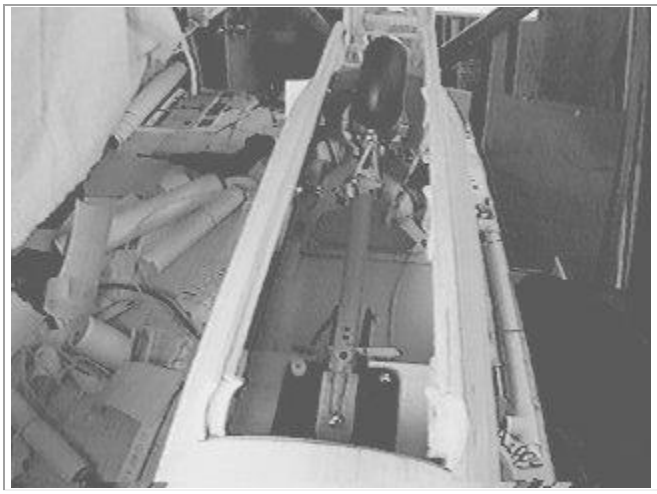
In the background you can see the pull-pull cables for nosegear steering. The servo is not mounted in this view so the cables are slack.



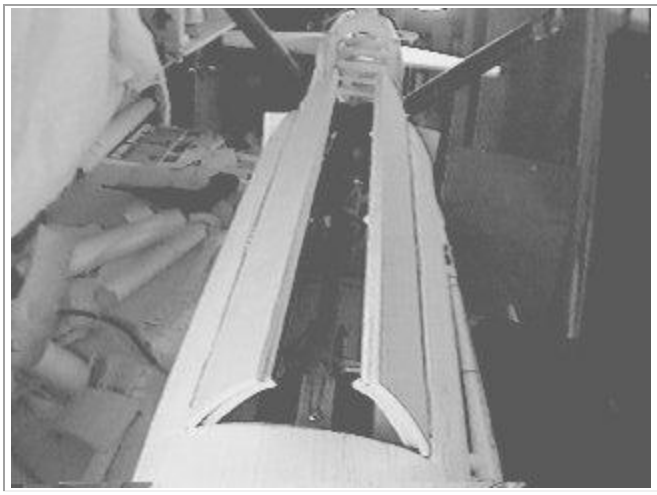
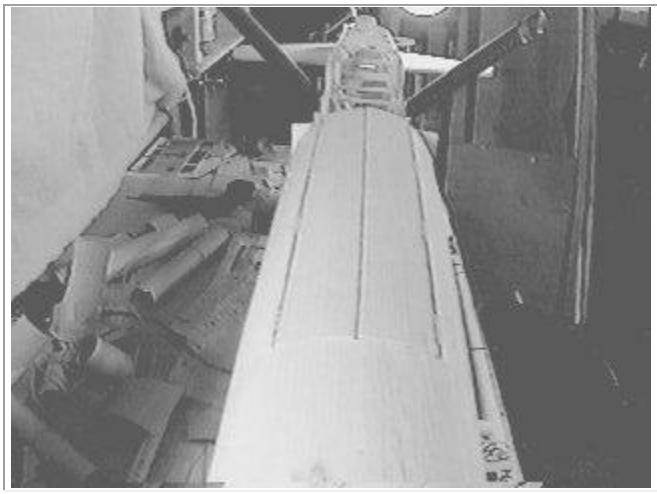
Here are the actuators from the back. The retract unit can be seen in the background.



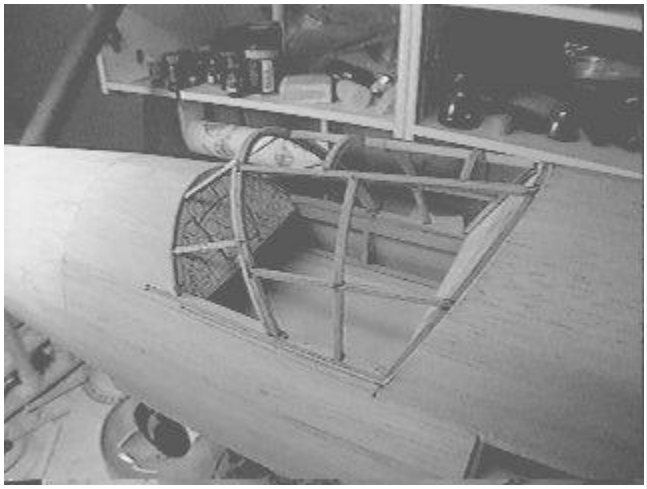
Closeup of the nosegear unit. Note that I am mounting them with 8-32 nylon bolts (only two of them are installed in this picture). The idea is for the bolts to fail before the nosegear or it's mounting structure get destroyed.



Nosegear retraction sequence - #1

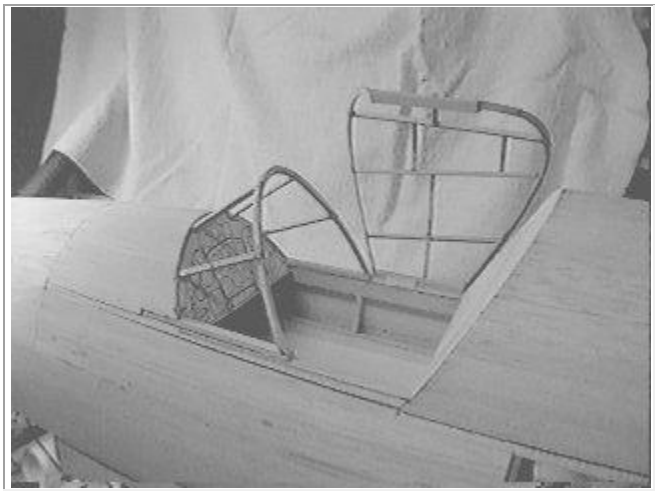
	retraction - #2
	retraction - #3
	retraction - #4

Canopy and Cockpit Area, Rear Engine

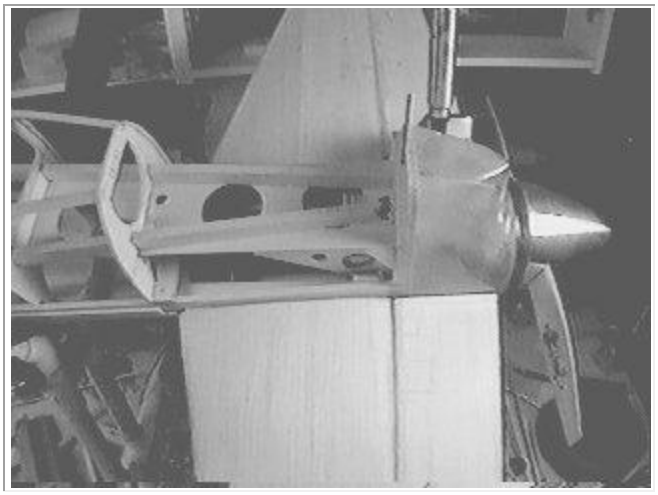


The canopy frame is made up with 3/32" plywood. I left about 1/16" thickness to allow for the plastic that will be glued over the frame. It wasn't easy to find a glue that sticks well to both acrylic or buterate plastic and wood. Epoxy doesn't stick to the plastic. Plastic glue doesn't stick well to wood. We finally found Ambroid glue which does the trick. This stuff has been around since the early 1900's. It's great stuff, try it!

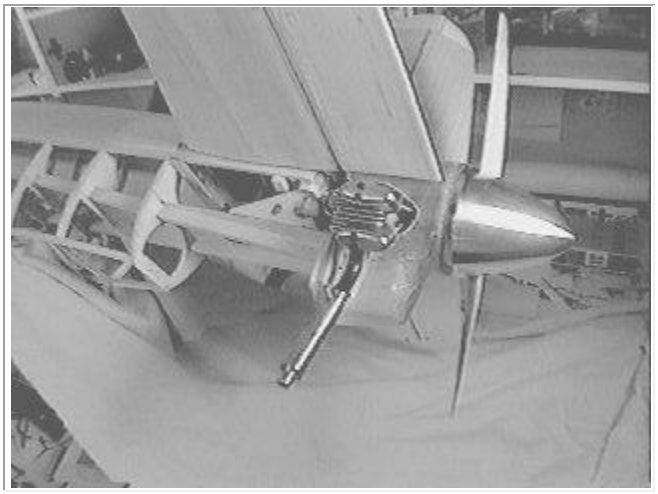
Note the paper instrument panel. This was created by scanning a photo of the real instrument panel and drawing over the image with a CAD program. The resulting drawing was then scaled to the proper size and printed. This was used as a pattern to make the instrument panel from sheet plastic.



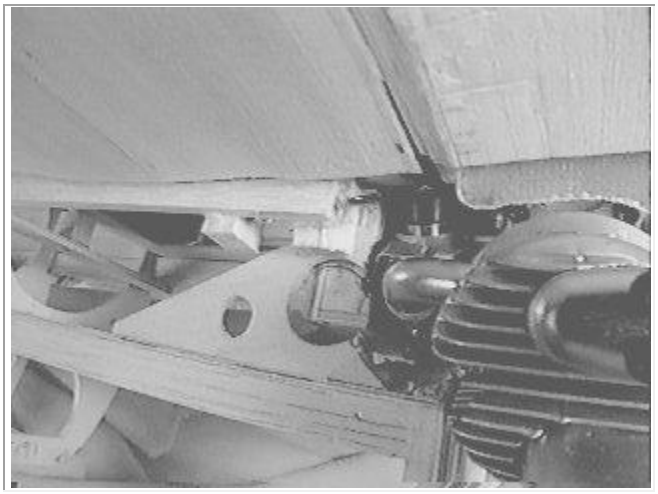
The canopy in the open position. Dollhouse hinges (brass) are used for hinging. The canopy was secured with eyeglass screws through the canopy sill, accessed through the vent hole in the canopy.



Here are a few shots of the tail section. The spinner in this case is from Tru-Turn. They made the only 3-1/4" spinner in the proper shape. They did a special cutout for the pusher prop - this cost about $15 extra.

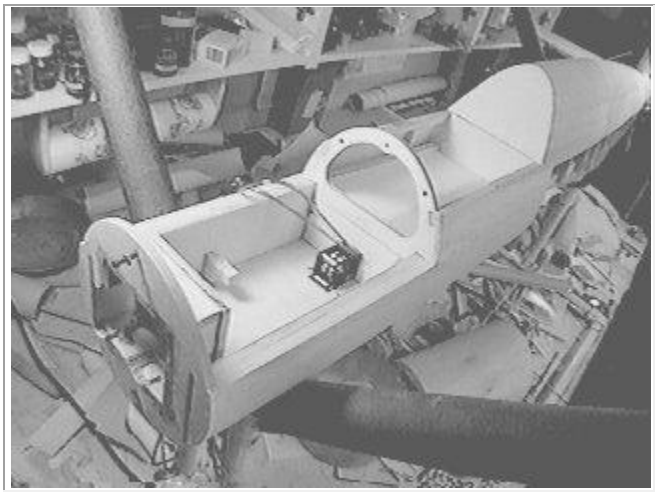


The tail section from below left. The spinner is a bit short of scale length, but it is close enough for "sport-scale." Note close proximity of elevator and engine head.

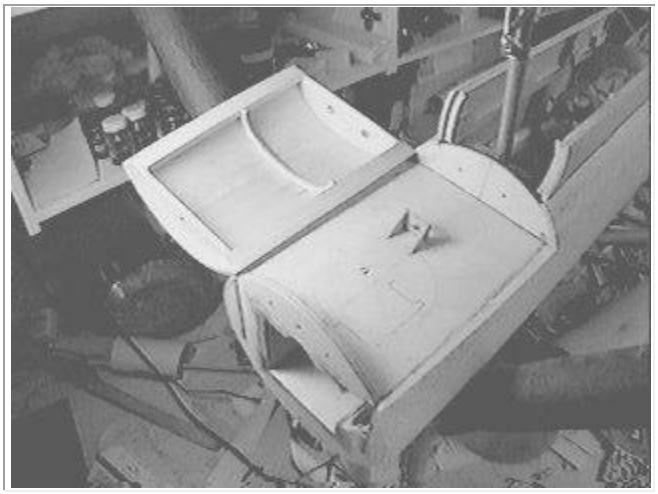


Close-up of carburetor area. Note the throttle arm right next to the stab skin near the hinge line. The throttle linkage runs right through this part of the 1/4" x 1/2" stab "sill", which is braced against the triangular rear firewall brace. This brace can be seen in this photo, it is the piece with two round holes cut into it. Much of this had to be cut away to clear the carburetor and rear engine.

Tail section. Rudder and elevators at maximum deflection. The rudder is driven by a steering shaft that runs down next to the firewall, between the engine mount and the carburetor, and down to the lower rudder. This shaft is bent at 90 degrees on top, and fits into a slot in the lower rudder. This allows the entire stab-fin assembly to be removable.



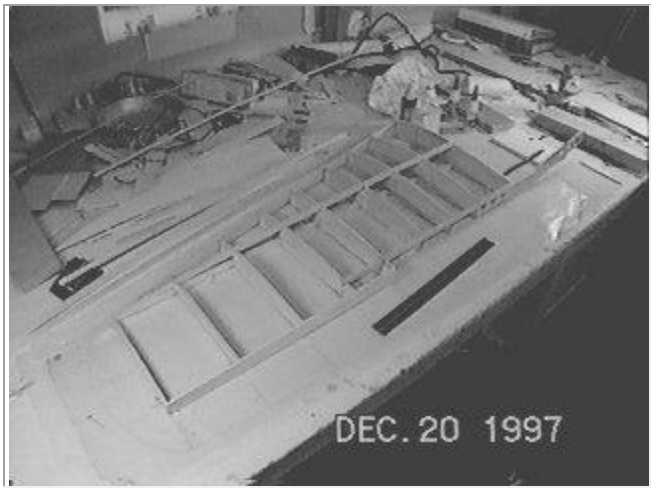
The upper forward fuselage with hatches and canopy removed. The canopy area is lined with .010 sheet plastic, so it can be painted without having to fill the woodgrain.



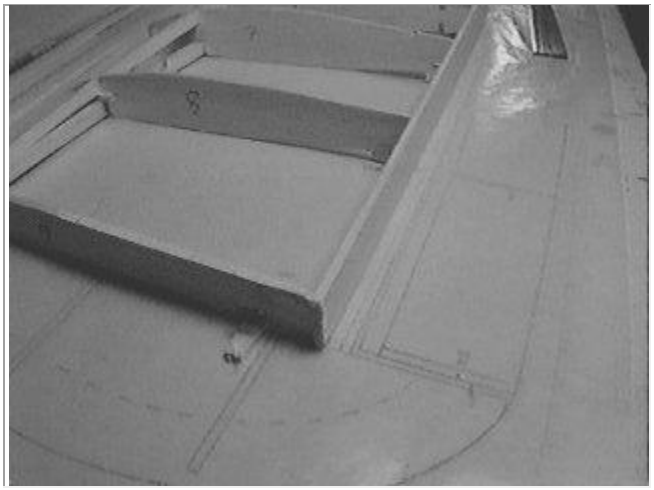
Lower fuselage hatch in the open position. It is held on by one screw in the front and 2 screws in the back. The reason for two screws in the rear is that a centered screw would not be accessible because of the nosegear strut.

Note the frame for holding the retract valve. The retract servo will be mounted just forward of the valve, you may be able to just see the outline of the servo drawn on the wood.

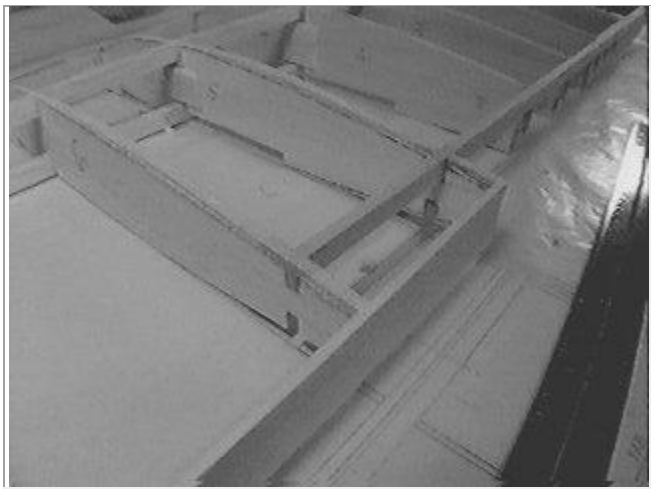
Wing Construction, Part I



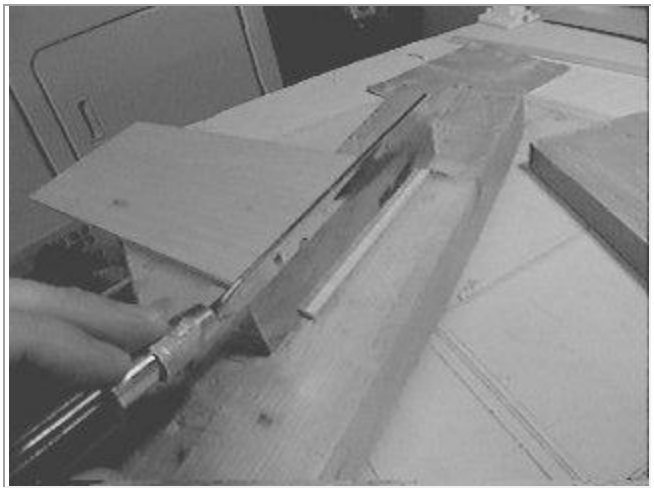
The left wing framed up on the building board.



Here is the wingtip-aileron area. Note that I have moved the aileron spar forward a bit - A scale-type offset hinge was done instead of the bevel hinge shown on the plans.

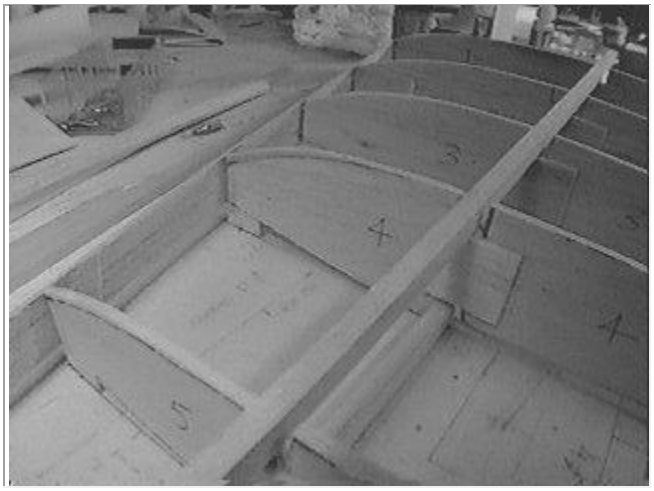


This shows the area around ribs 5 & 6. A T-bar sander is used to level the ribs with each other. A 24-36" straightedge comes in handy here to check the contour.



Cutting a cross-grain shim. This is a good method for shimming up ribs and formers to make a smooth contour. This shouldn't be necessary in too many places. After these are glued on I use a 24" or 36" steel ruler across the formers or ribs to check the contour.

A shim cut from 1/8" balsa. Even though this is 1/8" thick, it bends quite easily without breaking. A little thick CA glue and you can instantly make a rib or former 1/8" bigger. The shim can be trimmed and sanded very easily.

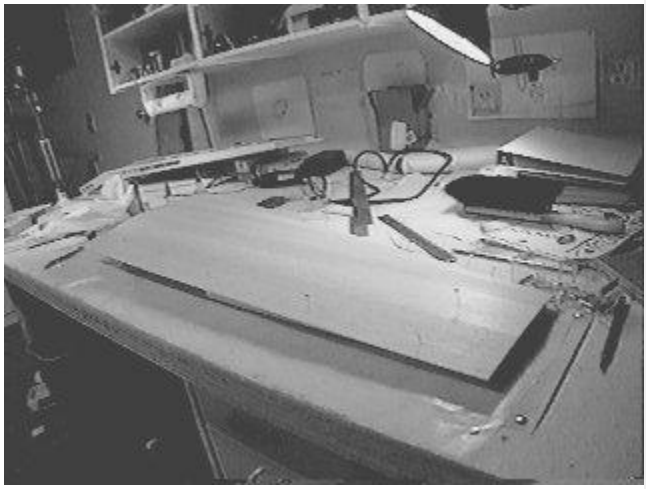


We elected to enlarge the main dihedral brace (W2) to span both upper and lower spars. This is probably not necessary, but we were concerned about the strength of the wing when subjected to negative Gs.
In this picture you can see the temporary square 1/8" balsa braces glued over the gaps in the ribs where the plywood dihedral brace (W2) will glue in. This keeps the ribs in form. They will be cut through before W2 goes in.

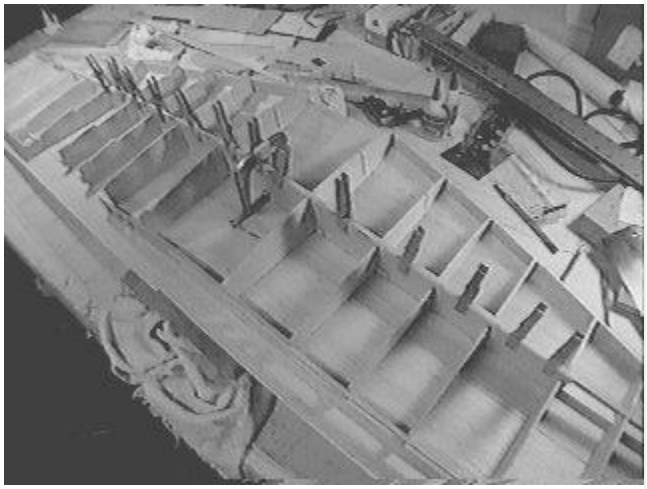
Wing Construction, Part II

Here we glue up sheeting for the wings. The process begins by selecting 3" wide pieces that fit reasonably well. They don't have to fit perfectly for this method. There should be no large gaps when you push the pieces together, however. Once you've decided which two pieces to glue together, cut a long piece of cellophane packing tape, 2" or so longer than the balsa planks. (note the tape roller in the lower center of the picture) Lay the tape sticky side up on the table between the planks. Lay the first plank on the tape, covering half of the tape and leaving the other half exposed. Now starting from one end, butt the two planks together sticking the second piece to the tape, pushing them together as you go. A firm, hard surface is best for this.

Once both pieces are stuck to the tape, pick them up, open the joint and use thick CA to glue the seam. Wipe the excess and use accelerator to speed the process. Flip the pieces over, remove the tape, and use more accelerator on this side. The side with the tape will be the "good" side that will be on the finish side of the model. The tape keeps the planks flush, and a large sheet can be made this way that will have no "steps" in it where the seams aren't quite flush. If you hold this sheet up to the light it might appear to be a single piece except for the different coloration of the wood! This makes sanding and finishing much easier later. Some guys sand this sheeting assembly before gluing it to the model, I didn't find this to be necessary. It came out so smooth I don't think much sanding will be necessary.



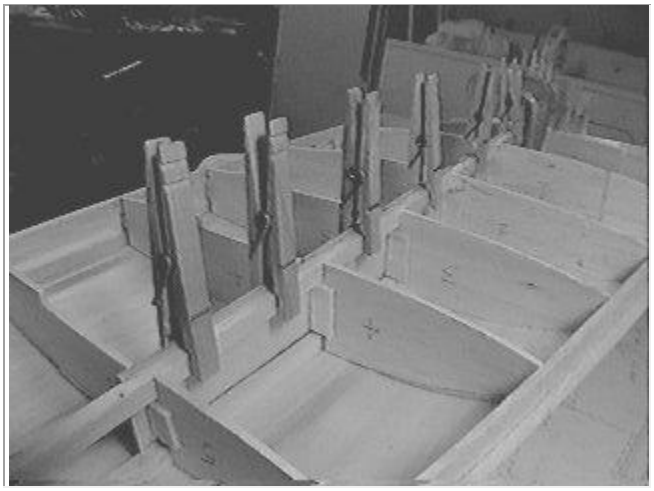
The sheeting is glued to the wing. Note how smooth it looks. Using this method we were able to use thick CA to glue the sheeting to the ribs. After all the shimming and sanding we were able to achieve a nearly perfect fit. After turning the wing over we saw that the sheeting was firmly glued to all of the ribs and almost no gaps were found. It was a challenge getting the thick CA on all of the ribs, LE, etc. and positioning the sheeting before it cured. If the wing were much bigger we would have had to use something slower like alphatic resin glue. The slow CA has the advantage of fast tacking. With the alphatic resin glue, inevitably some part doesn't get pinned down well enough and since it takes an eternity to dry, we've had problems with the surfaces pulling apart and drying that way.



With the top sheeting on both wing halves, we butted them together upside down and epoxied in the main wing dihedral brace, W2. Note that the washout is not fixed yet - that doesn't happen until you sheet the second surface. With top and bottom sheeting glued in place the wing becomes rigid. At this point, only W2 is holding the wing halves together. I did some shaping of the center wing mating surfaces (spars & sheeting) before this glue-up.

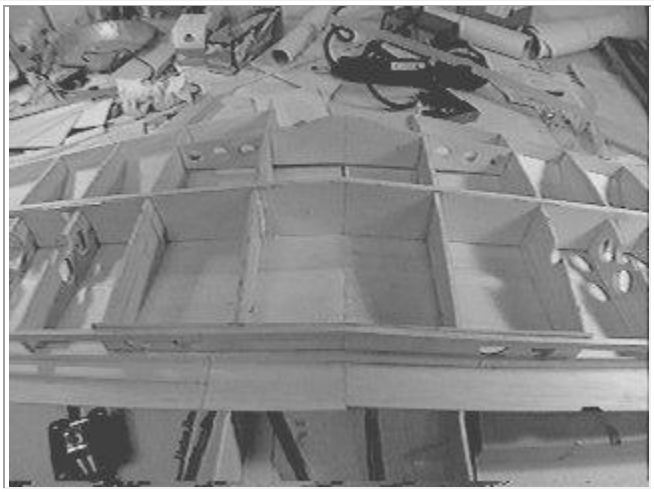
Note again that we extended W2 to span both spars. This is optional to provide extra strength for negative Gs.

The dihedral brace W2 clamped in place. 30 minute epoxy was used, as we always do when joining birch ply to balsa in high stress areas. Note the 3/32 plates that held the ribs together before W2 was in place. We sawed through them and then slid W2 into the slot. Note the small shims between the lower part of the ribs and W2. These were used just to put more pressure against W2 on the bottom since we couldn't clamp down there.

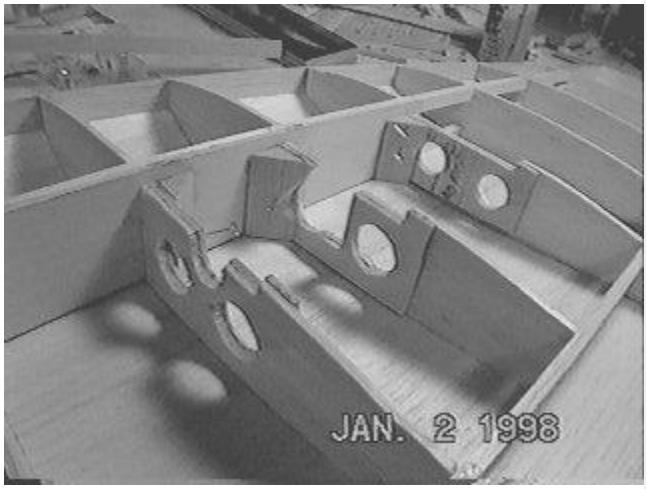


Another view of the W2 glue-up. We couldn't clamp W2 to the upper spar, but we found that the rear ribs (with shims) applied enough pressure to keep W2 firmly against it.

This is an exciting step, because the wing finally begins to take shape!

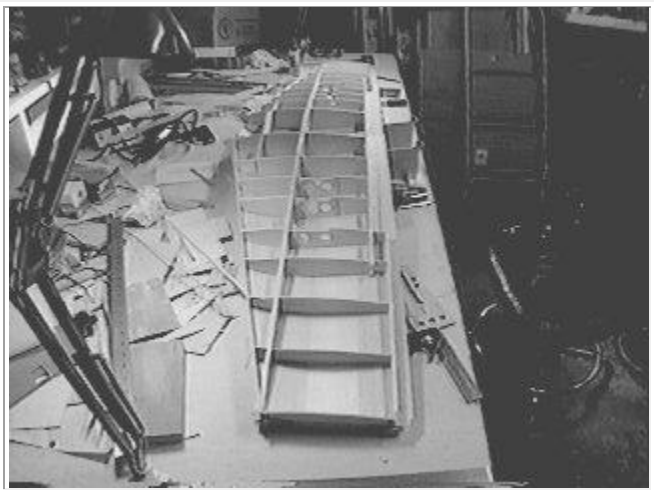


The wing center section with W1, W2, & W3 now glued in place. Mind carefully the installation of W1. It *must* mate exactly with (F10). The wing hold-down dowels go through there. The 81" version even has oversize slots in Rib #1 to suggest the variable placement of W1. You will have to wait until you can mate the wing and fuselage before gluing in W1.

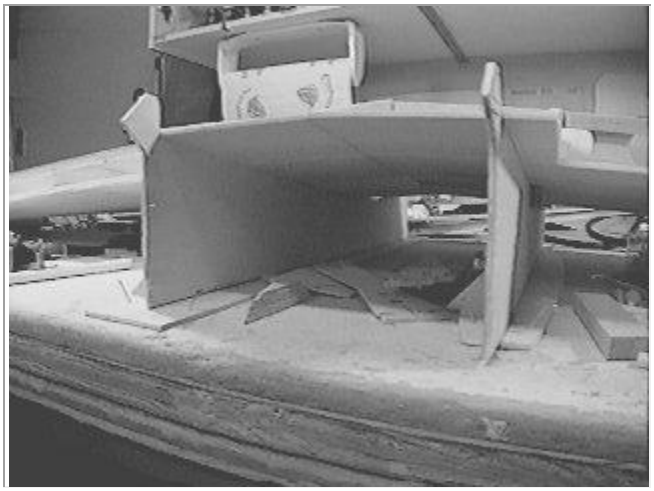


The retract plate support doublers are glued in place with epoxy. Note also the 1/2" triangle stock to reinforce the W2/doubler joint. This is a bit different than the structure called for on the plans. I used thicker plywood - 1/8" ply for the doublers and 1/4" ply for the plate.

After seeing too many models with retract support structure ripped out, or with retracts damaged through hard landings, We have arrived at our current thinking. The idea is to make the fasteners that hold the retracts to the wing weaker than either the supporting structure or the retract units. That way in a hard landing, it is the fasteners that fail and little else. We use nylon bolts, 8-32 in this case. We've found these to be very strong in the past, too strong in fact for our Dynaflite Spitfire. Its retract rails were ripped out with 8-32 nylon bolts!
This practice was proven out during a hard landing with the Do 335 at a contest. We were attempting a "spot" landing (probably a foolish thing with this plane!) and landed hard. Two of the four nylon bolts popped, preventing damage to the structure.



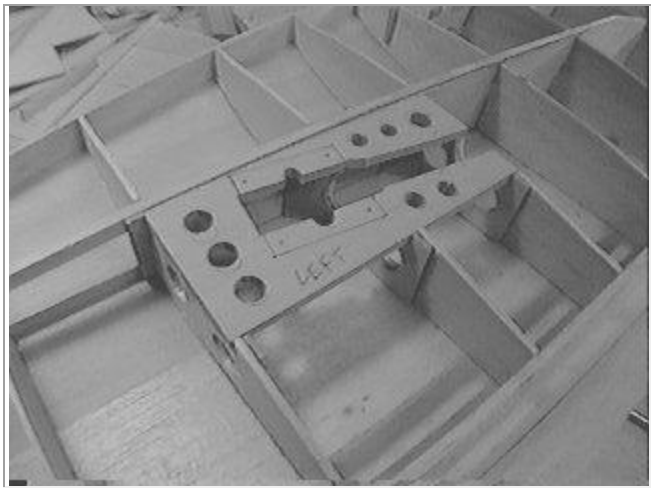
The wing from above, in the building jig. A fixed jig is the best way to align the wing. Other methods could be used, of course.



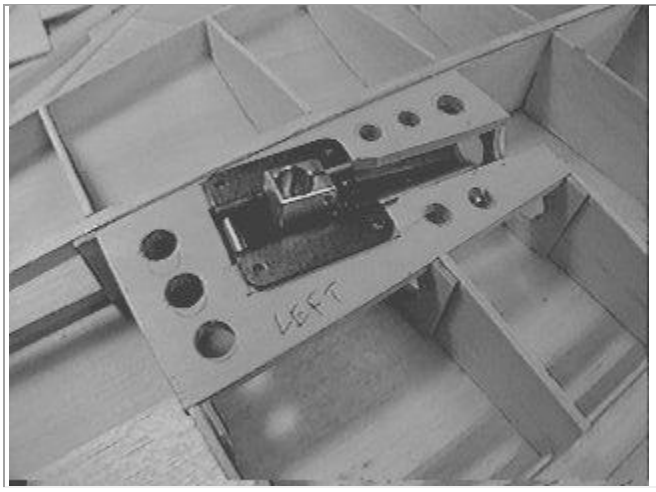
Here is the main part of the jig. Using the templates for rib #1, these supports were cut from 1/8" lite ply. Small plywood blocks were glued to their sides next to the top for pinning through the wing (one is just visible on the right side in the picture). These supports are cut so that the wing root is at 0 degrees incidence to the building board. The wingtips are then blocked up until the proper washout is achieved.

Here is the wingtip, blocked up to it's proper -1.5 degrees incidence. Because the wing is upside down, of course, this means that the tip is *higher* than the trailing edge.

This method results in a very accurately aligned wing. Once all equipment installation is done, simply glue on the bottom wing skins and the wing alignment (washout) becomes permanent.



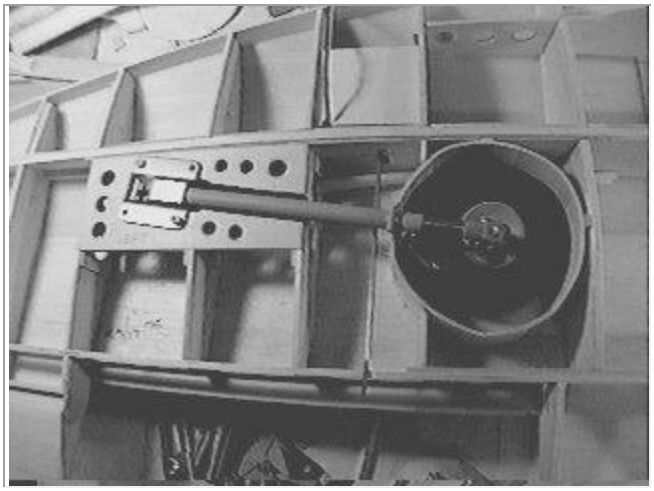
Here is the retract support plate glued in place.



Here is the plate with the retract installed.

Here it is with the strut attached. The standard 631 struts were too short, we had to exchange them for longer ones. The folks at Robart managed to turn this around in less than three weeks, we were grateful for that. They didn't charge us for it either.

Mind carefully the length of the landing gear struts. You want the Do 335 to sit as close to flying attitude on the ground as possible. We ended up with a nose-down sit, which makes it hard to get off the ground on take-off. Once this type of retract is installed it is very hard to change the length.

	Here the strut is in the retracted position. The flap control rod clears the strut with room to spare. We really like the look and feel of the 631 retracts. They look and feel alot more robust than the music wire retracts we've owned.

Aileron Construction

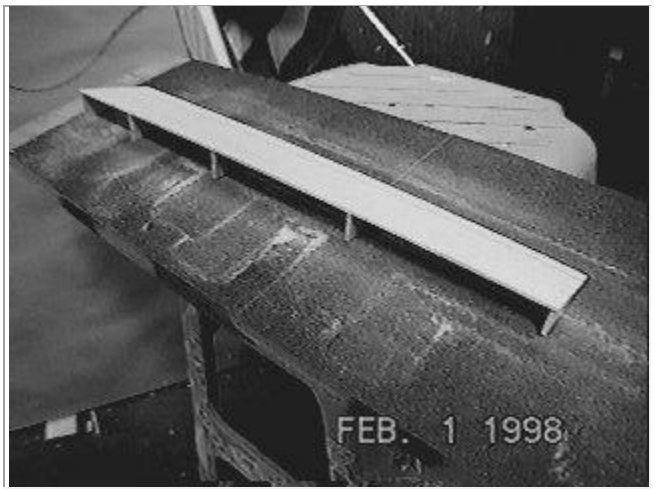
	Photo #1 After cutting sheeting to the right shape, we glue the ribs on and sand this half to accept the other side.

Photo #2

Here the aileron is being sanded with the aid of a T-bar sander to maintain even pressure across the ribs and trailing edge. Sandpaper is stuck to a piece of 3/4" plywood with 3M77 for this purpose. When the sandpaper wears out you can remove it from the plywood with a Monokote heat gun. The heat releases the 3M77's stickiness.

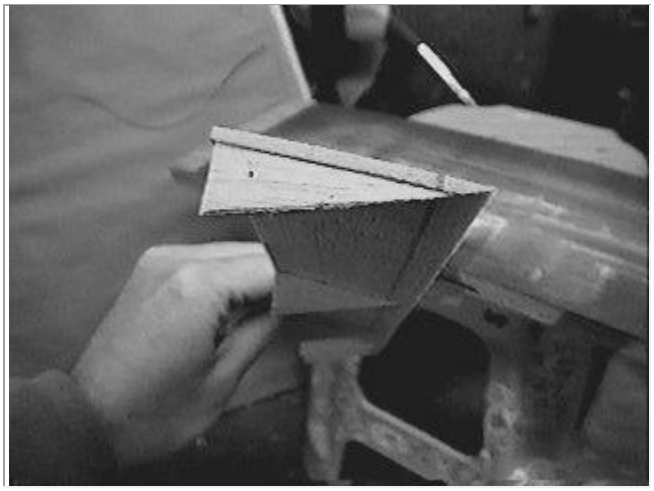


Photo #3

Here you see the edge-on view of the aileron after sanding. Note how the trailing edge is sanded sharp.

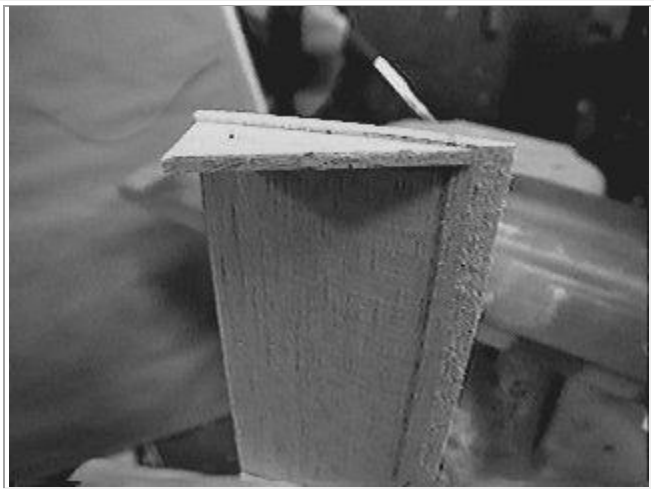


Photo #4

Another view of the sanded aileron half. The sanded edges are just a little rough - perfect for good glue adhesion.

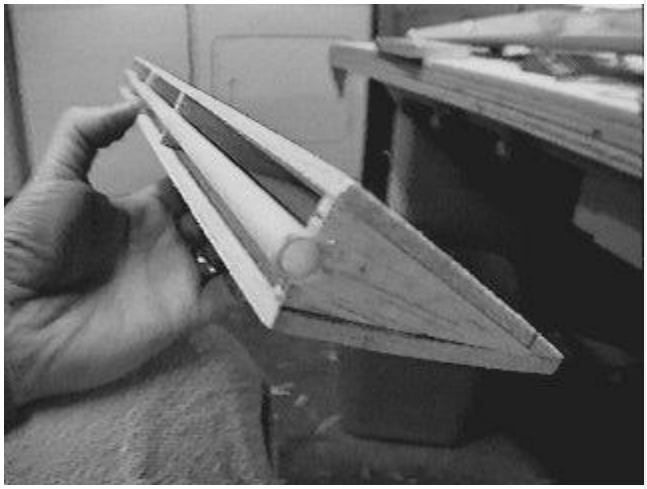


Photo #5

Now for the hinge. We chose to do a scale-type hinge on the ailerons. It's a bit more work, but the result is very cool. After playing with some wooden doweling and some plastic tubing, we decided this would make a great hinge. The plastic tubing you see here was brought home by our kids with some helium balloons attached to it. They are very light, and with a 1/8" wooden dowel inside them they make excellent hinges!

Note also here the trailing edge, which is half the width it would have been if I hadn't sanded the first half sharp. Sharp trailing edges add a lot to the appearance of a wing from the rear.

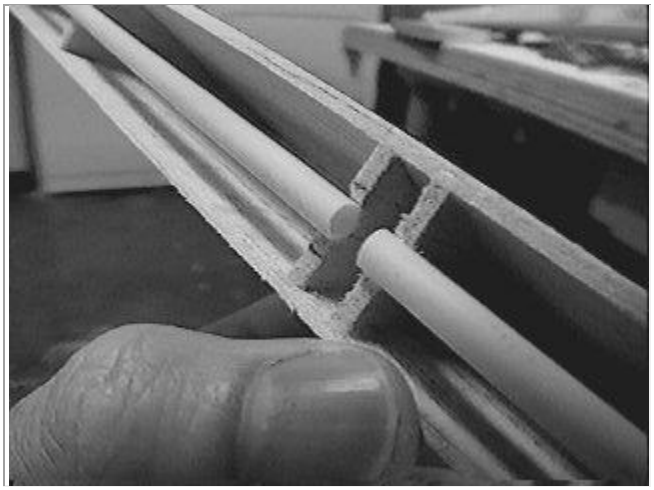


Photo #6

Here is a close-up of the middle of the aileron, where the 1/8" plywood hinge bracket will fit into a slot in the aileron. This will give a third hinge point in addition to the braces at each end of the aileron.

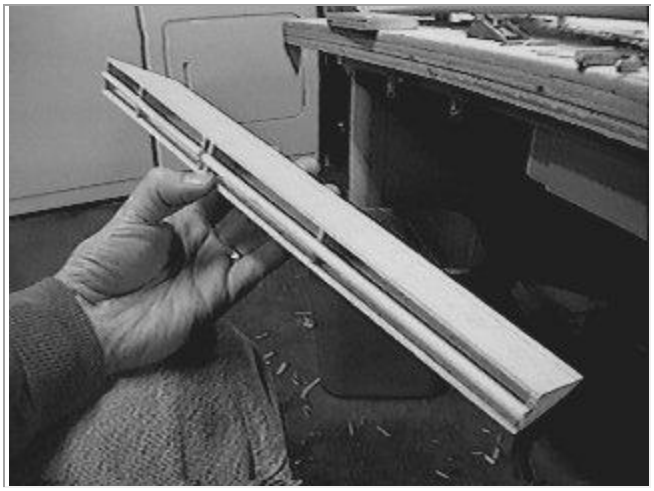


Photo #7

Another view of the aileron with plastic tube hinge attached.

Photo #8

Now I've glued two 1/8" strips on either side of the tube. This presents a flat surface to which I will glue the leading edge.

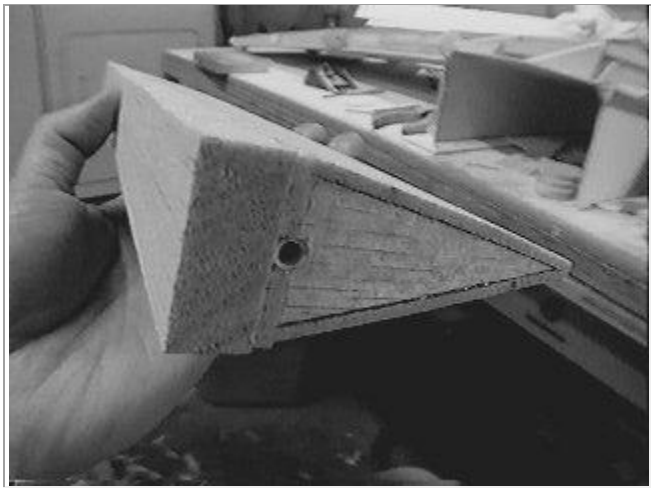


Photo #9

Here the 1/2" soft balse leading edge is glued in place. After this I used a compass to draw a semicircle centered on the tube for use in shaping the leading edge.

Photo #10

Here the aileron is sanded to final shape.

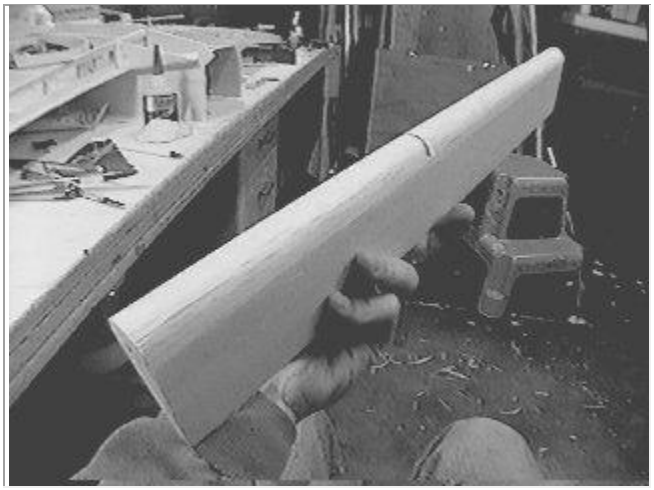


Photo #11

The finished aileron. Note the slot in the middle to accept the hinge bracket on rib #7.

Photo #12

Here is a close-up of the aileron slot. This is the external view of what you see in Photo #6.

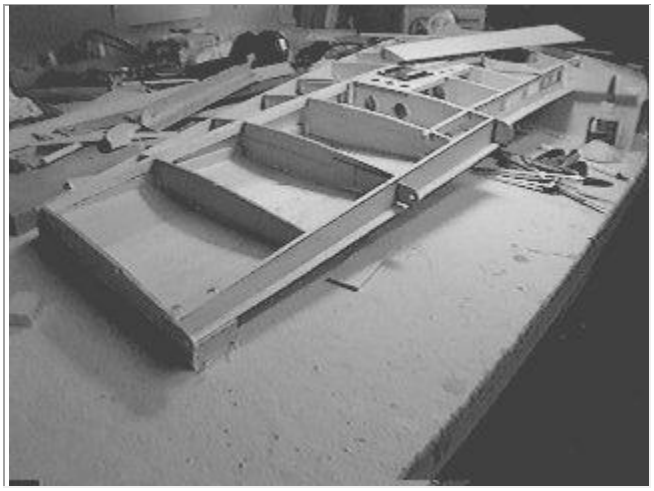


Photo #13

Here you can see the three plywood hinge braces attached to the wing. The inboard brace acts as a brace for the flap hinge dowel as well.

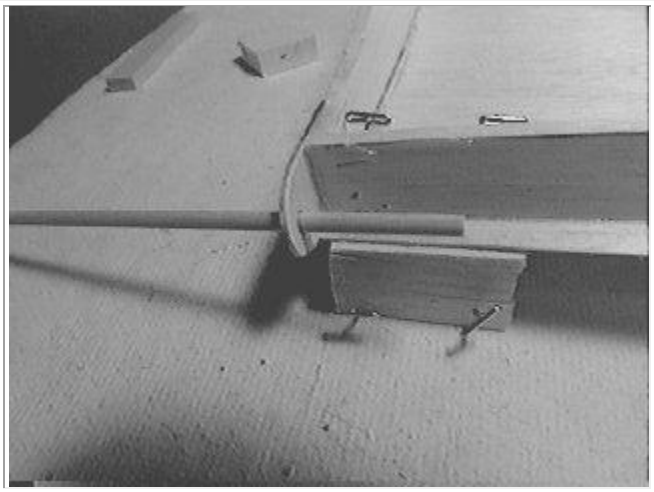


Photo #14

Here is the dowel going through the wingtip hinge brace.

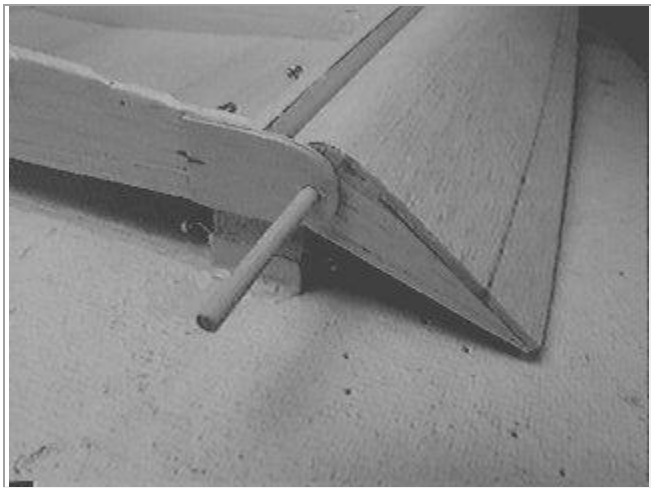


Photo #14

Here is another view of the wingtip, with the aileron now in place.

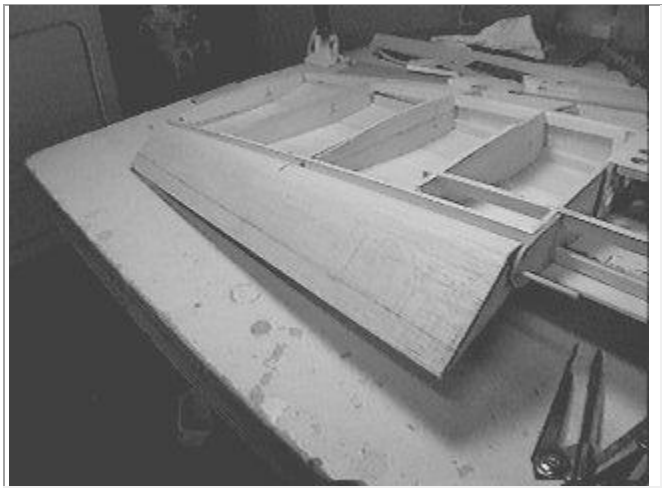


Photo #16

The completed aileron mounted on the wing.

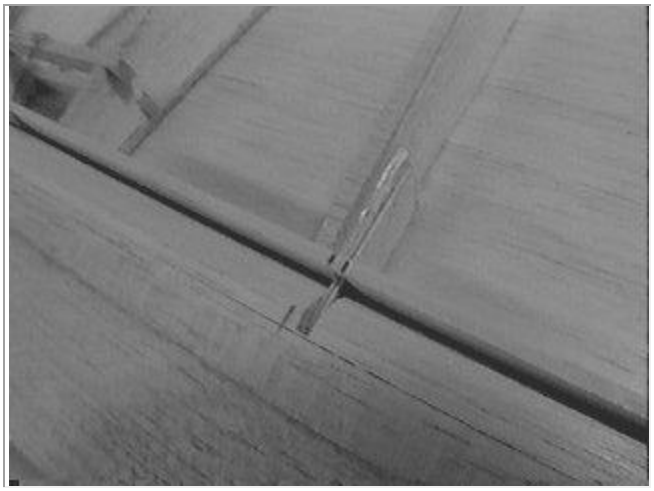


Photo #17

Here is a close-up of the 1/8" hinge brace, glued to rib #7.

Flap Construction

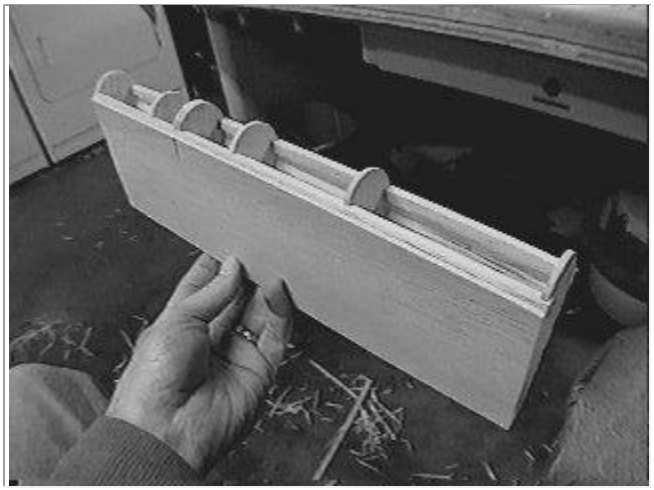


Photo #1

The flap is constructed in much the same way as the aileron, except the leading edge radius is larger, so you can bend a piece of 3/32" sheeting to form the leading edge. Al Master's suggestion of wrapping the wetted sheeting around a broomstick worked well, although I ended up cutting this piece a bit short before forming it.

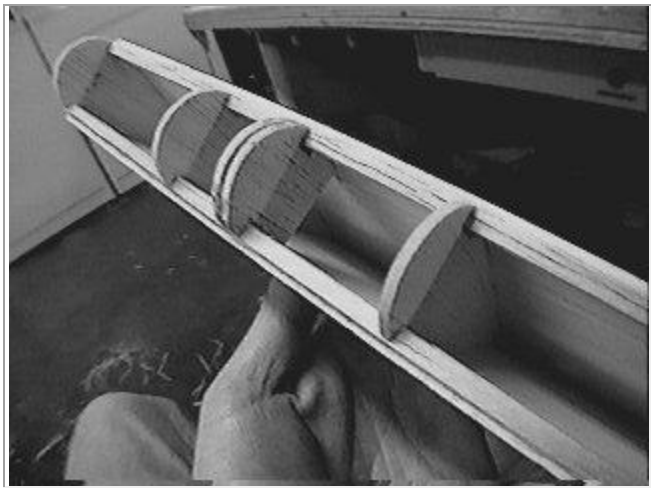


Photo #2

Here is a close-up of the flap leading edge. Note the two extra formers spaced closely together. These are the supports for the formica control horn that I will glue in later after finish sanding, but before painting.

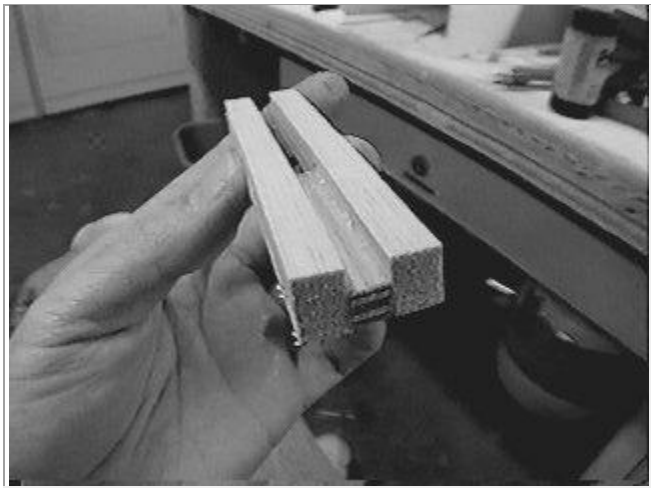


Photo #3

This is the flap hinge dowel support piece. It is made from 5/32" balsa and a small piece of 1/4" plywood in the middle. The dowel will be secured to the plywood with screws.

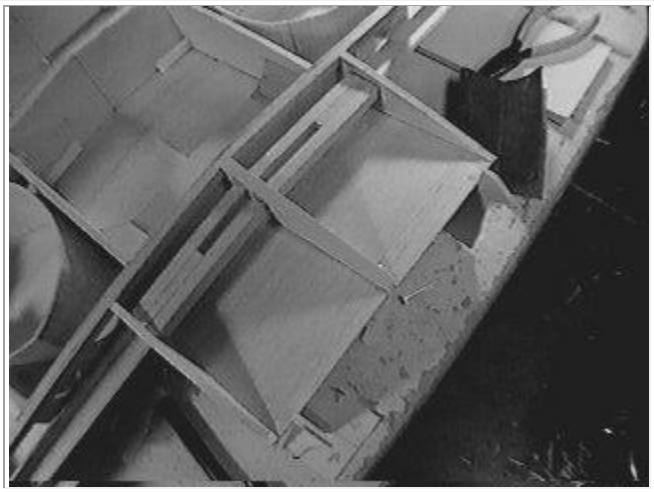


Photo #4

Here the two inboard flap hinge dowel supports are glued in place. Holes will be cut in the top sheeting to make this area accessible. The dowels have to be pulled out all the way to get the flap loose and remove it. You could mount the flaps permanently of course, but it is nice to have things serviceable. It also makes finishing & painting a bit easier.

Photo #5

Here is the outboard (right-hand) flap hinge dowel support piece glued in place between ribs 5 & 6. Access to this dowel is through the aileron spar. The ailerons have to be removed first, of course.

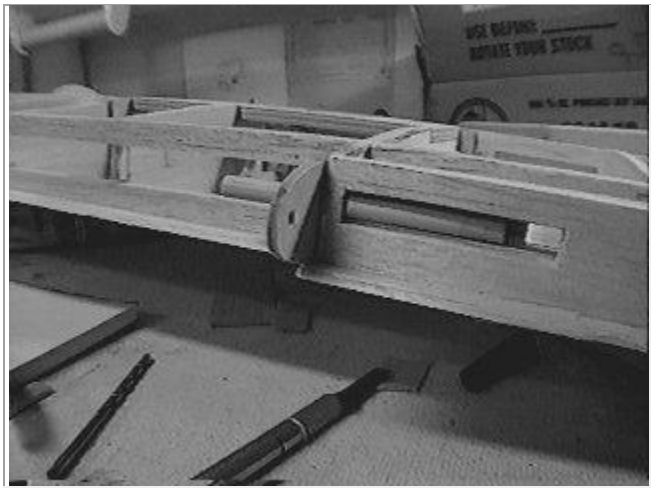


Photo #6

Here is the slot in the aileron spar to access the dowel. The wingtip is to the right in this picture. The flap will go to the left.

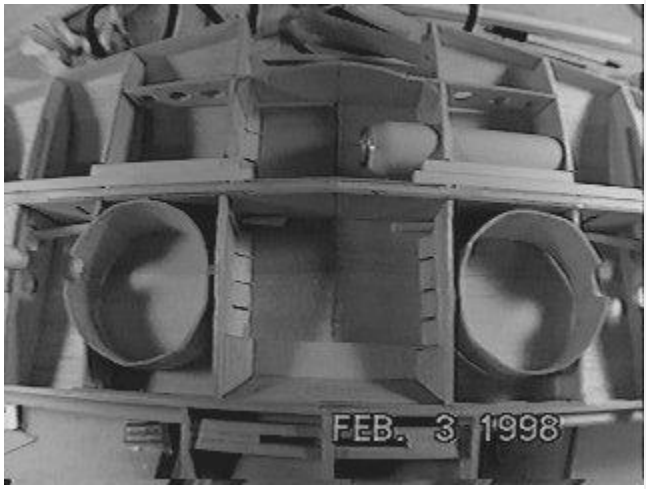


Photo #7

Here is a view of the wing center section, right before the bottom sheeting is applied. In the lower part of the picture you can see the flap hinge supports.

In the middle section you can see the 1/4" ply wing bolt plate, secured with 3/4" triangle stock glued against the #1 ribs. Here you can also see the short sections of 1/2" triangle stock glued against the top sheeting. This is for sheeting support where the wing saddle of the fuselage rests.

In the forward section you can see W1 braced with triangle stock, the air tank for the main landing gear, and the square plastic tube conduits for the flap and aileron servo wires.

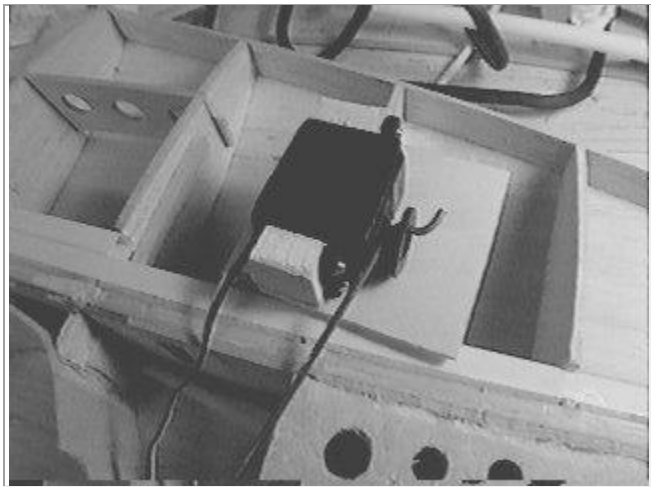


Photo #8

Here is the flap servo, mounted to a 1/8" lite ply plate with two pine blocks to hold the screws. This assembly gets flipped over and installed face down into the bottom of the wing.

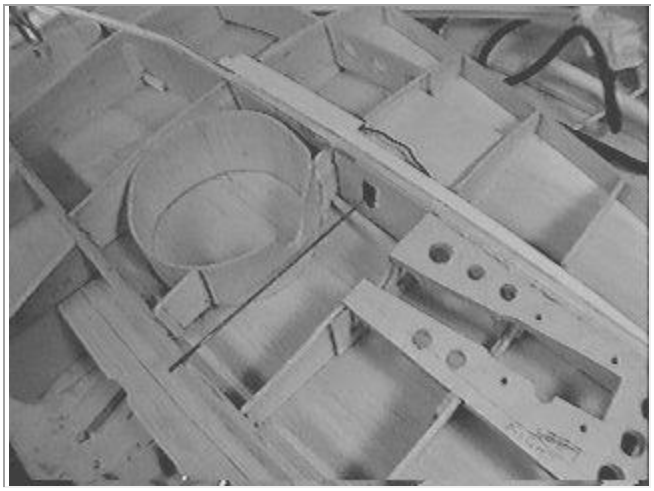


Photo #9

Now you can see the flap servo plate mounted on 1/4" hardwood rails in between ribs 2 & 3. The pushrod goes through a hole in the spar and will exit the skin near the flap leading edge.

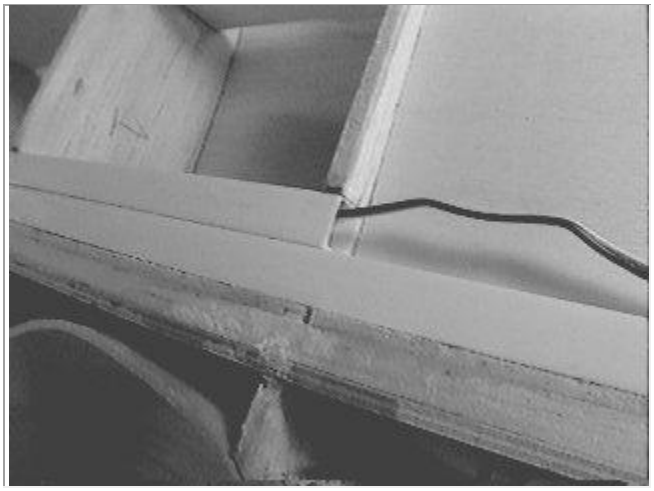


Photo #10

Close-up of the square plastic tubing used as a conduit for the servo wires.

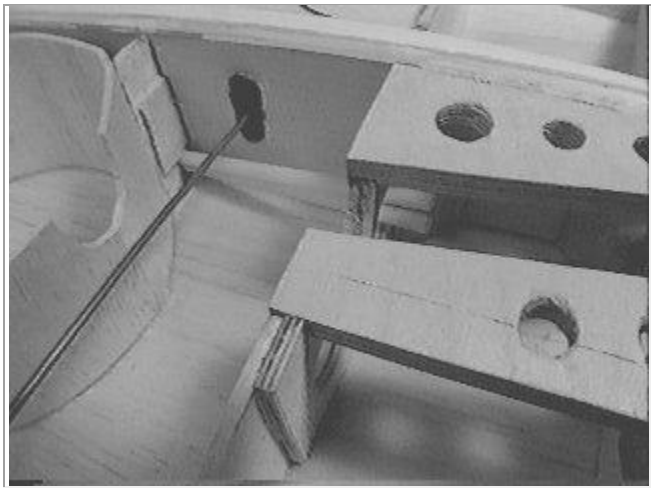


Photo #11

Close-up of the flap pushrod. We used all 4-40 hardware.

Wing/Fuselage Mating

Photo #1

A historic moment! The wing meets the fuse for the first time. The fit looks good!

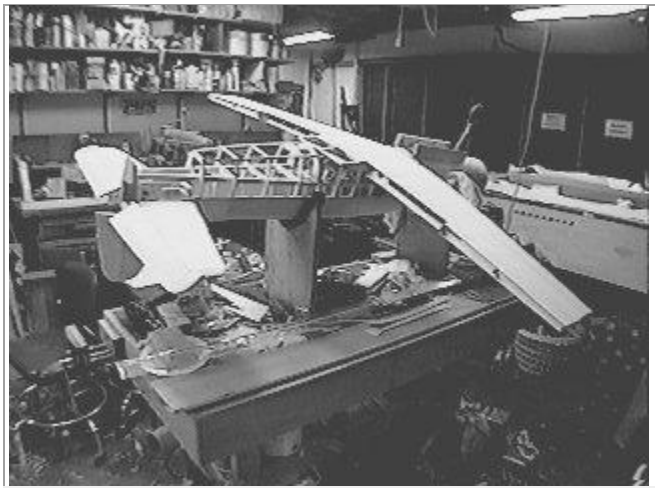


Photo #2

Same assembly from a different angle.

Photo #3

This is what it's all about! She's finally starting to look like an airplane!!!

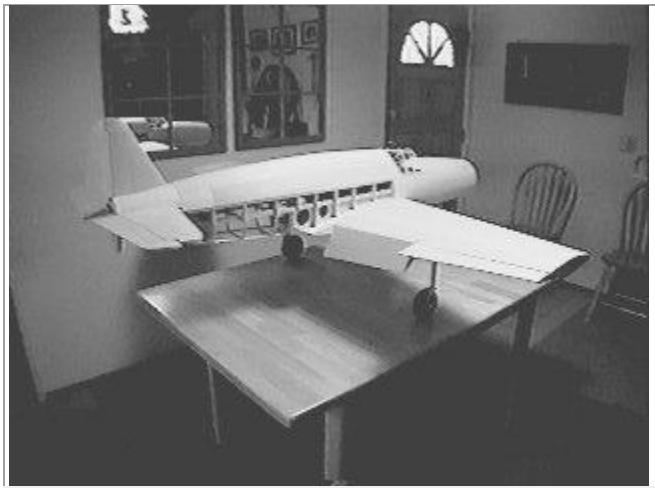


Photo #4

Another view.

Photo #5

Note the block under the nosewheel. The strut lengths are a bit out of whack. I chose to shorten the mains, mainly because the nosewheel installation is more critical with the closing doors and all.

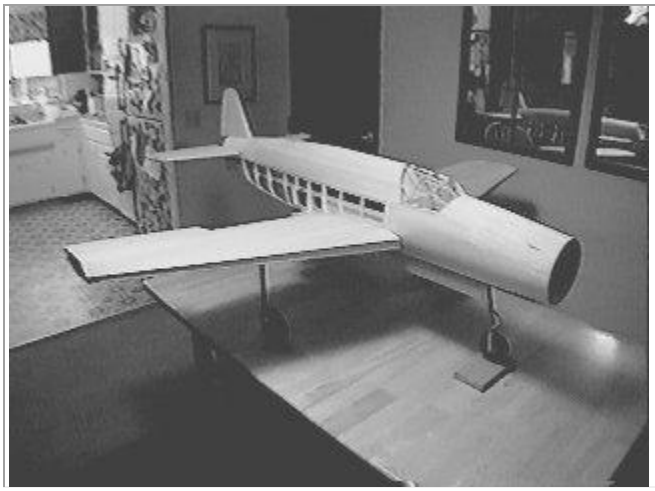


Photo #6

She looks almost ready for a sortie!

Lower Fin & Rear Fuse

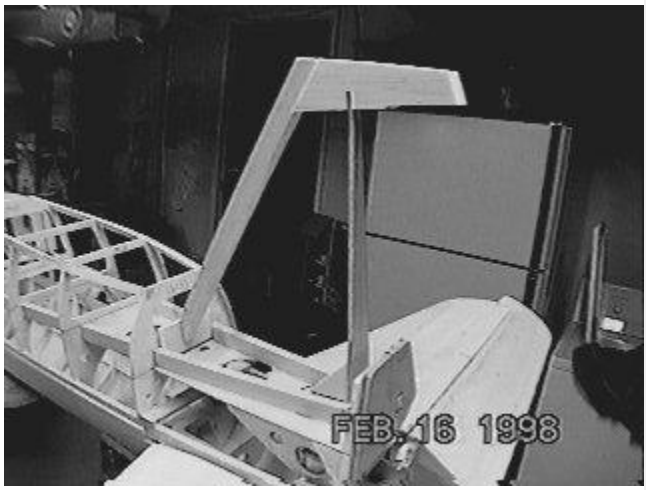


Photo #1

The basic framework of the lower fin. The leading edge is 3/8 x 1/2, the spar is 1/8" ply. We had to move the spar forward because of the scale hinge style we chose.

We debated whether to make the lower fin removable. We were afraid of what would happen in the event of a gear-up landing. We decided in the end that the structure would probably survive it, especially if I reinforced it just a bit, without adding too much weight. I was also afraid of a removable unit separating in flight.

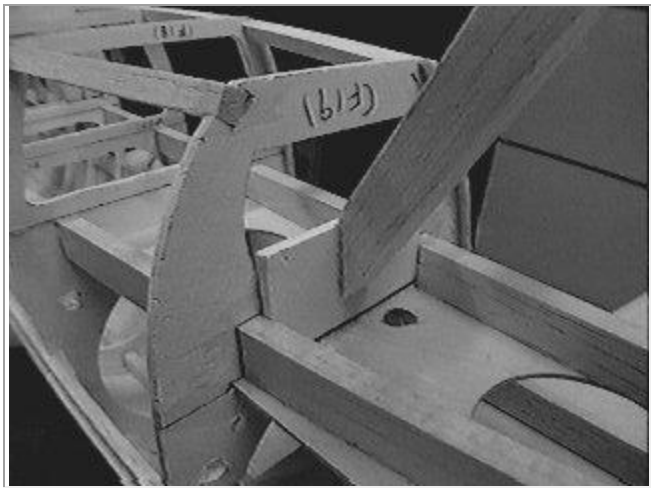


Photo #2

The plans showed the leading edge extending only just below the lower skin. We decided that for just an ounce or two I could extend it down to F19, which would make it much stronger. Note the added piece of 1/8" lite ply behind F19. This was needed because of the hole in F19. Note also just below this the hole in the tank support for access to the tail hold-down screw. The 81" version uses a different tail hold-down arrangement.

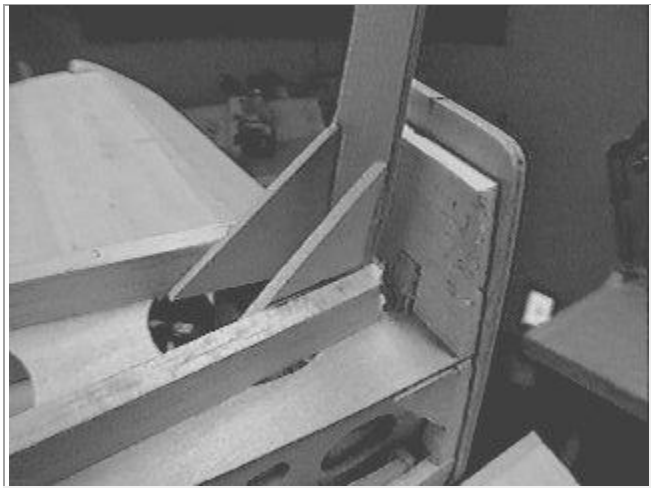


Photo #3

The plans showed the lower fin spar butting up against F20. Since it had to be moved forward for the scale hinge, it no longer rests against F20. I therefore reinforced it with 1/8" lite ply gussets. These gussets are glued to the crutch pieces.

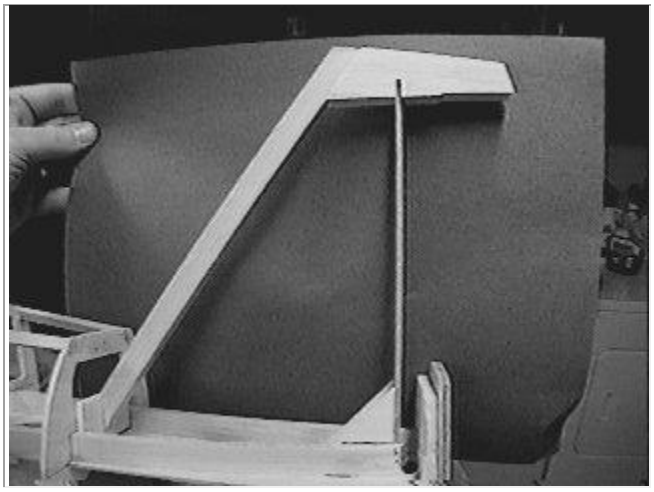


Photo #4

Here is a plan view of the framework. You can see the gap between the spar & F20.

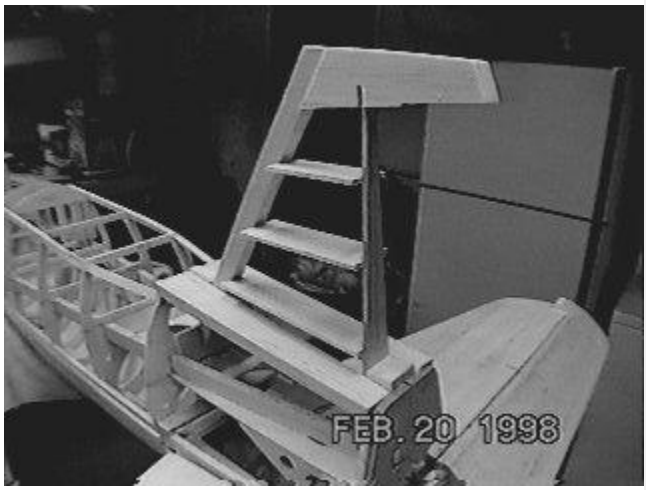


Photo #5

The fin ribs are added. These are just rectangular pieces of 3/32" balsa. We "upgraded" the sheeting here from 1/16" to 3/32" to make a slightly stronger structure. The plans called for 1/16" ribs and sheeting.

Note also here the fuse bottom pieces that go around the root of the fin. These are 5/16" hard balsa for strength. These pieces will be hollowed out later for lightness. Weight in the tail is critical! Every extra ounce here will mean 2 oz. of lead in the nose.

Photo #6

The fin framework after sanding. Note the airfoil shape and the thinness of the tip! The bottom is left as a separate piece intentionally. On the real Do 335, this piece was a spring-loaded, shock-absorbing skid! Because it fit up inside the fin, there is a break in the outline.

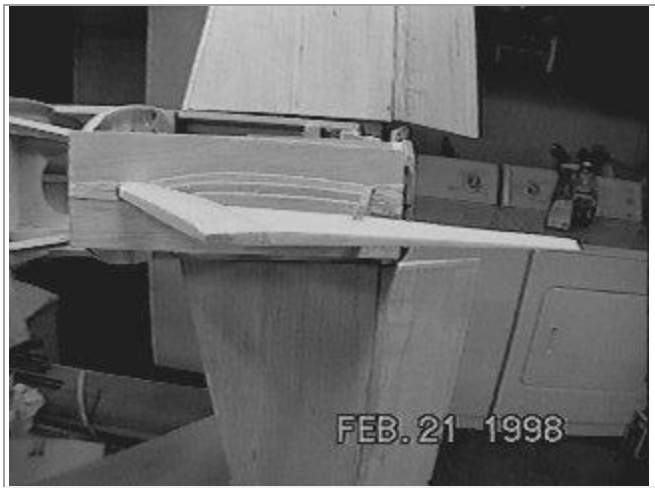


Photo #7

Edge-on view of the fin framework.

Photo #8

Rear view of fin framwork. Note taper.

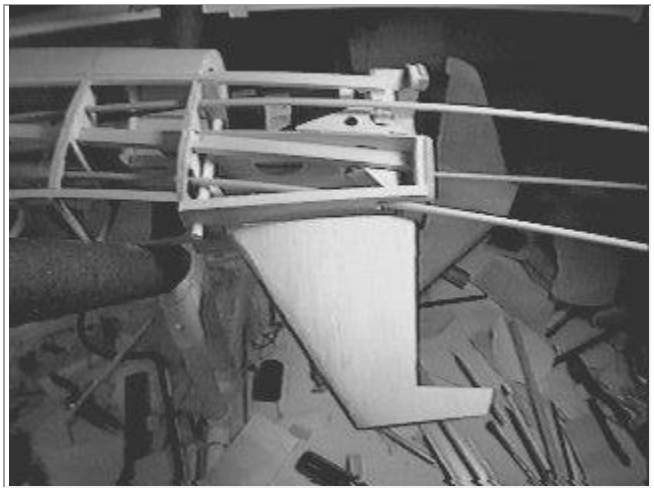


Photo #9

The lower fin is sheeted with soft 3/32" balsa.

In preparation for applying the rear fuse sheeting, all pushrods are routed to their final locations. Clearances are checked. Note the white plastic tubing at left next to F19. This is the access hole for the forward tail hold-down screw. An 8-32 nylon bolt will be used (they're very light and strong).

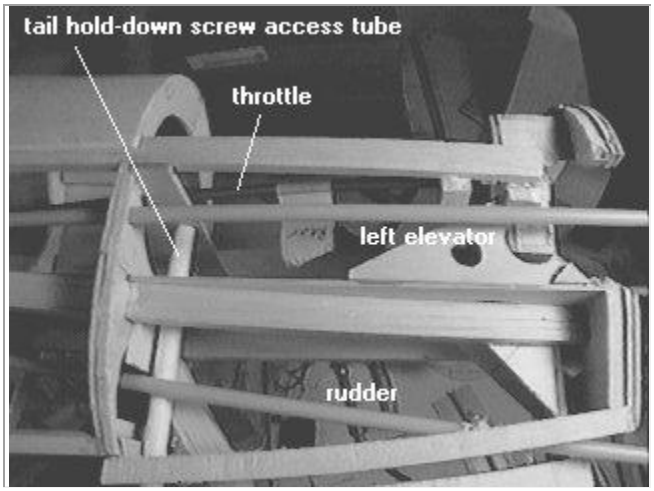


Photo #10

Close-up of the rear fuse before sheeting. At the bottom of the picture is the rudder pushrod. In the upper part of the picture, the white pushrod that goes through the middle of the engine cutout is for the left elevator. Harder to see is the red throttle pushrod, it has the masking tape tag labeled "rear" on it.

Wings, Part III

Photo #1

The wingtip frame from the plans follows the outline of the wingtip and is about 1" wide. In other words there is a large cutout next to the tip rib W9. We cut this part per the plans, but did not follow the plan suggestion of using simple triangle bracing on top and bottom and sheeting over with 3/32" balsa. For one thing this looked very weak to us, and it also didn't have a nice smooth contour. We often like to pick up our airplanes (with a partner) by the wingtips, so we didn't want this area to be flimsy. So we used very soft, light 1/2" balsa sandwiched on both sides. Yes, this will add a few ounces, but this isn't a glider!!!

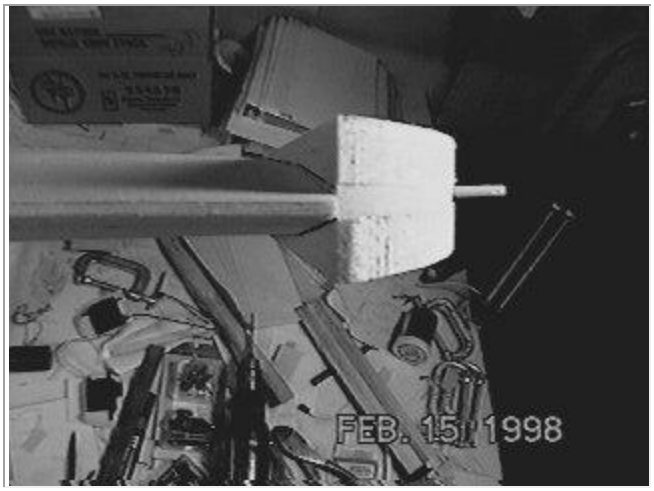


Photo #2

View of the wingtip sandwich from the rear. Note the 1/8" dowel aileron hinge pin protruding.

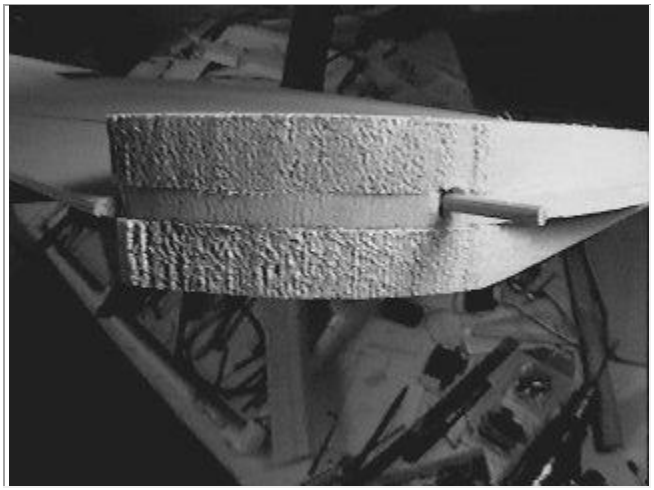


Photo #3

Close-up of the rear wingtip. The aileron hinge pin is visible, it will be secured from underneath with a screw.

Photo #4

The rear of the wingtip with the aileron removed. Note that the wingtip block is now flush with the plywood hinge pin brace that was glued to W9 earlier. Note also the hole in the middle. This is the hollow formed by the cutout in the 1/4" balsa wingtip piece which is the center of the sandwich.

Photo #5

High-angle view of the wingtip block.

Photo #6

The wing with all the pieces in place for the first time!

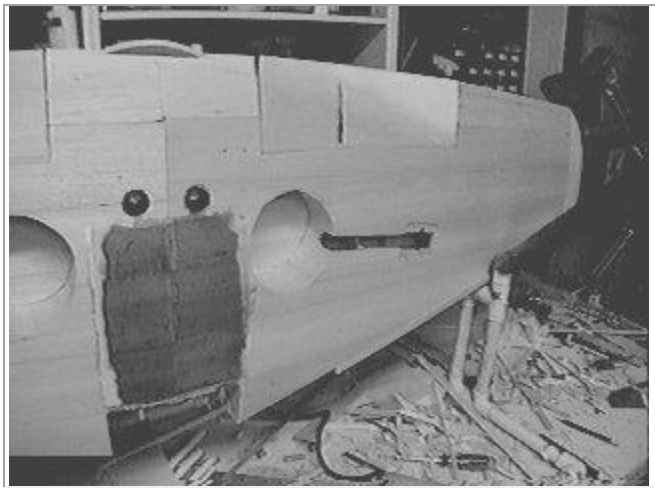


Photo #7

The center section is glassed.

Photo #8

Edge-on view of the wing trailing edge.

Wing/Fuselage Joint, Part II

Photo #1

Here is the wing-fuse joint from above, before the lower rear fuse work is begun.

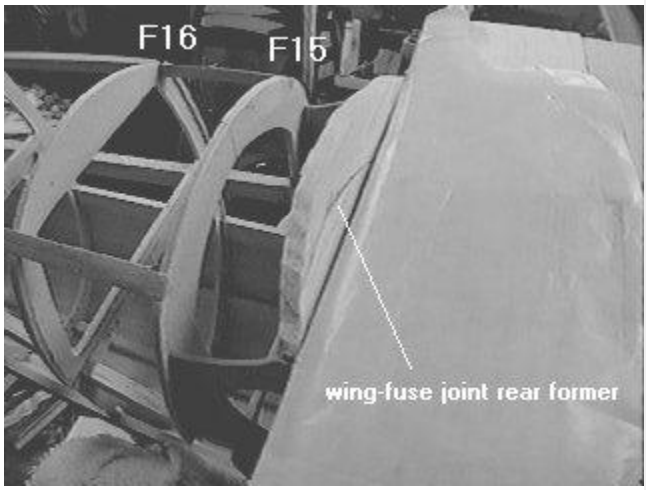


Photo #2

This area of the fuse was one of the most difficult to visualize and "think build." Once the side sheeting was applied, though, and the wing attached, it started to make more sense. It's one of those things that you need to see and manipulate in three dimensions before it starts to materialize.

The wing-fuse joint in the rear is formed by two 1/4" soft balsa formers. You can see the rear one labeled in the picture at the trailing edge of the wing.

Note that wax paper has been placed around the wing TE to keep from gluing the former to it. After this picture was taken, I glued the forward former to the wing TE, leaving the wax paper in place between the two formers where the joint will be.

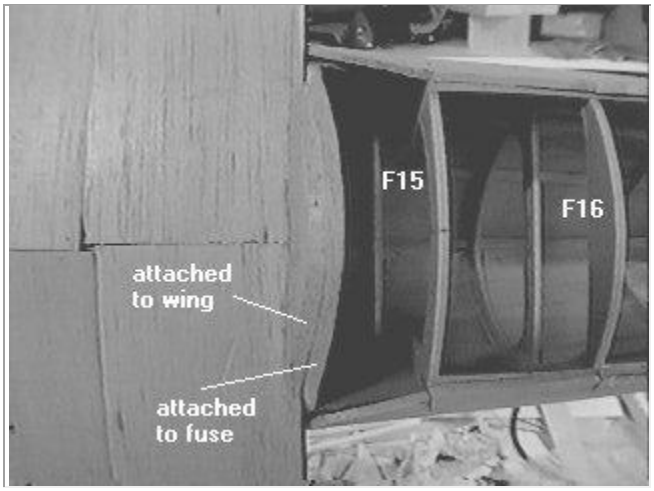


Photo #3

Using a T-bar, We sanded the two wing-fuse joint formers to the contour formed by the two fuse formers behind them, F15 & F16. The wing was then removed and sheeting was applied. See the result below.

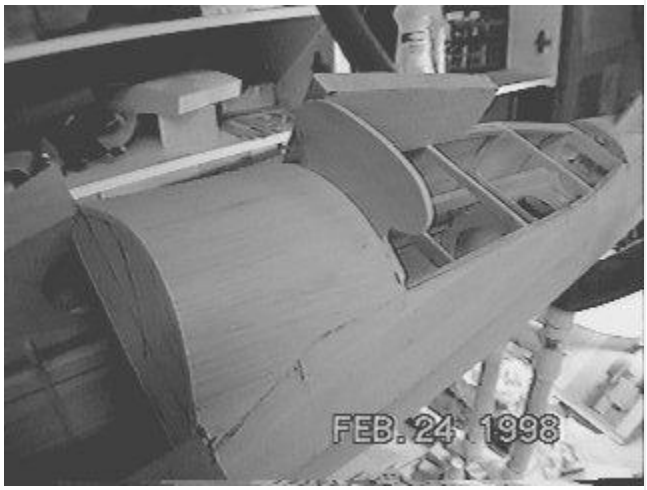


Photo #4

We start by cutting the air scoop cross-section using the template from the plans. This is from 1/8" lite ply. This piece will hold the dowels which will hold the whole assembly to the fuse. A 6-32 nylon bolt will hold the rear.

Making this lower air scoop removable costs almost nothing in terms of weight, but adds alot in servicability. I'm actually looking forward to servicing this airplane! Every area of the fuse containing components that will need service is easily accessible.

I've cursed over too many airplanes that had no removable hatches - and components requiring service buried deep within structures with limited access. It's just not worth it!!!

Photo #5

Close-up of the lite ply template and side blocks. Soft 1/2" balsa is used for the blocks. Inside the block on the right you can just see a smaller inner block that was needed to fill in the hole in the inner cove next to the skin.

Photo #6

All side blocks have been added. You can clearly see the inner cove filler blocks in this view.

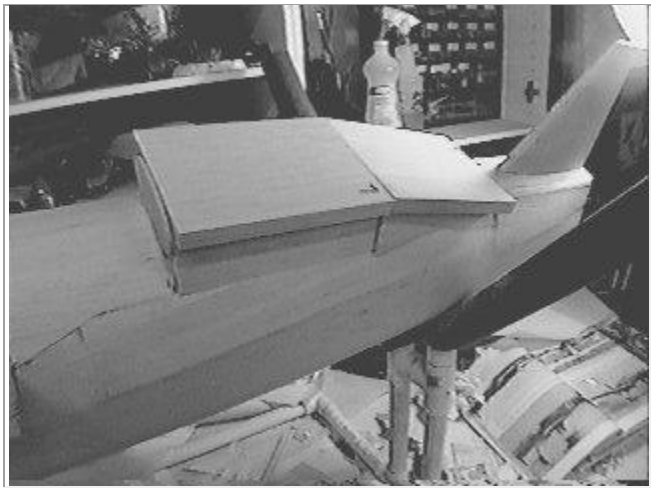


Photo #7

The bottom blocks are added. Thick CA is used throughout. The blocks are tack-glued to the fuse with a couple of small drops of thick CA.

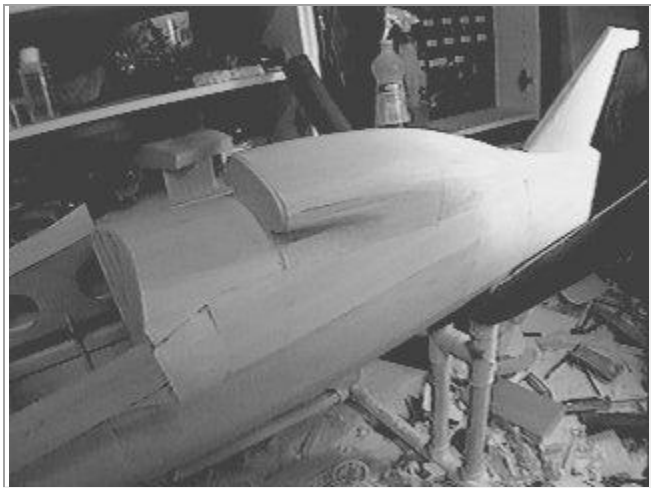


Photo #8

The main part of the scoop is carved and sanded to rough shape.

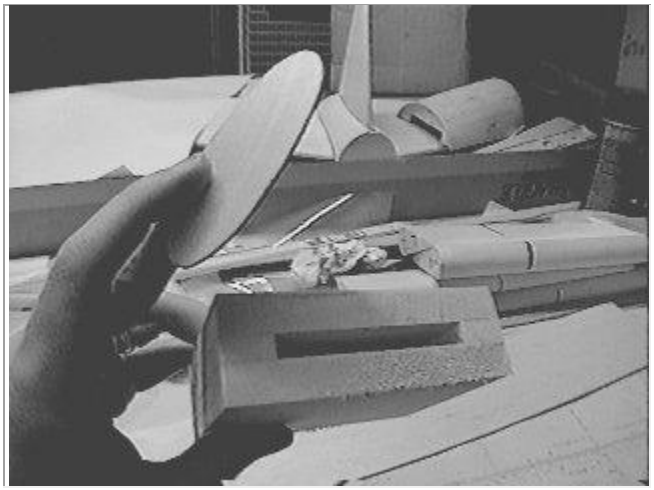


Photo #9

The forward part of the air scoop is made from an open-ended "box" of 1/2" balsa. The front face is made from 1/16" ply.

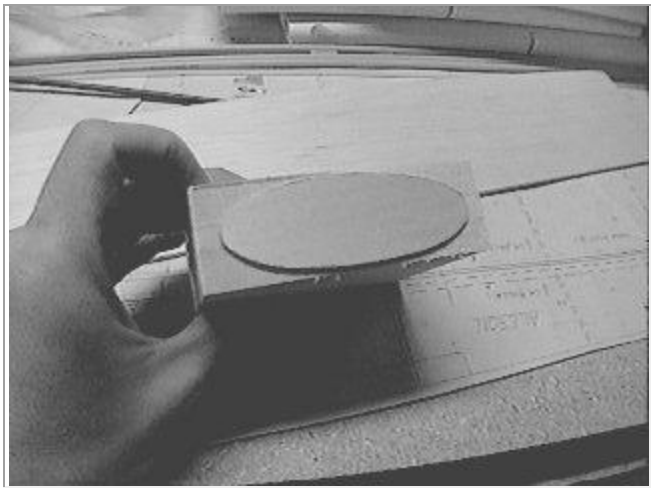


Photo #10

The front face of the scoop is glued onto the blocks with thick CA.

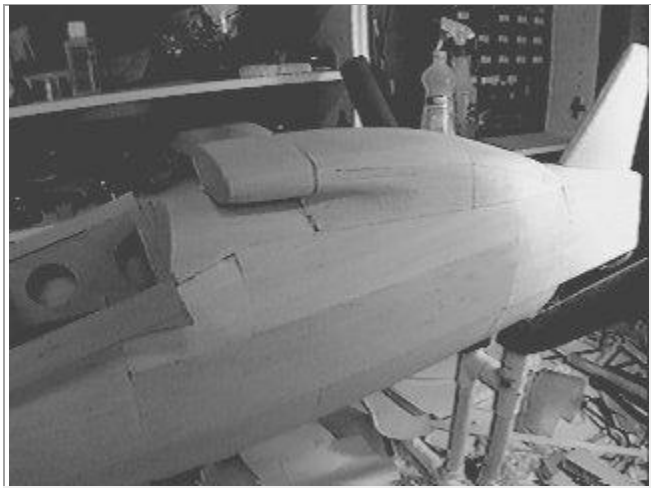


Photo #11

The (nearly) finished lower air scoop. Some filler will be needed in the area between the forward part of the scoop and the fuselage.

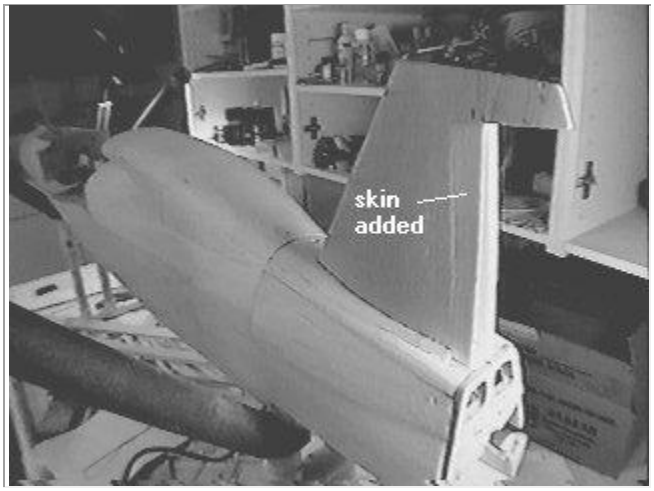


Photo #12

The lower rudder work is begun. We had to add some skin to make the rudder hinge line in the right place. It seems the lower fin spar ended up too far forward and at the wrong angle. It doesn't really hurt anything, it just means there's a larger void between the spar and the lower rudder. We used 1/8" soft balsa for the addition to give it a little extra strength.

Photo #13

This is the lower end of the 3/32" music wire torque rod that connects the upper and lower rudder halves. It (happily) goes through the engine area just between the mount and the rear of the engine.

I filed flats on both sides of the lower end, which will fit into a flattened piece of brass tubing glued into the rudder.

Many different arrangements are possible for driving the lower rudder.

Photo #14

Here is the flattened brass tubing. The lower part is cut and spread open to provide additional leverage once this is glued into a balsa block in the lower rudder.

Photo #15

Here is the wire fitted inside the flattened tubing. This is the lightest linkage I could think of that would be sufficiently robust. The lower end of the music wire had to fit through the 3/32 hole, so I couldn't solder anthing to it directly.

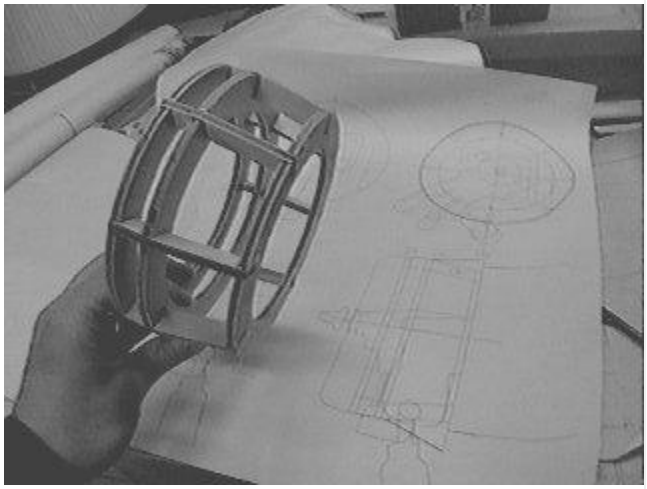


Photo #16

Sneak peek! Here is the foward cowling framework. This is the first thing we designed and built using a CAD program. We used AutoCAD on our Sun workstation. The result? Faster design and *perfect* parts fit. My local blueprint shop will plot my creations for 80 cents per square foot.

I've since used TurboCAD on the PC with great success.

We had a fiberglass forward cowl from Al Masters, but we decided to build up a cowling for a number of reasons. For one thing, we knew for sure that we would need weight in the nose. So why not build a robust cowl that will easily handle some lead? Less lead will be required if it is mounted in the front cowl ring, and a stronger structure is required if this weight is to be prevented from ripping the cowling off during landing! Don't laugh, we've seen this happen!

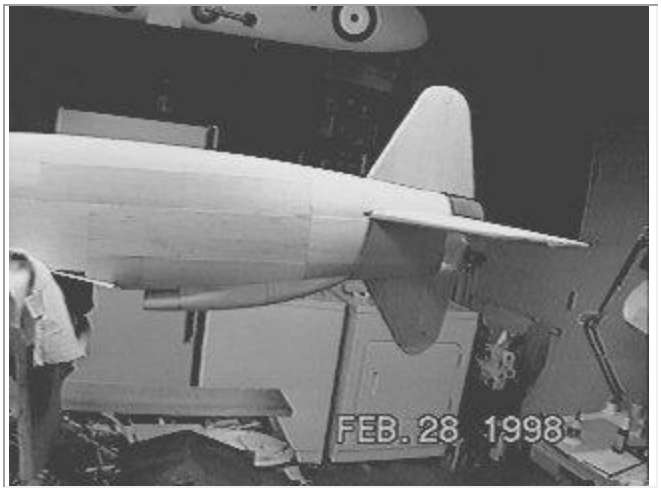


Photo #17

Here is the finished rear fuse. Looking good!

Front Cowl & Wing Fairings

Photo #1

The cowl framework (as seen in the last installment) has now had 1/32 ply epoxied to the forward part. The plywood was soaked in water and wrapped around a quart paint can to establish the "curl" before gluing it on.

The circular piece of 1/16" ply in the foreground will serve as the backplate for the forward cowl ring, which will be built up from the segments stacked behind it. These were cut using a paper template on the scroll saw and sanded to shape on the bench sander.

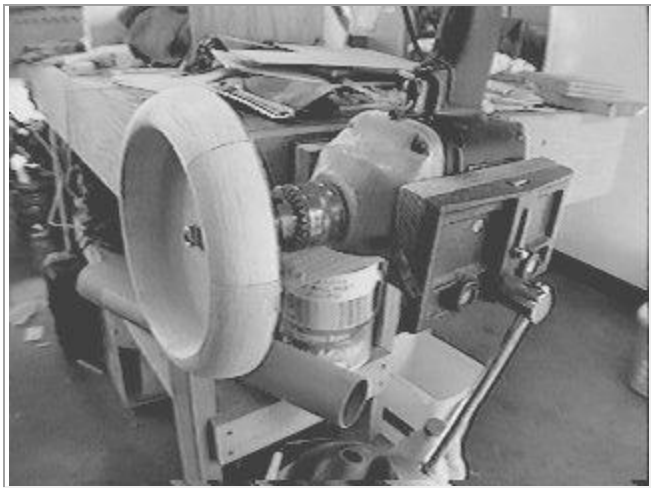


Photo #2

Poor man's wood lathe. Our 1/4" drill is pressed into the woodworking vise. We were a little concerned about this but it didn't seem to affect the operation of the drill at all. We clamped it just tightly enough to keep it from moving. After gluing the segments together to form the cowl ring, we used a piece of sandpaper to shape it as shown.

Photo #3

Here's the final shape.

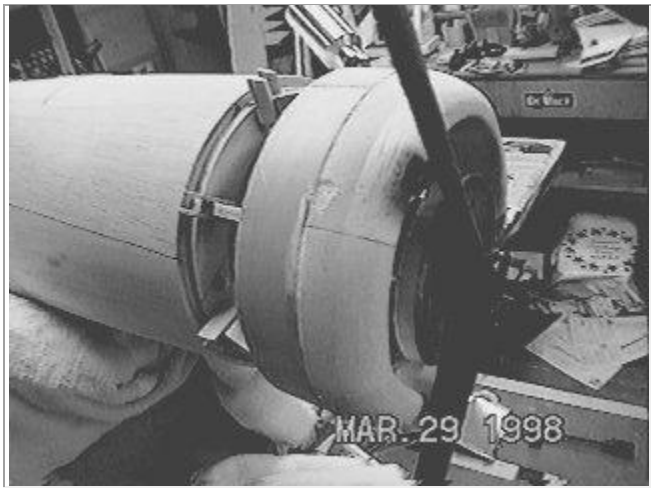


Photo #4

The ring is glued to the framework and the center plywood is cut out. Popsicle stick segments are glued to the framework to support the cowl flaps, which will be cut from thin aluminum flashing. This is the cheap variety that is used for roofing.

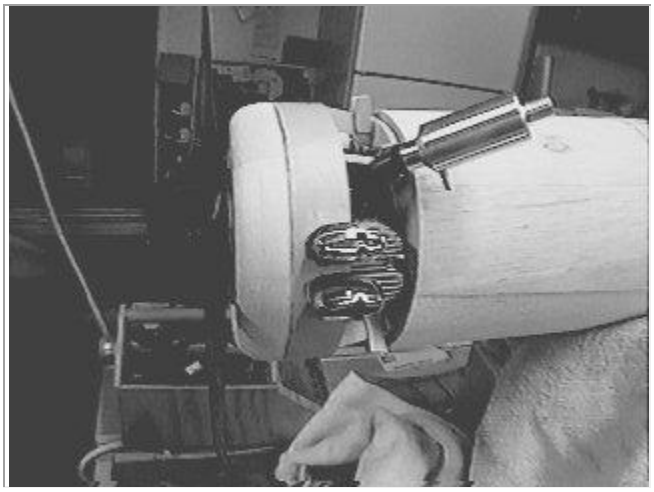


Photo #5

The lower part of the cowling showing the engine cutout and muffler.

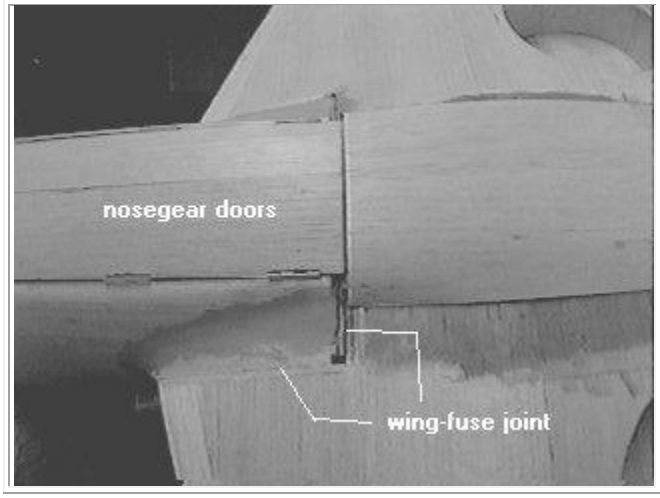


Photo #6

The front part of the wing-fuse joint. See the rear part below. This is just a strip of 3/32 sheet, sanded thin at the edges and glued to the formers you saw earlier. There is no former in the center, in fact it is nearly flat at the center joint.

All filler and fairings are from West Systems Epoxy with their microlight filler powder.

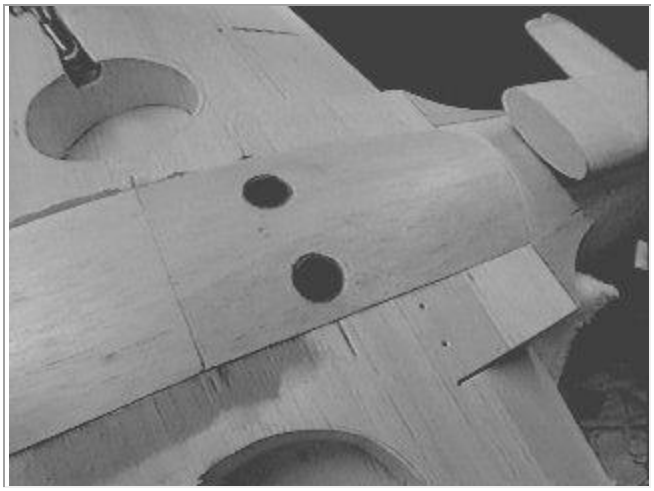


Photo #7

The wing hold-down bolt access holes are lined with sections of the hard cardboard tubing that K&S packages and sells their music wire in.

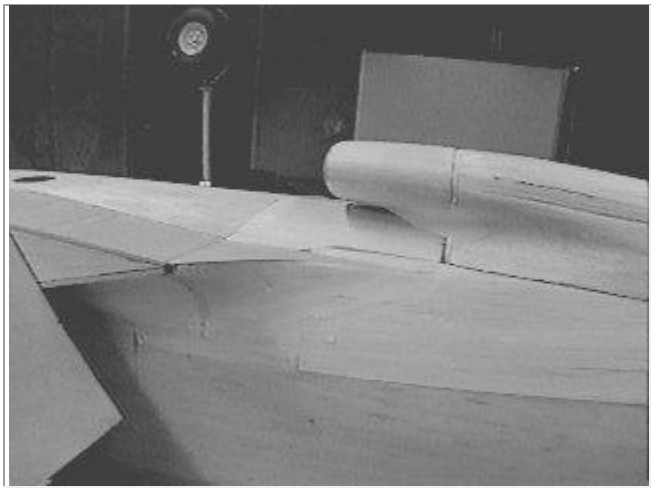


Photo #8

Lightweight white water-based filler paste is used on the wing root and removable lower air scoop.

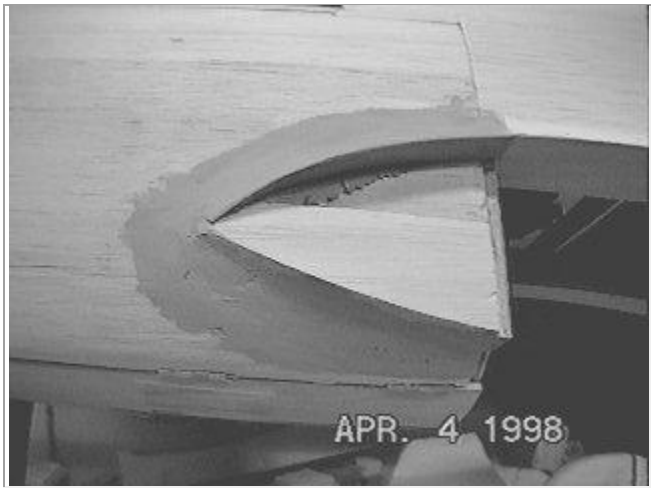


Photo #9

The front part of the wing-fuse joint. Note the sharp leading edge. This is a strip on the wing root LE that breaks up airflow at high angle of attack, causing the wing root to stall before the rest of the wing. The people I've talked to that have flown this model say that it works very well. In combination with the washout, it makes it hard to break the plane into full stall. It just "mushes" at low speed.

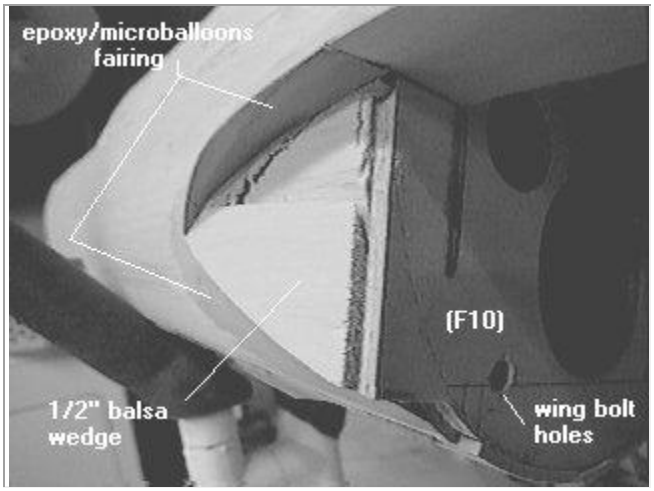


Photo #10

Looking foward at the wing-fuse joint and former (F10). This fairing was formed by making a wedge out of 1/2" balsa and butting the flat side of this wedge against the wing root (W1) while gluing it to the fuselage. Epoxy w/microballoons was used to form the rest of the fairing from the wing spar forward. All fairings aft of the spar are made with lightweight white water-based filler to save weight.

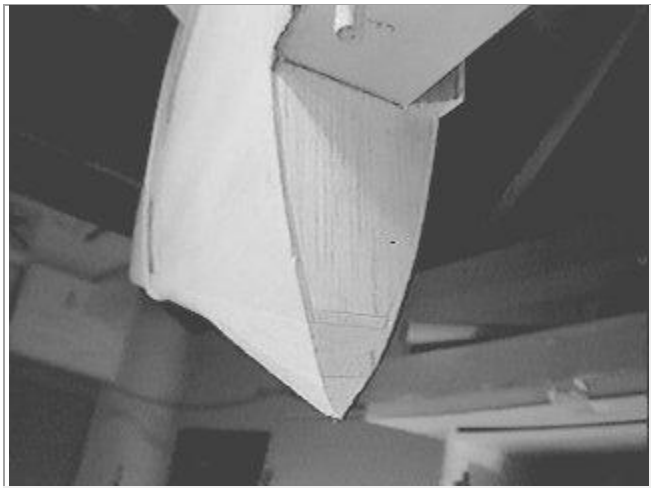


Photo #11

Close-up of wing root leading edge and rib W1. One of the wing hold-down dowels is just visible at top.

Finishing

We use 1/2 oz glass cloth with epoxy resin thinned 20% or so with denatured alcohol. The thinned resin goes on like water and soaks in -- no sanding required. I apply a coat of 'slurried' primer over this, primer mixed with microballoons. This mostly fills the weave of the cloth. Over that I use automotive primer from a spray can.

This finish is time consuming, but you end up with a hard, durable finish that will never wrinkle, sag or peel. I can leave the plane in direct sunlight on the hottest day without worry. Dings and minor damage can be repaired and repainted and the plane looks like new -- without recovering the whole thing. It's worth the extra time in my opinion.

Painted on markings are a fair amount of work, but well worth it in our opinion. They will never peel off, sag, wrinkle, or anything else undesireable. You can wipe and clean the model as much as you like and the markings will be totally unaffected.

Here is one method for painted on markings. You start with drawings or printouts of the markings. We used CAD printouts scaled to size. You then glue those templates to Frisket paper with 3M77 spray adhesive. We supply such printouts with the 81" short kit.

Frisket paper is available in most art supply stores. It is a low tack film that comes in sheets and rolls. With the template glued to the Frisket, you cut around the template with a hobby knife, cutting through the Frisket film. When this is done, you have a sticky-backed template in the shape of the marking.

After spraying the marking color (black in the case of the VG PH markings in the photo below, or white in the case of the fuselage cross) you remove the backing from the Frisket film and apply the template over the painted surface. Once all of the markings are done in this way, you can apply the camouflage colors.

You can see the swastika and "102" templates (barely) in place on the vertical tail. The red color is from automotive spot putty, which we use to fill larger dings and holes. It dries very fast and is very lightweight.

The Frisket is low-tack, and so comes off rather easily. For this reason I would recommend doing this part as the very last step before painting. Any handling after this is likely to dislodge the Frisket paper templates. Standard rules about spraying lighter colors first especially apply here. Black is very hard to cover with white, for example. Watch for

Finishing, Part II

	Photo #1 Overall view. Enamels for plastic models were used: Testor's Model Master - RLM 80 Olivgruen (olive green) Floquil 303033 Medium Green (-34138) - RLM 83 Lichtgruen (light green) Testor's Model Master - RLM 76 Lichtblau (light blue) The RLM 83 color is a fairly light green. The photos on the main page of the building guide reproduce the colors more effectively. Accurate colors and markings add alot to the look of a scale model and are worth the time and effort. Take it!

Photo #2

Rear 3/4 view. We used Chevron "Perfect Paint" dead flat clear overall for fuel-proofing.

Panel lines were done with plain #2 pencil - before the dead flat clear was applied.

Photo #3

View from tail looking forward. Spinners and props are AeroMaster RLM 70 Schwartzgruen (black green). Black is often used mistakenly.

Color chips from Monogram Aviation Publications "Painting Guide for German Aircraft 1939-1945" were used for paint matching. Alot of sources are available for color reference.

Photo #4

Rear fuse close-up. The model is finished in the markings of Wr. Nr. 240102, the only surviving Do 335. Brought to the US after the war, it was stored for years at the US Navy's NAS Patuxent River. In the 1970's it was returned to Germany for restoration by Dornier. It was displayed at the Deutsches Museum in Munich for 10 years and then returned to the Garber Facility of the NASM where it is today. See the photo section for current pictures of this aircraft.

Photo #5

Nose section close-up. Spinner is Pica's FW-190 spinner. Prop is 3-blade Master Airscrew 13-6. Cannon blast tubes are made from styrene plastic tubing (Plasti-struct), shoved into holes carved out of the balsa skin. Epoxy & microballoons was used to fill in around the tubes, then the tops were cut open and then ends shaped.

Supercharger air intakes are from balsa block, carved and sanded, then hollowed out. Music wire bent into a circle is used to reinforce the circular opening. The forward intake is used to hide the radio on/off switch. A piece of music wire is used to operate the switch with a finger stuck into the opening.

Exhaust stacks are from styrene "square" plastic tubing, glued to sheet plastic backplate.

Photo #6

Canopy in open position. Brass doll house hinges are used. The cockpit is not finished. I will complete it after the flying program begins. Note the rails for the ejection seat are in place. The Do 335 was one of the first aircraft to feature an ejection seat.

Photo #7

Sitting next to my truck you get an idea as to scale. Even the 70" Do 335 is BIG! The post-finishing weigh-in looks like about 16 pounds. Final weight was more like 19 pounds.

Photo #8

Photo #9

Same view with flash. Main LG doors are made from sheet aluminum, the type used as flashing for chimneys - available at the hardware store. Cheap, durable, easy to replace. It can be bent and re-bent to shape. If the paint chips, metal shows through - kinda realistic :-)

Flying the Do 335

It's hard to describe the way the Do 335 flies. It "feels" unlike anything I've ever flown. It is **extremely** stable, to the extent that it almost "resists" any displacement of the two propeller discs. I suspect that this is mainly because of the weight distribution caused by the rear engine and the gyroscopic effect of the rear propeller. Pitch and roll response are both crisp. A guy who built and flew the smaller 56" version told me to expect it to be sluggish in pitch. I put extra throw into the elevators for this reason, but I've found I don't need it. It is very responsive on all axes. Needless to say it is not as maneuverable as a conventional plane, but then most twins aren't.

Use flaps only with sufficient power. It is not recommended to throttle back to idle with full flaps applied. You can get into a stalled condition too easily. Expect some slight pitch up as flaps are applied.

Our Do 335 had too much of a nose-down 'sit' which made for long take-off runs. Mind your retract installation carefully and you can avoid this problem. The plane should sit on its gear as close as possible to flying attitude. Torque yaw is not a problem. The torque of the two engines cancel out.

As with any plane with high wing loading, performing stalls downwind is not recommended! This is the only situation in which we have seen this plane tip stall. It is a very scary experience! Also, in general, make all of your maneuvers smooth and gentle. This is not a TOC aerobatic plane!

More Info

RCSB Thread

Go to http://www.rcscalebuilder.com and register. It's free and worth your trouble. Trust me. The 60" Do 335 thread is in the "Other Designers" forum.

Yahoo Group "Do335"

Go to http://groups.yahoo.com/group/do335/ and join the group. This is a good place to post questions and connect with others building the Do 335. The building guides are also posted here in PDF format.

Phone and "Snail Mail"

Finally, if you don't have Internet access and need help, feel free to contact us by letter or phone. The address and phone number are listed on the title page of this building guide.

Good luck with your Do 335 and keep in touch! We would like to hear your results.

Gary Hethcoat

Wings on the Web / Aviation Research