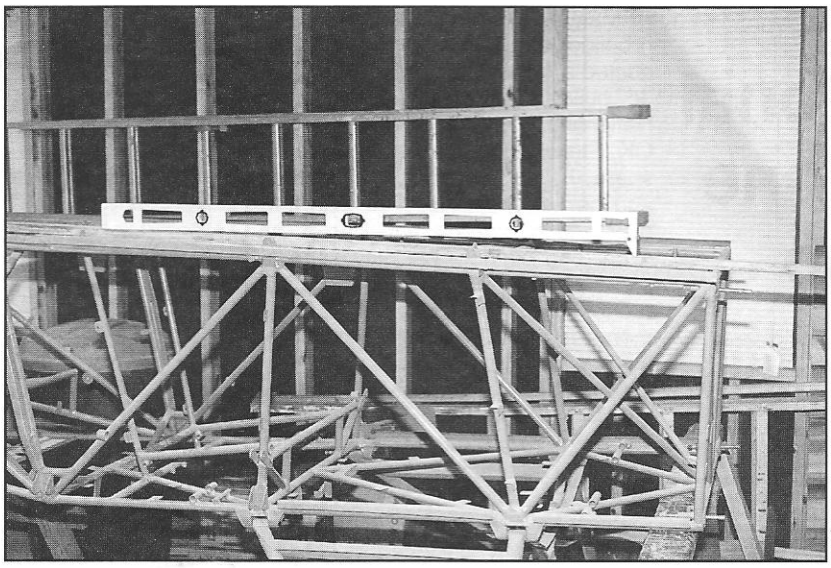
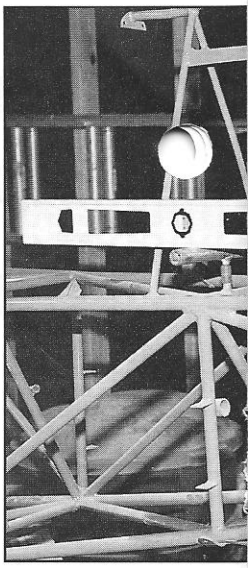
Rigging the Center Section and Horizontal Stabilizer

by Neil Sidders



NOTE: The wood blocks between the lower attach point were used to spring the struts out to print dimensions. They are being forced less than 1/16". A 4 foot level with a 1 1/4" shim used to set the fuselage at 1 1/2° nose down.



Stabilizer spar set lev reports suggest this i

As a Technical Counselor, I'm often asked how much tolerance is allowed when building a welded tube fuselage. My standard answer is NONE! While it is true that building a welded tube structure that is dimensionally perfect is near impossible, that doesn't mean you can get sloppy and make up for errors with stringers and fabric. The wing cell on our Acro Sports is a case in point. If the wing attach zones aren't square and parallel, you will have an airplane that is difficult to rig.

Those of you who are long time readers of the newsletter know that we started building 3 Acro IIs. All three of us are Tool and Die makers and therefore we each placed a high demand for accuracy on each other. The accuracy in airplane building deals more with symmetry and parallelism that it does with pure dimensional accuracy, although the latter is still important.

My point to this is, your attitude toward accuracy in the first part you make will have a key role in how your airplane flies once it is finished.

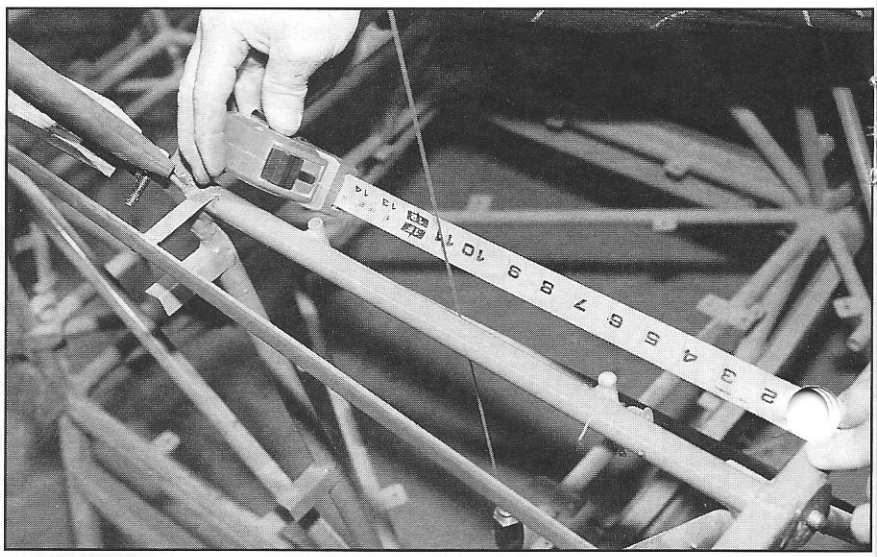
When it was time to build the struts for the center section, it was evident from the newsletters that most builders were having to use the adjustable fork to rig the wing properly. This sent up a Red Flag and we attacked the drawings with TRIG and found the rear up-right was about 1/8" too long. The newer plans have this correction on them. This was also in newsletter #32/33.

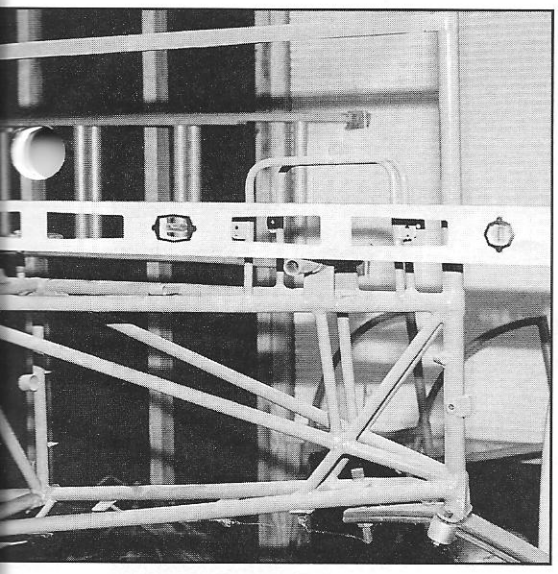
We built a simple jig and built "N" struts for 4 of the 5 Acro's being built in the area.

The photos in this article are of Bruce Owens airplane. Bruce built a new home and just finished his shop or he would be farther along.

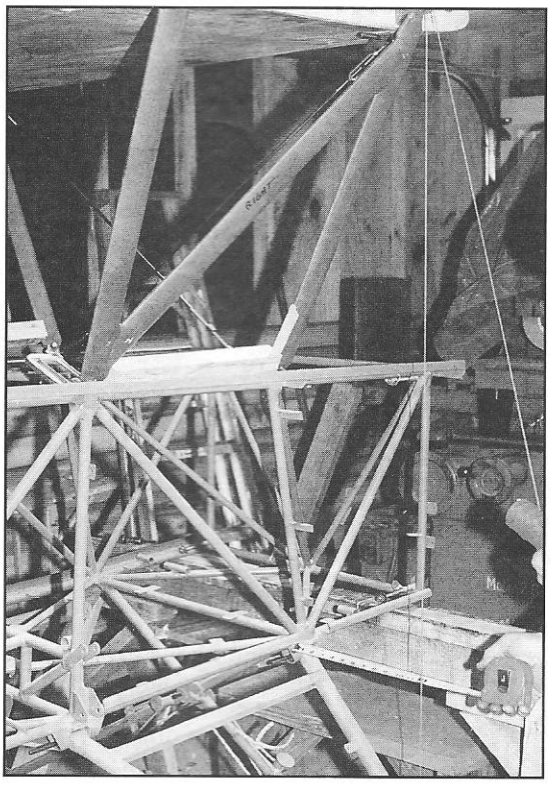
The first step is to level the fuselage left to right, and front to rear. A four foot level works pretty good for this. We used a long straight board down the center of the frame to see if any one cross tube was high or low. This airplane proved very straight and true.

Left and Below - Using the front cross tube as the datum, a plumb line is dropped from the leading edge. Both sides measure exactly 10 1/2" proving the wing section is square to the fuselage.





with fuselage jigged at 1½°. Builder-pilot a good place to start.



Left and Below - With the center section in place, center the wing section left to right. This airplane is exactly 12½" on each side and the center section checks level span wise.

We worked the horizontal stabilizer first. All you need is the rear spar carry through, and the "H" tube. These parts were all built to print dimension. With a level on both carry through tubes and no shims, the assembly was about 1° down in front. A 5/16 shim set the spars at 0 incidence.

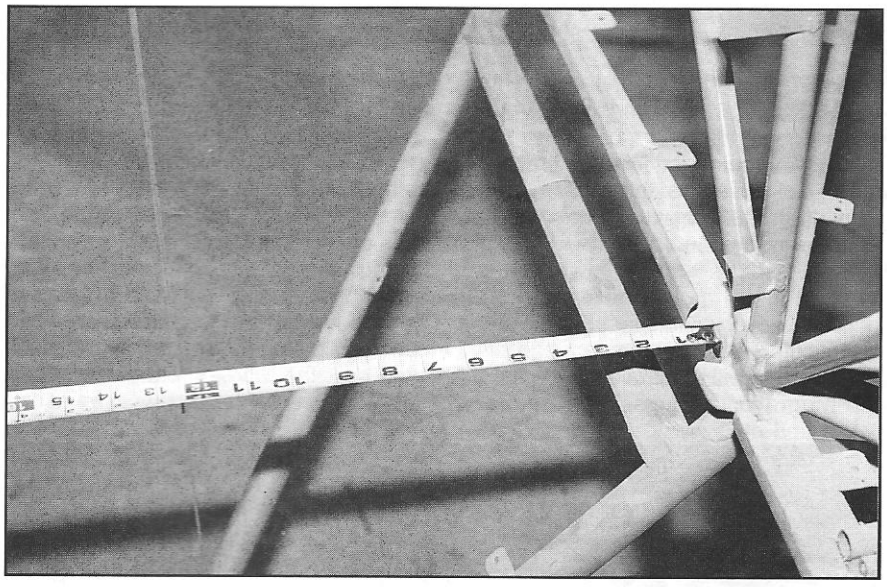
In newsletter #61 Don Baker gives some values for rise/run. These are actually sine values of the angles given. To know how much shim is required for a given change in incidence, multiply the sine times the length of the spar center lines. Simply put, to raise the stabilizer 1.5° multiply the sine of 1.5° (.026) times the spar center line (19") and you get .497". Call it 1/2". Since this airplane had to have 5/16" shim to get the 0 incidence, it required a total of 13/16" shim for 1.5° of lifting incidence on the tail. (leading edge up) Builder reports suggest that 1.5° is a good place to start.

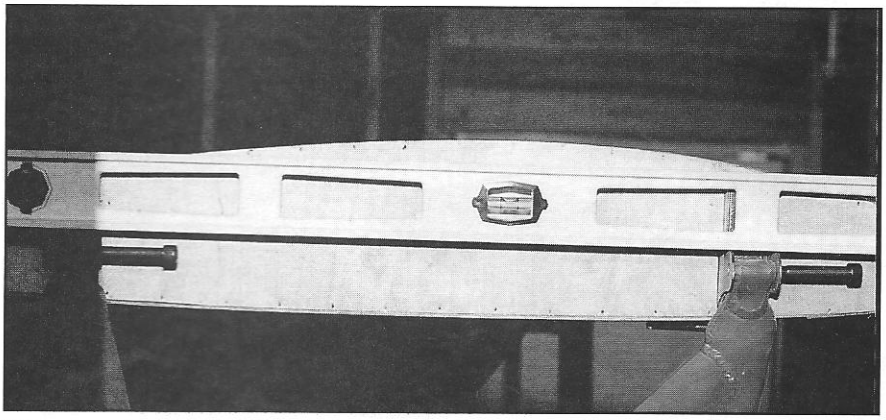
It's a good idea to set this incidence before you build the stabilizer sections. If you don't and find out later you need a lot of shim, it may put the bolts in the "H" tube in a bind.

Light weight engine/prop combinations may require more incidence where as a heavy engine with a C/S prop may need to be closer to 0° or even down loading incidence on the tail. A shorter motor mount would be a good idea with a heavy engine/prop combination.

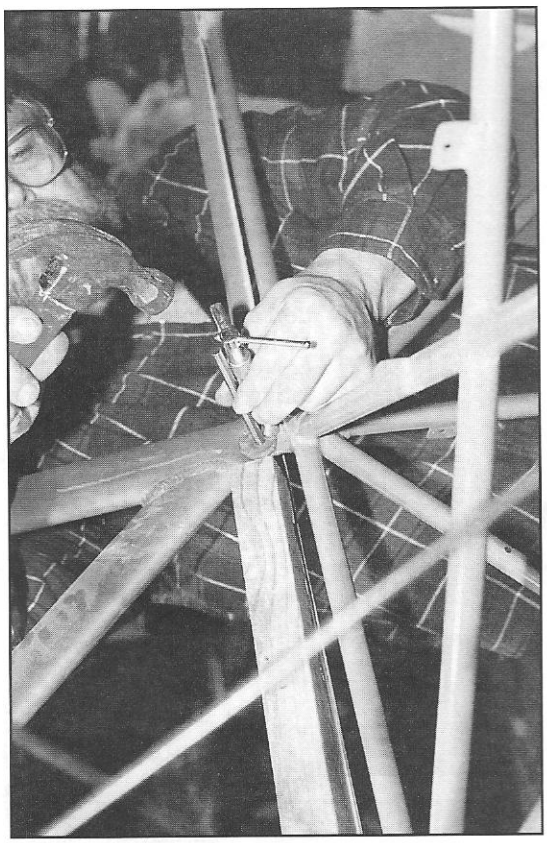
With tailplane incidence taken care of we can move on to the top wing center section. I don't like to work harder than I have to when setting angles so I would rather set an angle one time and then just level everything from that point.

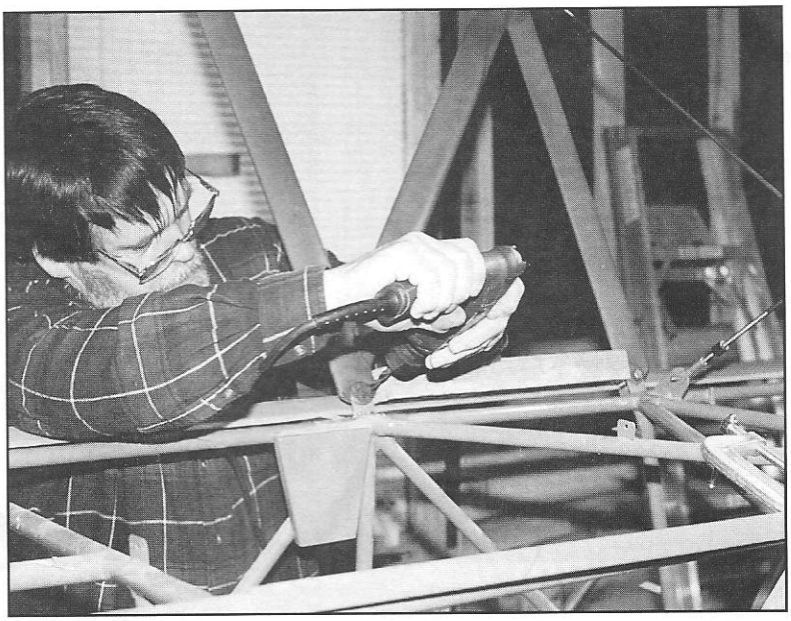
Use the same sine value of .026





With the wing section squared and centered left to right, a level is placed on the spar attach plates. Bolts are only in the forward fuselage attach point at this time. The wing section is shifted forward or aft until it reads level. Check both sides.





Left and Above - With the wing section set and the struts clamped, transfer punch, then drill the rear mounting holes.

times the length of your level. In this case 48". (.026 x 48 = 1.256) A 1 1/4" shim at the end of a 4 foot level is 1.5°.

Set your shimmed level on the fuselage and raise the tail until it reads level, then the wing attach points (both upper and lower) can be checked with a level.

Now, if you did an accurate job of building the top wing spar attach plates, and located them to the spars properly, the cord line will be parallel to the top of the wing attach fittings. With the fuselage jigged 1 1/2° tail high, set the level on top of the spar fittings. When the bubble centers, the incidence is set.

To get to this point we must first mount the struts to the fuselage. Locate one of the front strut holes in the strut tab on the fuselage. The first hole is going to be the "KEY" point for alignment. You must determine a datum line on the front of the fuselage that is perpendicular to the fuselage center line. If you built the tube structure accurately, you can use the front cross tube as the datum. If the right front strut tab is your KEY point, then what ever dimension it is from the datum you established must be duplicated precisely on the left tab. Yes, you must determine a datum for the height of the hole too. If these two KEY holes are not located symmetrically, the center section will be skewed to the center line of the airplane, and it will be impossible to get all four wings to rig properly.

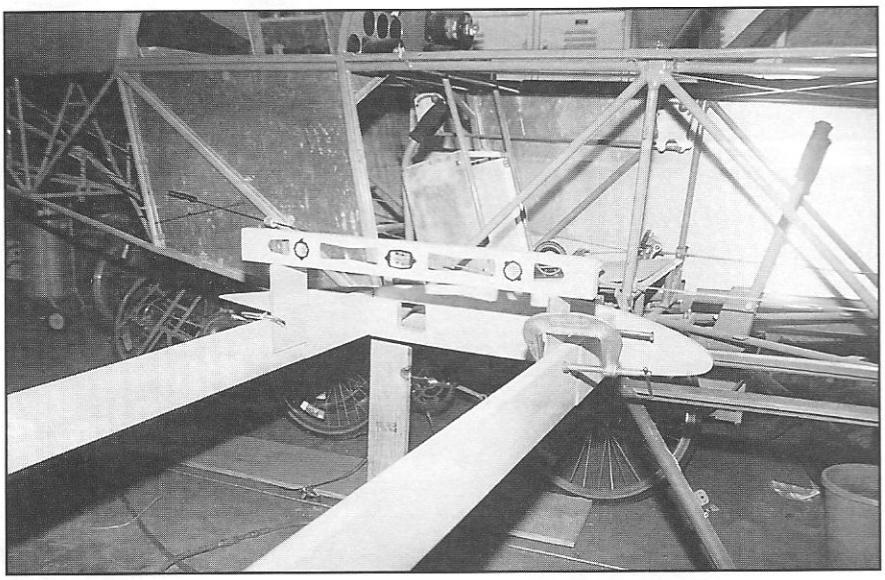
The CENTER SECTION is the HEART of a Biplane.

With the holes located in the two front tabs, we can install the struts and center section. If you have your roll wires you can install them or make up some means by which to adjust the center section left to right. (I have used hay, OK, safety wire and looped it through the anchor points then twisted it with a stick.)

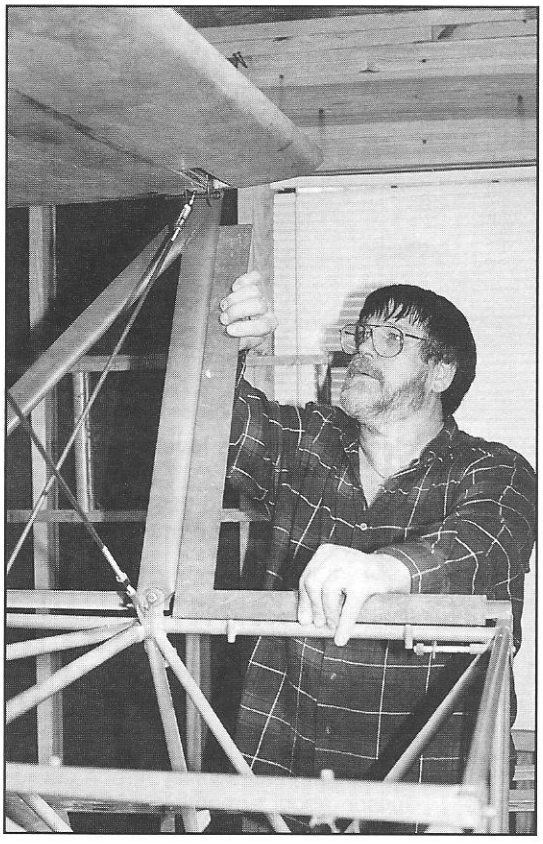
Drop a plumb line from the spar fitting and measure in to the longeron. This airplane measured 12 1/2" on each side and the center section checked perfectly level when the level was placed span-wise across the ribs. After setting the left to right location, move the level to the top of the spar fittings and pivot the struts on the front bolt untilth bubble centers. C-clamp the strut to the tab and then do the other side. Check everything again, then transfer punch and drill the rear holes.

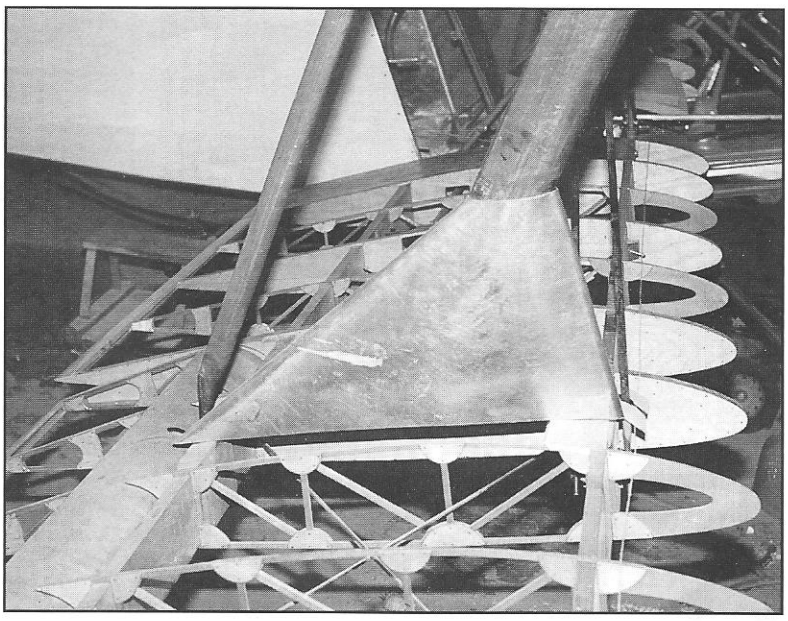
If you think that an irregularity exists from one front strut to the other, drill only one KEY hole and clamp the other strut to its' front tab. Center the wing section as previously explained. Since we suspect some error we must check the alignment of the wing section for square to the fuselage. This can be done one of several ways. Here are two.

Pull a string down the center line of the fuselage and drop a plumb line from the center of the center section leading



Fuselage 1 1/2" tail high. Equal length plates were clamped to the spars so a level could be placed on top. If you have a second set of hands you can just hold the level against the bottom of the spars. Once the spars are set square and level the rib locations can be laid out.





Left - Proof of an accurately built "N" strut. The first upright should check 90 to the top of longeron. If the rear strut is too long the front strut will lean back on top.

Above - Back to my own airplane. One of the very early issues of the Newsletter has an Acro I in it that used aluminum fairing on the I struts. I like the way it looked and I'm considering it for mine.

edge and a line from the center of the trailing edge. They should line up. Working with the free (un-drilled) front strut, move it back or forward to correct square, and up or down to correct level.

The second method is to drop a plumb line from the leading edge and measure forward to the datum line you established in the beginning.

I used a method of laying out the bottom wing that allowed them to absorb any irregularity or lack of parallelism that may exist in the welded fuselage. After making all the wing parts, but prior to assembly, I positioned the fuselage directly over a line on the shop floor with a perpendicular line exactly under where the front spar of the lower wing would be. (The fuselage is still $1\frac{1}{2}°$ tail high.) Nail but don't glue the plywood doublers to the root end of the spars and drill all the mounting holes $\frac{1}{4}$". When you make the wing attach fittings that weld to the fuselage, drill them $\frac{1}{4}$" also. You will drill them out to $\frac{5}{16}$ later. Slip some ribs on to the spars and clamp the attach fittings to the fuselage. Adjust the front spar to line up with the line on the floor using a plumb bob. Do both wings at the same time so there won't be any stagger between the bottom wings. Set the spars level (no dihedral) and jig the root and tip rib level. (remember the fuselage is set to $1\frac{1}{2}°$) This is easily done by holding the level against the bottom of the spars since the cord line of both spars is the same from the bottom. With both sets of spars set square to the fuselage center line, lay out the rib locations on the front spar only. This could have been done with the spars on the bench. Now use a carpenter's framing square to transfer the rib locations to the rear spar. Tac weld the wing attach fittings to the fuselage. Now the incidence is set and the wings will assemble square to the fuselage.

I have known builders who built the wings and fuselage without any interaction between the two, then had to use the internal brace wires to force the wings into alignment. This is not unacceptable, but it sure is nice if you don't have to force things into alignment.

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