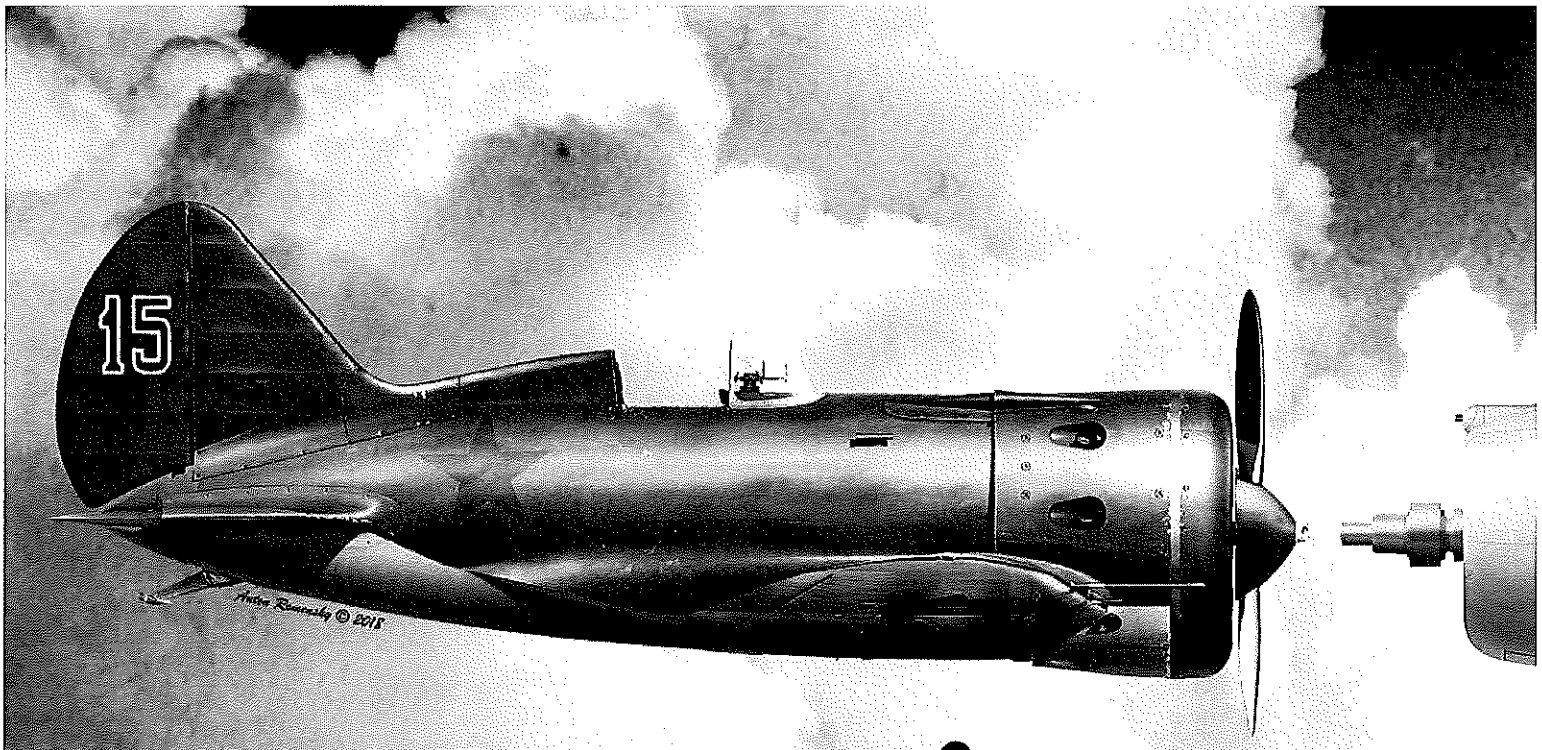


Fighter Scratch-building

by Paul Kohlmann | Photos by the author and as noted

Editors note: The blue hakaristi, which means hook-cross, was used as the official national marking of the Finnish Air Force between 1918 and 1945 and predates use of the symbol known as the swastika used by the Nazi party in Germany.

Scale modelers are known to have active imaginations. The running joke among the breed is that we run around the house making airplane noises as soon as we can test-fit our projects together.

But the imagination doesn't stop when the building is complete. Watching scale models take to the air tends to increase our whimsical nature even further. Each scale flight is a vicarious adventure—perhaps a tribute to a famous pilot or the recreation of a moment from the past.

When two scale warbirds take to the air at the same time, this effect reaches its peak—particularly when the warbirds in question are models of aircraft that once met in true aerial combat.

The Project

My friend, Derek Micko, and I set out to create such an encounter. We have each designed a number of warbirds throughout the years and we talk regularly regarding our projects. Somewhere along the way, we agreed that it would be fun to collaborate. Ultimately, we each committed to design a model with the following criteria:

Warbirds. Because the whole purpose of this collaboration was to create two models of similar performance that would interact with each other, the choice of aircraft type was obvious. No aircraft spent more time interacting with other similar types than fighters. Derek and I have both gravitated toward World War II fighters as subjects for most of our projects. Our first criterion was that we would each design a warbird.

Size. Derek and I both started out designing models with 30-inch wingspans, but throughout the years, our projects have grown larger. Derek has gone as far as 80 inches, while I have gone up to 60-inch wingspan aircraft. After some discussion, we agreed that 60 inches was a nice target. At this size, the models would have plenty of authority in the air and be great platforms for detailing, but they would still be economical and transportable in a passenger car.

The stubby Polikarpov I-16 was quite a hot rod in its day. Photo by Jesus Fernandez.

Derek Micko's Polikarpov I-16 is fully assembled and ready for covering.

Polikarpov I-16

The Polikarpov I-16 was the premier Russian fighter during the 1930s and, at the time of the German invasion, comprised more than 88% of the Soviet fighter force. Famous historian Walter Boyne likened the I-16 to that of Rodney Dangerfield, in that it received no respect for its significance, and for a period of time, eminence on the battlefield. It was the first monoplane with retractable landing gear to enter frontline service.

Early versions had an enclosed cockpit, and later versions carried a variety of weapons, including cannons, rockets, and bombs. It was a test bed for ram-air engines, retractable skis for winter operations, and a parasite aircraft on the TB-3 bomber (one hung under each wing of the TB-3).

There were many versions of the I-16 in its years of service from 1934 to 1950—yes, Spain flew this aircraft until 1950! Throughout its long history, many nicknames were attached to the aircraft. The Spanish Republicans called it the Mosca (Fly), while the Nationalists called it Rata (Rat), and the Soviets called it Ishak (Little Donkey). The Germans less affectionately called it cannon fodder.

But this reputation was not always the case. During the Spanish Civil War, while flying for the Republicans, the I-16 was far superior to the Fiat C.R.32 and Heinkel He 51 biplanes it faced in the Spanish skies. It was also an even match for the early versions of the Bf 109s before they were upgraded with a more powerful Jumo engine.

Later, in the skies above Manchuria, the I-16 faced off against the Japanese Nate (Nakajima Ki-27) and Claude (Mitsubishi A5M), and these fixed-gear fighters proved to be a closer match. During the Russo-Finnish War, the I-16 was outclassed by the Fokker D. XXI and by its partner in the Fighter Face-Off—the Curtis P-36 Hawk.

The I-16 was extremely maneuverable with a top speed of slightly less than 300 mph. It was a robust aircraft. It was often able to take severe damage and return to base, and in later years, this was a necessity. In times of desperation, some Russian pilots turned to taran (aerial ramming attacks) to bring down German aircraft.

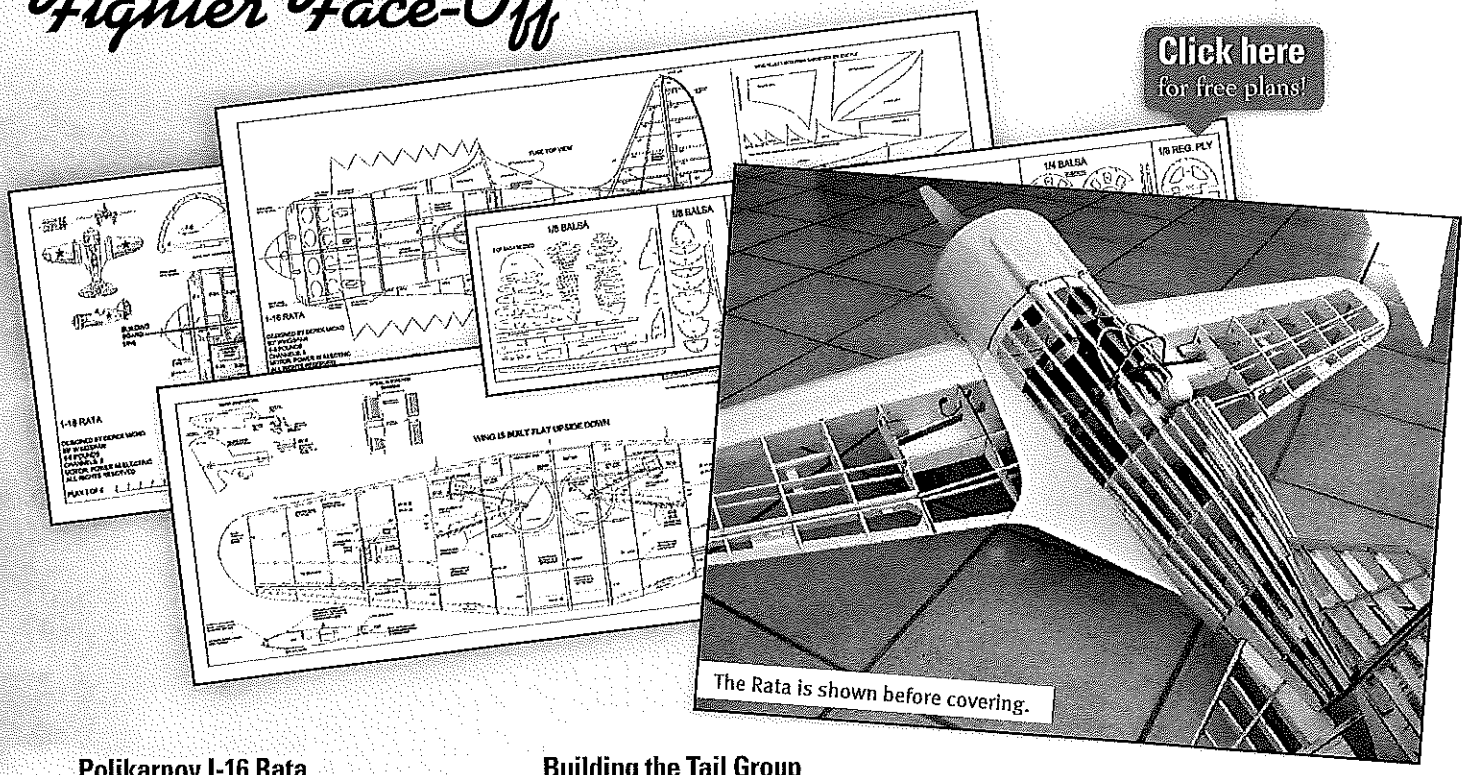
Surprisingly, some of the pilots actually survived the collisions to fight another day. Because of its wing loading and maneuverability, the full-scale I-16 was challenging to fly, but those who learned its habits really liked its virtues. We hope to represent the full-scale I-16 with an easy-to-fly model.

Useful references from the *Model Aviation* "Construction Series"

"Balsa Builder's Basic Toolbox," March 2015: Although the fighter face-off models are slightly advanced for beginners, a review of the tools of the trade might be useful before getting started.

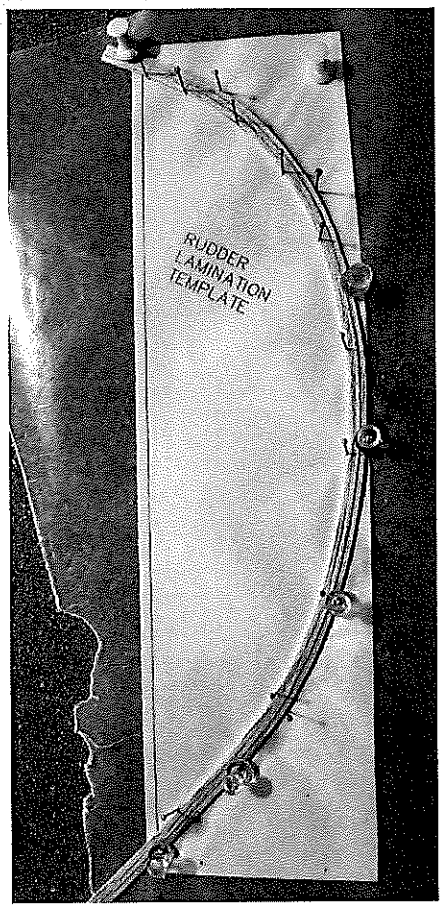
"Balsa Builder's Basic Toolbox," March 2015: A magnetic building board is a flat work surface that is preferred by many builders over the traditional building boards and pins.

Fighter Face-Off



Polikarpov I-16 Rata

In this month's installment, I will discuss the initial construction of the Rata. So clear off the building board, gather some balsa, and let's get to it!

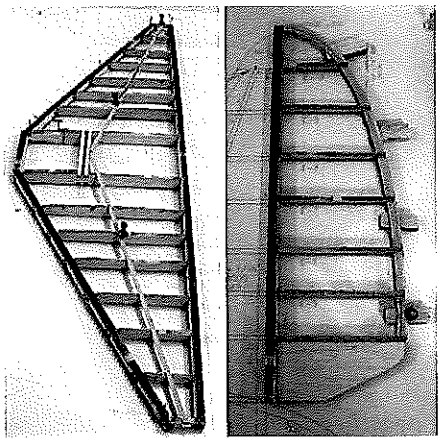


Lamination of three 1/16-inch square balsa around the rudder outline.

Building the Tail Group

Just as Paul did with the Hawk, I'll start with the tail surfaces. These also feature laminated edges made from three laminations of 1/16-inch balsa. They were cut using a balsa stripper and one end of them was glued together. These were bent over a form to dry and I glued them together with Elmer's Glue. In keeping with a traditional build style, I decided to use Titebond wood glue primarily though the build. This really didn't add much to the build time.

Those who are familiar with my Bearcat design will see some similarities. The fuselage is built over the top view of the plans and the formers are split at the horizontal line. The horizontal stabilizer is built first, right over the plans, and remains on it as the fuselage is added around it. The horizontal's main spars have alignment tabs to account for the taper in thickness.



This shows the horizontal stabilizer and elevator assemblies.

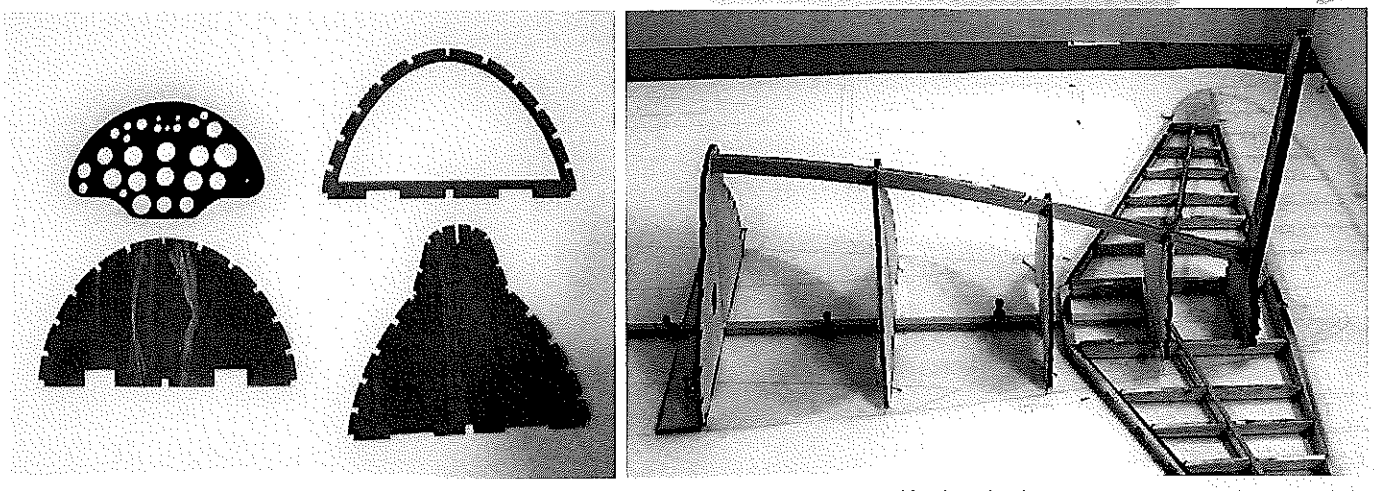
All of the H parts were removed from the balsa "tree" and dry-fitted together. After the alignment was set, I used Titebond to glue the H pieces in place and added some 1/8-inch square and 1/8 x 1/16-inch basswood stringers. The horizontal ribs tab into the trailing edge (TE) and leading edge (LE). Because of the sharp taper, I filled in some of the tab area with scrap balsa for strength.

The elevators are built in halves and the ribs key into the LE. Dry-fit all of the parts and trim the TE to the plans and dry-fit it as well. When satisfied with the fit, glue the assembly together. I pinned blocks of 1/4-inch balsa under the TE to eliminate any possibility of warps.

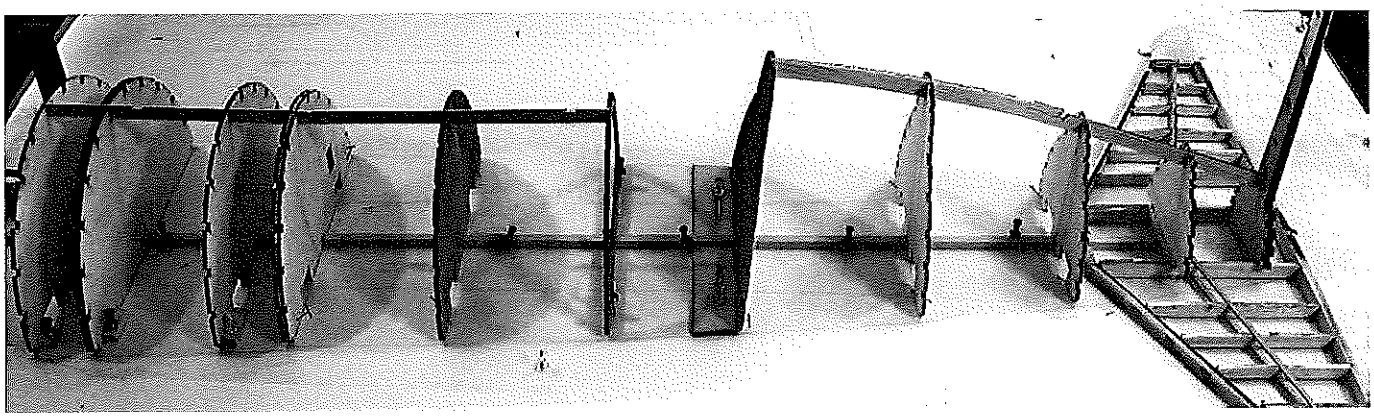
I removed the horizontal stabilizer and elevators from the board and sanded them thoroughly. The horizontal stabilizer's balsa tips were added and the elevator tips were blocked in for strength. The horizontal stabilizer was then pinned back to the board with 1/8-inch balsa shims under H-12 to provide support.

Building the Fuselage

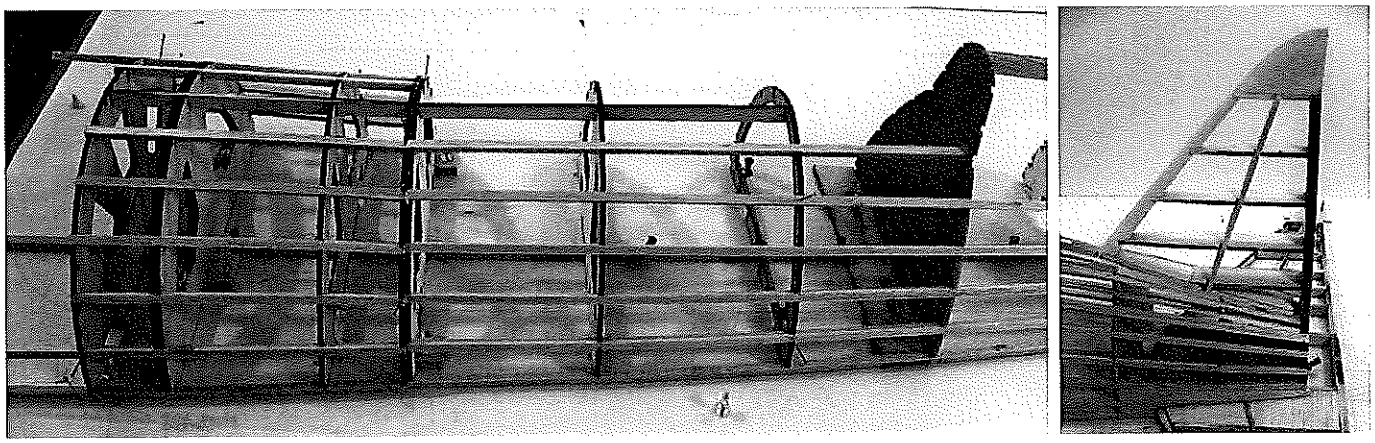
The full-scale I-16 had a round fuselage. The model's fuselage is built over the top view of the plans. A 1/4-inch



The formers are painted before the final assembly. In the secont picture above, the tail formers and keel are in place.



The main formers and keels are in place. Note the temporary mounting tabs on the forward formers.



The 3/16-inch square balsa stringers have been added and the vertical stabilizer is complete.

basswood stringer down the center helps with rigidity and alignment.

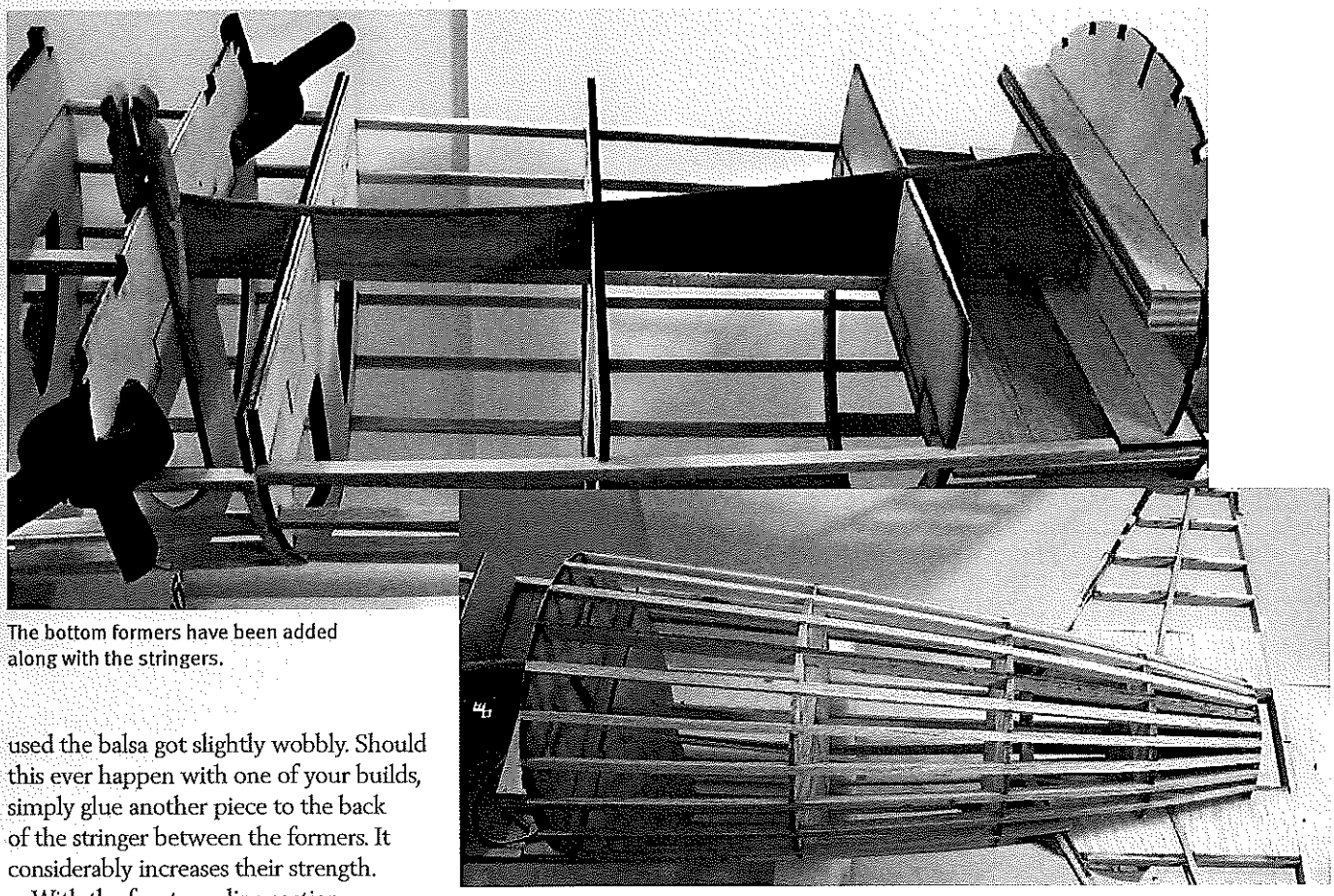
Before pinning it to the board, sand a notch where F-2 would meet the stringer to avoid gluing these two parts together. The half hole in F-2 is for the back of the motor shaft. You will also need to cut a notch in the stringer for WMP-4. Pin the 1/4-inch stringer, WMP-4, and the horizontal stabilizer in place over the plans. Test-fit F-8 to F-10 and V-2 in place over the plans. When I was happy with the alignment, these were glued in place with Titebond. Former F-10 slides between two 1/8-inch stringers on the horizontal stabilizer.

Because the version I was doing had an open cockpit, I decided to paint some of the parts ahead of time. The full-size interior was a grayish blue and I used rattle-can paint to spray F-5 to F-7 and the instrument panel flat black.

Former F-7 and the top keel (K-2) were dry-fitted then glued in place. Former F-4 is a made from F-4 and F-4A glued together. Former F-4A is slightly smaller and this is the break point for the cowl and the rest of the fuselage. Glue the two F-2s together. Dry-fit F-1 through F-6 to the center stringer and add small tabs of scrap balsa to allow for easier pinning.

When I was satisfied, I glued these in place along with K-1. This keel part is notched and helps with alignment.

The main fuselage stringers are 3/16-inch square balsa cut from medium balsa sheet. The front section near the cowling is not as critical because it will be sheeted with 1/16-inch balsa, but the rear stringers need to be firm to ensure strength. Some of the ones on which I



The bottom formers have been added along with the stringers.

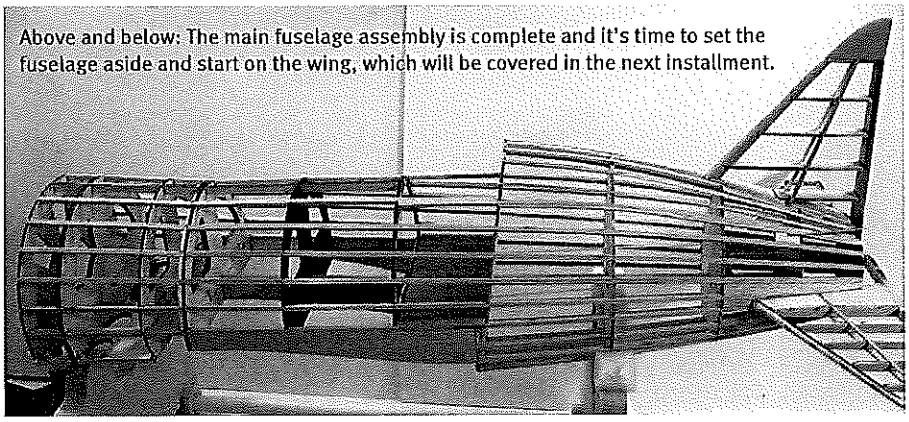
used the balsa got slightly wobbly. Should this ever happen with one of your builds, simply glue another piece to the back of the stringer between the formers. It considerably increases their strength.

With the front cowling section finished, the rear stringers were added, starting at the top and alternating sides. The stringers on the turtledeck are 1/8-inch square basswood soaked in ammonia, if needed, so they bend to the shape.

The top stringers between F-9 and V-2 were blocked in with scrap to allow for the bottom rib of the vertical stabilizer. The vertical parts interlock and tab into V-2. The top of the fin is a lamination of two 1/8-inch balsa parts. These were rough shaped before being glued to the vertical stabilizer.

Scrap 1/8-inch balsa was used to fill in around and in the horizontal stabilizer. The cockpit floor is 1/8-inch balsa cut to fit and painted to match. At this point the model was given a thorough but gentle sanding to blend any rough areas and to prepare it for covering. It was then unpinned from the board.

The fuselage was turned upside down and set in a stand. The bottom formers were added and I installed the 1/4-inch balsa center wing saddle piece. Wing mounting plate 3 was added to F-7L and glued in place.



Above and below: The main fuselage assembly is complete and it's time to set the fuselage aside and start on the wing, which will be covered in the next installment.

The remaining bottom formers and keel were added next. The elevator servo was mounted under the cockpit and between F-6L and F-7L and the .047 Du-Bro pushrod tubes were added at this time. The bottom 3/16-inch stringers were added and blocked in around the horizontal stabilizer.

The battery mounting plate is made from two laminations of 1/8-inch light plywood and locks into the bottom of formers F-1 to F-3. The outer 1/8-inch wing saddles are added between F-4AL and F-7L.

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—Derek Micko
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SOURCES:

Model Aviation archives
http://library.modelaviation.com

Manzano Laser Works
tomj@tularosa.net
http://manzanolaser.com

BONUS CONTENT

Derek Micko and Paul Kohlmann have designed a pair of 60-inch built-up balsa warbirds representing aircraft that met in combat. Derek chose the Polikarpov I-16 Rata while Paul selected the Curtiss P-36/Hawk 75. Free, downloadable plans for these models can be found on this website.

This is the third and final installment of the series. The entire article can be found on this website and in the digital edition of *Model Aviation*.

In this article, Derek will complete the framing of the Curtiss P-36's wing so that he can focus more on the retracts and details that are specific to the aircraft.

The I-16 Rata

Last month, I covered building the horizontal stabilizer and most of the fuselage. This month I will finalize the construction and finish.

Framing the Wing

The wing is built in three sections: the center and the two outer panels. Prepare for the build with several subassemblies by gluing the wing mounting plates together, A/Bs to W-1 (making sure to make a left and a right version), retract plates, the TE (a composite of balsa and 1/8-inch square basswood glued to the "inside" edge to allow for more rigidity and less warping), and the wing spar 3 (also of composite construction, a 1/8-inch balsa spar with an 1/8 x 1/4-inch basswood plank glued to the bottom). The ribs and spars have tabs to help create a warp-free wing while building in the correct washout.

When viewing the I-16 in the "front" view, the top of the wing is flat. The dihedral is made from the bottom wing line. Because of this, the wing is built upside down as one piece, flat over the board. There is a 1/8-inch square stringer that is used for alignment on the plans. Cut and pin this to the board.

Dry fit all of the ribs into wing spars 1 and 2 and set them on the 1/8-inch square stringer over the plans. The retract plates "key" into W-2, WS-1, and W-3. Bevel the front edge and the rear edge to match the angles on WS-1 and to mate flush with WS-3 (to be added later). Titebond was used on all of the main wing assemblies and construction.

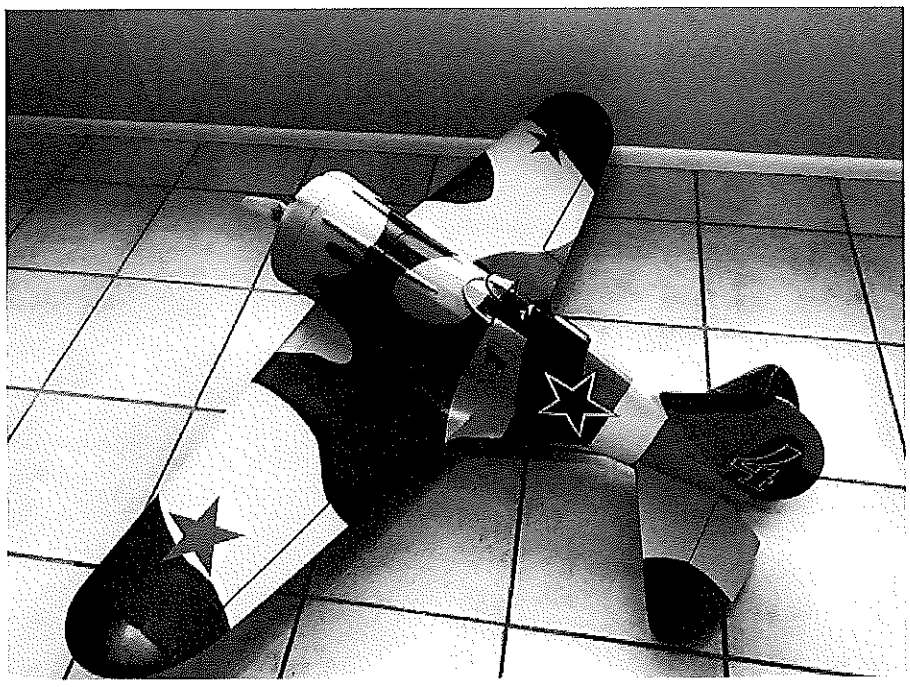
Add the 1/4-inch square basswood stringer between W-2 and W-3 in front of WS-1 and the retract plate. Mark WS-1 where it needs to be trimmed for the retract and cut this away with a Zona saw.

Drill the holes for the retracts and temporarily mount them. Fill in with block balsa scrap around the retract unit and then sand to match the rib contour. This will allow for a better surface when sheeting later.

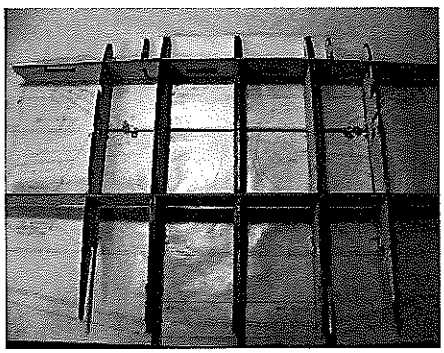
Next to build are the outer panels. Test fit the ribs into WS-3, fit the spar assembly into the center section, and slide the aileron pieces into place with scrap 1/32-inch balsa between them. When satisfied with the fit, glue and pin to the board. Add the 1/8-inch square basswood stringers to the top and bottom.

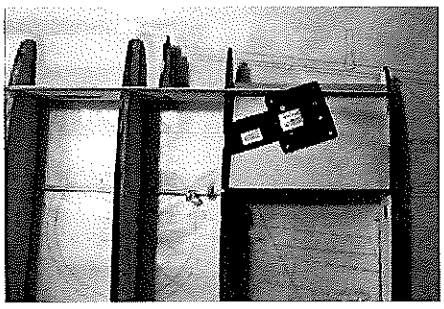
The outer LE "keys" into the ribs and is glued in place. It is sanded to match the contour of the ribs. The top and bottom of the wing are sheeted from WS-3 forward with 1/16-inch balsa. Cut a rough shape that is approximately 1/2-inch to 3/4-inch wider than what's needed. This allows for overhang and can be taped/pinned down when gluing to the ribs.

Mark the cutout area for the retracts and remove this area before gluing in place. Use Windex on the top surface when

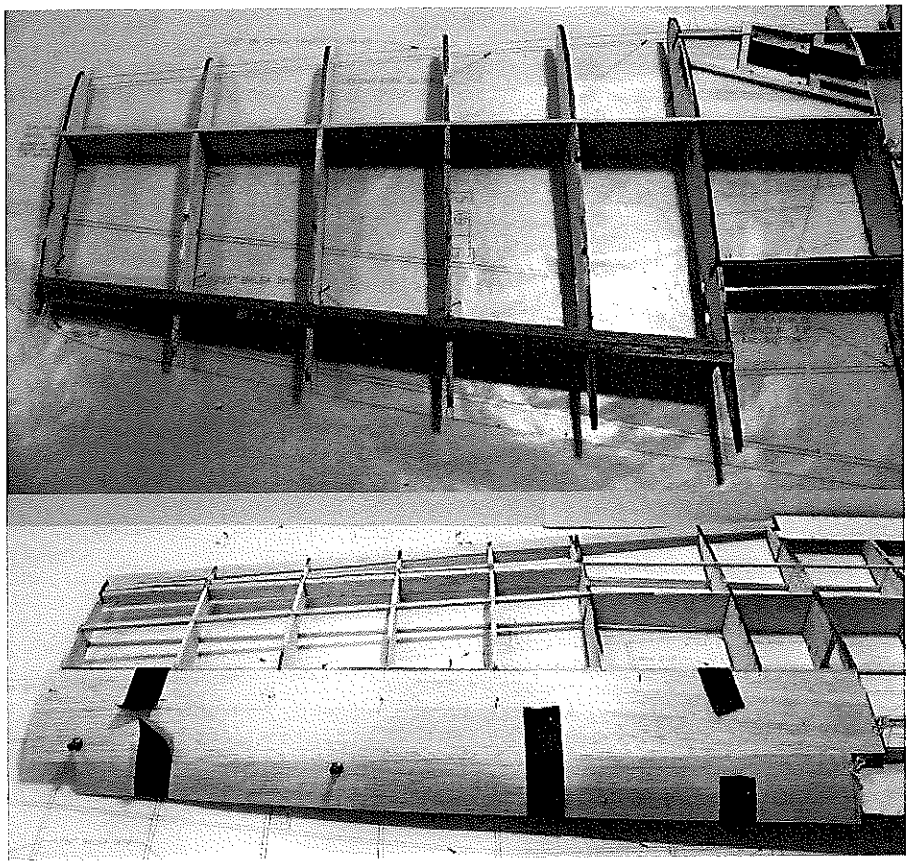


The Rata in color with its "Black Lusi" dog badge.

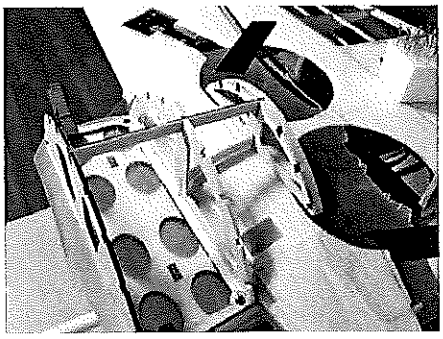


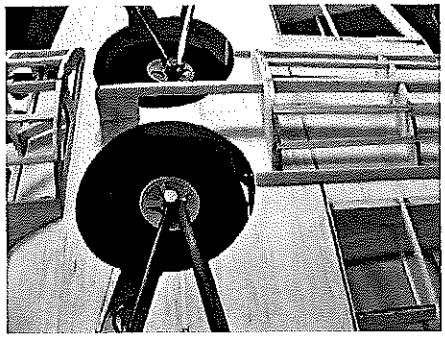


Center-section and retract details.



Left panel framing and sheeting of the wing.





Framing of the hatch and belly pan details.

gluing. The ammonia helps make the balsa pliable and if you wet the "outside," it curls in the correct direction. The TE is slid and glued into place at this time. The other panel is built the same way.

Glue wing mounting plate-3 (WMP-3) in place and remove the wing from the board. Add the remaining 1/8-inch square basswood stringers, top outer sheeting, LEs from 1/2-inch balsa triangle stock, and wingtips from laminations of 1/4-inch balsa. The remaining bottom sheeting is now added and the wheel wells are cut out. The LE center section bottom is blocked in with scrap, as is the wing mounting bolt area in the front. The LE is then sanded to a round contour per the plans.

Rudder and Cowl

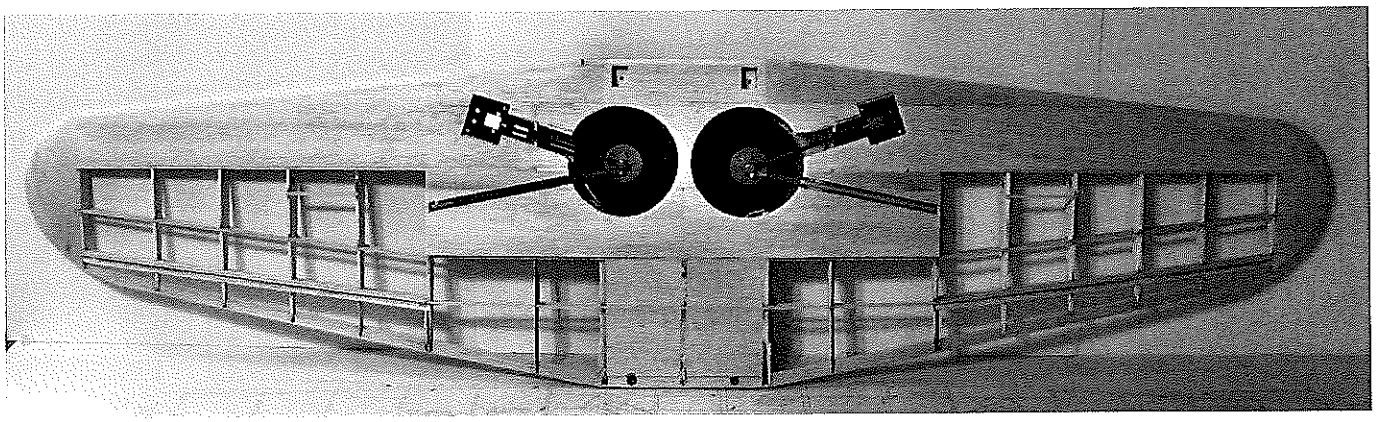
The rudder and cowl are straightforward and built by referring to the plans. Before gluing the cowl rings in place for final sanding, test fit the motor, a Turnigy 42. (A 42-58 500 Kv was used on the prototype and provided plenty of power.)

Hatch and Belly Pan

The wing was set in place over the fuselage and checked for alignment. When squared, drill holes for the four 4-40 bolts and their brass inserts that are mounted in the battery mounting plate (BMP) and WMP-3.

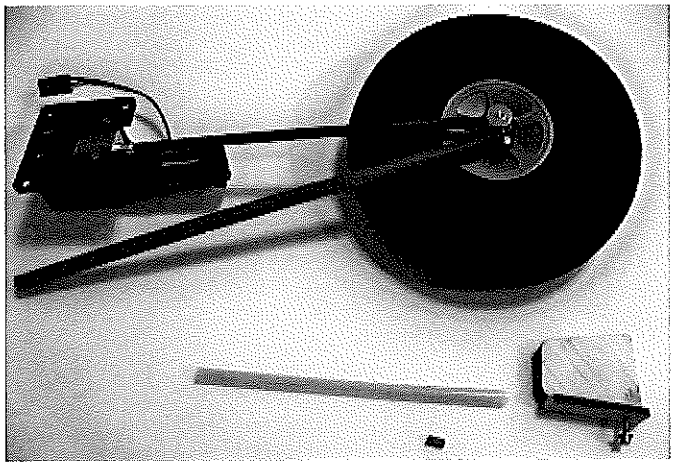
With the wing mounted, the hatch work is next. The hatch rail is made from three pieces glued together using the plans. Lay waxed paper over the battery/wing mounting plate and align the hatch rail with some plastic tubing or dowel (this will be removed when the 1/8 x 1/4-inch magnets are added).

Next, F-2A and F-3A are set in place

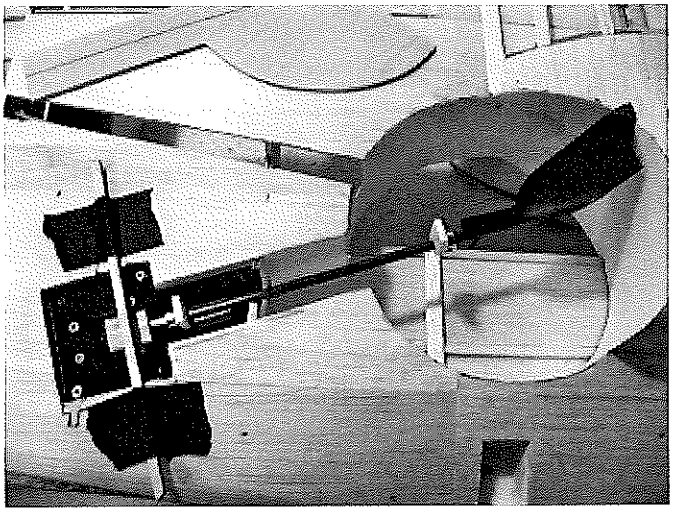


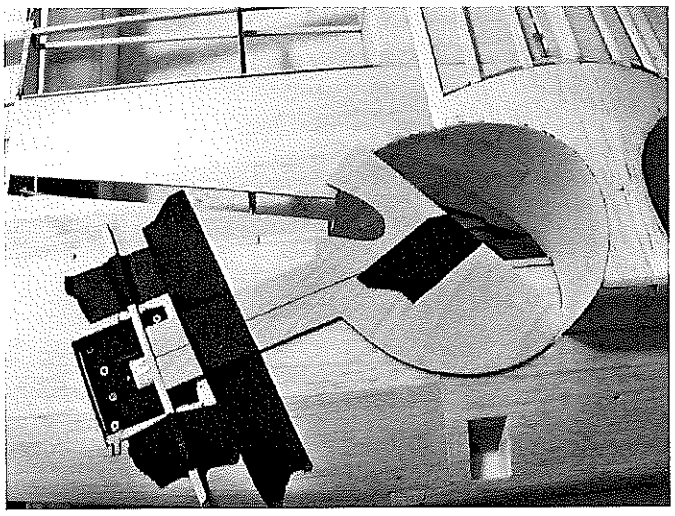
The main wing construction is complete.

BONUS CONTENT

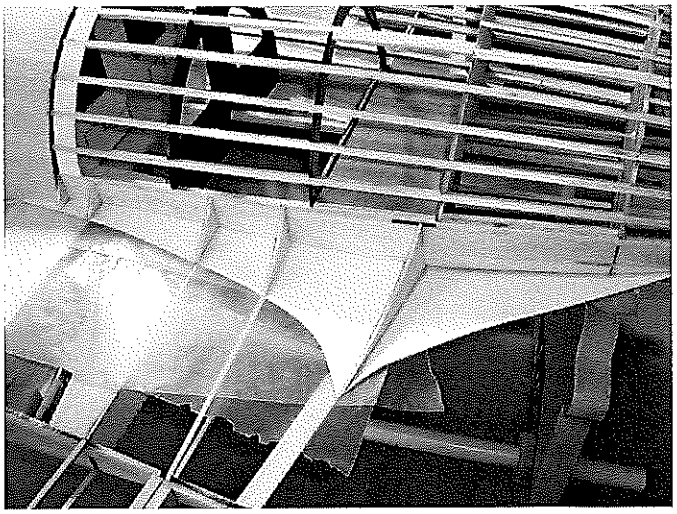


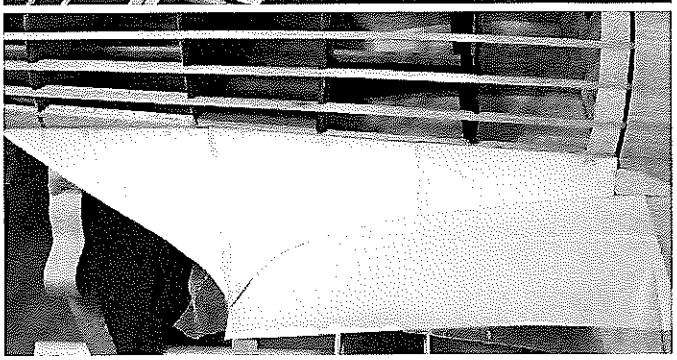
"Thinned" tire and strut assemblies.





The gear-mounting tabs are in place and the door is attached.





A cardstock wing fillet with ribs and the completed top section.

and glued. Add F-1A and the hatch keel. When it is dry, remove and epoxy the magnets in place. They will be mounted in both the hatch rail and the battery/wing mounting plate, so polarity will need to be checked. The hatch is placed back in place and the $^{3}/_{16}$-inch stringers are added.

At the bottom, between F-2A and F-3A, there is a piece of $^{1}/_{8}$-inch balsa that is cut using a template on the plans. The hatch is sheeted with $^{1}/_{16}$-inch balsa using a template. Some fitting is required so the wheels can clear the sheeting when extending. Take time to ensure that there is a fair amount of clearance.

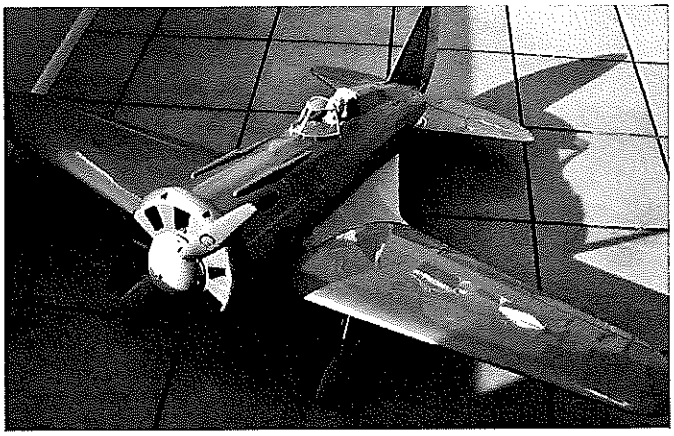
The belly pan construction is similar to how the hatch was built. Review the plans for construction and utilize the templates when sheeting with $^{1}/_{16}$-inch balsa.

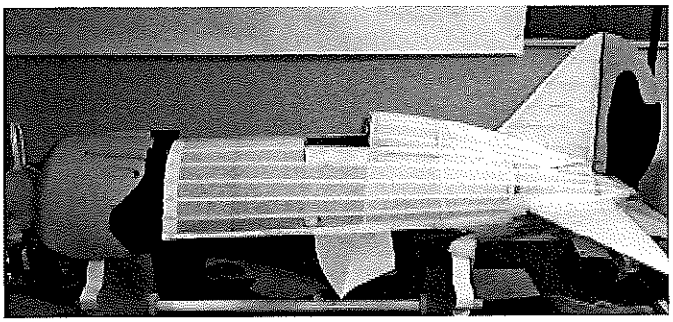
Wheel Wells and Retracts

The wheels used for the prototype need to be 4.5 inches in diameter and as thin as possible to be scale and to fit into the wing. Dave Brown Products Lite Flite Wheels (part # WR45-5745) are the right diameter but are still too thick. They are roughly 1.5 inch and need to be closer to 1 inch. The wheels need to be "thinned."

Separate the hub into two pieces (one slides over the other) and trim these parts to allow them to be narrower. Using the treads on the tire as a guide, shave off approximately $^{1}/_{4}$ inch of the outer foam from each side using a large kitchen knife. Sand the foam tire with a large sanding block until the face of the tire is smooth and reassemble the hub. The details on the plans will help you visualize this process.

The retracts used are 3.5 kg no-name clones with a $^{5}/_{32}$-inch





The plastic film covering and the re-covering of the fuselage in silkspan.

piano wire strut and axel (Great Planes GPMQ4281). This strut is the "functional" strut and does all of the work. The rear strut is cosmetic and for that reason, it does not need to be overly strong. This rear strut was made from three sizes of soda straws or aluminum tubing—one 7/32 inch, one 5/32 inch, and one short piece of 5/64 inch. The 7/32 and 5/32 size are not overly critical, as long as the smaller one slides into the larger one freely.

The ends of the outer and inner straws have holes punched in them and their ends are rounded. The outer straw has the mounting bolt for the axel passing through the punched hole and is secured with that bolt. There is a small assembly of plywood, balsa, and a screw that the inner straw mounts to. Then the smaller one slides into the larger one and the entire assembly is set in place. Review the plans for additional clarification.

Gear Doors

To help the gear doors stay in line during flight when extended and lie flat against the wing when retracted, the doors need to be mounted in a nonconventional manner. The main door is still connected to the strut, but it allows the door to swivel/rotate during extension and retraction. When extended, the door will push against a tab or fence that aligns it with the direction of flight, and during retraction the wheel well pushes it flat.

There are two 1/8-inch Lite Ply door-mounting tabs for each strut that have a 5/32-inch hole in them. Glue a 5/32-inch wheel collar to this and remove the setscrew.

With the strut retracted into the wing, the door mounting tabs slide into place approximately 3/4 inch in from each end. These tabs were intentionally cut too long, and a straightedge was laid across the wheel well to mark the correct height. Then these were cut.

The main gear door was made from two pieces of 1/32-inch plywood glued together cross-grain with epoxy. This resulted in a lightweight, but stiff door. Titebond was added to the tops of the door mounting tabs and the door was set in place. The rear strut (plastic soda straw) has a door that is similarly mounted. Review the plans details. The alignment tab/fence was made per the plans from the 1/8-inch Lite Ply parts and was customized to fit each side to ensure a good fit.

Fillets and miscellaneous items

Using scrap 3/32-inch balsa, "in-fill" between stringers behind F-4A and behind the wing saddle (per the plans) to provide some additional strength and more surface area for the covering to attach to. The wing fillets are added next. The main piece is cut from cardstock and set in place between the wing and fuselage, with waxed paper over the wing to prevent any wandering glue from making this a one-piece model.

Next, there are five balsa "ribs" that were made from 1/8-inch balsa and glued in place. I also added a 1/8-inch square stringer. The plans provide both the cardstock and the rib templates. These are starting points that a builder will need to fine-tune for his or her model.

Starting at the rear, add the three main top pieces, allowing them to overlap if needed. The last bit at the front was made from balsa scrap sanded to shape. The model was then flipped over in the stand and a scrap piece of 1/8-inch balsa was added just behind the wing TE and flush with it. The bottom rear fillet piece was added, and now the fillet blends with the wing.

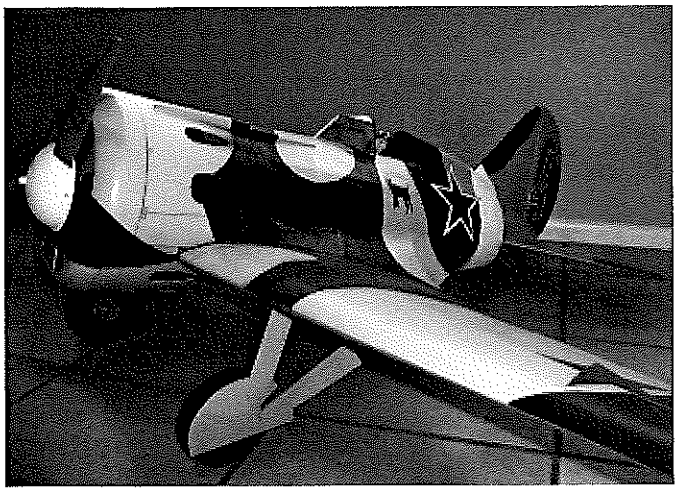
Mount the two 17- to 25-gram servos in place and cut the ailerons free. Sand to shape and hinge. CA hinges were used for simplicity on the prototype, but there is enough surface if you want to use "pinned" hinges.

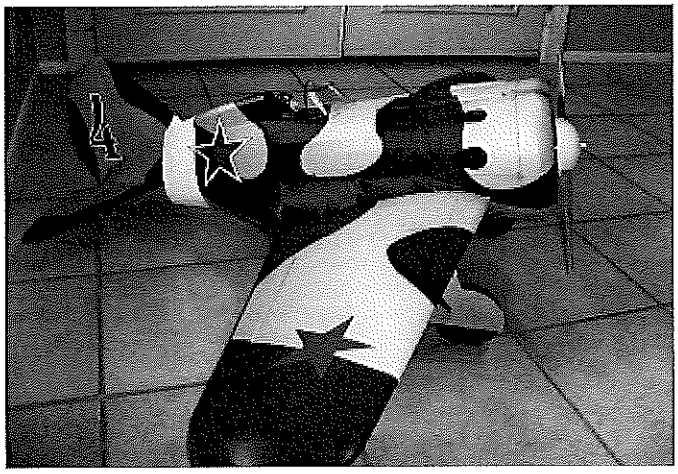
The tail wheel assembly was built according to the plans, glued in place, and the tail cone pieces were added.

The last bits of construction are the gun blisters and the canopy. The blisters are made from balsa block capped with plywood parts (from the IP) as a guide. The canopy frame is built from three pieces of Lite Ply (precut and on the same sheet as the IP) and is assembled according to the plans. Before attaching it to the fuselage, add thin, clear plastic sheet.

The Great Russian Cover-Up!

The Rata received a thorough sanding over its entire airframe. Remember that any bumps or excess glue will show when





Finished and ready for flight.

covered, so take your time with this step. Should a stringer snap (as it did with me), fear not. Merely glue the parts back together with a "splint" stringer on the backside.

Those who followed my online build thread saw the struggles I had with painting over film. For this reason, after initially covering the model with MicroLite, I later finished most of it with silkspan. This might take longer to apply, but the results are worth it.

With the airplane covered, I made final preparations before flight testing. All control surfaces were glued in place and connected to the servos. The center of gravity was set at 20% Mean Aerodynamic Chord and the model was balanced. With the 4,000 mAh 4S LiPo battery pack in place according to the plans, surprisingly, no additional ballast was needed!

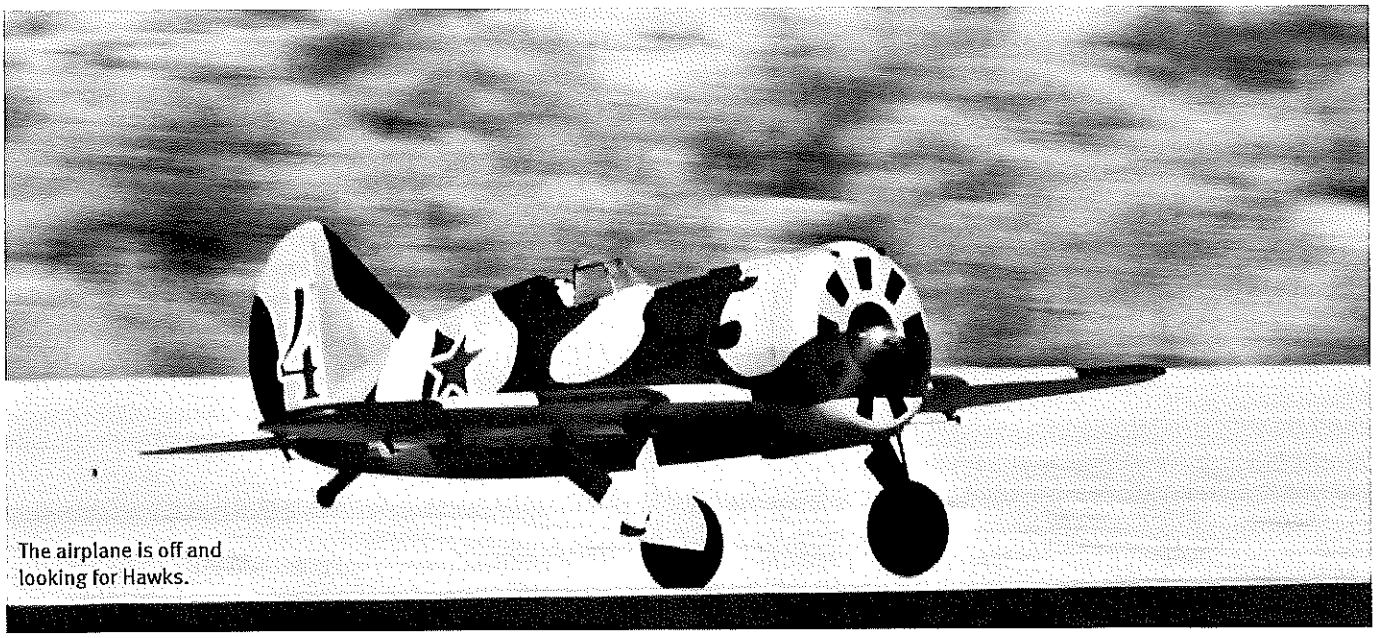
The retracts and gear doors were tested to ensure smooth operation before the model was painted. Behr house paints were used on the prototype and Callie Graphics supplied the insignia and nose art.

First Flights

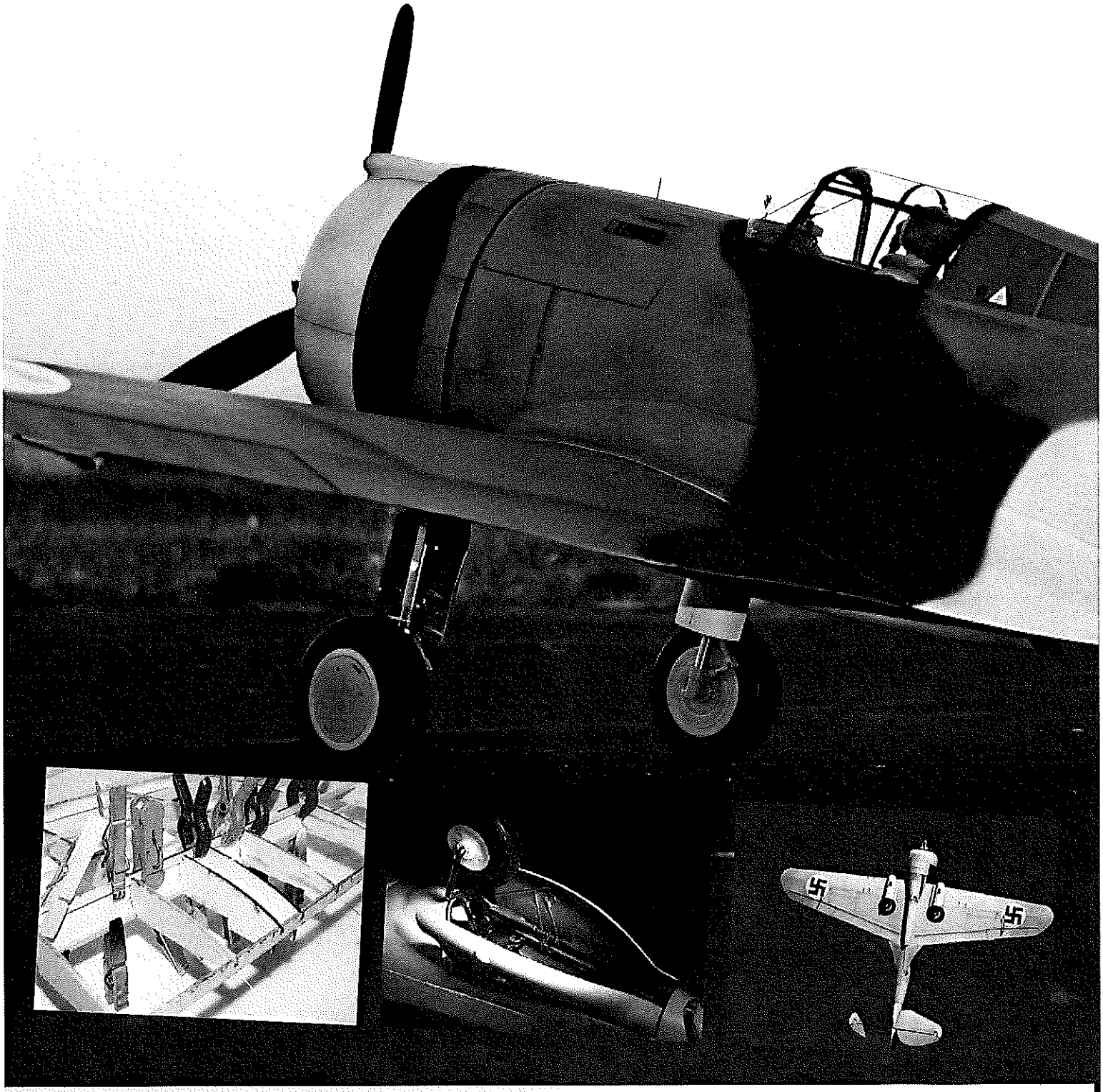
With the model balanced and final checks complete, it was time to test-fly. When aligned on the runway, gently but quickly advance the power to approximately a quarter. This raises the tail and makes the rudder effective for tracking.

From there, advance the throttle smoothly and at roughly half throttle, you are flying. Trim the model as needed and test out its stall characteristics.

The prototype was gentle and dropped its nose and one wing half slightly but did not snap. Landings are straightforward, with a gradual reduction of power until just before the wheels touch the ground.



The airplane is off and looking for Hawks.



Flying the Rata

After the Rata was aligned on the runway, I gently, but quickly, advanced the power to roughly a quarter. This raised the tail and made the rudder effective for tracking. From there, I advanced the throttle smoothly, and at approximately half throttle, the model was flying.

I trimmed the Rata as needed and tested its stall characteristics. The prototype was gentle and dropped the nose and one wing slightly, but did not snap.

Landings are straightforward and are performed with a gradual reduction of power until slightly before the wheels touch down.

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