Companion Guide: "Building Fly Baby" Article 4: Fuselage Secondary Structure

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and the Fly Baby Community

This Companion Guide is written to accompany the fourth of Pete Bowers' Fly Baby construction articles in EAA SPORT AVIATION magazine. The previous article described how the basic fuselage was assembled. This article addresses some of the secondary structure that must be added to the fuselage.

You will need to download these articles from the EAA Archives to actually build the wings. This Companion Guide merely supplies additional background information and some helpful hints on the actual construction. A full Table of Contents is included on the next page.

There are two kinds of figure references in this Companion Guide. If the reference is "Figure 1-1" (with a hyphen), it's a figure in the original EAA articles. Figures without a hyphen are contained in this document and should closely follow the text which refers to them.

For specific assistance in building the components described, see the Workmanship and Hardware articles on the PB100 Web Page.

Many thanks to Matt Wise, Jim Katz, Jim Hann, and the others of the Fly Baby community for providing some great pictures to illustrate the points in this Guide.

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1 OVERVIEW: WHAT'S A SECONDARY STRUCTURE?

All right, what's this Article all about?

Basically, Pete had a limited amount of space he could use for each article. That's why the wing construction and assembly were in separate articles, and why the fuselage construction article is followed by "Fuselage Secondary Structure." No reason it couldn't have been included in the previous article, but Pete had a page limit per magazine issue.

Figure 1 shows much of the material to be added to the fuselage. There's quite a bit of it…but most is pretty straightforward and simple.

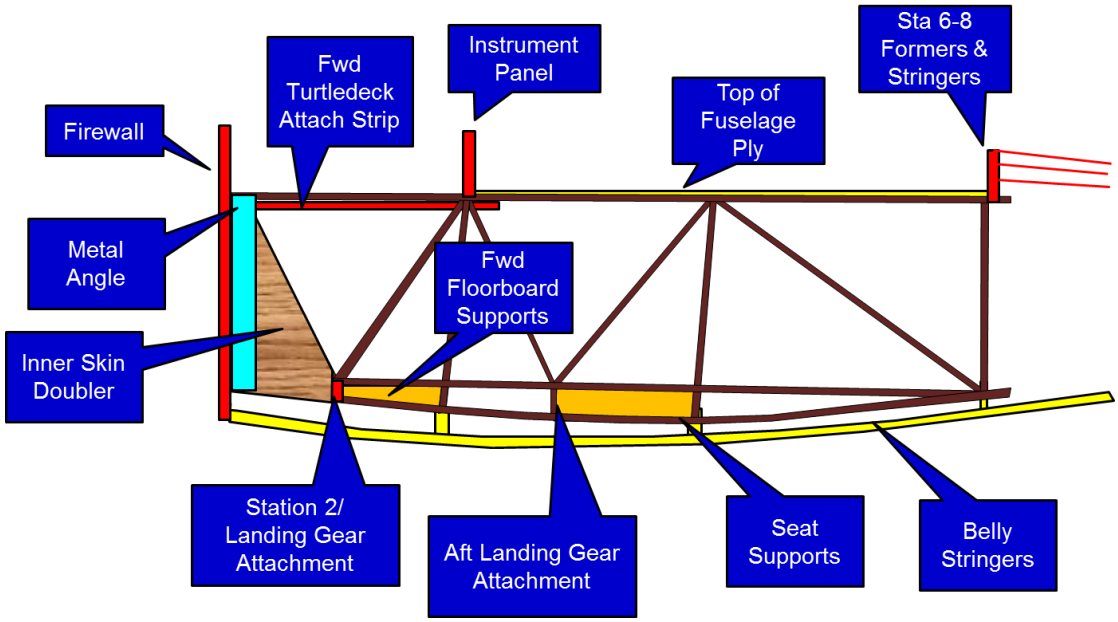

Figure 1: Secondary Fuselage Structure

In a few ways, this is where the fun starts. As Pete says at the start of the article, "Lots of room for variation." The firewall, the instrument panel, and the formers define the cosmetic look of some of the most visible portions of the aircraft. This gives you the chance to give the plane your own "look."

Figure 2 provides an example. It's a montage of instrument panel photos, with Pete's original in the center. Notice the shape variations…and how it can change the look of the airplane. My own airplane (at the 6 o'clock position) had a rounded shape, while several others are much more flat. Pete's panel has a removable section for the barometric instruments (as does mine) but other folks don't bother…or, if they do, they make the removable section much larger (see the panel at the 10 o'clock position), or change the shape (8 o'clock).

Figure 2: Instrument Panel Shape Variations

1.1 Installation Decisions

You'll be making the instrument panel in this section. In addition to picking which gauges to use, you may have to also consider the electronics that'll be needed…radio, transponder, ADS-B, etc. If you have an electrical system, planning is needed to position the switches, circuit breakers, and wires.

Be advised that the distance between the normal instrument panel location and the fuel tank is rather tight. Instruments fit fine there, but it might be tight for many radios and especially transponders. Figure 3 shows this area. Radios and/or transponders can be mounted below the Station 3 top section, but care must be taken to ensure that they don't interfere with the controls or access to the fuel valve.

Section 5.1 discusses aspects of the installation of an electrical system.

Figure 3: Limited Space Behind the Panel

1.2 Note about Illustrations

To make things clearer, I have drawn up a lot of sketches to illustrate some of the aspects of the assembly. Peripheral details on these sketches are just there to complete the drawing—they may not, exactly, match the original Pete Bowers figures. My sketches always are in color; Pete's are black and white.

Where there is a difference between my sketches and those from the Pete Bowers article, assume the original article sketches are correct.

This is especially true when looking at the sketches of the fuselage trusses. There are subtleties that Pete includes that may not be reflected in this document.

If two pieces in my sketches are supposed to be the same size but look different, just assume that was an error.

1.3 Workmanship

Let's review the Basic Workmanship rules for building Fly Babies. Key notes:

- Do not varnish any areas which will subsequently be glued

- Varnish any closed areas (double-plywooded forward section, etc.) before they are closed up.
- Drill holes in wood directly to size, using a brad-point drill bit
- Varnish all bolt holes
- Varnish all areas where metal parts will be in contact with the wood
- All metal components should be painted or otherwise protected.

2 ERRATA

2.1 Hole Size for Landing Wire Support Plates

This is a first; a case where Pete got the drawing right but the article wrong.

Almost all the way down on the left side, the Article says, "…With outer edge of assembly [landing wire terminal assembly] flush with outer plywood skin, clamp the assembly in place and drill through it to locate **3/4** inch bolt holes in Station 3."

A 3/4" bolt would be tremendous in size. The plate shows 3/8" holes, so drill 3/8".

2.2 Location of the Instrument Panel Beveled Brace.

On the first page of the article, on the top of the second column, Pete says, "Remove the fittings, and install the last four corner bows of Figure 1-4 per Figure 1-20, and add plywood from Station 6 to the forward side of Station 3 after adding cross-piece "A" ahead of Station 6.."

Not sure where the second reference to "Station 6" came from. The diagram shows this cross-brace being installed in front of Station 3, not 6.

2.3 Biplane Wing Supports

Several illustrations include add-ons for if one eventually plans to use biplane wings on the Fly Baby. The biplane plans are not currently available, though they may be available on loan or by private sale.

Figure 1-14 on page 16 of Article 3 shows a half-circle plywood block to be installed at the top rear of the firewall. There's no reason NOT to include this.

Figure 1-17 shows a traverse rod to support the biplane wings. This was actually eliminated in the final version of the biplane planes, so just leave the "Biplane Rear Spar Support Tube" off the aircraft.

2.4 Firewall Shape

Figure 1-14 on Page 16 of Article 4 shows the firewall shape. The original layout assumed that the "Lower Inner" longeron would poke-through the firewall. Pete later corrected it so that just the upper and lower longerons did so.

This changed the shape of the lower part of the firewall, as illustrated in Figure 4. He also noted that the shape of the firewall at the bottom was wrong; the provided dimensions are correct, but the angle as shown is off. Use the dimensions.

Also, the text of the article refers to "Figure 1-15," but not Figure 1-14. The latter is what will give the dimensions of the fuselage formers

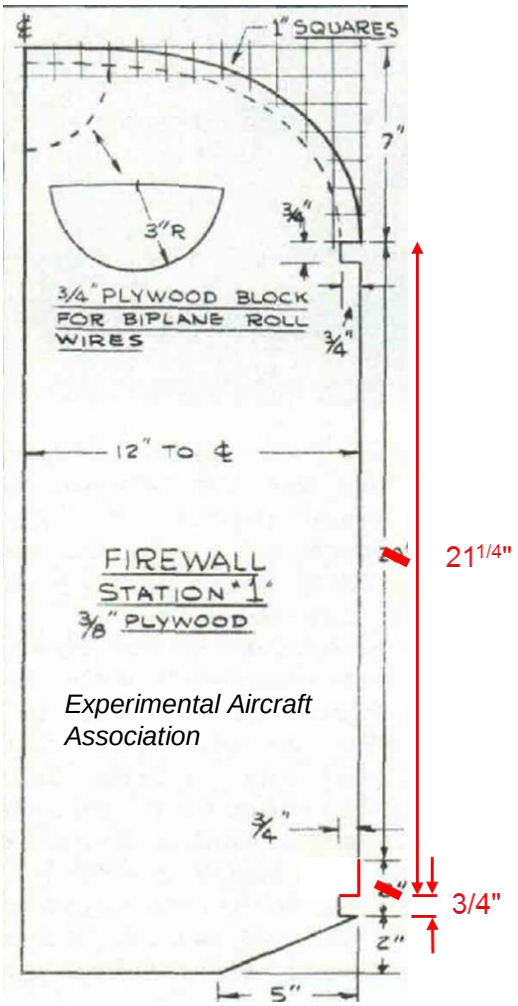

Figure 4: Corrected Firewall

2.5 Fuselage Positioning

All of the work that follows is performed either on the top or the bottom of the fuselage. As such, having the fuselage sitting upright on the work table isn't the most optimal position. If your table is 30 inches high, the ~24 inch height of the fuselage puts it almost five feet off the floor. This is hard to work on, especially when you have to reach down into the fuselage. At this stage, the fuselage sides are covered with plywood, so you can't just reach in.

There are two ways to make life easier. If you have the room, you could set the fuselage atop some temporary supports right on your shop floor. Figure 5 shows the fuselage inverted, for working on the Station 2 bulkhead and the landing gear reinforcements on the bottom of the fuselage at Stations 2 and 4.

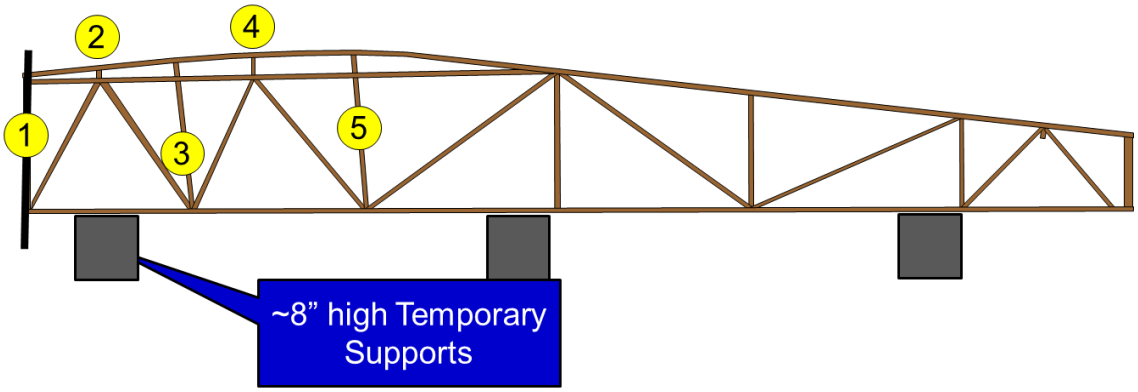

Figure 5: Fuselage Positioned for Station 2 Installation

The other option is to lay the fuselage on its side, as shown in Figure 6. Depending on where you're working, you may want to add a piece of foam or similar support at the tail to keep the fuselage from rocking.

Figure 6: Laying the Fuselage on Its Side

One factor is the firewall: It sticks above the top longerons, and goes below the bottom longerons. So upright or inverted, the fuselage will need to be positioned to let the firewall hang free. That is one advantage to setting the fuselage on its side.

Pete describes the sequence that the various Article 4 components are added to the fuselage, but it isn't critical. Formers and stringers to define the top and bottom shapes of the fuselage will be added…but these can get in the way of performing other tasks. For example, he says to install the Station 2 bulkhead after completion of the aft-fuselage turtledeck. However, if you position the fuselage upside down, which would mean the fuselage will be resting on the somewhat delicate turtleback!

Pete has the builder installing the aft turtledeck first, but I'd recommend leaving it for last. He already recommends waiting on the belly stringers until ready to cover the fuselage. This document will be providing background on making the stringers, with a recommendation to set them aside and glue them in later.

3 SAFETY ISSUES

There are no significant safety issues related to the secondary fuselage structure.

4 CONSTRUCTION DETAILS

At this point, the major structural elements are in place, and (hopefully!) the glue has cured. Position the fuselage as needed to work on it.

4.1 Firewall

Figure 1-14 on Page 16 of Article 4 provides the outline of the firewall, to be made from 3/8" plywood. Notice the notches…these are designed to fit over the stub ends of the top and bottom longeron, as seen in Figure 7.

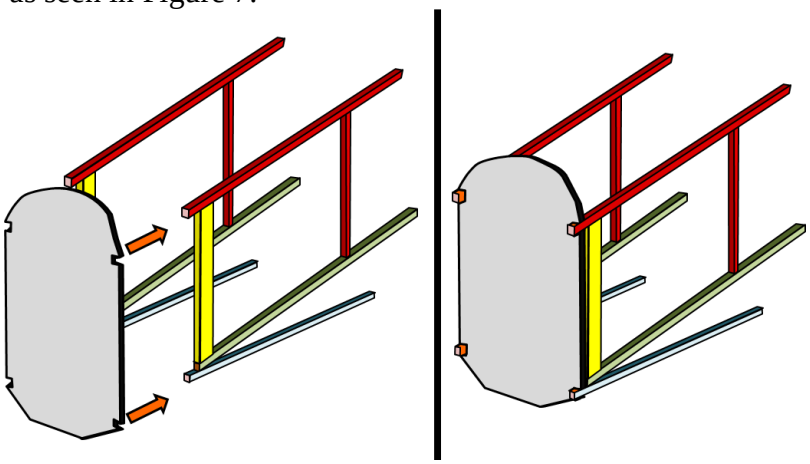

Figure 7: Firewall Fitting

Note that the primary component the firewall will be glued to is the front upright on each side. When the firewall is in place, the stub ends will be sticking out from the plywood. Once the glue has cured, these can be trimmed off.

However, the above figure omits one major component on the fuselage sides: The plywood covering. Remember, the plywood was applied to the fuselage at least 3/8" further than the upright. This is so the firewall is actually enclosed within the two plywood sides, as seen in Figure 8.

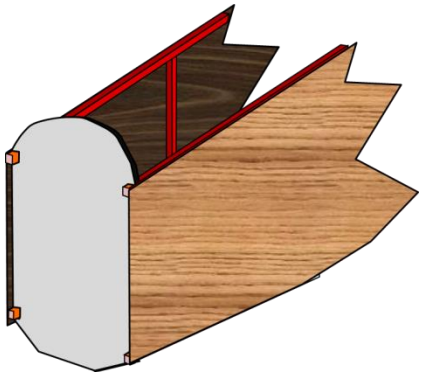

Figure 8: Firewall with Plywood covering

So when the firewall is installed, it's glued to the forward edge of the Station 1 uprights, the top and bottom longerons poking through the plywood firewall, AND is basically encapsulated by the two pieces of plywood.

So this isn't just a simple stick-it-in-place-and-glue-it job. You'll need to be fitting the firewall carefully, not only to make the notches fit the longerons, but to get it tightly (but not too tightly) between the plywood sides. Of course, this has to be solidly clamped while the glue cures. I think if I were building, I'd use a genuine construction-type nail gun to ram that plywood against the two uprights as solidly as possible.

Now that I've scared you into building this section as well as possible, there's a bit of a "cheat" coming. In addition to that massive amount of glue, the firewall is going to be attached to the rest of the fuselage with two great big thick pieces of angle aluminum or steel, and a nice variety of bolts. You can see the angle on page 16, in Figure 1-16 in Article 4. So keeping the engine in place is not TOTALLY reliant on the glue.

This piece of angle is 1/8" thick, with each arm 1½" wide. You'll need two pieces, each 22" long. It'll eventually be bolted in place

Some more of the fuselage needs to be installed before adding this angle, so don't put it in yet. It's added as part of engine installation in Article 7.

Before moving away from the firewall, there's one more thing to add. Take a piece of 3/4" plywood and cut a 3/4" wide doubler that matches the top arc of the firewall. Jim Katz provided a great picture as Figure 9.

Figure 9: Doubler on Top of Firewall

Pete's drawing in Figure 1-14 is a bit goofy…if you go by the 1" squares, the top of the arc is "thinner" than the three-quarter inch at the sides. He later admitted the drawing is a bit off.

Pete also shows a half-circle block to be added to support biplane wing bracing. It's not needed, unless you someday intend to build a set of biplane wings. It's simple enough, though, might as well add it.

A Note on Firewall Shape

Before cutting out your firewall, consider: The top of the firewall is what defines the shape of the top of your fuselage up front. If you want a rounder fuselage, cut the area above the "notches" more-roundedly.

4.2 Station 2 Bulkhead Installation

Installation of the bulkhead at Station 2 was not included in the previous Article, since getting it slightly off in size would have had a significant effect in getting the firewall to fit properly. Now that the firewall is in place, install Station 2.

Figure 10 shows what the Station 2 installation location should be looking like (the photo shows the two sides separately, and shows the fuselage upside down on the work table).

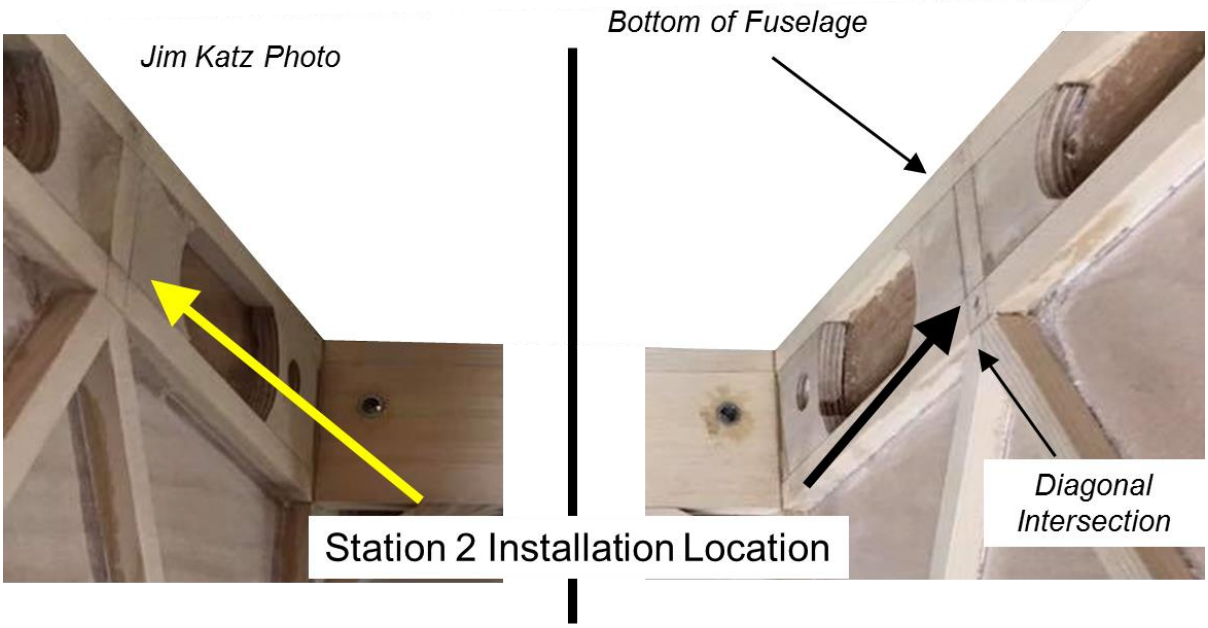

Figure 10: Station 2 Location

The building process was described in the Part 3 guide, and is summarized in Figure 11. Install the laterals (cross-pieces) between the Lower Longerons and the Lower Inner Longerons. Cut these to size, but they should be around 22.5 inches (plus or minus a little bit, if you're using 3mm or 4mm plywood). Use pieces of 1/8" plywood as temporary gussets to hold the laterals in place while the glue cure. Make sure the temporary gussets aren't glued down! Then glue 1/8" plywood on either side, making sure to varnish the inside, first. Ensure there are a few drain holes in it.

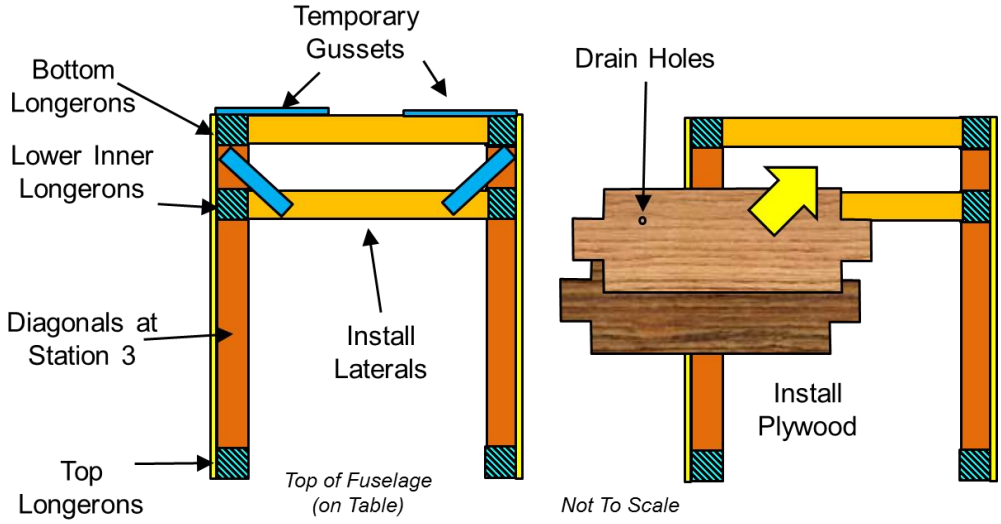

Figure 11: Station 2 Construction

The temporary gussets on the bottom of the fuselage (top of the diagram) will actually be replaced by similar permanent ones, but as part of a general reinforcement of the area. You could glue half-circle gussets here, now, but suggest waiting until the full installation.

You might be tempted to position the lateral across the ends of the two diagonals that intersect at Station 2. Don't! The top of the Station 2 bulkhead supports the floorboards in the forward cockpit. Putting the lateral higher (actually, lower when the fuselage it upside down) will mess up the flooring. Skip ahead to Figure 17, it shows the right installation.

4.3 Inner Plywood Reinforcement

Now that Station 2 is in place, it's time to glue in the inner skin doubler as shown in Figure 12. This is 1/8" plywood, and it covers from the upper part of the top longeron to the bottom of the lowest longeron

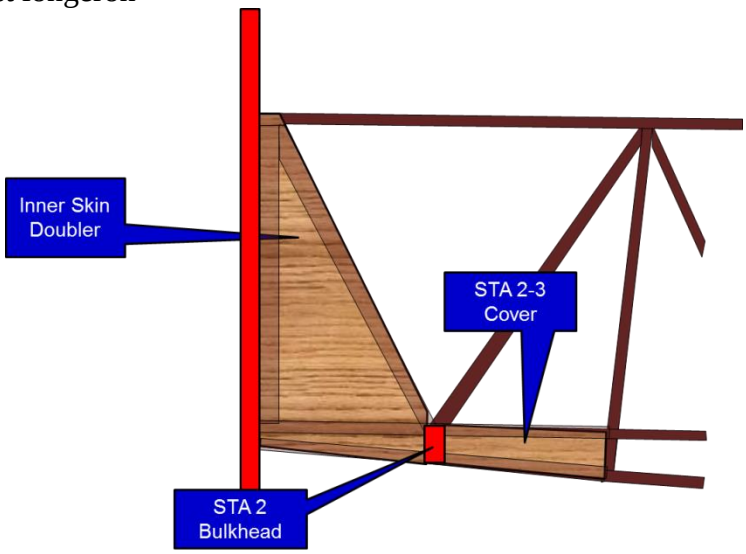

Figure 12: Forward Inner Reinforcement

Don't forget to varnish the inside and add a few drain holes. Also, because the Station 2 bulkhead wasn't in place, you may not have installed the inside cover in the Station 2 to Station 3 area, as described in the Guide for Article Three. Good time to do this, now.

Figure 13 is a photo of Jim Katz' forward fuselage, showing the reinforcement. Jim installed this reinforcement before the firewall….it does make access easier.

Figure 13: Photo of Inner Skin Reinforcement

4.4 Support Rails

Two sets of support rails are installed in the fuselage floor area, to support the seat and the forward floor.

4.4.1 Seat Support Rails

The seat support rails are, again, easier to install if the fuselage is upside down on some low supports. They're installed between Stations 4 and 5. The rails are straightforward, and are well-depicted in Figure 1-17 on Page 16 of Article 4. Pete did change the height of these beams slightly, to 2 5/8". But it really doesn't make much difference, as long as they're no deeper than the Station 4 and 5 bulkheads. Make them deeper if you wish. The two rails are 13 inches apart at their centerlines.

Ignore Pete's comments about accommodating the biplane spars; it's no longer applicable. Remember to varnish the inside!

Figure 14 shows completed seat support rails.

Figure 14: Seat Support Rails

4.4.2 Floor Beams

The floor beams install between Stations 2 and 3. They're shown in Figure 1-18 on page 17 of Article 4. They're similar to the seat support rails, with two exceptions: They include a reinforcement block for the wing fold pivot tube, and they're only covered with plywood on one side. They don't have much weight on them, in flight, compared to the seat support rails. So they don't need plywood on both sides.

4.5 Landing Gear Reinforcements

The landing gear struts attach at the bottoms of Stations 2 and 4. Obviously, this needs to be very strong.

Reinforcement consists of quarter-segments of 3/4" plywood integrated with half-circle gussets similar to those used on the junctions of the fuselage (Type B gusset).

The three-quarter inch blocks have a 3.125" radius, as shown in Figure 16. They're glued into the corner, then the Type B gusset is glued to the longeron, the bulkhead, and the two blocks. It'll be one solid unit when the glue cures.

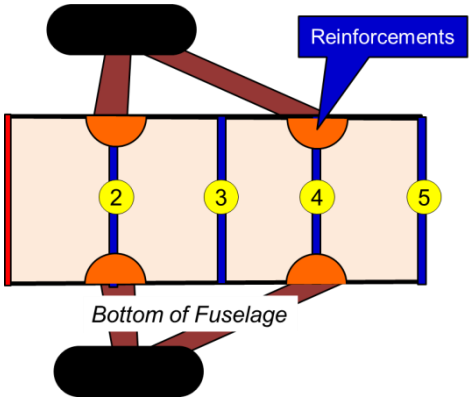

Figure 15: Landing Gear Reinforcement Locations

While the picture is pretty, it actually hides a bit of reality that you should be ready to correct.

You see, the Type B gusset is a half-circle with a $3^{1/8}$", the same radius as the quarter-blocks. However, the two blocks are separated by the thickness of the bulkhead…and the gusset overlaps the longeron, as the above figure shows. The blocks and the bulkhead form an assembly over seven inches wide, which the $3^{1/8}$" half-circle won't cover.

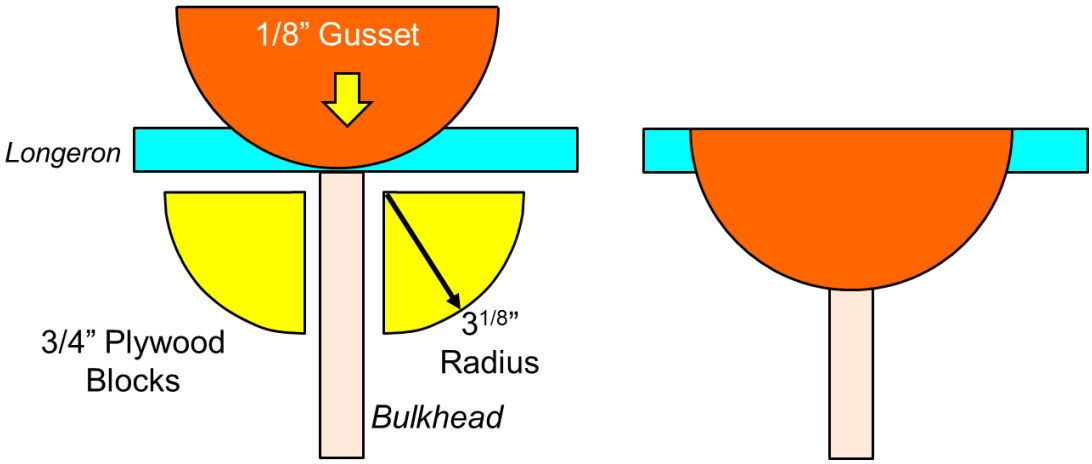

Figure 16: Landing Gear Reinforcements

Now, we can probably define the shape of those blocks mathematically. But that's a lot of effort for a Fly Baby. So just eyeball-cut the 1/8" gusset to cover these areas. Precise matching of the gusset to the block area is not required, but you don't want the gusset to be smaller than the blocks.

Figure 17 shows a completed assembly at Station 2, including the metal fitting that will be described in Article 5 (Figure 2-2 on page 5). In this case, the builder made the blocks bigger than the standard $3^{1/8}$". Not a bad idea, for such an important piece of structure.

Figure 17: Landing Gear Reinforcement with Bracket

4.6 Upper Wing Wire Support Assemblies

The wing wire support assemblies are brackets that hold the straps from the landing wires, and tie them together in the cockpit. They're shown in Figures 1-19 and -120 on Page 17 of Article 4. Each consists of a pair of thin steel plates (0.100" 4130) and a pair of 1/2" thick aluminum plates. Pete doesn't specify the alloy for the aluminum; I suspect it really doesn't matter, since they're there mostly for spacing.

Figure 18 shows another view of construction. Make sure you use the 1/4" spacer when clamping the unit together. The actual wing wire terminal (which replaces the red spacer in the figure) is 3/16" thick, so using a 1/4" spacer will leave enough room that the terminal slides easily between the aluminum blocks.

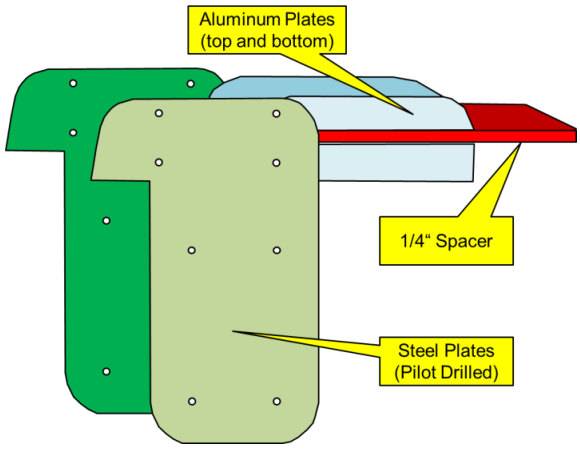

Figure 18: Landing Wire Anchors

Figure 19 shows what they look like when installed. The landing wire terminals (painted maroon in this picture) slide between the two aluminum plates, and are joined by the Master Turnbuckle at the middle. AN3 (3/16") bolts clamp the aluminum plates between the pair of steel plates. AN6 (3/8") bolts attach the anchors to the bulkhead.

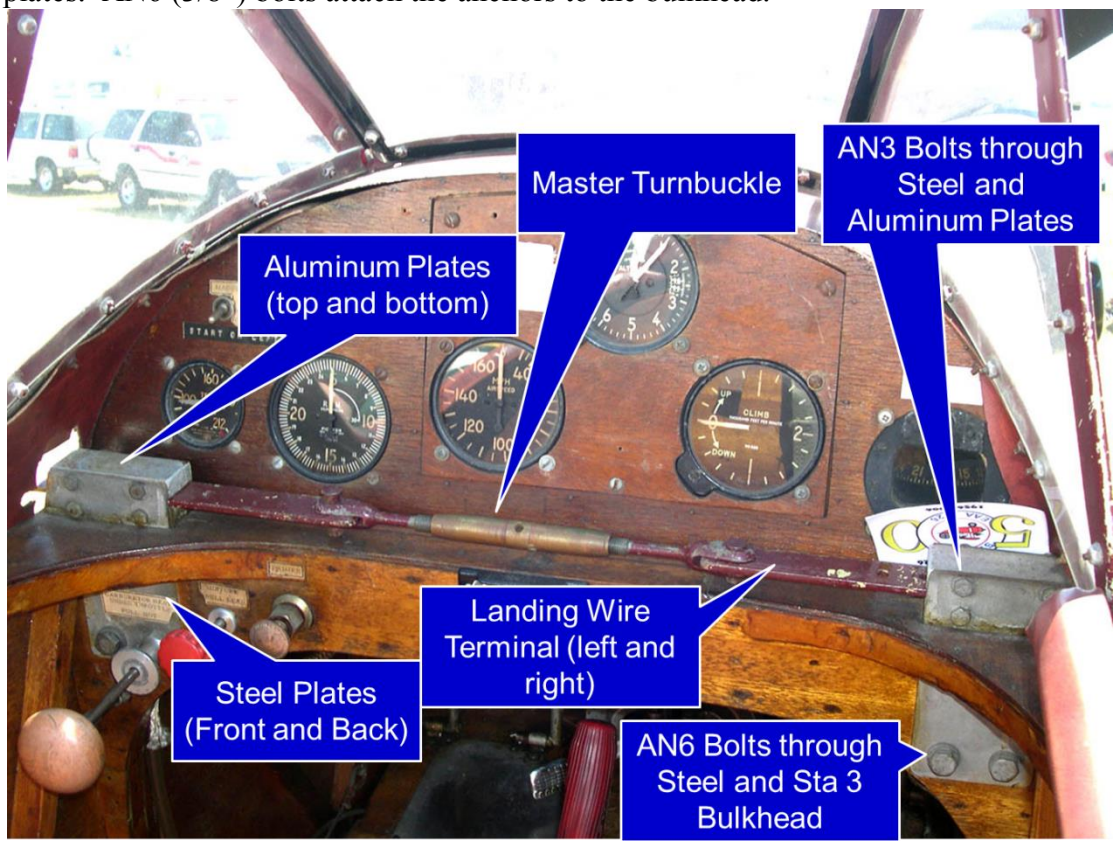

Figure 19: Landing Wire Support Assemblies

At the lower left, you'll see that one of the AN6 bolts has been replaced by the throttle cable. This is a common practice (the above photo is of the original Fly Baby).

The perspective view given in Figure 1-19 clearly shows how these units are assembled. Rather than drilling all the holes in the steel plates to final size, pilot-drill them to 1/8". Temporarily assemble the unit with clamps, with a 1/2" spacer between the two aluminum plates. Drill through the aluminum plates with a 9/32" bit, inserting a #6 bolt through each hole as it's completed. Then drill out the holes to 3/16", removing each #6 bolt as you go.

Figure 20 illustrates the installation of the anchors. The "notch" is designed to fit over the top longeron, and the anchor is positioned so that the outer corner is flush with the outside of the fuselage skin. A key factor is the 1/8" scrap plywood spacer underneath the top of the anchor. The top of the fuselage will eventually be covered by 1/8" ply, so this is a substitute for that.

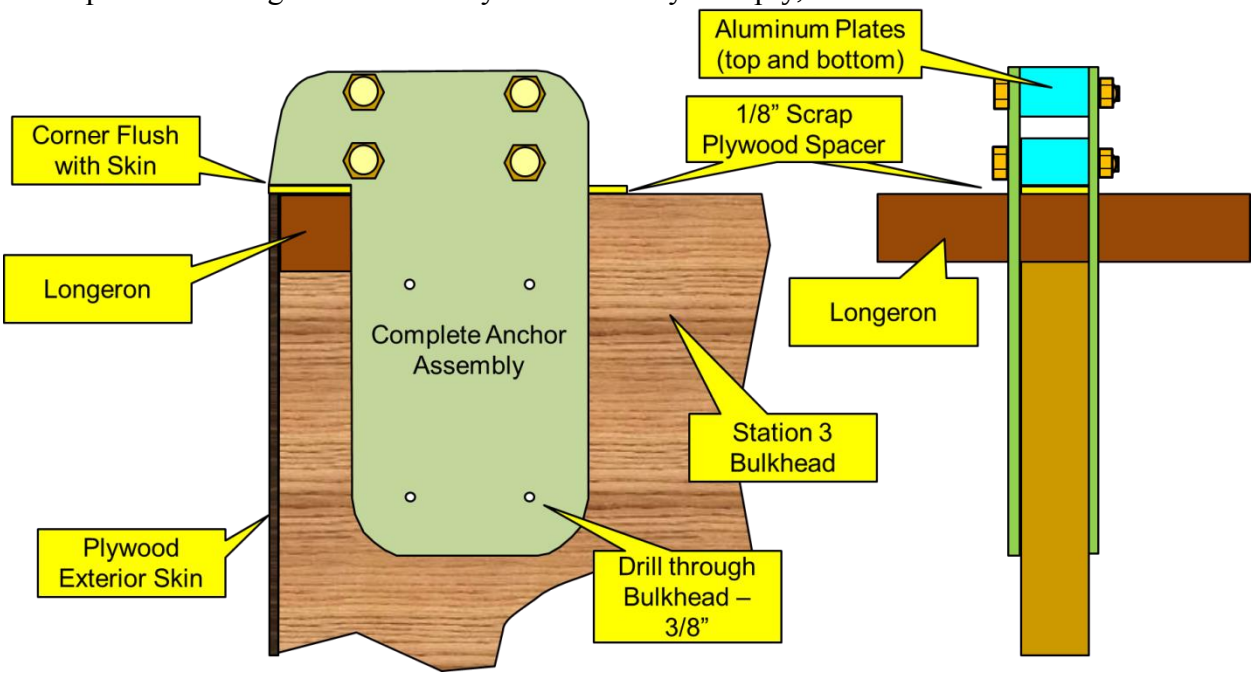

Figure 20: Landing Wire Anchor Installation

The four holes in the lower portion of the anchor mark where the bolts will go through the Station 3 bulkhead to the plate on the other side, clamping the unit solidly in place. Notice that there's a typo in the article; the holes are 3/8", not 3/4". Figure 1-19 is labeled correctly.

4.7 Cockpit Plywood

That big hole where the pilot sits means there's no diagonal bracing to strengthen the structure. So Pete did, basically, a horizontal version of the Station 3/Station 5 bulkhead. Corner bows are applied, and the entire surface, from slightly ahead of Station 3 to the rear side of Station 6, is covered with 1/8" plywood. This is shown in Figure 21.

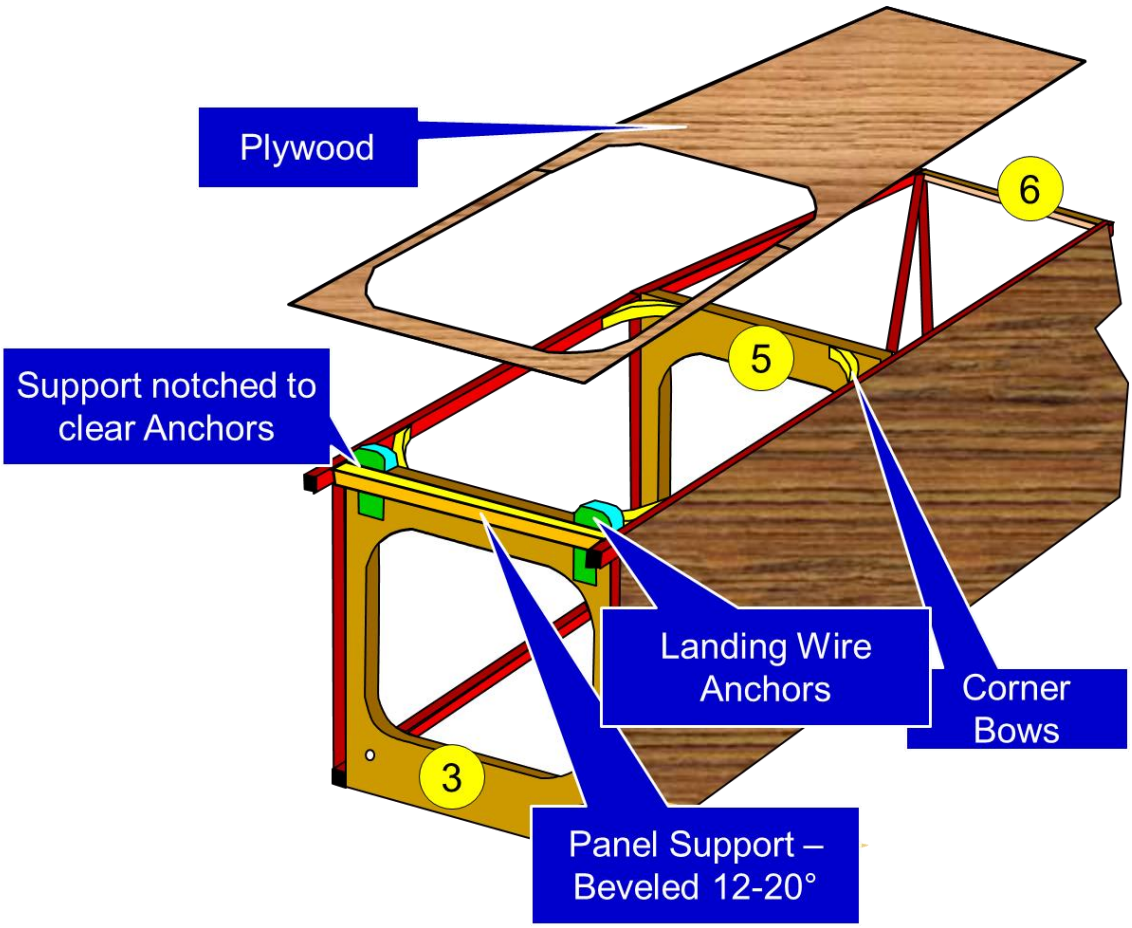

Figure 21: Cockpit Top Plywood

4.7.1 Beveled Panel Support

In the figure, there's an item labeled, "Beveled Panel Support." This is a piece of 3/4" thick spruce that goes across the fuselage just in front of the Station 3 bulkhead, and glued to both the bulkhead and the top longerons. The top, longest, edge is one inch, as seen in Figure 22.

Note that because of the landing wire anchors, this lateral will need to be notched ~1/8" where it overlaps the anchors.

The bevel sets the installed angle of the instrument panel…and that's up to you. Pete says the bevel should be such that the top of the panel is two to three inches forward of the base. My calculator shows that as 12 to 20 degrees. It really depends on your own height and your preferences. I'd lean (no pun intended) to the lower part of the range…about 12°.

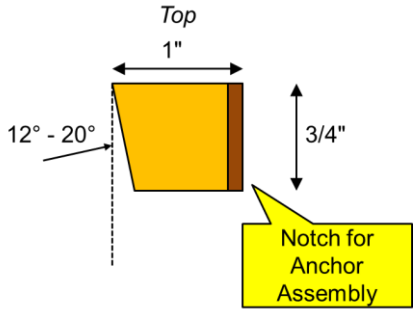

Figure 22: Beveled Panel Support

4.7.2 Corner Bows

The Corner Bows are the same used on Stations 3 and 5. They're shown in Article 3, as Detail "C" on Figure 1-4 on page 5. The tops of the bows are glued flush with the tops of the longerons and tops of the Station 3 and 5 bulkheads (Figure 23).

Figure 23: Gluing Corner Bows

4.7.3 Plywood

Lay a big piece of plywood atop the fuselage, mark, and cut it (Figure 24).

Figure 24: Cockpit-Area Plywood

OK, maybe not QUITE that easy. The back of the plywood runs to the rear each of the Station 6 lateral, and to the front edge of the new beveled piece in front of Station 3.

Pete says this can be done in two pieces, front and back, with a butt joint around mid-cockpit. With the large area to be cut out from the middle, it'd make this easier to handle (though Jim Katz, in the above photo, did it as one piece).

Two things to consider when installing this plywood:

First, the plywood goes over the area where the landing wire anchors attach. So a pair of slots will have to be added on each side that will admit the legs of the anchors (Figure 25). This is a good argument for doing the plywood in two pieces, in case the slots get botched.

Figure 25: Slots for Landing Wire Anchors

Second, the plywood goes all the way to the back of the Station 6 lateral…but in a later section, a turtledeck former will be installed against the aft side of the top lateral at Station 6. So either be ready to trim the plywood back if it goes past the lateral slightly, or install the former NOW so it's there when the plywood is installed. This would produce the smoothest interface. Construction of the turtledeck is described in Section 4.10.

How to install the plywood? If I were doing it, this is what I'd try. Cut the plywood to the "approximate" dimensions, with some overhang. Then trim it back using a router with a "Flush Trim" bit. These are designed to trim countertop material laid atop a wood base without cutting the base. The bits have a ball bearing at the end of the bit, and the router is adjusted so that the bearing rides on the "good" material while the router cuts away the plywood on top. Figure 26 shows how it works for both the outside and the inside of the top plywood.

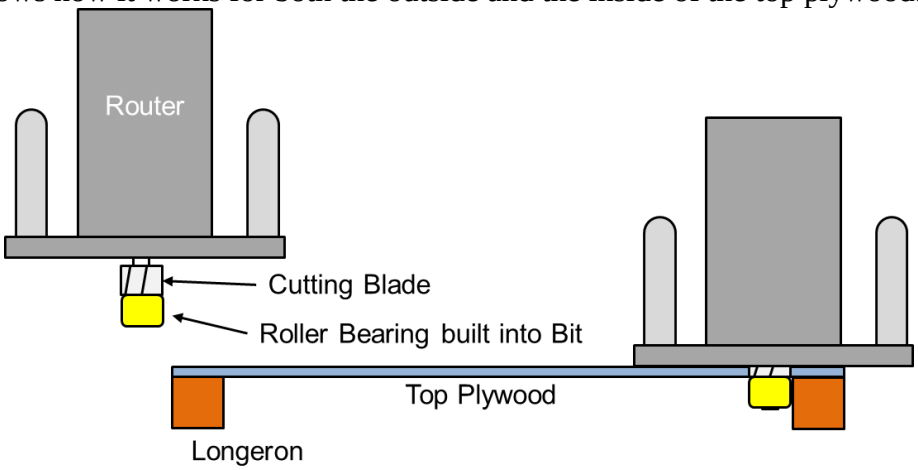

Figure 26: Using a Flush Trim Bit

4.8 Instrument Panel

This is a fun part. However, once the panel is installed, be very careful about turning the fuselage inverted when working on it. The panel is primarily supported by a metal forward turtledeck cover, and that won't be built for quite a while.

4.8.1 Structure

Pete's standard shape for the panel is shown in Detail "A" of Figure 1-21 on page 17 of Article 4. Cut this from 3/4" plywood, or laminate it up. I suggest the plywood to eliminate the

effect of the springback when pieces are laminated. Notice that the bottom of the frame is beveled to match the angle of the beveled cross-piece installed earlier. The frame is covered with 1/8" plywood that will be cut to install the instruments

The outer corners of the frame sit directly on the longerons, but the plywood covering is actually about 3/4" deeper than the frame. This covering matches the beveled brace, and the plywood is glued to the brace. Figure 27 shows how it all goes together.

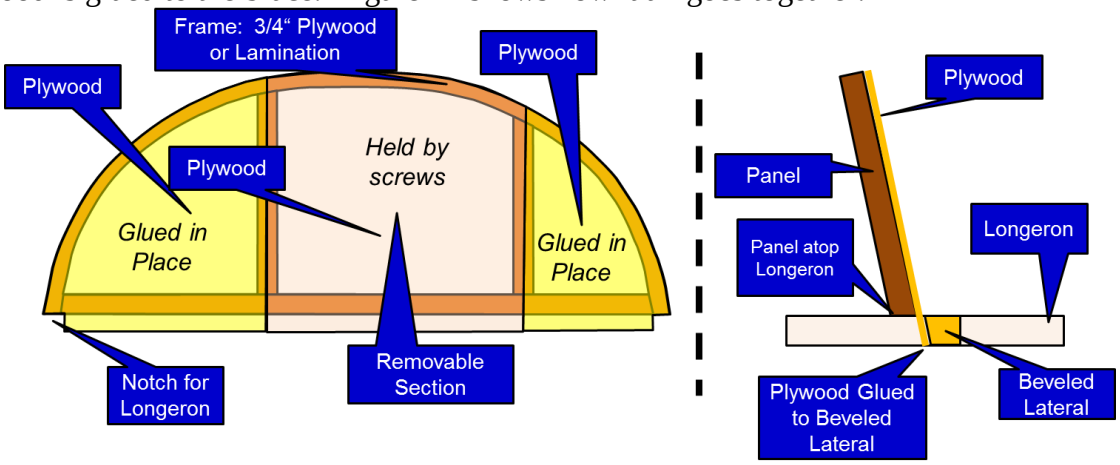

Figure 27: Instrument Panel

Pete's standard design has three "bays". The bay in the middle is intended to be removable, once the panel is installed. The pilot-static instruments (Airspeed, altimeter, and rate-of-climb, if you've got one) are placed in this removable panel. It This panel just gets two flexible rubber hoses to it, the static line and the pitot line. This makes the whole panel easily removable, as you can just unplug those hoses if necessary. This then opens a huge gap in the panel and one can reach around and work on the other instruments easily. Figure 28 shows a completed panel of a slightly different design. Jim Katz had his plywood laser-cut.

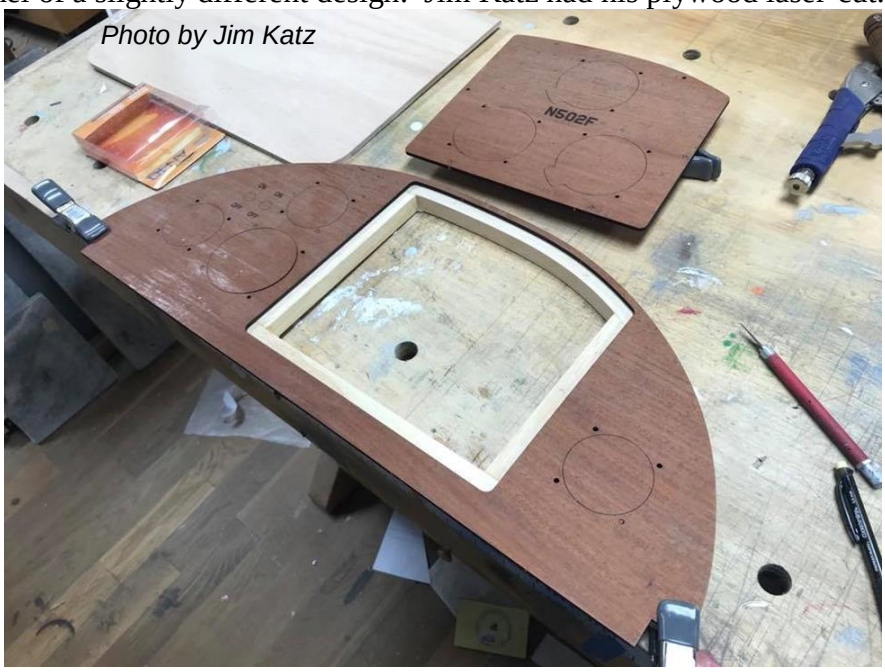

Figure 28: Completed Panel

The thing to keep in mind about the panel is that the stock shape isn't required to be used. You can make yours a bit more curved, you can make it a bit flatter. You could even make it a tad taller, though the forward fuselage lines might be a bit affected.

Some folks have used the same pattern for the instrument panel as for the firewall.

4.8.2 Instruments

What instruments are required? 14CFR 91.205 is the instrument requirements, but note the title: "Powered civil aircraft with standard category U.S. airworthiness certificates: Instrument and equipment requirements."

The Fly Baby is NOT standard category! So the regulation doesn't even apply. However, the DAR that inspects the aircraft prior to flight will probably require that the airplane meet at least FAR 91.205 requirements, even with an Experimental certificate.

OK, then, what instruments are needed on a Fly Baby?

The list is probably shorter than you think. If you're running a Continental engine, the DAR will expect you to have the following instruments:

(1) Airspeed indicator.
(2) Altimeter.
(3) Magnetic direction indicator.
(4) Tachometer
(5) Oil pressure gauge
(6) Oil temperature gauge
(7) Fuel gauge indicating the quantity of fuel in each tank.

What's not here? Vertical Speed Indicator. Gyrocompass. Turn-and-bank. Gyro horizon. Clock.

Only six of the required gauges actually are installed in the panel; Fly Babies usually have a Cub-type "cork on a wire" gas cap.

If you've got an electrical system, add a voltmeter or ammeter to be able to track its health.

Since the Fly Baby is not a certified airplane, the instruments do not have to hold a Technical Service Order (TSO). This means the gauges are a lot cheaper.

However, one hears bad stories about non-TSO'd gauges. You might be better off buying used TSO gauges.

4.8.3 Installing Instruments

Most instruments use one of 2-3 standard templates for cutting the holes and drilling for the mounting screws. These templates can be found in a variety of sources.

There's still going to be a lot of dust and stuff in your workshop, so don't leave the instruments installed once they've been test-fitted. Wrap them up and store them safely.

4.9 Forward Turtledeck

As part of the "Misc Installations" in Part 10 of the article series, a metal cover is fabricated to form the forward turtledeck. There's no additional structure required for this…it just used the firewall and the instrument panel.

However, there has to be a way to attach the turtledeck. It's held in place by a series of small screws into anchor nuts installed on a strip of wood underneath the top longeron.

According to the article, this piece of wood is 1/4 inch by 1/2 inch plywood, and is glued under the upper longerons from the firewall to a point 7 inches aft of Station 3 (Figure 29).

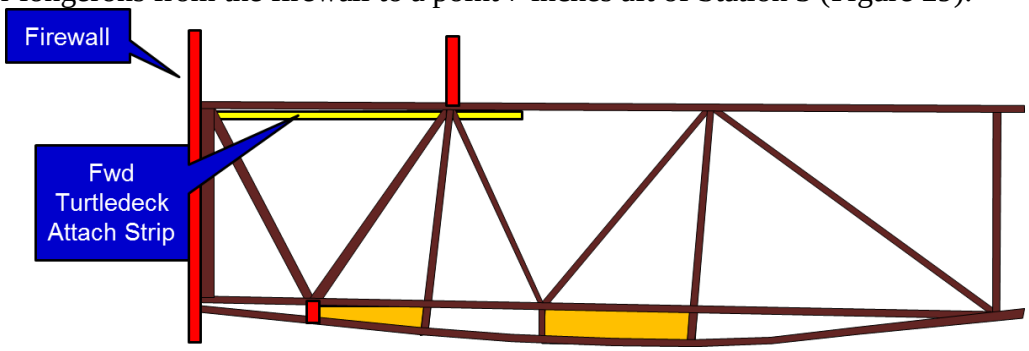

Figure 29: Turtledeck Attach Strip

Since two diagonals meet at the top of Station 3, the strip will have to be interrupted in this area.

Figure 30 shows the forward turtledeck area on my own aircraft. The odd thing is, it appears that the builder of my airplane did NOT glue strips down for the turtledeck attachment screws. He drilled THROUGH the top longerons. This is not the optimal implementation, but it hasn't caused any problems yet.

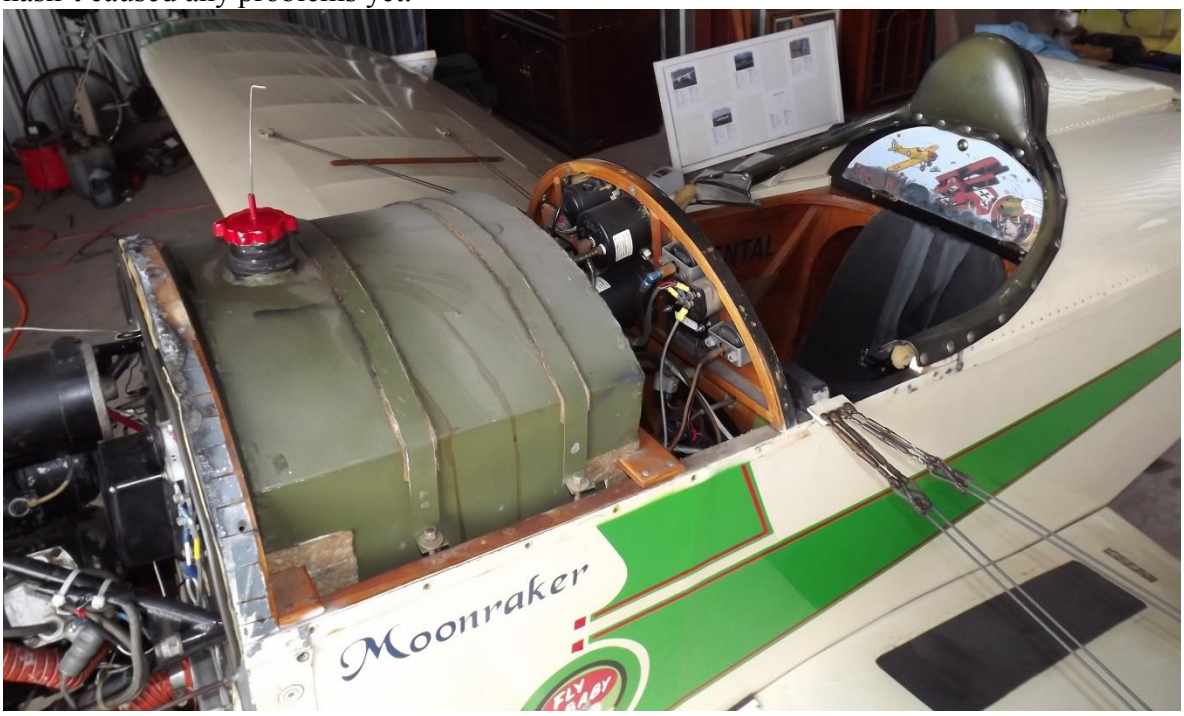

Figure 30: Fly Baby With Forward Turtledeck Cover Removed

4.10 Aft Turtledeck

Pete uses "Formers" to denote elements that define the semi-circular shape of the top of the fuselage. He does a pretty good job of describing how to do the aft turtledeck formers and stringers in the article, and in Figures 1-14 and 1-15 on page 16.

The formers attach BEHIND the cross-pieces at Stations 6, 7, and 8 (Figure 31). You'll notice the lower "notches" on the formers in Figure 1-14 have different widths. This is to

accommodate the half- or quarter-circle gussets at some of these locations. Obviously, the width of these areas will be adjusted to match the actual gusset configuration.

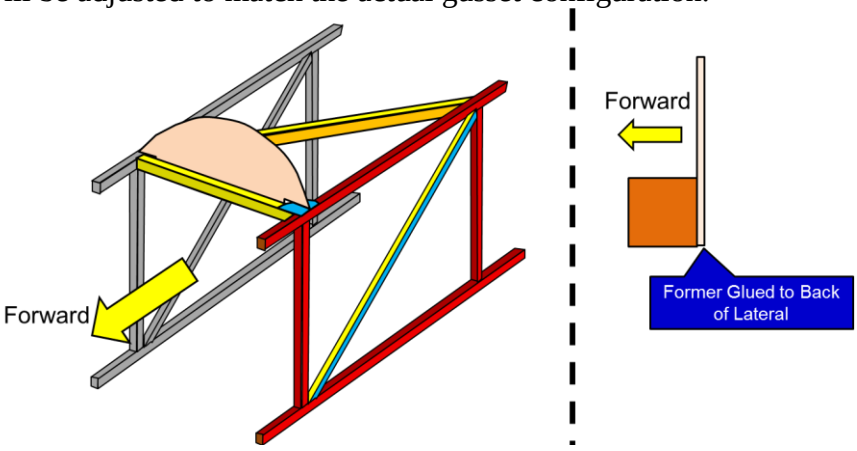

Figure 31: Former Attachment

The former at Station 8 is kind of special. Note Detail "D" on Figure 1-15 on page 16 of Article 4. There are two bolt holes in the Station 8 former. These must be carefully positioned relative to the aircraft centerline, because the front spar of the vertical stabilizer will be attached here. Drill the holes in the lateral, first, then drill through the Station 8 former after it's installed (Figure 32).

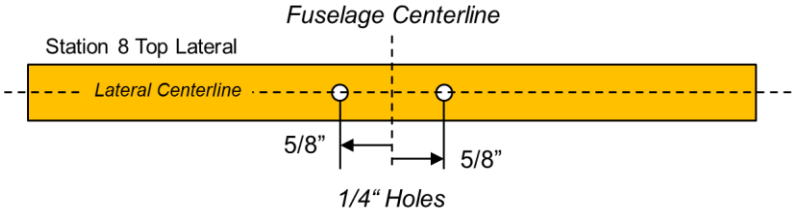

Figure 32: Holes in Station 8 Top Lateral

The stringers are strips of wood 1/4" thick, and 1 inch high. They don't have to be good spruce; "junk wood" can be used. The stringers are slipped into the slots on the formers as shown in Figure 33.

Figure 33: Turtledeck Under Construction

Figure 1-15 shows the stringers receiving a shallow notch on their tops, at Station 6, and scalloped plywood applied across this area. The plywood is necessary because of the tension of the fabric when it's tightened after being applied. Without the reinforcement, the former itself will warp (it's only 1/8" plywood). This scalloping can be seen in the left-hand photo in Figure 35.

Pete doesn't call for scalloping at the aft former. Some do it (Figure 34), others don't (Figure 35). The Station 8 former is actually kind of small, so it resists tension loads better. In addition, some reinforcement is added as part of the vertical stabilizer installation.

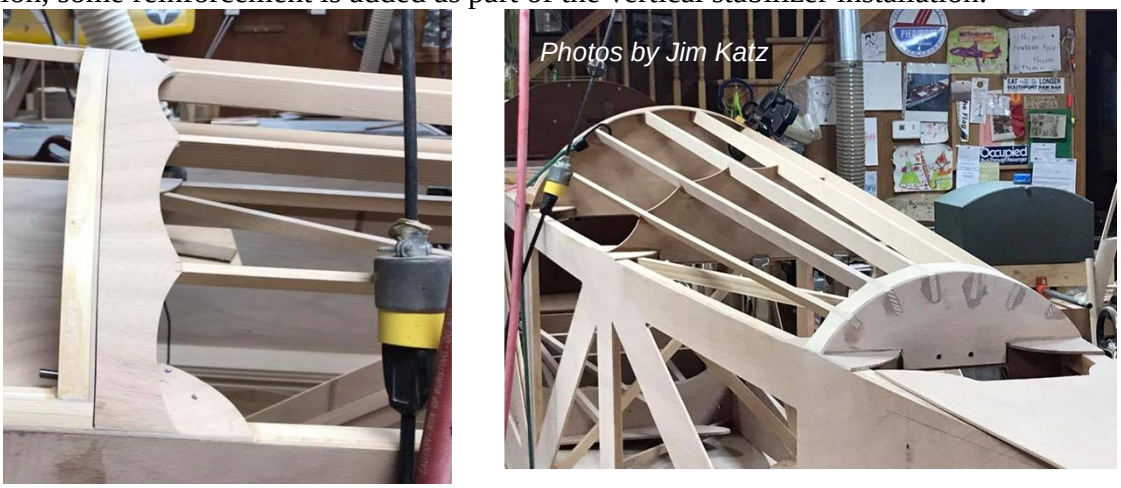

Figure 34: End Formers with Scalloping

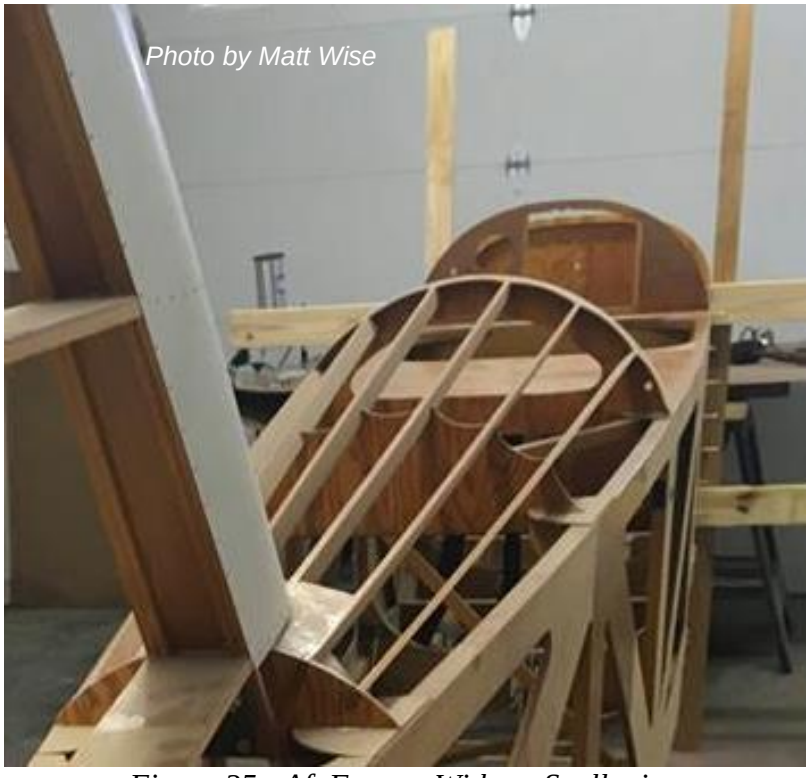

Figure 35: Aft Former Without Scalloping

The former at Station 7 is scalloped, and the notches for the stringers are a bit shallower so the stringers sit above the line of the former. This is to keep the fabric from actually making contact with the former. You'd end up with a funny ridge, otherwise.

In fact, if you're going to run into trouble with the turtledeck, it'll be around the former at Station 7. If the slots in Station 7 aren't correct, you'll end up having to cut and shape them quite a bit to let the stringers run straight.

One way to fix this is with a "floating" former. Rather than cut out the full former and make slots in it, make a small former with "cards" that fit the stringers, as shown in Figure 36.

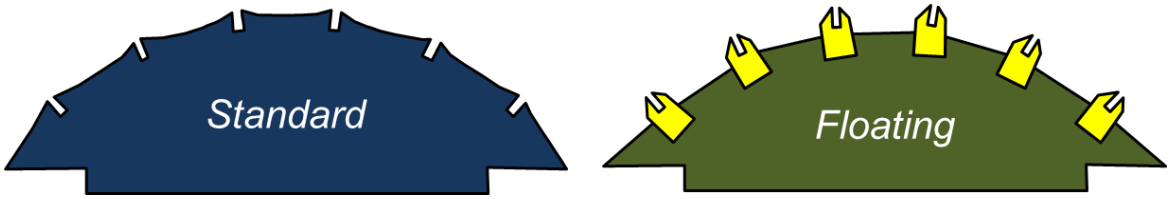

Figure 36: Station 7 Former Options

The "cards" are glued to the stringer and the former itself. Figure 37 shows an actual implementation of the "floating" former. Note that the builder added lightening holes as well. The aluminum channel supports a sliding canopy.

Figure 37: "Floating" Station 7 Former

4.11 Aft Fuselage Inspection Hole

Remember the double plywood applied on the left side of the extreme aft fuselage? There needs to be an inspection hole cut here, to assist in rigging the elevator cables.

The hole itself is shown as Detail "E" of Figure 1-22 on Page 17 of Article 4. Note that you want it at least 1/2" clear of the diagonal. Drill a ~1/2" hole at each edge of the polygon shape, then cut out the panel. The larger-diameter hole avoids the stress concentrations a sharp corner would produce.

Depending on your own particular inclination, the panel to cover this hole can be a simple sheet of ~0.040" aluminum, or you can cut a flush cover as shown in Figure 38.

Figure 38: Aft Fuselage Inspection Cover (Fuselage is Upside-Down)

The fuselage in the above figure is upside down, but note the rather large hole below the inspection panel near the top of the fuselage. This is for the elevator control horn. This can be somewhat hard to install…but enlarging the inspection hole as seen in Figure 39 is an option. The cover for the inspection hole should be extended upward to accommodate the "arm" going up (but not, of course, the hole itself).

Figure 39: Inspection Panel with "Arm"

4.12 Belly Stringers

The Fly Baby doesn't have a totally flat fuselage bottom; a pair of stringers are attached to the belly to make a much smoother transition.

As Pete says in the Article, though, hold off on installing the belly stringers. Without them, you can get your whole torso inside the airplane to work anywhere inside. WITH them, you have a maximum of 14 inches of clearance.

What else is left to do inside? Potentially, quite a bit. Seat belt and shoulder harness, wiring, fuel tank installation, controls, and even wing test-fitting are easier without having the belly enclosed by the stringers.

In addition, the fuselage gets a tad more awkward to handle on the work table with the belly stringers—more lightweight stuff that has to be protected.

So… have the material available, but hold off on the stringers until just before covering the fuselage. At that point, varnish the entire interior of the fuselage (leaving the attachment points for the stringers), attach the stringers, then complete the varnishing.

Figure 40 shows the run of the belly stringers. Due to the bending required, they start out as five laminations of 3/8" square wood. Unless you can find a ~12-foot run of wood, you'll probably need to join pieces with a scarf.

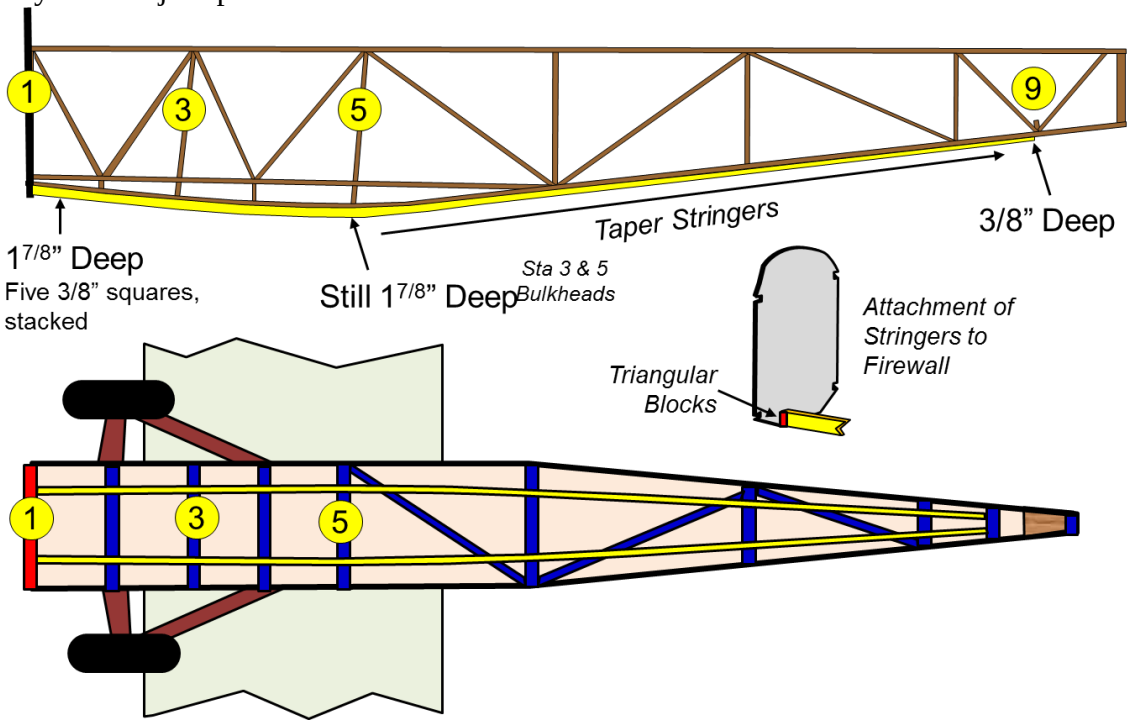

Figure 40: Belly Stringers

Attach the first lamination (the one closest to the structure), gluing and nailing it to the laterals as it runs to the tail. Add "cards" (similar to those optional for the Station 7 former) at the laterals and bulkheads where it passes, as shown in Detail "C" of Figure 1-22 on page 17 of Article 4.

Then start laying down the additional laminations. Starting at Station 5 going aft, the total thickness of the stringers will taper until it's just a single lamination at Station 9. So run all five a couple of inches aft of Station 5, then gradually start leaving off the outer laminations until just the first is left. Once the glue has cured, use a draw plane or spokeshave to trim down the shape of the stringers, with a sander if necessary.

See Detail "C" of Figure 1-22 to see how the stringers are terminated at Station 9.

5 ALTERNATE APPROACHES

The following topics have been discussed within the Fly Baby community. They may provide advantages to the builder, but have not been verified as viable.

5.1 Electrical Systems

5.1.1 The Decision

Do you need an electrical system in your Fly Baby? Probably not. Here's why:

- Electrical systems add weight. My Fly Baby has a C-85 with a complete electrical system (including strobe and wingtip lights. It weighs 150 pounds more than the plans call for. Some of it is because the airplane is overbuilt, but probably at least half of that is electrical system.
- Complexity. N500F, the prototype, had one two wires running into the cockpit...the mag switches. My current bird has wire bundles running along the cockpit floor. Antenna cables, strobe power, strobe bulb, wingtip lights, battery cables, etc. etc. etc. ALL of that has to be built up and installed.
- You don't need a Transponder or ADS-B. If your airplane doesn't have an electrical system, you are not required to carry a transponder. You won't be able to enter Class Bravo airspace (TCAs), but you can operate within the 30 NM "veil" with impunity (FAR 91.215).
- You save money. No generator, starter, battery, switches, wires, etc. Buy a handheld for $250 if you need a radio.
- It's lower maintenance. How often, when you have had aircraft troubles in the past, has it been due to electrical problems? Pretty often, I bet. When I look back in the logs of my Fly Baby, the only problems I see are electrical ones... dead batteries, dead generators, ground-up flywheel teeth, etc. Get rid of the electronics, get rid of the problem.

Not convinced? OK, let's take a look at how to get by with the minimum amount of electronics.

5.1.2 Supporting a Starter

If an A65 engine is to be installed, the starter issue is moot…the models of A65s that could accept a starter are few. Even with a C-85 engine, the first Fly Baby didn't have a starter.

Fifty years ago, starter-less airplanes were common. Today, not so much. After 20 years flying my starter-equipped Fly Baby, I'm pretty lazy. I'd just as soon not go back to hand-propping, myself.

However, a starter doesn't imply the need for a full electrical system. A typical aircraft battery can support a number of engine starts without recharging. Install a Continental with a starter, but DON'T add the rest of the impedimenta of an electrical system: Install a battery, and an external port that lets you charge the battery in the hangar.

Note that the FAR that states the requirements for transponders or ADS-B exclude aircraft that do not have an electrical system. An "Electrical System" is defined as including an engine-turned generator or alternator, a regulator, and a battery. If the airplane doesn't have a generator, it is not required to carry a transponder or ADS-B unless actually in Class B airspace. The "Veil" doesn't apply. So you can turn the starter with a battery with impunity.

5.1.3 Batteries for Fly Babies

The absolute largest battery you'll have to consider is the aviation "25" size...G-25, RG-25, CB-25, etc. These usually weigh about 20-25 pounds. That doesn't sound like much...unless you're trying to hold one up at full arm's reach.

But even a 25-series battery can be overkill for a Fly Baby. Some builders have used motorcycle batteries with good results.

Depending upon how you're going to end up mounting it, pay attention to the required positioning of the battery. Some batteries can only be mounted upright, which means your cables have to run in a particular orientation.

I replaced my gel-cell battery with a drycell battery from Odyssey. I'm very happy with it... it cost about the same as a conventional aircraft battery, can be mounted in any position, and has performed perfectly in my aircraft with no changes to the electrical system.

Where to put the battery on a Fly Baby? There are a number of factors.
First, the battery will have to be replaced on occasion. I've been getting about three to four-year life with mine. So install it at a place you can get at. If you're using a maintenance-free battery, it's all right to put the battery in a less-convenient location. You still want to be able to look at it, come annual time, though.

Second, if you've got a starter, you'd prefer a location closer to the firewall to minimize the run of the battery cables. Long runs are awkward to do, weigh more, and the extra length increases power losses. Keep in mind, too, that the Fly Baby has a wooden structure. On a metal airplane, or a car, you can just attach the ground terminal of the battery to nearby structure and just run a positive cable to the starter, etc. Won't work on a Fly Baby.

Third, if you're using a cell with liquid electrolyte, you need a location where a vent tube can be run out the bottom of the plane to shed any released gasses or boiled-over electrolyte.

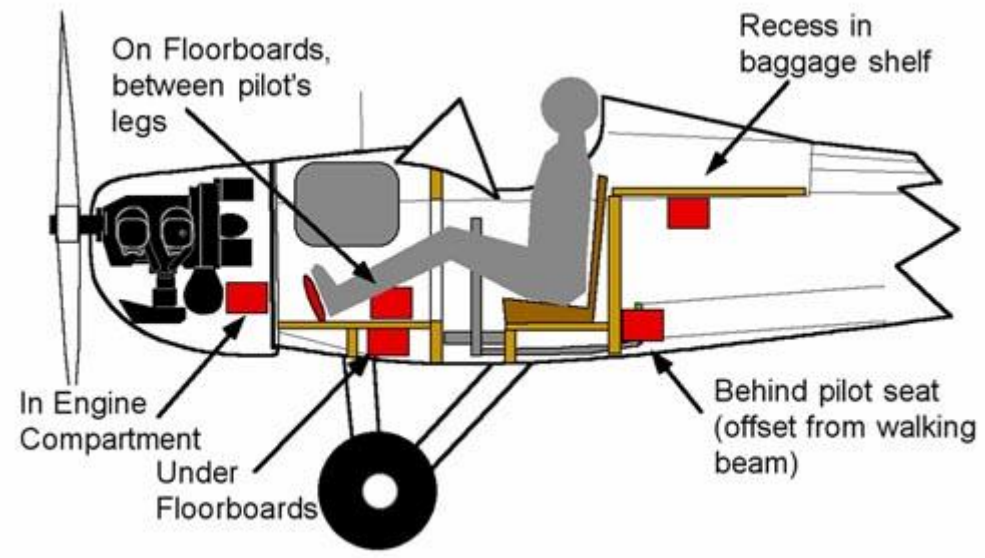

Figure 41: Potential Battery Locations

All these locations have advantages and drawbacks. The engine-compartment mount is pretty standard on production aircraft. But you may not have enough room, under the cowl.

Placing the battery on the floorboards between the pilot's legs is fairly common in homebuilts. It does rob a bit of room from the pilot, and can make it harder to stretch your legs

during a long flight. Some builders put the battery far-forward, between the rudder pedals. This is a pretty good location, but is a bit harder to get to for installing and removing.

My own Fly Baby has the battery installed under the floorboards. It's out of the way, but access requires the addition of a belly inspection panel. The Belly Panel is a good idea, in any case.

On the other hand Drew Fidoe built a shallow battery tray into the floorboards between the rudder pedals and the Station 3 bulkhead. It's a simple aluminum tray, about flush to the deckplate forward of station 3.

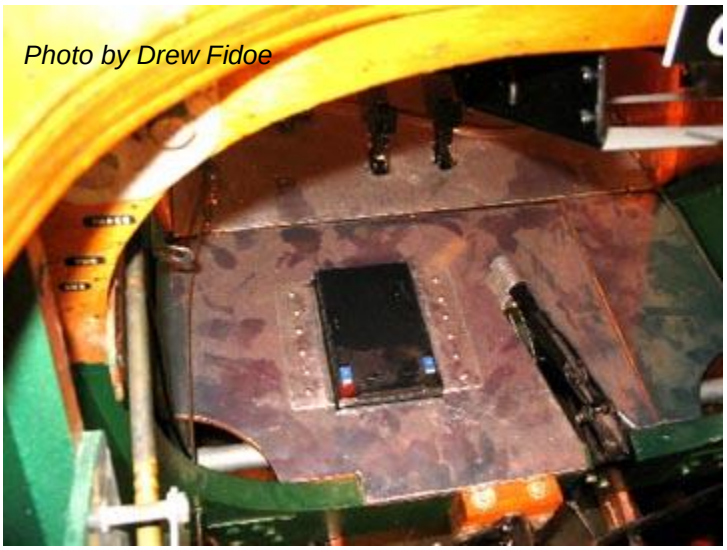

Figure 42: Drew Fidoe's Battery Installation

The last two potential battery-installation spots are behind the pilot's seat, either in a recess in the baggage shelf, or a new mount somewhere lower in the fuselage.

Keep in mind that if you mount an unsealed battery anywhere but in the engine compartment, you'll want to have a top for the battery box to prevent any gases from reaching the pilot.

I installed mine under the floorboards up front, using the battery holder illustrated in Figure 43. This does require access via a belly panel.

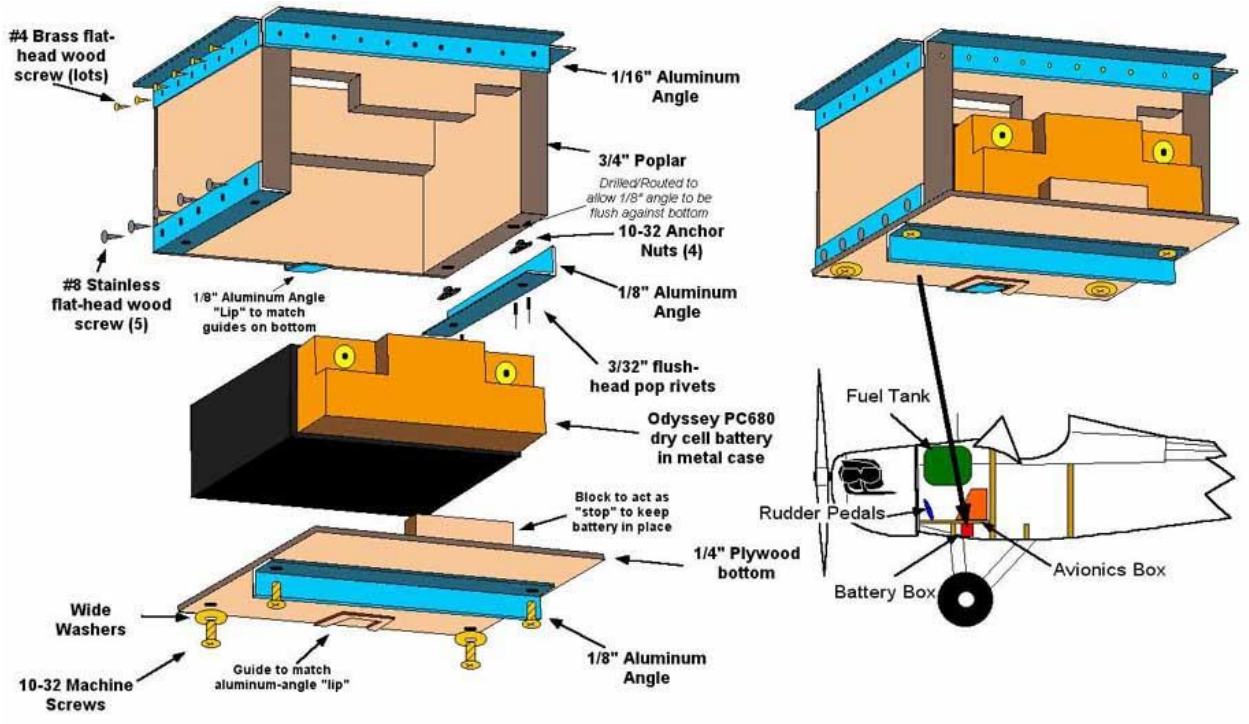

Figure 43: Battery Holder for Odyssey PC680 Battery

5.2 Removable Turtledeck

You may have wondered why the stringers on the aft turtledeck start at Station 6, not at the cockpit at Station 5.

Pete designed the Fly Baby with a removable turtledeck section aft of the cockpit. This was originally intended to allow an easy switch between an open-cockpit airplane and one with a canopy. The removable section can be seen on the floor in the background of Figure 44

Figure 44: Removable Turtledeck

Now, some folks have built their airplanes without the removable turtledeck. They install a former at Station 5 and run the stringers aft from there. I'd use the "cards" described in Section

4.10 on both the Station 6 and 7 formers. You'd also want to add some pretty good strengthening at the new former for Station 5, as getting in and out of a single-seat open cockpit plane like this requires bracing yourself against the cockpit back.

There's nothing major wrong with making the turtledeck a one-piece unit, but over 30 years of Fly Baby operation, I've found the removable turtledeck useful. If nothing else, it's very convenient for working on the instrument panel…remove the turtledeck and sit on the baggage shelf. It's much easier than having to climb into and out of the cockpit all day while working on the panel.

So this is one item I recommend sticking with the plans.

5.3 Additional Storage

The baggage shelf under the turtledeck does pretty good for the bulky stuff, but sometimes a little additional storage is nice.

5.3.1 Map Pocket

The fuselage sides in the cockpit feature two diagonals that meet at Station 4. With the addition of a piece of wood and a bit of 1/8" plywood (Figure 45), a nice little pocket results. It's a perfect place to keep charts or anything else thin enough to fit.

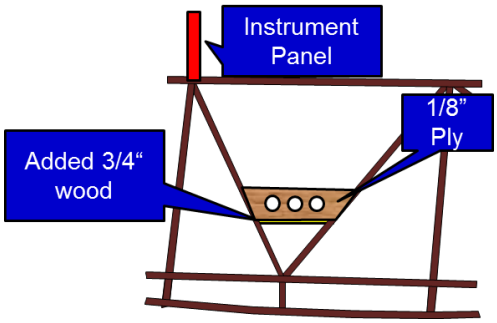

Figure 45: Map Pocket

Figure 46 shows some real-world examples.

Figure 46: Map Pockets in Use

5.3.2 Forward Floorboards

The area on the floor immediately in front of Station 3, between the two floor supports, is mostly free. As shown in Figure 41, it could be used for an aircraft battery, but if not, it could be used for a small flush locker in the cockpit floor.

Hans Teijgeler cut down an Ikea storage box and mounted it flush in the floor, as seen in Figure 47. It's not large, but it's handy for keeping things like gloves handy.

Figure 47: Floor Storage (with cover removed)

The box actually sticks above the floor slightly, with aluminum flanges holding it to the floorboard like the battery holder in Figure 43. Make sure it has a cover so what's inside doesn't come out in flight.

5.3.3 Lower Baggage Shelf

The standard baggage area in the turtledeck is handy, but some folks like a bit more storage. Several builders have added a shelf behind Station 5 under the existing baggage area. A support is added between Station 5 and the diagonal, and a plywood floor is added.

It works, but there are some cautions, here.

First, the "Walking Beam" for the elevator control is installed at the bottom of Station 5, and the elevator control cables lead aft from there. Obviously, you don't want this shelf to interfere with the walking beam or cables! See Figure 48.

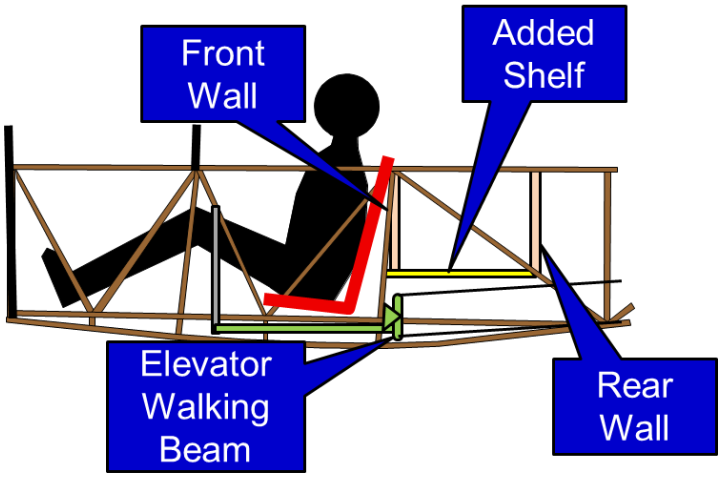

Figure 48: Additional Baggage Shelf

Second, because of this highly critical control hardware, you do not want stuff coming off the shelf and tangling with the elevator cables or walking beam. The baggage area is going to need a rear wall, one that won't come loose. On the same note, it'll need a front wall, too…the pilot seat does not completely "plug" the front entry to this baggage space.

Third, to GET access to the area, either the back of the pilot seat must be hinged, or a triangular access door must be added to the side of the fuselage. If you're routing out the plywood back there, it would be relatively easy to work a door into the design. Otherwise, it's a real pain in the posterior to access this area.

My airplane has this shelf, but no back or front. An emergency kit (in a box) is tied down to the shelf and an ELT is bolted there (you can see this back in Figure 44), but when I carry anything else back on the shelf, it's in a bag which is held down to the shelf with multiple straps.

And, frankly, even that makes me nervous. I don't routinely use the area.

END OF COMPANION GUIDE FOR ARTICLE 4