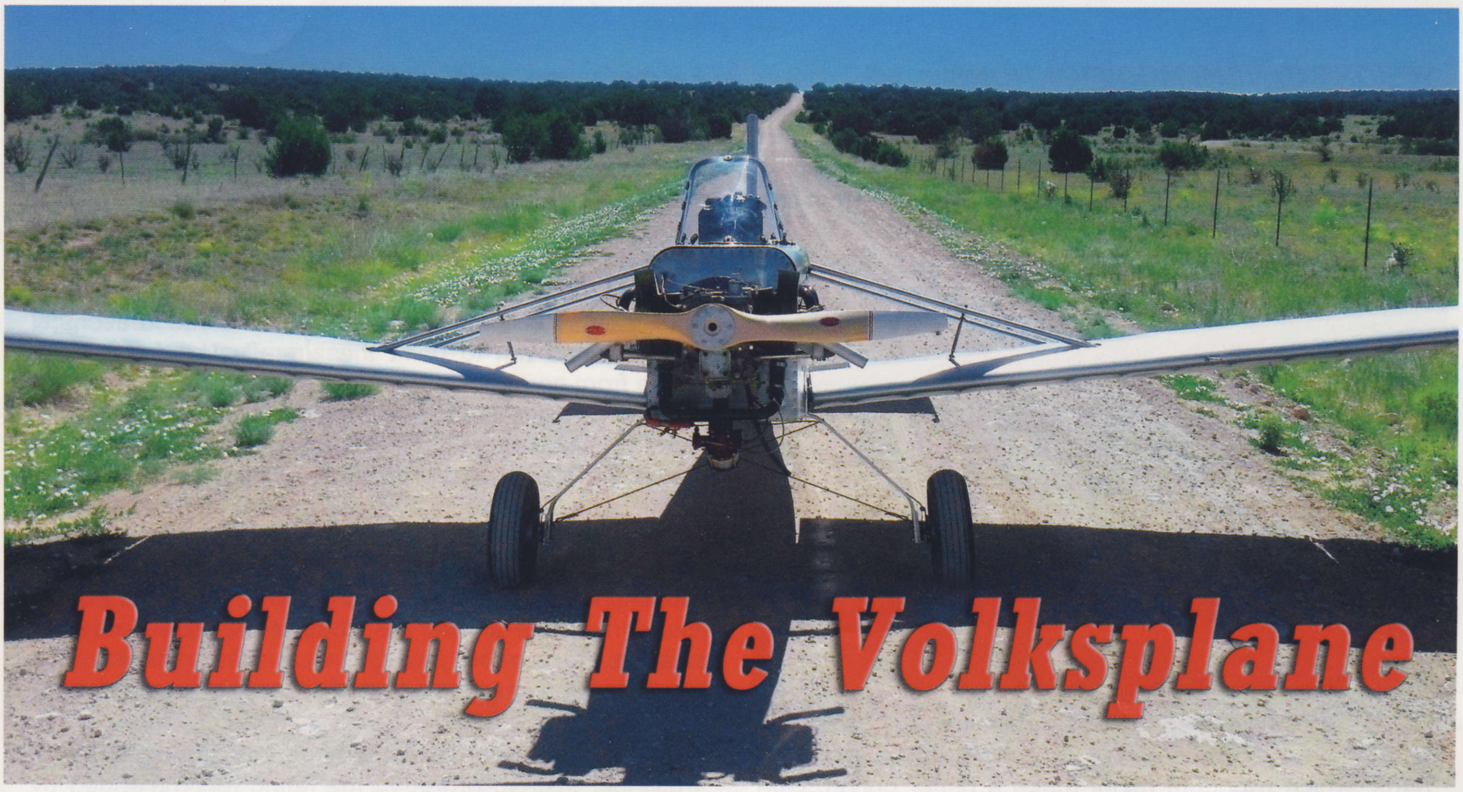

Building The Volksplane

by B. W. Stone
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Helpful Hints for Volksplane Builders

In the previous articles, B. W. wrote about his decision to build a Volksplane VP-1, describing the pros and cons of this 50-year-old design as seen through the eyes of the present-day builder. In this article, he walks us through the construction process for both the airframe. ~Pat

For the most part, the actual construction of the VP-1 airframe is, as its designer intended, so straightforward and simple that a complete description thereof would make awfully dull reading. But of course, we are experimenters; I deviated from the plans when I thought there were valid reasons to do so. And despite its simplicity, there are a couple of items that were pretty tricky to build. Here's how I went about it...

PERFORMANCE SPECS

As you'll recall from the previous article, I was not going to ask my new airplane to do very much. Performance requirements were virtually nonexistent. Range was of little consequence. The desire to pay as I went ruled out kits. Plans-building allowed me to buy my materials as I needed them, and (if necessary) shelve the project when I was ordered out to sea with my US Navy assignments; I could always pick up again where I left off.

With those factors as my criteria, just about anything that flew would be fine by me, so the VP-1's stock performance fit the bill. That said, there were areas in which I felt the plane could be modified to be more "user-friendly," and there were definitely modifications that would improve performance so cheaply and easily that it made little sense *not* to incorporate them. Here is what I was planning before I cut the first piece of spruce:

DESIRED MODIFICATIONS

The very first and most important modification was one I considered so elementary that it merited little discussion: *more power!* As we used to say around The Boat, there's no excuse for overshooting final in an afterburning airplane. Extra available power solves a lot of problems, like obstacle clearance on takeoff from short or soft fields. Extra power adds a margin of safety when flying in mountains or at high density altitudes. And to someone who was used to climb rates of 30,000 feet per minute, the improved climb rate available from a larger engine (even if it only meant the difference between, say, 600 and 800 feet per minute) was worth the cost.

Best of all, that cost was negligible. Bud Evans designed the VP-1 to fly on a 50-hp, 1500-cc engine, and the prototype first flew on only 40 ponies. Today, engines as high as 80-hp are easy to make and weigh only about six pounds more than the stock engine Bud used. I considered that a no-brainer, and decided to use a larger engine. *A discussion of the engine begins at the end of this article. ~Pat*

The other modifications I adopted fell broadly into three categories:

- Weight-saving mods.
- Cost-cutting mods.
- Safety mods.

Some modifications fell into more than one category, providing the benefits of each; these were easy decisions to make. Some, however, pitted the categories against each other, and required me to prioritize one over another. The engine was a particular challenge in that regard.

WEIGHT-SAVING MODIFICATIONS

The VP-1 was originally designed to utilize Cessna axles, wheels, and hydraulic disc brakes, all bolted to a landing gear bent out of solid 3/8" aluminum bar stock. Nowadays a prebuilt landing gear is available from the Grove Aircraft Company of El Cajon, California. A typical VP-1 setup comprises:

- The spring-aluminum gear legs, part number 1131-3, weighing 12.5 lbs.
- Any wheel suitable for a 6.00-6 aircraft tire, such as Grove's part number 65-111. This 6-inch aluminum wheel-and-brake assembly weighs 18.2 lbs; the optional magnesium assembly weighs 15.3 lbs.
- Two axles, such as part number 5032, weighing 2.2 lbs total.

The total weight for a nearly-ready-to-install landing gear from Grove therefore totals 32.9 pounds, which seemed a bit excessive to me considering the low gross weight of a VP-1.

Grove makes high-quality aircraft-grade equipment, but the Volksplane is small enough, light enough, and slow enough to roll safely on lighter and cheaper go-kart parts, which I thought might make a better option. One catch: Bud designed the VP-1 to be stored in a garage with its wings removed in order to minimize operating expenses. The idea was to tow the VP-1 to the airport *on its own gear.* If you are going to do this, I recommend against a lot of highway towing on go-kart wheels; the Grove gear is probably a smart choice for that mission. However, I was not interested in the tedious chore of putting wings on and taking them off for every flight. I intended to leave my plane assembled and hangared, which meant very little wear and tear on the sealed ball bearings of my go-kart gear. I decided to assemble my own gear using parts from multiple suppliers. I used:

Azusa go-kart brakes are actuated by 1/16" aircraft cable running through bicycle brake cable guides. In this photo the swaged fitting has not yet been hooked up to the brake actuator arm.

- Grove's spring-aluminum gear legs
- Azusa Engineering's Azusalite 6-inch wheels, part number 1072, made of Zytel nylon weighing just 2.4 lbs. for the pair.
- Azusa's 4.5-inch mechanically-actuated go-kart drum brakes, part number 2208, weighing 3.2 lbs. per pair.
- A pair of pre-welded 5/8" stub axles with mounting plates for the Azusa brakes, which I bought from Great Plains Aircraft Supply Company (GPASC). The axles weigh about a pound apiece. Although GPASC apparently no longer carries them, Wicks Aircraft offers a similar axle (part number AZ-585.)

By doing it myself I saved 12.8 lbs. and a lot of money. At today's prices, Grove's complete assembly would cost $1857, while a gear built my way would cost only $924. For me, saving weight was the primary consideration: the cost savings were "gravy."

The next major weight modifications were easy ones: I omitted the fiberglass engine cowling and turtle-deck fairing shown in the plans. Both were explicitly optional per the plans, and losing them would not only save about twelve pounds, but would also save a little money and a little more construction time. For the same reasons, I also planned not to paint the aircraft. The fuselage is made from gorgeous aircraft mahogany plywood, and for longevity's sake had to be varnished, inside and out, with durable epoxy varnish. Rather than hide that mahogany under the weight and tedium of a fancy paint job, I figured I would let it be its own decoration. I figured likewise for the wings; the silver coats would look nice with the mahogany fuselage, so I planned not to paint over the aluminum-pigmented UV coatings. Since I was unable to find a definitive answer on whether the Poly-Spray UV coating was durable enough to act as a top-coat, I did finally spray a single top-coat of silver paint on the fabric.

Lastly, I decided to cover the aircraft in ultra-light 1.7-oz PolyFiber instead of the 2.7-oz fabric recommended by the plans. The lighter fabric is intended for the Part 103 market and was not available when Bud designed the Volksplane VP-1. But it is more than sufficiently strong, being rated for aircraft of up to 65 hp and a V_{NE} of 120 mph— my Volksplane exactly.

MONEY-SAVING MODIFICATIONS

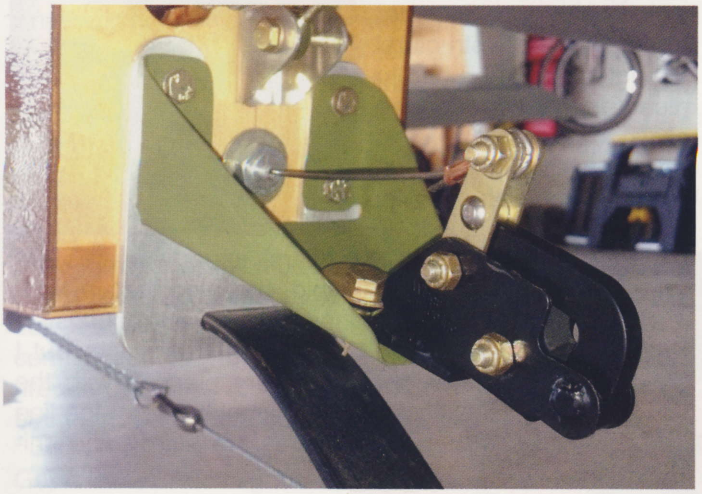
There were precious few modifications that I made purely for their cost savings. Most of the areas in which I saved money (such as the landing gear) were primarily chosen for other considerations. A better scrounger than I could definitely have potentially lowered the overall cost by refurbishing most of the engine parts himself. However a brand-new engine case should be considered a must, but even with new bearings and rings, the new parts could be had for under $2000. However, time is money, and I had less of the former. I was therefore willing to buy entirely brand new parts for the engine rather than spend the time overhauling inexpensive but serviceable used parts. Especially where the engine was concerned, I considered it money well spent.

That said, I did save a few bucks on the instrument panel. My oil temperature and oil pressure gauges are both SunPro aftermarket accessories available off the shelf at AutoZone for about $18 apiece. They're cheaply made, but they work just fine, and if they ever do break I'll be able to replace them easily.

SAFETY MODIFICATIONS

My single biggest concern with this hand-propped aircraft was how to start it myself, unassisted, without finding myself in a losing tail-chase behind a runaway Volksplane. Any solution involving conventional chocks or tie-downs necessarily involves pulling chocks or untying prior to entering the cockpit, so for some period of time, I would be *counting on the low idle thrust of the VW* engine not to move the airplane. It worked for Bud, but I wanted a more secure way.

I designed a bracket to attach a Schweizer-style glider tow hook to the fuselage sternpost. Released via a Bowden cable running through the aft fuselage from the cockpit, the tow hook allows me to tie the tail down before propping the engine to life. The tow hook holds the plane safely in position while I climb into the airplane and strap in. When I'm ready to go, I simply pull the release and taxi away. While the hook itself is rated for much higher loads, the bracket is only designed for a 500-lb load to keep its weight down. As the engine, even at full throttle, only produces about 200 lbs of thrust, the safety margin is more than enough. This mod is one that you must commit to before you get too far along. Once the bottom fuselage skin is installed it would be extremely difficult to retrofit the Bowden release cable.



A simple Schweizer-style tie-down release is a useful safety precaution for any hand-propped aircraft.

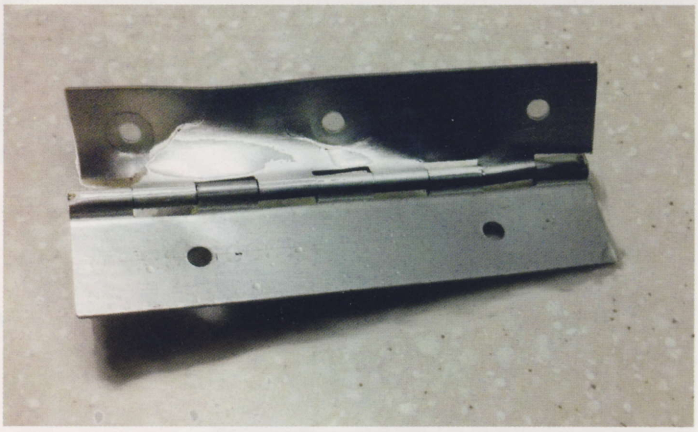
On the principle that "simpler is safer," I also made a number of decisions regarding the engine. The overriding principle behind these decisions was to minimize the number of moving parts and to dispense with anything that wasn't absolutely necessary. These choices are discussed more fully in the accompanying engine article. Suffice it to say that I:

- Wanted a fully gravity-fed fuel system. This ruled out the stock Volkswagen intake with a traditional downdraft carburetor.
- Wanted to simplify the intake by deleting carb heat, which I could do by using an AeroInjector, a guillotine-slide carburetor that's resistant to carb icing.

The engine proved to be a particular challenge when it came to balancing simplicity against safety, weight against cost, etc.

Lastly, the rudder-pedal hinges as designed are extremely weak, as I discovered when I experienced a catastrophic failure of the left hinge— on the ground, fortunately. So while I didn't actually make the following modification until after the airplane had flown, I recommend that it be incorporated from the outset.

As designed, the rudder pedals are flat plywood panels, hinged at the bottom using .040" extruded aluminum piano hinges. Those hinges are strong enough for the back-and-forth rotation about their axis which is all they were intended for. However, the pedals connect to the rudder via aircraft cables attached at their inboard edges. As your feet will press on the pedal somewhere out*board of that cable attachment*, any force on the pedal creates a torque that tends to twist the pedal, with the outboard edge being twisted forward by your foot *and the inboard edge being twisted aft by the rudder cable.* Normal flight loads are no problem; the rudder forces are exceedingly light. But if you stomp a pedal to make a tight turn on the ground, or even if you just press on both pedals to stretch your legs in flight, you will torque that hinge in a way it wasn't designed to withstand.



After 60 hours, the aluminum hinge called for in the plans failed on the left pedal, jamming it in this position.

After about sixty hours, my left hinge failed. Inspection revealed damage on the right one as well. I simply removed the hinges and replaced their attach bolts with eyebolts: three AN42B-7A eyebolts on each pedal, with a total of four AN42B-21A eyebolts coming up through

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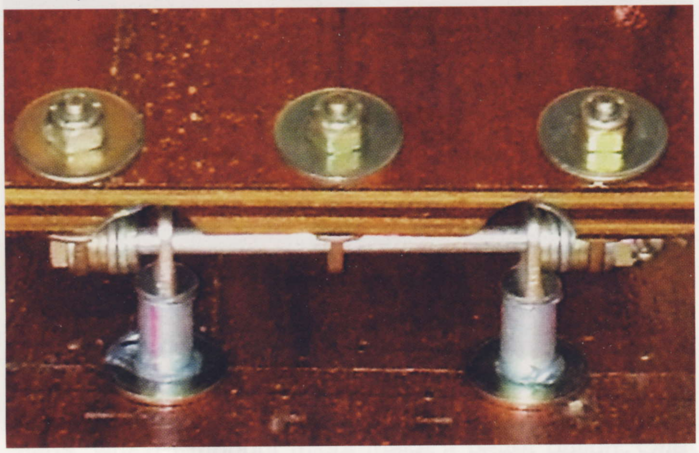
the cockpit floor. I passed an AN3-40 bolt through each of these to act as the hinge pin, and secured it with a castellated nut and cotter pin. Although you could turn bushings for this purpose if you prefer, I kept the pedal from moving side-to-side with a buildup of five AN960-10 washers at either end of each pedal. Lastly, to make the pedal stand proud above the surface of the cockpit floor (so it can hinge aft of the vertical as well as forward) I turned bushings 5/8" long, visible in the photo.



This close-up of B.W.'s improved rudder-pedal hinge shows how he used 5/8" aluminum bushings and AN42B eyebolts to raise the pedal hinge line an inch above the cockpit floor. Eyebolts in the pedal itself, and an AN3-40 bolt as hinge pin, complete the modification.

MISCELLANEOUS

There was only one modification that I made because I thought it was simply better: I wrapped the wing leading edges (prior to covering) with 1/16" mahogany ply rather than the .012" aluminum called for in the plans.

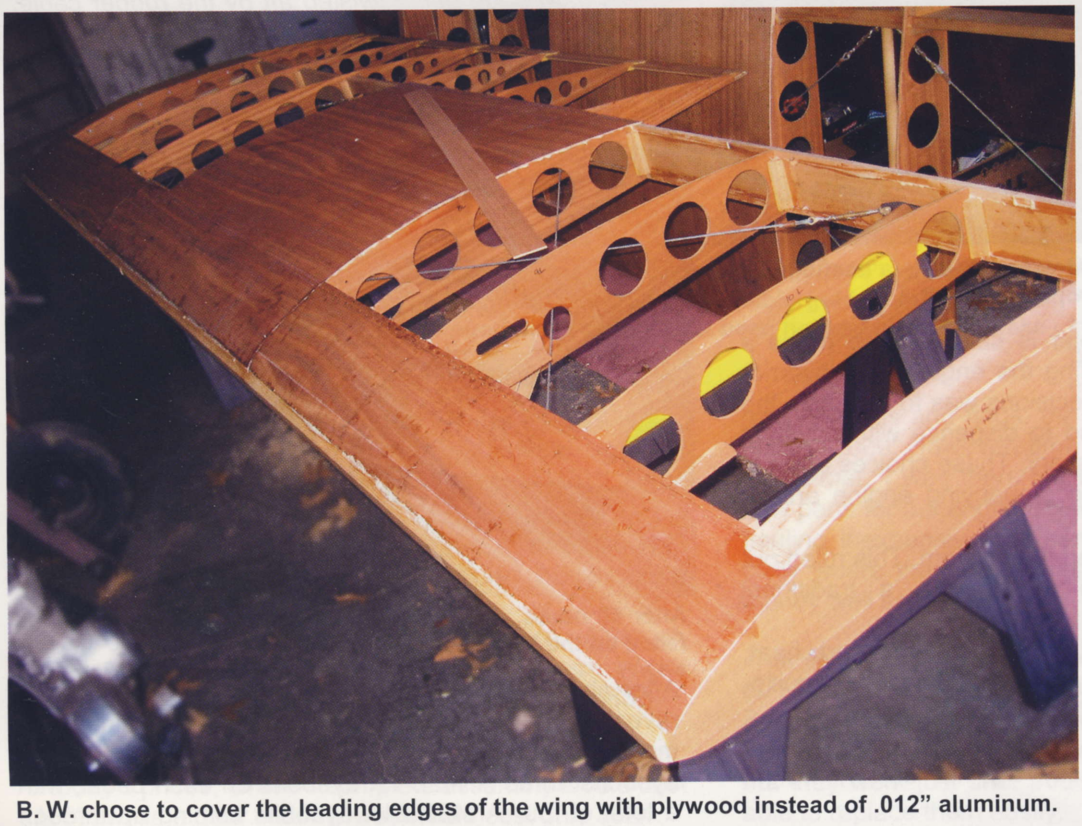
The purpose of the leading edge sheeting is to give some support to the fabric in an area subject to relatively high pressure differentials. But I disliked the idea of using sheet aluminum for several reasons:

- The aluminum is not part of the wing's structure; it is merely a fairing nailed to the wing ribs.
- The aluminum would complicate the rib-stitching process; I would first have to punch holes in the aluminum with an awl, and then hope that the rough edges of the punched hole wouldn't wreak too much mischief on my rib cords as I stitched.

In contrast, if I substituted 1/16" ply for the aluminum:

- The plywood, which would be glued to the leading edge, the spar, and each rib, would actually become a part of the wing structure, making the wing stiffer.
- Because I could adhere the fabric to the underlying plywood, rib stitches would not be required in this area, thus making the covering job go marginally faster. (Granted, the additional work necessary when building the wing structure erased this benefit, but I didn't realize that when I made the decision.)

Merely substituting the plywood for aluminum would only add 12 ounces to the plane's finished weight. However, in order to gain the structural strength I wanted, I had to glue the aft edge of the plywood ply to the wing spars, which in turn required some spruce "filler strips" to be glued to spars' upper surfaces. All told, the modification added about two pounds to the finished airplane. But I am very pleased with the end result; the leading edges are sturdy and uniform.



B. W. chose to cover the leading edges of the wing with plywood instead of .012" aluminum.

Finally, I made one modification when the aircraft was nearly complete that I would recommend a Volksplane builder consider from the outset: I moved the engine two inches further forward by mounting it on longer mounting spools. Although this idea was prompted by the difficulty of installing an updraft intake manifold with the engine in its original position, it turned out to be a critical factor in maintaining the proper center of gravity.

The intake manifold will be covered in detail in the engine article appearing in the next issue. Suffice it to say that I wanted an updraft configuration, and I wanted to use commercially-available parts instead of fabricating my own. The intake manifold that Great Plains Aircraft Supply sells for KR-1 and KR-2 aircraft seemed like a likely choice, but when discussing its dimensions with Steve Bennett of Great Plains it was clear that the stock VP engine installation would not leave enough room between the engine and the firewall for this manifold to fit.

Steve makes his living selling Volkswagen engine parts to homebuilders, and in the course of his business, has sold to a few Volksplane builders. Although he did not have the detailed information I needed to calculate how far to move the engine, he did report that the VPs he was familiar with had all come out tail-heavy.

In retrospect, that's not a surprising report. As you'll recall from my previous article, the prototype VP-1 weighed 440 lbs empty, but required 37 lbs of modifications. All of those mods go behind the center of gravity, and some of them, like the tailwheel or the stabilator balance weights, are on awfully long moment arms.

So without detailed numbers, I had to do a little "eyeball engineering." As much to make room for the manifold as to get the CG right, I decided to make my engine mount spools two inches longer than the plans called for. I must lead a charmed life; weight-and-balance came out well within limits. Without the mod the CG would have been aft of the aft limit.

HELPFUL HINTS

After four pages of modifications, you might be worried about construction itself. Relax: I told you it would make dull reading. Building the fuselage is not much more complicated than making a packing case, and the wings are akin to balsa model wings. Here are just a few recommendations that I hope you will find helpful.

Get a lathe. This might seem like an excessively specialized machine tool for a simple airplane, but I bought one specifically for this project, and was repeatedly glad I did. For instance, the attachments where the flying struts land on the wing spars are made by drilling a hole through the center of a cylindrical aluminum bushing which transfers the load from the spar to the strut. Sure, you can make these bushings on a drill press, but you can make them more accurately on a lathe, and when you go to test-fit the wings for the first time, you'll be glad your bushings were bored square. And there are plenty of other examples: the bushing for the rudder-servo actuator could be improvised out of aluminum rod and a washer, but is easily machined if you want to do it right. The rudder bellcrank is made out of a sheet of 0.125" aluminum riveted to a turned aluminum collar 0.75" thick; good luck making that one without a lathe. Lastly, the rudder itself hinges on a torque tube made of 6061 aluminum which rides in two nylon bushings. If you don't get those bushings exactly the right diameter, and exactly

Specialized parts such as this bushing for the rudder-servo actuator are easiest to make when turned on a lathe.

square, the rudder will bind. Borrow one if you can, but buy one if you must: Harbor Freight's 7" x 10" "Mini Precision Lathe" (part number 93212) is only $499.99 and will pay for itself in making these parts.

Route the wing ribs instead of band-sawing them. Bud's plans call for the wing ribs to be stack-sawn on a band saw, then final-sanded to shape on a disc sander. This will work just fine, but you will have some variation between batches of ribs. To get the ribs absolutely identical, I very carefully sawed and sanded one rib to size and drilled the lightening holes in it. Then I used that rib as a template on a router table. Using a straight router bit with a contour-following bearing, I routed matched pairs of ribs (e.g., left and right butt ribs, left and right wing tips, etc.) precisely to finished size in one pass. By drilling small holes in the approximate location of each lightening hole, I left room for the router bit to do each lightening hole exactly to size as well. The whole job took only a couple of hours, with another hour or so required to hand-cut a couple of slots (such as those for the aileron pulleys) that are only required on one pair of ribs.

You can judge for yourself whether B.W.'s technique for shaping the wing ribs was effective: this degree of uniformity is difficult and time-consuming to achieve with band saw and disc sander.

Give the flying struts some thought. Fabrication of the flying struts was easily *the* most difficult part of my Volksplane experience. The plans are unclear, written directions are nonexistent, and the .049" streamline tubing out of which they are made is tricky to work with. Having access to a friend's first-class machine shop, my first inclination was to machine the slots into which the sheet-steel tabs are welded. But streamline tubing is subject to internal stresses as a part of the manufacturing process. When you make longitudinal cuts into it, you relieve those stresses in ways that cause the ends to spring. There's no easy way to clamp your workpiece without either crushing the area you're machining, or machining a diagonal slot as a result of the tubing springing apart.

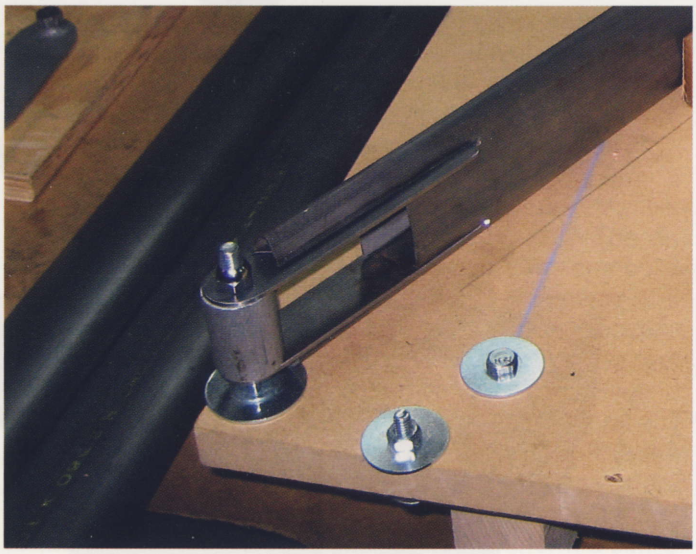
So my second idea involved cutting the slots with a pneumatic die grinder and a grinding wheel the same thickness (.090") as the steel sheet tabs. This, too, was a mistake; the die grinder is too powerful to control accurately, and my slots proved horribly oversized. This left gaps to be filled by the welder, meaning excess heat to be applied to the struts, which warped them horribly.

When I rigged up the wings to test-fit the struts, only one of them fit, and even that one required a little gentle persuasion with a mallet before the attach bolt would slip through. The other three had warped so badly that the bolt holes were as much as 3/16" off of true. It was a bitter pill to swallow, both in terms of time and money, but I made what I thought was the only prudent choice, and scrapped the wing struts.

This photo should give you some idea of the challenges involved in building the flying struts. The two sheet-steel tabs have to be parallel to each other both vertically and laterally, and the large cutout between them leaves room for the heat of welding to warp the streamline tubing.

My second attempt at the struts, using my third idea for cutting the slots, was successful. Having carefully located both the inner and outer edges of the slots with a Sharpie marker, I traced them carefully with a Dremel

On what should have been a milestone day, the first attempt to test-fit the flying struts showed three of the four to be unusably warped, which is why they're absent from this photo. B.W. scrapped $500 worth of streamline tubing and prudently decided to start over again



On B. W.'s first attempt to build the flying struts, he used aluminum spools, such as those shown at lower left, to hold the sheet-steel "ears" in place while they were welded to the main piece of streamline tubing. But this allowed the tubing to warp badly over the long length of the weld not supported by the spools. The end product was unusable. To prevent the warping when he made the second set of struts, B.W. replaced the aluminum spools with steel-bar heat sinks that filled the entire gap and supported the pieces being welded over their entire length.

tool and cutoff wheel. Setting the Dremel to about 15,000 rpm yielded a speed high enough to grind the tough 4130 steel, but low enough to be readily controllable. I simply traced the lines by hand. It sounds tedious, but it only took two evenings to have all four struts ready for the welder: 32 cuts in all. In the end, the simplest solution turned out to be the most accurate.

The very last thing I did was to cut heavy heat sinks out of mild steel bar, as long and as wide as the cutouts at each end, and an inch thick. These heat sinks were bolted in position during welding. Not only did they hold the struts immobile, they absorbed some of the worst of the heat variations. Both factors prevented the struts from warping during welding. They worked like a champ, and the second set of struts bolted right on with no problems.

THE ROADS NOT TAKEN

You're probably wondering, after all my pontificating, how well I did. Were the mods worth the effort? Do I wish I had made additional mods? Are there mods I wish I hadn't bothered to make?

Landing gear: I am pretty pleased with my landing gear, which is lighter, cheaper, and simpler than Grove's. The mechanical drum brakes do require frequent adjustment, however. This is a minor drawback given how little I fly my Volksplane. But hydraulic brakes are self-adjusting and might be a good option for a frequent flyer. Per the plans, I installed only a single brake lever to actuate both brakes simultaneously. If I were to do it again I would use two separate brake levers to gain the tight turn radius possible with differential braking.

Weight: much to my chagrin, after all of the efforts to save weight, my airplane came out heavy. Against a minimum possible gross weight of 477 pounds, mine weighed in at 515 (38 pounds or 8% heavy.) Granted, I made modifications that I expected to add weight (such as the longer engine-mount spools necessary to move the engine two inches forward, or a stainless-steel firewall in lieu of aluminum.) But that weight should have been offset by 24 pounds I saved using the lighter landing gear and deleting the cowl and turtledeck fairing. So I don't know exactly what threw my weight off. Perhaps, like so many homebuilders, I sprayed one coat too many on the fabric, and used one too many layers of glass on the fiberglass fuel tank, etc. Still, I can't possibly have sprayed 38 pounds of excess paint on a job that should only weigh 18-20 pounds total. An extra coat would only have added a pound or two.

The only area where I added material for the sake of "extra" strength was in the wing leading edges - a two-pound mod, as previously discussed. The fuselage was admittedly designed for grade A-A Douglas fir marine plywood, and I used aircraft-grade mahogany, but the weight differential is negligible - less than five additional pounds for the entire airframe. The overage was frustrating, but fortunately did not threaten my 750-pound gross weight. It's a good reminder, not that I should need it, to watch every ounce that goes into my next project.

MODIFICATIONS NOT MADE

There are several mods I wish I had thought of in advance, and only figured out I wanted after the fact. Here are some highlights:

- More power = higher fuel flows, of course. I smacked myself in the head for forgetting that elementary point. The stock 8-gallon tank might be fine for a 1500-cc engine, but my thirstier engine needs a bigger tank. My next rainy-day project will be to build and install a tank that holds 10-11 gallons.
- The inspection holes in the fuselage are *extremely* un-user-friendly, especially as you need to reach through them to perform such tricky tasks as safety-wiring turnbuckles on the flight-control cables. You need two hands everywhere, and you can't squeeze your two hands through one tiny inspection hole. If I had it to do all over again, I would put two inspection holes at each spot in the fuselage where the plans specify only one.

But the engine is where I really feel I learned some lessons. There are things that I would do differently were I starting from scratch right now, and things that I still could do differently if I wanted a little winter project. For details, see the article in the next issue of *CONTACT! Magazine.*

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