by Gary Fuller

Attack this sport-scale model's simplified structure for twin flying fun

A-20 Havoc

In the late 1930s, the Douglas Aircraft Company designed Model 7B for the US Army Air Corps. The first prototype flew in 1938. After the Air Corps' initial evaluation and because of a lack of funding, it decided not to purchase any 7Bs. The aircraft's performance caught the French government's eye, and it ordered 270 under the designation of DB-7.

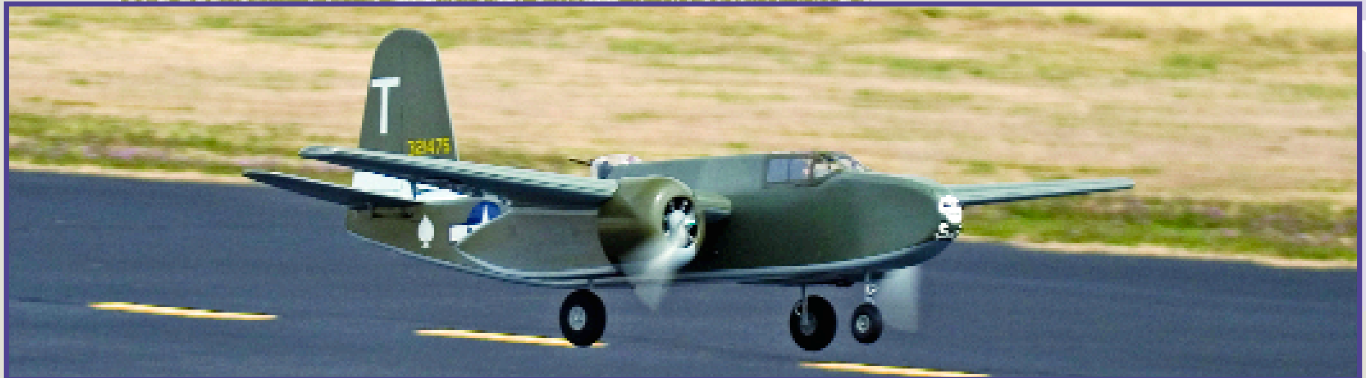
In late 1939, the US Army Air Corps reversed its decision not to buy any 7Bs and ordered 63 of the airplanes as the A-20. This model proved to be versatile, and the US and many of its allies used it in all theaters of World War II. More than 7,000 of the fighters were built.

I had a lot of fun building my version of the aircraft. I modeled it in the color scheme that is on the A-20 in the National Museum of the United States Air Force in Dayton, Ohio. It was painted to represent an A-20G flown in the 5^{th} Air Force, 312^{th} Bomb Group, 389^{th} Squadron in 1944.

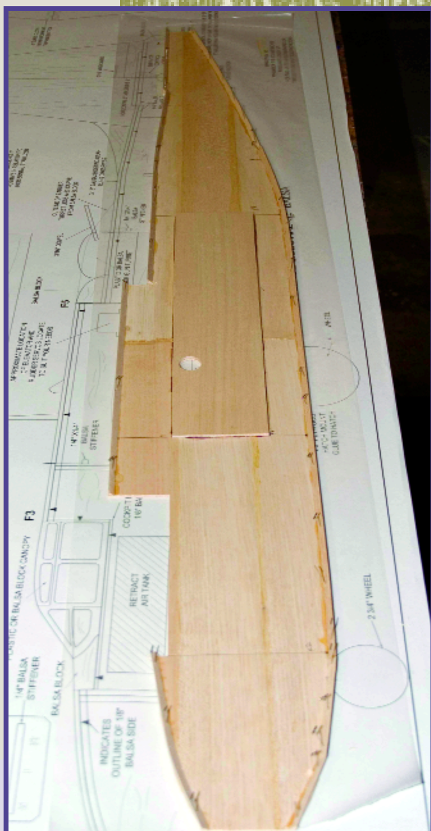
I used Flat Olive Drab and Flat Dove Gray MonoKote to cover my A-20. I painted the skull and crossbones on the nose. I wasn't about to paint all those little bombs on the side of the fuselage below the canopy, so I took a photo to a local sign shop and had the bombs and the "Little Joe" under them cut from vinyl. I made all the other markings from a MonoKote Trim Sheet.

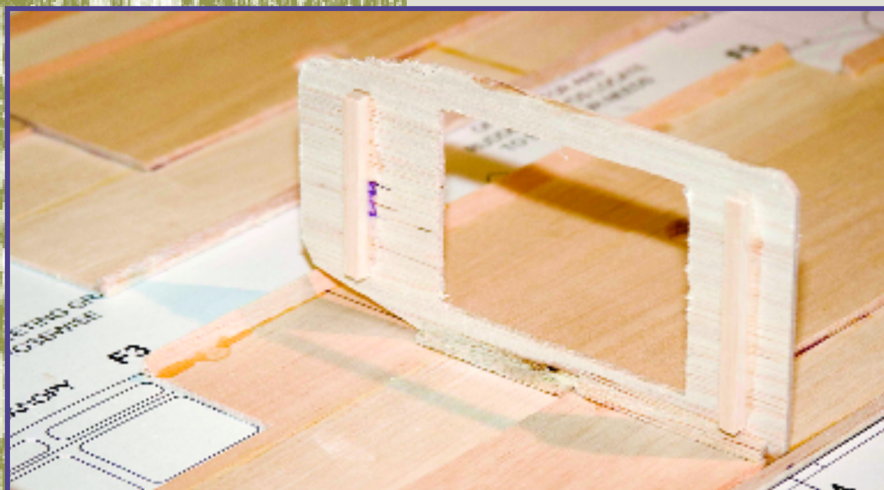
I wasn't interested in putting too much detail in the cockpit, so the only thing in there is a pilot. The gun turret has much more detail than the cockpit; I enjoyed doing

Low-level flybys look great. The A-20 is easy to land; just keep the speed up so that the control surfaces remain effective.

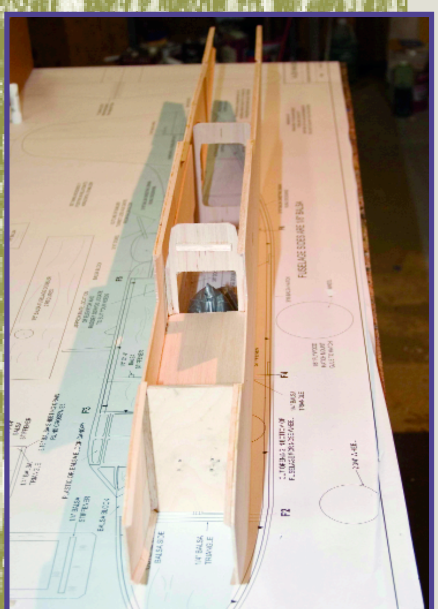


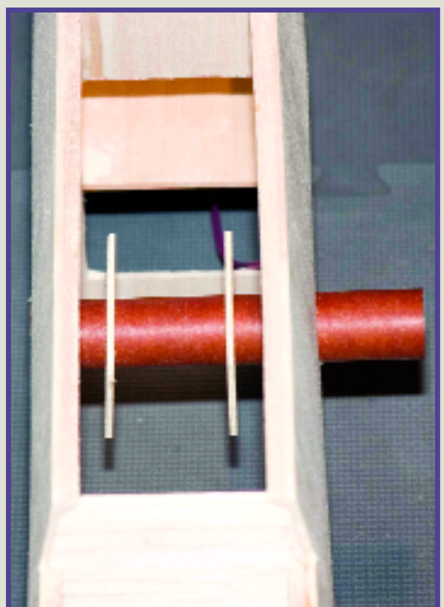
For easier takeoffs, program the nose-wheel steering to be less effective by setting up a mix switch. The A-20 comes up to speed quickly on smooth runways.





Former F4 is glued in place on the right fuselage side; 1/4 square balsa reinforces F4 crosswise. Balsa triangle stock reinforces the glue joint between F4 and the fuselage side. Notice that the top of F4 has not been glued to the side yet.



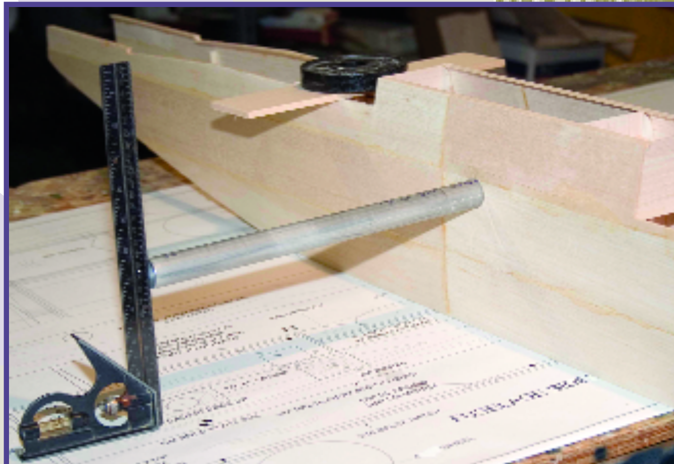


Above: T-pins hold the 1/4 balsa triangle stock to the fuselage side while the glue dries. The wing-root doubler has been glued in place; all that remains is to adhere the nose-wheel-well doubler.

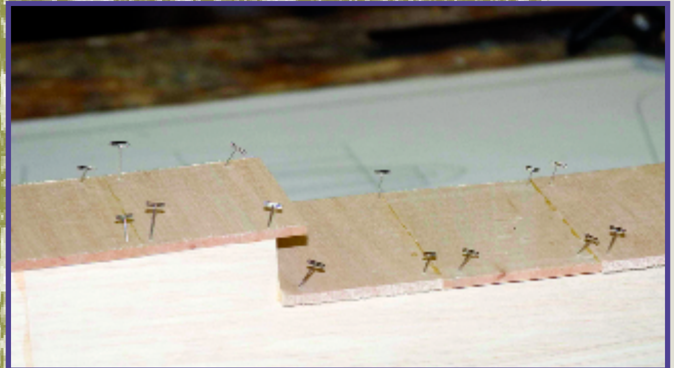
Near right: A bag of lead shot stabilizes the fuselage while the left side is joined to the formers. The nose-wheel-well ceiling is installed at this time.

Far right: The wing-joiner-tube sleeve has the 1/8 plywood doublers installed but is not yet glued to the fuselage side.

Static photos by the author Flight photos by Erin Fuller

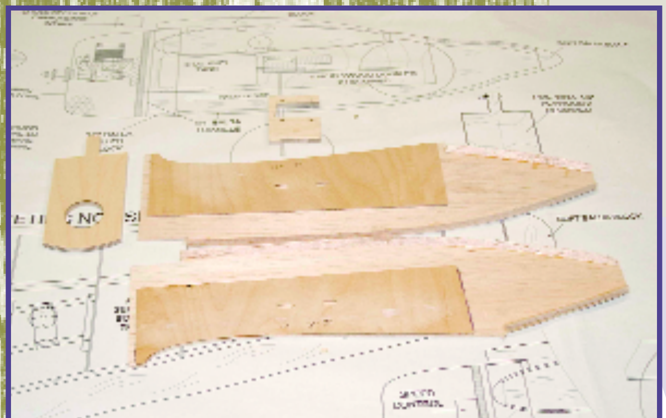


Measure the height of both ends of the wing-joiner tube. Make them the same height above the workbench before gluing the 1/8 plywood doublers in place on the fuselage sides.



T-pins hold the 3/16 balsa top sheeting in place while the glue dries. The author prefers Ambroid-type glue because it is easier to sand.

Rib R1 is glued to the upper and lower wing spars at the correct angle using the template cut from the plans and glued to a piece of scrap plywood.

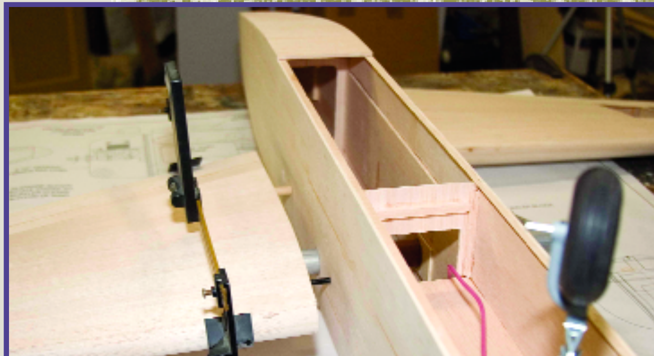


The nacelle sides are ready to have the 1/4 plywood firewall and landing-gear mount plate installed. Their construction is much like the fuselage's.

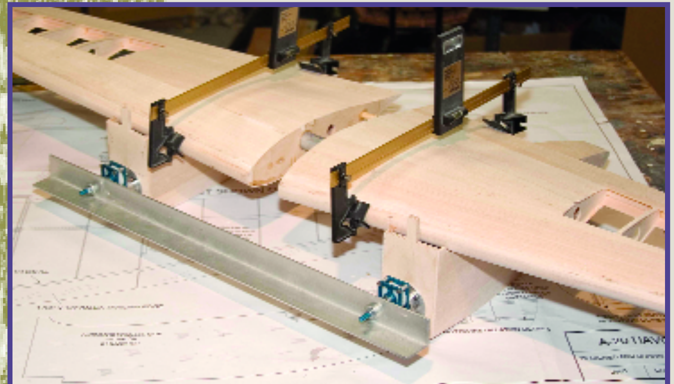
A-20 Havoc

- **Type:** RC semiscale twin
- **Skill level:** Intermediate
- **Wingspan:** 80 inches
- **Flying weight:** 12.5 pounds
- **Wing area:** 700 square inches
- **Length:** 62 inches
- **Engine/motor:** Two .25-.35 glow engines or two 500- to 750-watt motors
- **Radio:** Four- to six-channel system with seven standard servos, optional retracts
- **Construction:** Balsa and plywood
- **Finish:** MonoKote
- **Other:** Retracts capable of carrying 13 pounds, two 6.5-inch fiberglass cowls, two 4-inch main wheels, one 2.75-inch wheel for the nose

This is how the nacelle looks when it's ready to install on the wing. Glue the firewall to the nacelle side at a 90° angle.

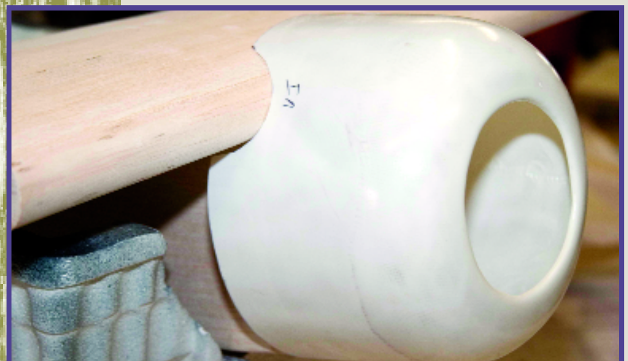


Use an incidence meter to set the wing at the correct angle, and then push the wing into the fuselage side just enough so that the antirotation dowel and the 1/4-20 screw (with the head cut off) will mark the location of the mounting holes.

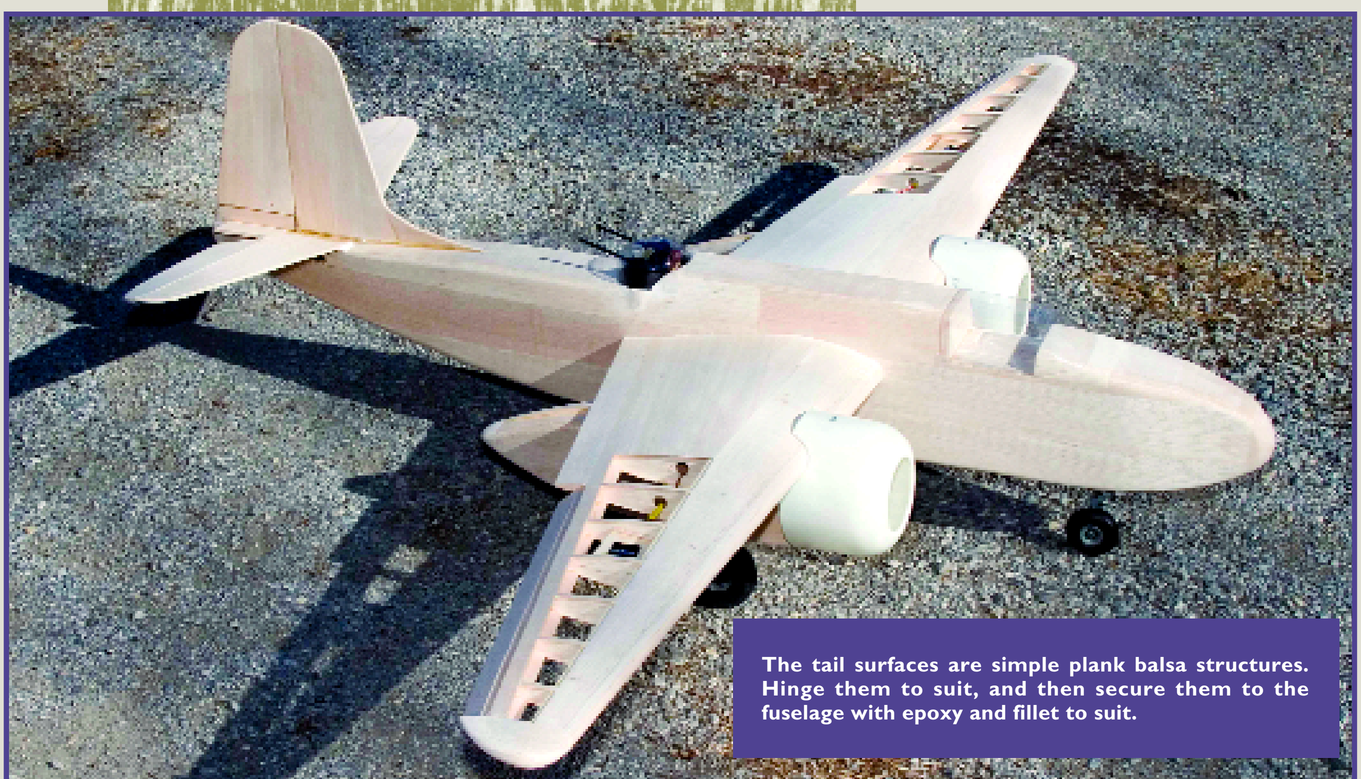


The custom fixture made from right-angle aluminum stock holds the motors aligned to each other while the nacelles are adhered to the wing.

Slide the 1/8 plywood doubler over the 1/4-20 wing-mounting screw, apply the glue to the doubler, and tighten the screw to hold the doubler in place.



As specified, 6 1/2-inch-diameter round cowls are available from Fiberglass Specialties. They are cut to length and then trimmed to fit using the template on the plans.



The tail surfaces are simple plank balsa structures. Hinge them to suit, and then secure them to the fuselage with epoxy and fillet to suit.

the research and detailing that part of the airplane.

When I started designing my A-20, I decided that I wanted to use round cowlings on the nacelle, to make the model look more realistic. Most of the companies that produce fiberglass replacement cowls for kits also have various sizes of generic radial-engine cowlings, so I went that route. I got them from Fiberglass Specialties. I don't care to see a big, gaping hole in the front of the cowlings, so I installed vacuum-formed dummy radial engines from Dare Design and Engineering.

My completed A-20 weighed 11.5 pounds, which resulted in a high wing loading. If you decide to build this model, I recommend that you use contest-grade balsa throughout. You can also cut lightening holes everywhere possible to keep the weight down.

CONSTRUCTION

I like to cut out most of the parts before I start to build my models. If you have never built from plans, there are several methods to transfer a part's shape from the plans to the wood sheets. My favorite is to cut the plans to the individual parts and then use a glue stick to temporarily attach the paper parts to the appropriate thickness of wood. Then I cut the parts.

If I need to make more than one component, I use the glue stick to adhere a piece of scrap paper to the back of the part and then use the glue stick to attach it to another piece of wood. Then I cut both parts at the same time.

Don't use the glue stick directly on the wood; apply it only to the paper. Once the part has been cut, simply peel off the paper.

Fuselage: It doesn't matter if you start with the wing or the fuselage; I like to build the fuselage first. Because of its size, you will need to edge-glue some balsa sheets. I try to make sure the splice for the sides will be in the area that the 1/8 balsa wing-root doublers will cover.

When the sides are cut to shape, be careful; the joints will be fairly weak. But if you use the same method I do to cut the parts, the paper will help reinforce the wood.

Lay the fuselage sides on the workbench, either top to top or bottom to bottom. This will ensure that you don't make two left or right sides. Mark the locations of the formers and doublers on the fuselage sides. Glue the fuselage doublers to the sides. Then you can glue the 1/4 balsa triangle stock to the edges of the sides, as shown on the plans.

Glue formers F2, F4, and F6 to one fuselage side. Make sure the formers are 90° to the fuselage side. Don't glue the top of the side to formers F4 and F6 just yet.

Adhere the 1/4 balsa triangle to the formers and the fuselage side. Lift the fuselage side that has the formers glued to it from the bench, and place it so it is sitting on its bottom. Place the other side in position so it can be glued to the formers. Before gluing the other side to the former, ensure that it is properly aligned to the other side.

The wing-joiner-tube sleeve is next. First, I immobilized the fuselage by placing weights on the top of it.

Insert the fuselage portion of the wing-joiner-tube sleeve in one fuselage side, slide the 1/8 plywood doublers over the sleeve, and then slide the joiner tube into the other fuselage side. Insert the joiner tube in the sleeve and adjust it so it protrudes an equal length on both sides of the fuselage.

Measure the height at each end of the joiner tube. If the figures are unequal, enlarge the hole in one fuselage side until the tube height is the same. Use a carpenter's square to determine whether or not the joiner tube is square to the fuselage sides. If it is not, enlarge the same hole in the side until it is.

Slide the 1/8 plywood doubler up against the side with the enlarged hole and glue the doubler in place. Make sure the wing-joiner tube is still equal in height to the workbench and square to the fuselage side. Glue the other 1/8 plywood doubler to the other side, and then glue the wing-joiner-tube sleeve to the fuselage sides.

Carefully pull the tail end of the sides together and trim the 1/4 balsa triangle so the sides can be joined. Hold the ends together with a few clothespins without gluing the end, and then sight down the length of the fuselage and make sure it is straight. Adjust the sides as necessary until it is.

Place a piece of straight scrap wood across the horizontal-stabilizer saddle. Sight

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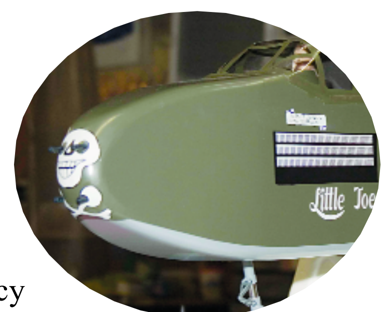
See More Havoc!

MA is honored to bring you Gary Fuller's sport-scale A-20 Havoc, but his account of the model's construction and flight is much more extensive than we could include in these pages. Therefore, we have posted all of his photos online, along with the entire article.



Isn't that hand-painted nose art cool? Gary's pictures show you how easy it is to get his results, and he includes other juicy details. There are also more great flying shots of the A-20 that his 12-year-old daughter, Erin, took.

To see this extra material, go to www.modelaircraft.org/mag and click on the "Exclusive Online Features" link.

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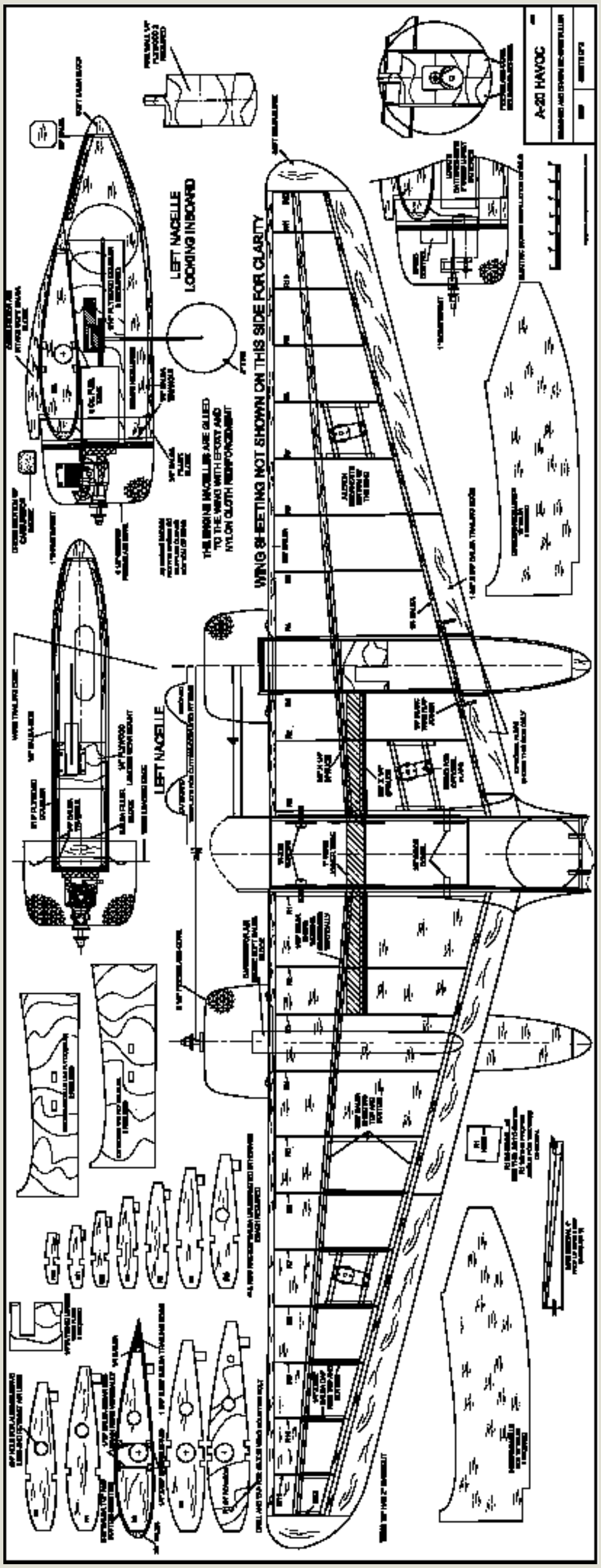

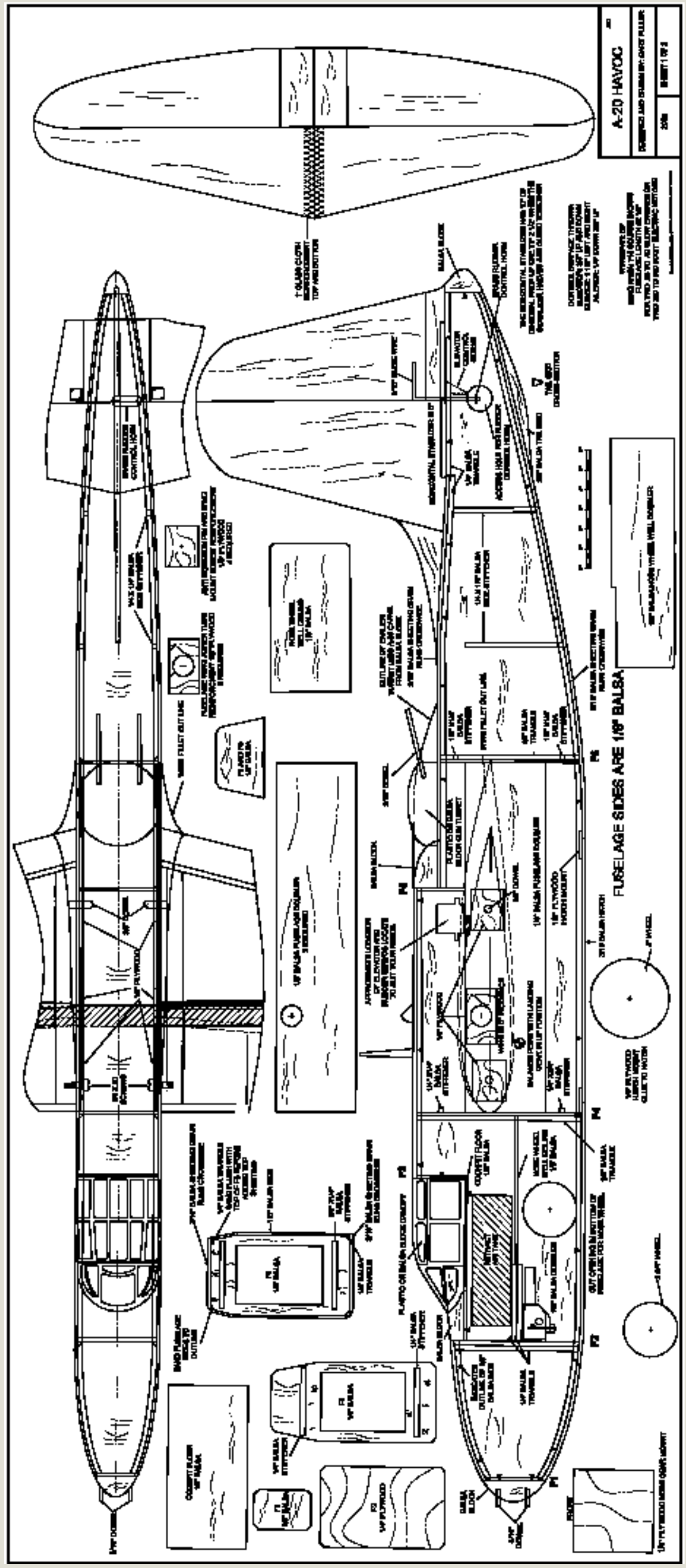

down the fuselage and check to see if the wing-joiner tube is aligned parallel to the scrap piece of wood. If it is not, adjust the ends of the fuselage sides until it is.

Double-check the end of the fuselage side to make sure it is straight and the horizontal-stabilizer saddle is parallel to the joiner tube. Glue the ends of the sides together.

At formers F4 and F6, pull the top of the fuselage sides together and glue the top portion of the sides to the formers. Insert formers F3 and F5, and glue in place as shown on the plans.

Mark the 1/4 plywood nose-gear mount and drill the mounting holes for the nose gear. Glue the nose-gear mount in place in the fuselage, along with the 1/4 balsa triangle stock. Glue the 1/8 balsa nose-wheel-well ceiling and 1/8 balsa cockpit floor in the fuselage.

Glue the 3/16 balsa top sheeting in place from the cockpit back to the horizontal-stabilizer saddle. Make sure the grain runs crosswise to the fuselage length.

Using a couple of large C-clamps, carefully pull the forward ends of the fuselage sides together and glue F1 in place. Adhere the 3/16 balsa top sheeting in place forward of the cockpit.

Glue the bottom 3/16 balsa sheeting to the fuselage bottom as shown on the plans. You might want to hold off sheeting the bottom of the fuselage in the wing area until after you have mounted the wing to the fuselage.

Set the fuselage aside.

Wing: Pin the 1/4 x 3/8 spruce main spar to the plans. Lay the 1/4 x 3/8 aft spar on the plans, but don't pin it in place there; you will need to pull it up into the ribs after you glue them to the main spar.

Use the R1 angle template that is shown on the plans to set rib R1 to the correct angle for the wing dihedral. Don't adhere R1 to any of the spars or the LE and TE until you have installed all the other ribs.

Glue in the wing-joiner-tube socket and the 1/16 balsa shear webbing. I recommend that you glue a cap of balsa to the end of the joiner-tube socket; it will keep the joiner tube from sliding from side to side.

Adhere the 3/32 balsa sheeting to the top of the wing. To do this, I glued the LE sheeting to the LE only. Once the glue dried, I wet the sheeting with Windex so it would be easier to bend to the wing contour. I positioned weights and used clothespins to hold the sheeting to the rib and spar while I let the Windex dry.

After the Windex dried, I removed the weight and clothespins and then glued the sheeting to the ribs. After that, I adhered the rest of the top sheeting to the wing.

Carefully remove the wing from the workbench and flip it over so you can glue the bottom sheeting to the wing. After you do that, put the 5/8 balsa TE and the wingtip in place. Sand the TE, LE, and wingtip to the specified contour.

Mounting the Wing to the Fuselage: The wing is held to the fuselage by a 1/4-20 screw from the inside of the fuselage. I modified a few 1/4-20 nylon slotted screws by gluing 1/16 plywood into their slots. I reinforced the glue joint with some sawdust soaked in cyanoacrylate glue. This makes mounting the wings to the fuselage fairly easy.

Place the fuselage upside-down on the workbench and weight it down so it is stable and difficult to move around. Rib R1 should have the forward hole drilled and tapped for a 1/4-20 screw, and the aft hole is for the 3/8-inch antirotation dowel.

Glue the antirotation dowel to R1. Make sure it sticks out approximately 1/2 inch.

Cut the head off of a 1/4-20 screw and thread it into the forward screw hole on the left- or right-wing R1 so that roughly 1/2 inch of the screw sticks out. This will be used to mark the location for the hole in the fuselage.

Insert the wing-joiner tube in the fuselage. Slide the wing upside-down onto the joiner tube and up next to the fuselage side. Adjust the wing angle so it will be approximately 0°, and gently press the wing into the fuselage so that the 3/8-inch antirotation dowel and the 1/4-20 screw mark the fuselage side.

Pull the wing off the joiner tube and then drill where the marks indicate for the wing-mounting screw and the antirotation dowel. Remove the 1/4-20 screw from the wing.

Slide the wing back onto the joiner tube and then up against the fuselage side, and check the wing incidence. If it is not 0°, enlarge the 3/8-inch hole in small increments until the wing is at the correct angle.

Inside the fuselage, slide the 1/8 plywood doubler over the 3/8-inch antirotation pin, and glue the doubler to the fuselage side. Be careful not to get glue on the antirotation dowel. You can wax the dowel before you do this to keep any glue from sticking to it.

See if you can install the wing-mounting screw to the wing from the inside of the fuselage. If you can't, enlarge the mounting hole in the fuselage side.

Glue the wing-mounting-screw doubler to the fuselage side. You can do this by placing the 1/8 plywood doubler on the mounting screw and then, from the inside of the fuselage, twist the mounting screw into the wing and use it to hold the plywood doubler in place as the glue dries.

Repeat this for the other side.

Empennage: I like to have the fuselage as finished as possible before I mount the empennage, so this is when I glue on the nose and tail blocks and sand the fuselage to its final shape. When you're ready to mount the horizontal stabilizer, install the wings and secure the upright fuselage to the workbench as you did for the wing-mounting procedure.

Adhere the horizontal stabilizer's sides at a 10° angle. You can do this by laying a half flat on the workbench and propping up the tip of the other half 2 1/2 inches. Reinforce the joint with a 1-inch-wide strip of fiberglass tape.

Place the horizontal stabilizer on the fuselage and determine whether or not it's parallel to the wing. Check the incidence of the stabilizer to the wing; you want the wing 1° positive to the horizontal stabilizer. If it is not, sand the stabilizer saddle until it is both parallel and at the proper incidence to the wing.

When you are happy with that, measure the distance from the stabilizer tip to the wingtips. Get this measurement to be the same for both sides. When you are satisfied with the horizontal stabilizer's position, glue it to the fuselage.

Nacelles: The engine nacelles build up the same way the fuselage did, only the process is a bit simpler. Make sure you build a left and a right inboard and a left and a right outboard side for each nacelle.

I used a pair of geared motors on my A-20, so I drilled the firewalls for the motor mounts before I glued the firewalls to the side. If you use glow engines, I suggest you do the same. Because the firewalls are mirror images, make sure you drill the throttle linkages in the correct location.

The nacelles are simply epoxied to the wing with glass cloth for reinforcement. To align and mount the nacelles to the wings, you will need a roughly 3-foot section of aluminum angle stock, which is available at most hardware stores. Use it to hold the engines in alignment with each other when you mount the nacelles to the wings.

Mount both wings to a short scrap piece of the wing-joiner tube. Slide the wings together, and make sure both wings' antirotation pins fit into a block with a $^{3}/_{8}$-inch hole.

On the finished model, the nacelles' centerlines are $8^{5}/_{8}$ inches from the sides of the fuselage. Since the fuselage will interfere with this method of mounting the nacelles, you will need to compensate for the fuselage's absence.

Measure the gap between the wing's root ribs and add that amount to $17^{1}/_{4}$ inches. (For instance, $18^{1}/_{4}$ inches for a 1-inch gap.) On your aluminum angle, drill two holes that distance apart. Their diameter will need to fit the propeller shaft of the power system you plan to use.

Mount the power plants to the nacelles. Then using each motor's propeller shaft, bolt it to the angle in the holes you drilled. Now both power plants are aligned to each other. That is crucial; since the nacelles don't need to be aligned to each other, the engines' thrustlines do.

Place the wing in the wing saddle of the nacelles. Adjust the wing in the saddles so that the inside side of the nacelles is approximately 7 inches from the edge of the wing root. Do not adjust the gap between the wings. If you measured accurately, both nacelles should be this length from the root rib. If the measurement is not the same on both wings, move the wing until it is.

Employ an incidence meter to check the engine upthrust/downthrust line in relationship to the wing incidence. Sand the nacelle saddles so that the thrustline is -1°. Once you are satisfied with all these measurements, tack-glue the nacelles to the wings.

Carefully unbolt the motors from the aluminum angle, and then separate the wings from each other. Flip the wings over so you can glue the nacelles to them with epoxy and glass cloth on the inside of the nacelles.

I like to mount the retracts, servos, and linkages before I cover my models. I used one servo for the elevators using a Y-type pushrod. If you do this, make sure it is as stiff as possible. You can also use two servos to control the elevators. The rest of the radio installation is fairly straightforward, so use your best judgment as a guide.

I used a pair of MaxCim MaxN32-13Y motors geared 2.2:1 swinging 14 x 8.5 APC electric propellers. Two 4S2P Li-Poly batteries supply the power. The speed controls are attached to the firewalls with hook-and-loop fastener, and the batteries are mounted just behind the firewall in each nacelle.

Flying: With the high wing loading the A-20 has, don't yank it off the runway as soon as possible. Give it a nice, long run, and ease it off the runway by gradually applying up-elevator until it rotates and lifts off on its own. For landings, keep the speed up and carry a little power on the final approach.

You can make nice, main-wheel-first touchdowns with a nice rollout before the nose wheel settles to the runway. The plans show optional flaps, but I did not install them on my A-20. My friend, Gary Scott, installed them on his model, and he reports that they are extremely effective. With motors, the propellers will create a lot of drag when power is reduced and they freewheel.

I have no idea how the A-20 will behave with one motor dead in-flight. When rudder is applied, the airplane will roll in the direction of the rudder and the nose will drop. I think the nose's dropping is caused by the 10° of dihedral in the horizontal stabilizer. The strong rudder authority should be a benefit if a motor ever quits.

If you have no twin-engine-model flying experience, make sure you set up the motors so that they are reliable. Don't try to get every extra bit of power out of them; set them for reliability. Set up the motors one at a time. Resist the urge to synchronize them; they only need to be close.

I don't do a great deal of aerobatics with my model, but I have made it loop, roll, and fly inverted. I'm pleased with my A-20; it looks good in the air and I like how it flies. **MA**

Gary Fuller
gfuller@dishmail.net

Sources:

MonoKote
(800) 637-7660
www.monokote.com

Fiberglass Specialties
(479) 359-2429
www.fiberglassspecialtiesinc.com

Dare Design and Engineering
(800) 578-3273
www.darehobby.com

MaxCim Motors
(716) 662-5651
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APC Propellers
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