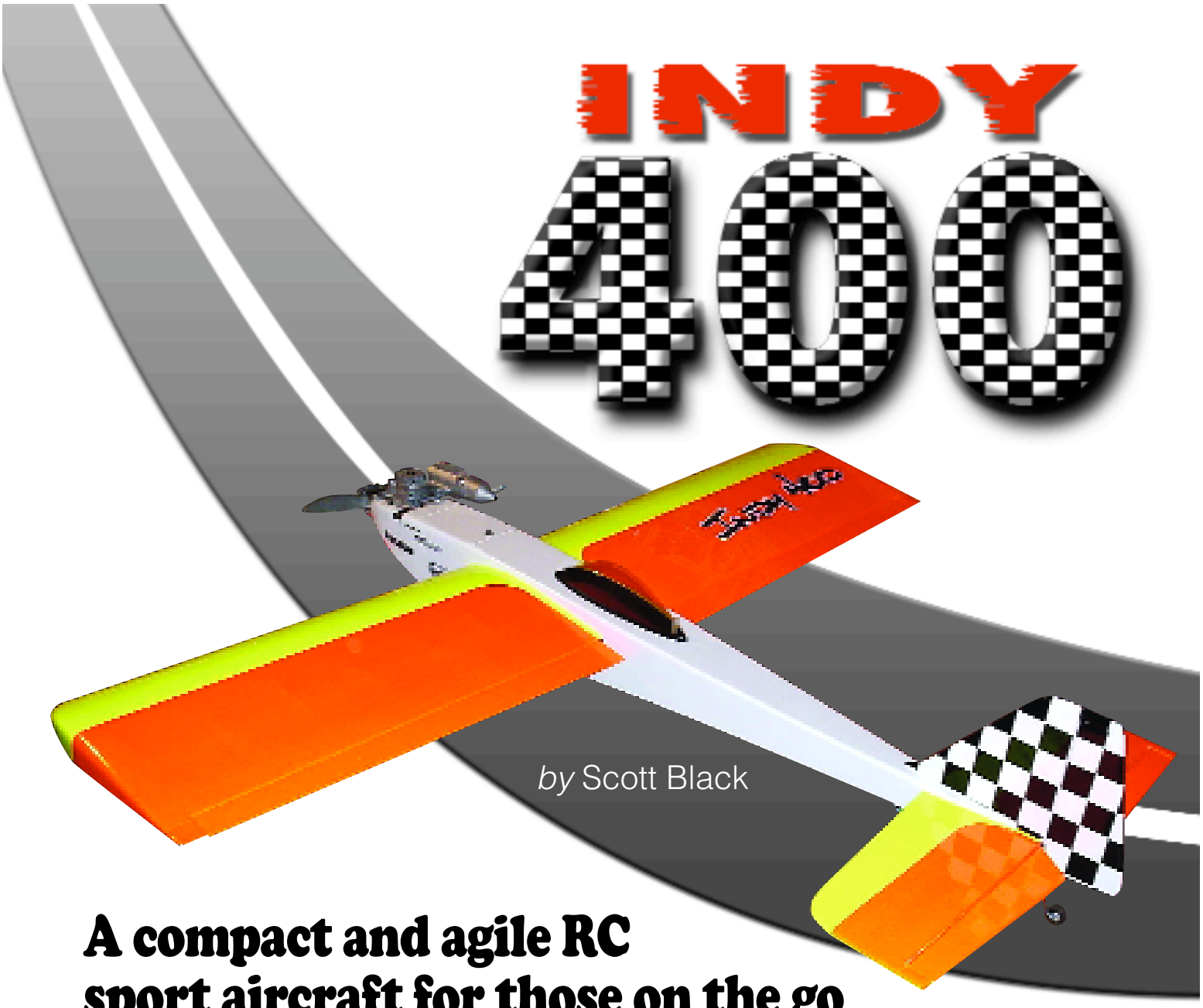
INDY 400



by Scott Black

A compact and agile RC sport aircraft for those on the go

The famed Indianapolis Motor Speedway is the backdrop for this photo, and it was the inspiration for this sporty design.

THE INDY 400 represents an evolution of a 20- to 25-size prototype I originally designed several years ago. Using many of the design articles and principles I had seen in *Radio Control Modeler* magazine throughout the years, I came up with an easy-building design I felt would fly quite well with a .20-.25 power plant.

My goal in taking this step, in creating the final Indy 400, was primarily to improve the overall aesthetics, weight, and aerodynamics of the aircraft. The final version of the model is a much sleeker, more swoopy and racy version of my original design. It's cool-lookin'!

The new version has benefited from my lessening the overall weight, and its sleekness has increased the aircraft's top speed. Because of its reasonable size you will always have room in your car to take the Indy 400 to the flying field. It is such a good all-around, fun-to-fly model that it might become one of your favorites to grab each time you head out.

Several local pilots are currently flying this design or the earlier version. They encouraged me to do this construction article because they enjoy the airplane so much. The Indy 400 has become one of their favorite airplanes.

Why the "Indy 400" name? Many residents of Central Indiana,

Photos by the author

From any angle this is a sleek, fast-looking model. It's right at home in Indy! It's simple to build and rugged.

Indy 400 Materials List

- Reliable .25-size engine
- Suitable engine mount
- Aluminum landing gear with 9- to 10-inch spread
- 2 1/4-inch main wheels
- 1-inch tail-wheel assembly
- 4-ounce Sullivan Slant Type Flextank
- 1 1/2-inch spinner
- Sig canopy (WC-807)
- Control horns/pushrods
- 17 hinges
- Aileron torque-rod assembly
- Heat-shrinkable covering material
- Four pieces of 1/16 x 4 x 36 balsa sheet (fuselage)
- Three pieces of 3/32 x 4 x 36 balsa sheet (ribs)
- Four pieces of 1/8 x 4 x 36 balsa sheet (fuselage/miscellaneous)
- One piece of 1/4 x 4 x 36 balsa sheet (stabilizer and rudder)
- Two 1/2 x 1/2 x 36 balsa sticks (shaped to LE)
- Three 1/16 x 1/4 x 36 balsa sticks (capstrips)
- Two pieces of 1/4 x 1 1/2 x 36 aileron stock
- Two 1/4 x 3/8 x 36 balsa sticks (TE)
- Two 1/8 x 1/2 x 36 balsa sticks (wing front edge)
- Four 1/4 x 1/4 x 36 balsa sticks (stringers)
- One 1 x 2 x 36 balsa stick (wingtips and nose blocks)
- Two pieces of 1/2 x 1/2 x 36 balsa triangle stock
- Four 1/4 x 3/8 x 36 spruce spars
- One 1/8 and 1/4 plywood sheet

such as myself, get Indianapolis 500 "race fever" each year. It is similar to the "flying fever" most modelers get in the spring. The Indy 400 name was inspired by the speed, excitement, and color that surround this great auto-racing event. I often use the eye-catching paint/color schemes of the Indy-style racecars for ideas for color/trim schemes on my latest models. The other part of the name came from the fact that the design has nearly 400 square inches of wing area.

When I start this airplane at the flying field, sometimes I swear I can hear a voice in the distance say, "Gentlemen, start your engines!"

The Indy 400 was designed to do several things, the first of which was to be a wonderful way to pass many lunch hours at work. As drafting supervisor of the company I worked for at the time, you would think the last thing I would have wanted to do at lunch was draw; however, this project became a great mental escape for me during the day. The hardest part was getting my mind back on work when lunch was over!

My second goal was to create a small airplane that did not act like a "little" airplane. This model handles very well. It flies like it is on rails, even in windy conditions. It is aerobatic yet easy to take off and land. After you are comfortable with the Indy 400, control responses can be set to higher throws. At this point the Indy 400 will be a sight to watch! The exclamation "Wahoo!" comes to mind.

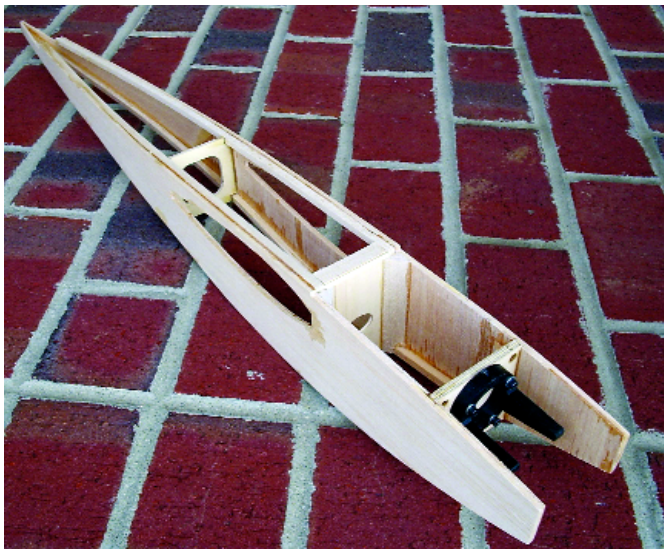
Third, I wanted to keep this little beast inexpensive. There are many strong .25-size engines out there for not too much money. I had used the K&B Sportster .28 on my last version, with good power and reliability. On this model I chose a new O.S. .25 FX. I liked the rear-mounted needle valve and had heard good things about this engine.

The inside of the Indy 400 was designed with standard-size servos and a flat 500 mAh battery pack in mind. There is really only one way to install the radio gear since the airplane was basically designed around it.

Don't worry, though; it is not as tightly packed as it looks. Your fingers will fit and installation is straightforward if you follow the plans. You can install the servos in a 2 x 2 arrangement or a 3 x 1 arrangement, as I've done with this specific model.

CONSTRUCTION

A materials list of the balsa, plywood, and spruce items you will need is included elsewhere in this article. However, if you are like me you have probably saved many odd-size sheets, drops, and scraps from other scratch-building projects and kits throughout the years. *Many* of the parts necessary for the Indy



The completed fuselage crutch assembly shows the simplicity of the structure's design. This is a quick build.

400 can be fabricated from these scraps.

You may want to dig through your old kit boxes for useful tidbits before you buy all the wood necessary for this project. I did. Make parts from your scraps and then buy what you need to finish up. For instance, the wing ribs can be light 1/8 stock; they don't all have to be made from 3/32 inch.

The best way to approach scratch building is to make a "kit" of all the potentially precut parts before you start. This will help make the building process much easier once you get started.

Accuracy is crucial. Make each piece as perfect as you can before going to the next. If you are off, even a little, it can cause you to be off much further down the line.

If you buy your balsa from the local hobby shop, make sure the selection is not all picked through. If it is, you may end up with what I call "petrified balsa," which is heavy and hard. This kind of wood is similar to thin sheets of rock.

Some scratch builders purchase their wood via mail order. Most mail-order balsa suppliers have good-quality wood. When in doubt regarding quantity, I usually overbuy with my initial order. That way I don't run out of the wood I need at 12:30 in the morning during a massive building binge. Besides, I can always use extra pieces and scraps for my next project!

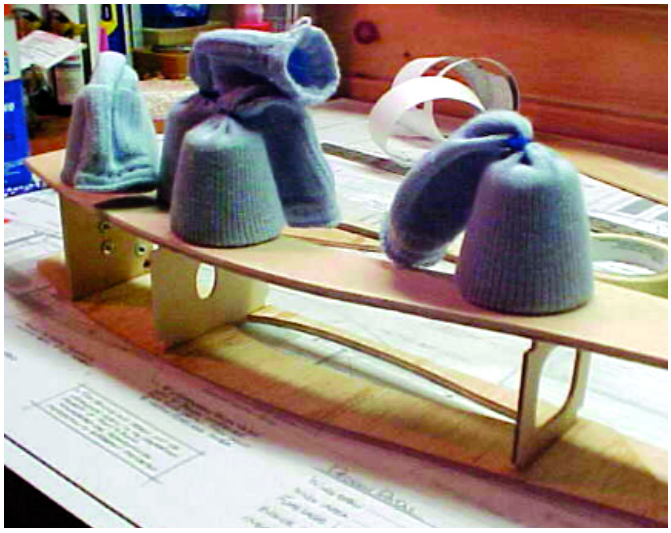
For part patterns you can cut up your plans, but I hate to do that. Instead I photocopy the parts I need. Keep in mind that some copiers reduce by 1%-2%, so be sure your copies are accurately sized. A small deviation is usually not too big of a problem as long as you are aware of it.

The next step is to transfer the patterns to the wood. You can trace them with carbon paper, push pins through the paper patterns to make a dotted line on the wood, or do what I call a "heat transfer." With a heat transfer you can *iron* your outlines directly onto the wood.

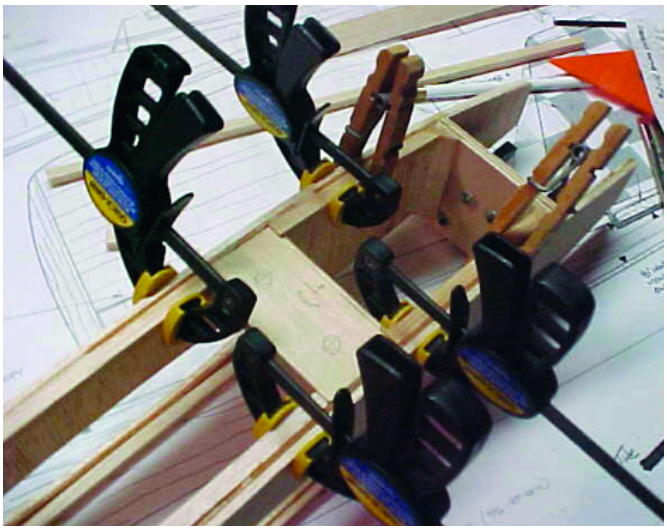
The toner used in copy machines is heat activated. Therefore, you can lay the photocopied pattern upside-down and then run a MonoKote iron across the back of it. This will melt the toner, and it will transfer well onto the wood. Keep in mind that you are making a *reverse* image. This won't matter most of the time on this airplane, but be aware of it.

You will be glad to know that all the ribs are the same size. If you have a jigsaw or a band saw with a blade that is perpendicular to the table, you can cut all the ribs at one time by stacking the wood required.

Unfortunately my jigsaw wobbles just enough that this is not a good idea for me. Instead, as my flying buddy Jim Lutes taught me, I make a master plywood template of the main rib pattern and harden the edges with cyanoacrylate. I cut carefully around this



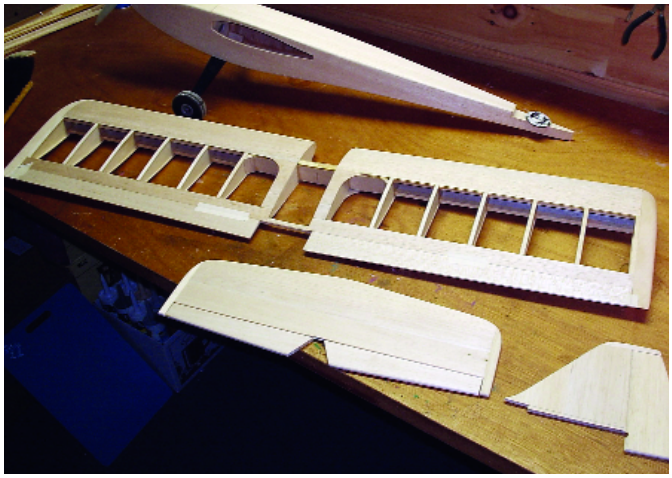
Weights are used to hold the fuselage sides and forward formers in position while the glue dries.



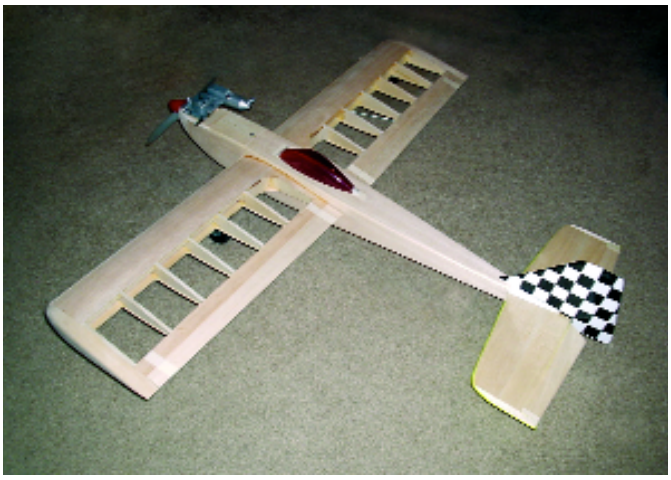
Clamps and clothespins hold the triangle corner stock in place after gluing. This allows for nice, rounded edges.

The basic wing structure takes shape over the plans. The plywood dihedral brace is positioned but not installed.

The dihedral brace is glued in place and clamped for drying. Spruce top and bottom spars yield a strong wing.



The components are finished and ready for assembly. Notice that the wing center-section is devoid of sheeting.



Nothing is lovelier than a nicely built wood model, all sanded and ready for finish.

pattern with my X-Acto knife to make each rib.

Then I pin all the ribs together, in an even stack, and lightly sand them to get them all as perfect and equal to each other as possible. Don't get too carried away with this sanding or you will end up with a nice set of ribs that may fit some other model but not the Indy 400!

Make sure all the spar notches line up perfectly. Also, make sure your building surface is *flat* and not warped. The Indy 400 wing is extremely strong, even without covering. Therefore, it would be difficult to remove a warp in the wing later by reverse-twisting it and reshrinking the covering to hold it in place.

Does that sound like something you've had to do in the past? It does to me!

I have one last comment about building from scratch. If you are interested in building this model but are reluctant because you will have to make it from scratch, don't be. In the scheme of things, having to cut a few parts by hand adds little time to building a model airplane.

Give this design a try; you will be pleased by how quickly it goes together. And you will have the pleasure and pride of being able to say "I built it from scratch."

Wing: Place waxed paper over the wing plans. The bottom 1/4 x 3/8 spruce spar is pinned down to the plans. The rear strip is oriented horizontally like the main 1/4 x 3/8 spruce spar.

All ribs except the two center ribs should be carefully aligned with the plans and glued in at this point. Make sure that each is 90° perpendicular to the building table.

After the ribs are in place, add the rear 1/4 x 3/8 balsa strip. You will have to support it off of the table. I used scraps of 3/8-inch-thick material to do this. You can also add the 1/8 x 1/2 balsa front secondary LE. The *real* LE is attached *after* the wing is installed and glued in the fuselage. See the plans; it is a two-step process.

The center ribs (two on each panel) will have to be cut down slightly and attached after the dihedral braces are installed and the wing panels are joined. Shear webs are not required on this wing because of the "beef" in the spruce spars. If you wanted, you could switch to balsa for the main spars and use shear webs. Either method would be plenty strong for this design.

When both panels are complete, they can be joined using the dihedral braces. These are going to be withstanding most of the loading forces to which the wing is subjected. Therefore, use good-grade plywood for these pieces. Light plywood might be sufficient, but why take a chance?

Use 15- or 30-minute epoxy to join the plywood dihedral braces to the spruce main spars. Take great care to make sure the wing panels are aligned with each other and the amount of dihedral shown on the plans is adhered to.

The main purpose for installing dihedral on this wing is aesthetics. To me, flat wings look like they are drooping. It is an optical illusion, but a slight amount of dihedral cures that perceived visual problem.

Once the wing panels are joined, add the remaining (four) center ribs. They will have to be cut to fit the dihedral braces. Gently true the wing with a long, flat sanding block in preparation for sheeting the wing with 1/16 balsa.

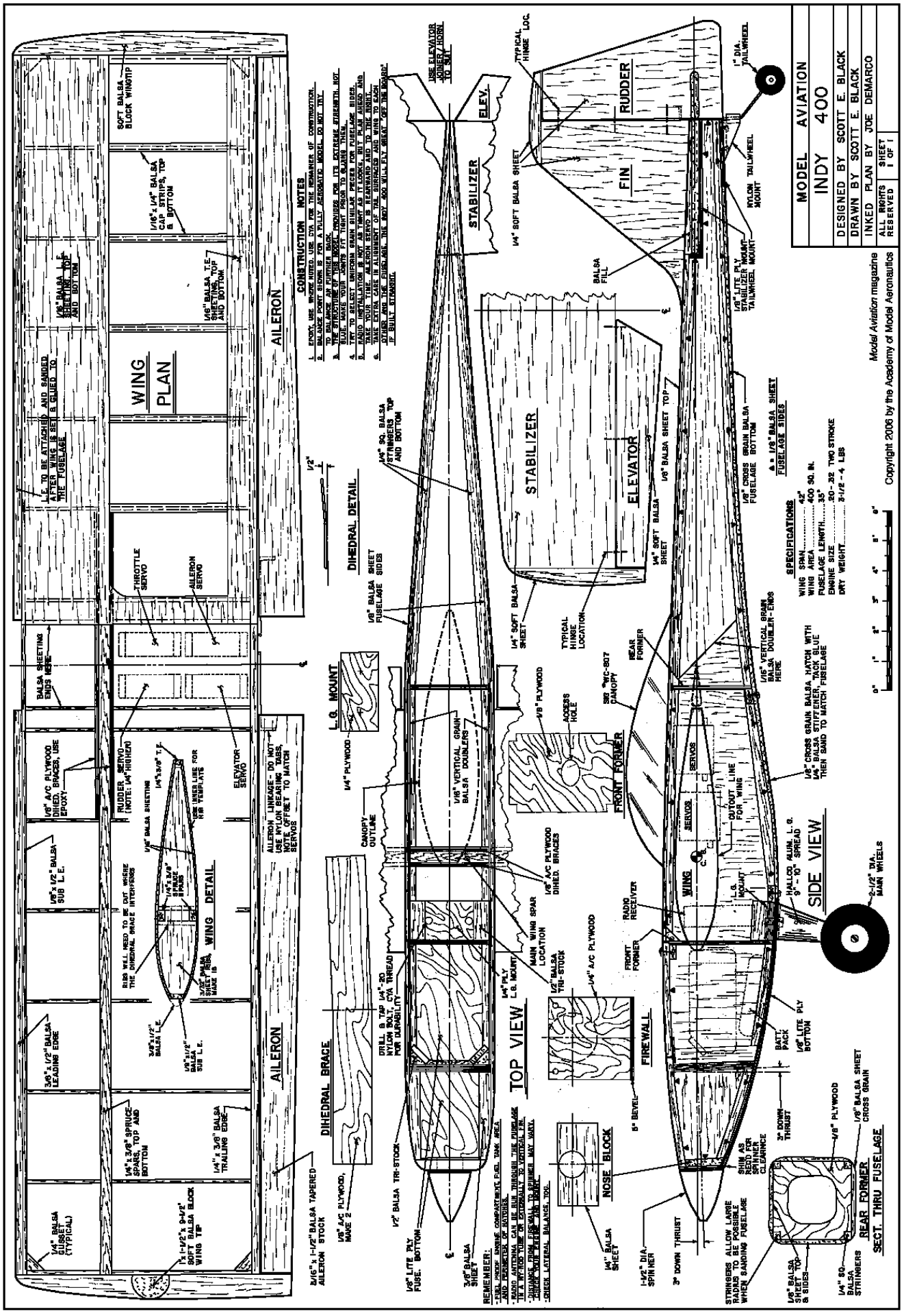
Taper the front LE and the rear spar to receive the wing sheeting. A little hand plane or a long sanding block works great for this. When you begin sheeting the wing, start with the top side first. Pin the panel being sheeted to the building board to make sure the wing is flat and true. If it is not, you could build twist into the wing while sheeting it.

I usually true the edge of my 1/16 balsa sheeting with a metal straightedge. Then I coat the tops of the ribs with yellow carpenter's glue.

The front edge of the sheeting is attached to the 1/8 x 1/2 front false LE strip with cyanoacrylate or carpenter's glue. The

Type: RC sport
Wingspan: 42 inches
Engine: .20-.32
Flying weight: 3.5-4.0 pounds
Construction: Balsa and plywood
Covering/finish: Heat-shrink film of choice

See page 199 for Full-Size Plans listing



sheeting is then bent into place across the ribs and pinned down. Glass Plus or Windex sprayed onto the top of the sheeting will allow it to bend easily without cracking. I attach the rear of the sheet to the ribs with thin cyanoacrylate. Capstrips are attached using the same technique when all sheeting is complete.

When the top of the wing is completed, remove it from the building board and sheet the bottom in the same manner as the top. If there is any way you can pin down the wing again (let one end hang off the building board), this will help ensure that there are no warps. The capstrips are finally added along with the limited center-section sheeting.

The center-section sheeting does not cover the wing *inside* the fuselage. This area is left open for radio installation. The wing's strength comes from the dual dihedral braces and spruce spars. If you have read ahead in these directions, you will see that the spars in the wing will also act as a surface for mounting servos.

Wingtips are your call. I like the looks of the ones shown on the plans, and they are easy to make. The original prototype had flat tips (boring).

One of the guys at my field used curved antivortex wingtips, as on the Sig Wonder and the Craft-Air Viking. They looked great, and he said they were not too much more work. Do try to find some fairly light wood for the wingtips or hollow them out before attaching them. There is no sense in adding too much extra weight for no gain in performance or strength.

The ailerons are similar to those in many kits you have probably made. However, the torque rods are installed *off center!* This is done because of the aileron-servo location and arrangement shown on the plans. As with the LE, the aileron torque rods are not to be installed until the wing has been permanently mounted in the fuselage.

I have been asked why I did not make the wing removable. I chose to permanently mount it because it didn't need to be removable. This model fits easily in trucks and small cars quite nicely.

If you think a permanently mounted wing will add to the damage of a crashed airplane, I disagree. If you crash a model with a bolted-on wing, the damage can still be extensive.

I crashed my first Indy 400 prototype when I exceeded the "Legendary Speed of Balsa" one fine summer afternoon, because of battery failure. (Pilot error? Impossible!) The model hit the ground nose first. Repairs were no harder than if the wing had been bolted down.

Set the wing aside in a location where you and your family can admire it. It's time to get on with the rest of the craft.

Stabilizer and Fin: The Indy 400's tail feathers are straightforward. I made mine from 1/4-inch-thick material but chose a fairly light balsa for this purpose. The tail feathers could be built up and sheeted or just built up, but the plank pieces seemed to work fine. There is plenty of room for Robart-type hinges or cyanoacrylate hinges. If you have a hinge preference, go with it.

The hardest part about this portion of assembly is the little fairing pieces that form the fillet between the fin, stabilizer, and fuselage body. I made a small T-shaped part, in place of the stabilizer and fin, from scrap 1/4 stock. I tack-glued the T shape to the fuselage tail section in the precise location. Then I tack-glued two blank fillet pieces to the T shape.

Using the fuselage outline as a guide, I carved and finish-sanded the fillet pieces. Afterward I carefully separated the fillet and T-shaped part, leaving two perfectly shaped little fairings that were ready to be glued in place once the stabilizer and fin were permanently attached.

The tail-wheel assembly I used was the Du-Bro unit for 40-size models. It fit the bottom of the fuselage perfectly and was easy to assemble and install. Where the tail-wheel wire goes into the rudder, make sure to drill it and then cyanoacrylate the drill hole with the thin variety. That will toughen this area. The control horn sandwiches the wire between the two control-horn assembly screws.

Fuselage: Try to find two pieces of lightweight 1/8 balsa with a similar grain. The goal is that they flex in a similar

manner when you bend them together to form the rear of the fuselage. That will help you keep this model straight!

You should build the fuselage on its side, ensuring that each former is installed square and perpendicular. Notice that the vertical 1/16 sheeting stops at the back of the engine mounting firewall.

Build over the plans to make sure everything is straight! I also suggest laying out the engine mount and drilling the holes and installing the blind nuts. It's much easier now than later.

I made a template from the plans to cut out the fuselage side. I carefully traced the lines and scored the balsa below. Then I came back and cut deeper, all the way through the 1/8 balsa side. Using the first side as a template I carefully cut out the second. I lightly sanded the two while pinned together to ensure that they were exactly the same. I waited until the 1/16 balsa doubler was added to cut through for the wing cutout so that it would be a cleaner cut of both.

Install the landing-gear block and be sure to add the triangle stock as shown. Strength is necessary here. You will drill and tap the mounting holes for the landing gear after the fuselage is completed.

The fuselage stringers are a vital part of this design. Yes, it's an old-fashioned construction technique, but it adds a great deal of strength for a minimum weight penalty. In addition, the stringers allow you to round and radius the fuselage during final sanding to make the Indy 400 even swoopier!

After you install the stringers, it's time to pull the sides together at the rear and join them. You will need to slice an angle cut off each lower stringer (see plans) so they meet properly. For now just clamp or pin the ends together.

Lay the fuselage on its side and measure up from the table to find the centerline measurement. Do the same after flipping the fuselage over on the other side. If the measurement is the same, it is probably pretty straight. Don't forget to eyeball it as well, just to be sure.

Add the three spruce crossbraces shown on the drawing for attaching the upper fuel hatch and the lower radio hatch. You can use plywood instead of spruce if you would rather—just something that will hold screw threads well. I cyanoacrylate-glued the threaded holes after they were made, to make the mount more durable for many years of flying.

I constructed a framework for the lower radio hatch from 1/8 balsa. Notice how it is slightly curved; this is accomplished with the special frame. Once the framework is built, you will be able to glue an oversized piece of 1/8-inch hatch material to it and it will follow the curve of the fuselage just right. Install the sheeting cross-grained.

Adding soft balsa blocks to the engine-mount area is a subjective process. What and where depends on the engine you select and the amount of rounding you plan to do during final sanding.

I chose an O.S. .25 FX for the Indy 400, which meant that I had to accommodate the rear-mounted needle valve. Take some time in this area. A tidy engine installation looks great. A sloppy one does not and can spoil any airplane's appearance.

The top sheeting on the fuselage is fairly straightforward. Pick a nice, light piece of wood for this step. After you have attached it you can trim it down and then sand it even with the fuselage sides. Notice the triangle stock at the front of the top sheeting. This gives the sheeting a stable place to be attached.

Add the plywood tail-wheel mount and the plywood stabilizer-mount pieces. The stabilizer mount should be installed level with the fuselage top. Laying a ruler on each area and then sighting from the rear is helpful to determine when the two surfaces are parallel.

The bottom sheeting is applied cross-grain. This gives additional torsion strength to the fuselage. The front area is shown as light plywood. This area was done with light plywood on the prototypes and cross-grain balsa on other airplanes. Both seemed fine. The Indy 400 in the pictures was done with cross-grain balsa pieces left over from the fuselage sides and top.

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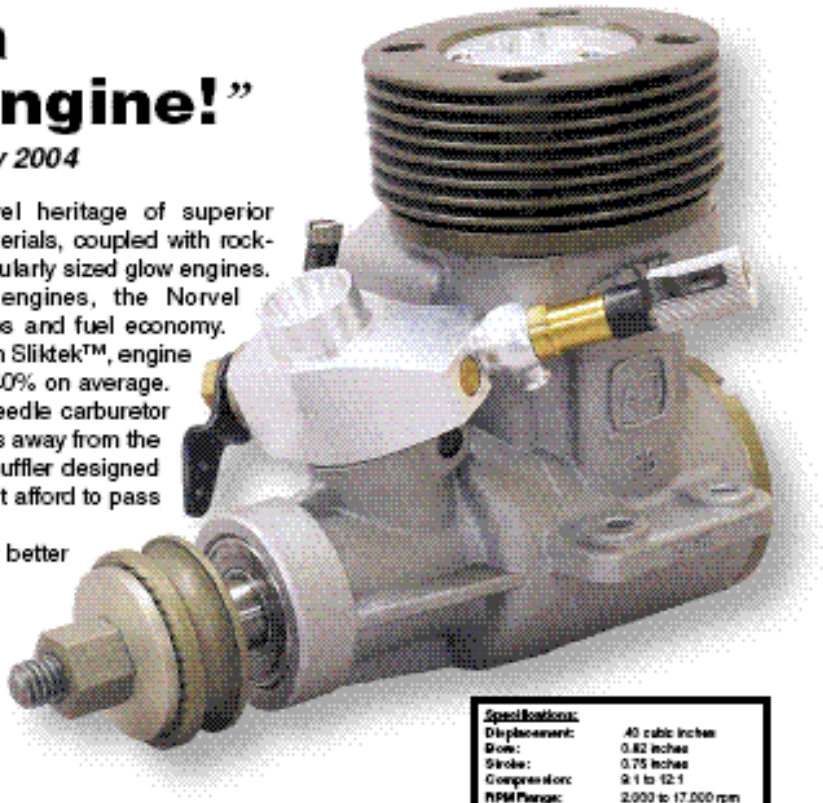

Specifications:	
Displacement:	.40 cubic inches
Bore:	0.62 inches
Stroke:	0.75 inches
Compression:	9:1 to 12:1
RPM Range:	2,000 to 17,000 rpm
Power:	1.4 hp @ 16,000 rpm
Fuel Consumption:	30 ounces/hour
Weight w/o muffler:	10.8 ounces
Weight w/ muffler:	13.1 ounces

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Now is a good time to try sliding the wing into the fuselage. If it is tight or binds you will need to enlarge the opening carefully until it is just large enough for the wing to pass through. Once in place and centered, you can view it from the back to see if it lines up with the fuselage and tail feathers.

Pin the stabilizer in place and see how everything looks. The straighter you build this aircraft, the better it will fly. Take extra care in sighting, measuring, and aligning. I used a big aluminum carpenter's framing square to lay on top of the fuselage to ensure that the wing was exactly 90° to the fuselage. A little wood typically needs to be removed from one side or another of the fuselage wing cutout to get the wing to lay correctly in relation to the other parts of the model.

Radio Installation: It looks like a tight fit in the radio compartment. It is, but there is plenty of room if you arrange the servos as shown on the plans and in the photos. Keep in mind that you can use regular-size radio gear. Lay out the components as shown and you will be pleased with the installation.

Notice how the rudder servo is mounted higher than the elevator servo. This was accomplished by adding another piece of spruce servo rail on top of the first one. It gives you the clearance you need.

Again, notice the offset of the aileron torque rods. This will show you exactly which servo goes in this location. I used a standard flat-pack battery and placed it under the fuel tank wrapped in a plastic bag. You did remember to cut the little pass-through hole in the front former, right? This is where the battery lead passes through.

Final Details: The canopy shown looks great, but there's nothing set in stone about this size or shape. I like the one I got from Sig, but you could choose another or none at all.

The metal landing gear mounts in a straightforward manner. You can use a premade unit such as I did or save some weight and construct a set from carbon fiber or fiberglass.

I highly recommend a tail wheel. You could try only a skid if you fly strictly from grass, but it would limit your ground-control abilities. If you are flying from pavement, a tail wheel is a must.

Covering: I used UltraCote on the model presented here, but any covering will work. The structure underneath does not rely on the covering for strength, so have fun. You probably have enough left over from previous projects to cover the Indy 400.

Have fun with color too! I used neon on the wings. I can get an extra flight or two in at dusk with these colors. You can't beat that! In my experience UltraCote-brand neon colors fade the least, but they all fade a wee bit in time.

The checkerboard tail is indeed a "signature look" for this model. You don't have to do the checkerboard pattern, but I swear it will make the model fly a bit faster!

I covered the entire rudder and fin with white and then carefully cut out black squares of trim-sheet material. For the layout I ruled a 1 x 1-inch grid on the fin and rudder with a fine-tip grease pencil. The grid came off easily with window cleaner when complete. Since it is an Indy racing theme, a few neat racing stickers look right if you are so inclined, but make sure they are fuelproof!

I enlarged the "Indy 400" logo from the plans to $10\frac{1}{2}$ inches long. Then I taped it to a black MonoKote trim sheet and carefully cut out the letters.

I used masking tape to lift all those letters at once and applied them to a white MonoKote trim sheet. I cut around the letters, allowing roughly $\frac{1}{8}$ inch of white to show as a border. After that was completed I lifted the logo again using a long strip of masking tape and was able to apply it to the wing. This method works great and looks great.

Flying: This is the part you have been waiting for!

Balance the aircraft. Mine required a little tail weight with the O.S. .25 FX. If you can locate the battery next to the receiver instead of under the fuel tank, this is preferable to adding lead weight to the aircraft.

If your landing gear is set up correctly, taxiing is no problem. There will be a slight pull to the left when you advance the throttle, but the Indy 400 really will get up and go quick.

I think you will be impressed by the aerobatic capabilities of this size model. The Indy 400 is certainly not a 3-D aircraft, but it is the kind of airplane that will easily become your favorite every time you go to the field.

It seems as though there aren't many sport .25 designs on the market anymore, but almost everyone has a .25-size engine around or you can buy one for little cash. Combine that with the amount of flying you can do on a gallon of fuel and the fun you will have with the Indy 400, and you can't go wrong! Have fun with this building project and this airplane. ***MA***

Scott Black
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