

# Falco Builders Letter



## A Falco Pilgrimage

by George Richards

2010 was the first year I had been to Oshkosh. It had been a long time coming but for most homebuilders it is a bit of a religious experience. I enjoyed the meet. I call it a meet rather than an air show since I feel that is what it is really. The air display is okay, but I feel I've seen better. It was the final day and the air show had just finished. The place had already begun to empty out the day prior but once the daily show had ended the floodgates opened and every aeroplane on the field was in a departure queue setting the airfield up to be a ghost town.

In front of me I was watching as a woman

with two battens controlled taxi flow like some kind of ballet when it hit me. "I need to get more involved with this." I didn't really know what I meant. It was like someone was telling me something that hadn't been thoroughly explained. Slowly over the next half hour it dawned on me what I needed to do. I needed to have my Falco at Oshkosh!

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The idea of getting my Falco to Oshkosh was new to me, but I did wonder why I'd never heard of anyone doing it from New Zealand before. I definitely wasn't keen on flying my Falco across the Pacific so it left one option: shipping. Yes, the exercise would be expensive but given the cost of the 'hobby' in the first place I didn't see it as unreasonable. The idea was starting to seem so obvious, I thought I better spin it by someone else.

I felt a bit silly when I first began to air the idea with others, but most thought it was a reasonably good one. I did face a bit of criticism for not wanting to fly it across the Pacific. For my money it's not good decision-making, but everyone is welcome to their own thoughts on this. A few guys at work looked at me as if I was mad, but then they were totally money-focussed and



**We start with this: ZK-SMR**

pilots are famous for being tight.

Now that this thing had my attention I needed to fill in a few blanks. There were a lot of questions that were filling my limited brain space. Could I fit the Falco in a container? If I could, could I do it reasonably quickly? It would be no point to have to spend a month or even a week for that matter, putting it back together. It was going to be expensive, but just how much? Would I be allowed to do it? What paperwork did I need, and who do I need to tell? When would I go? How much time would I need?

So I needed to make a start, I guess, so I



**George Richards at Oshkosh 2010**

figured I could set a date. 2011 seemed a bit close to get this organised so why not 2012. No good reason why not I guess and I needed something to work toward so tentatively, 2012 was set.

I sent an email to the EAA information center, and within three days I had a reply back with a lot of the legal info I needed. It even involved words like simple and easy and had references to website instructions and links to forms. Most of it was based around aircraft flying into the USA such as Canadian private pilots, but from what I could read, I fit a lot of these categories and with EAA sponsorship it was all going to be within the realm of possibility. I later discovered that I didn't fit many of these categories at all. The EAA really didn't understand the problem, but at least it got me going.

With the Falco shipping to the USA, I didn't want to spend all of my precious leave from work re-building the plane so I need to make the whole process as painless as possible. The tail needed to be removed in order to get it into the container. That would involve removing the rear fuel tank and disconnecting the rudder and elevator control cables which requires a duplicate inspection when I reassemble so I got approval for a local EAA member to do that.

As for all the wires and cables I planned on installing connectors at frame 8 to speed the process.

Up front the engine needed to come off. The plan was to remove the four main bolts plus one in the drag link for the nose gear. Then I can retract the mains and the upper drag link without disturbing the gear timing. There were a couple of other feed wires to the alternator and starter that needed to come off including a fuel line and a bunch of electrical items.

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I figured that if I put circular connectors in the lines for the electrical ancillaries, I could save a bunch of time right there. So that's what I did. The biggest pain in the bum was the three control cables, namely manifold pressure, prop and mixture along with cabin heat. I may be able to change the cabin heat method or even remove it just for the trip since it will be summer. I mean it was 39°C in Kansas City on the way back this year so I doubt I'll need heat. The only other item to remove would be the canopy—not a big job—just needs to be handled carefully. Of course in all this will be the need for other sets of hands—especially when it comes to rotating the fuselage to fit it in the container and ditto with the tail.

While planning the shipping I had a bit of a rude shock. In New Zealand we move shipping containers around on the back of trucks with a thing called a swing lift. When you order a container, they deliver it to your site, use the swing lift to put it on the ground then they leave you to fill it. You ring them when you're done, and they come and pick it up. Its a really simple, logical system. Well it turns out that these things were invented here in 1970. Unfortunately they have only taken off here, Australia, Hong Kong and the UK. Everywhere else requires you to remove



your goods directly from the container on the back of the truck. This adds a lot of complexity. Sure you can get a crane or a big forklift to drop the container but it's not ideal and its expensive. I thought the plan might end there but fortunately some time later I found a Kiwi expat who set up a small company with a swing lift in the USA so after much relief I continued planning.

So shipping was planned for Long Beach since Air New Zealand flies into Los Angeles at least once a day. Next I needed to find a field close by Long Beach to base myself from. There are a lot of choices in the Los Angeles area, but I ended up choosing Chino—for a number of reasons and at this stage I'm not convinced I've made the right choice. I've had some good



offers elsewhere now with some helpful people but I have a good relationship with the Riverside FSDO now so I'm going to stick with Chino. Hopefully it will pan out better than it's looking right now.

Apart from adding electrical connectors to the Falco to make it a bit more 'plug and play' I needed to update the GPS. Truth is that I was going to do this anyway but since the last one was starting to become difficult to get data for, I updated it for a true panel-mount aircraft-GPS. I ended up installing a Garmin G3X system. Now when I get to the USA I can buy USA map data over the internet and load it in via the data card.

With a quick look at the US terminal charts it became fairly clear that I had some learning to do. The layout is quite different from ours, and there are lots of coloured lines and shaded areas that made no sense at all to me. Clearly I would need to get this sorted out before taking on such a mission. So I went back to the internet and ordered some training videos from the people that arguably have made the most impact on pilot training in the USA, John and Martha King. The videos at first appeared a little cheesy, but I quickly fitted



into their relaxed style and compared to some learning I've done I would say they are very easy to understand, well-paced and enjoyable training systems. Some of the stuff is fairly basic but it's so enjoyable that it's fun to have a look back at the basics again.

Six months into the planning, Vicki and I had our 10th wedding anniversary and she had the need to shop so it was a perfect time to hit the USA and do a bit of spade-work. While Vicki shopped, I hit Chino. I briefly met up with Ray Hecker, who was busy flying on a Young Eagles weekend.



Wow! There are some great aviation sites to be seen at that airport. I spent most of the day visiting aeroplane museums but did get an idea of where things were and how my whole adventure might play out.

I also had a meeting with the Riverside

FAA FSDO reps. Expecting to just waltz into the building, I was a bit surprised at the security required to get into what appears to be a fairly unassuming house. Once in though the guys were great, I had been put off balance a little bit by the security but these guys were very friendly and genu-

inely keen to help me through the process. So it appears that what will happen is that I will need to show them the Falco in the container, this is just to check for no shipping damage. Then they will return when it is together and ready to fly. They then give me a test area over a lake to “shake down” the machine. According to John who said “we aren’t going to kill you with this” it will just be an hour or so. Then I get a “program letter” which releases me to go flying in the USA to go to Oshkosh, etc. The program letter is reasonably specific on destinations, but that is fine with me since Oshkosh is my main one.

Fuel was my next question. Over here we require fuel cards. It can be done with cash, but you get ripped off as people charge what they want and the stuff is expensive enough. I emailed Duane Root on this, and he quickly came back with the explanation of your system which seems very simple so on I went with the planning.

Bryn Lockie, who owns the hangar next to mine, had just imported a small plane from France which came packed on a crate inside a 20’ container. I figured I need wood so I asked him and he gave it to me. In the process of breaking it down



and chatting with him it became apparent I had another hurdle. The wood used for packing is required to be heat-treated and certified. Fortunately his crate had all the required markings so while it was more luck than good planning, I had everything I needed.

While wiring in electrical connectors I figured the trim would be quite time-consuming to disconnect and re-connect and if I could leave the seats and center console in, I could save some time so I altered the system slightly to include a joint in the middle. Pretty simple change but it all counts. So that's most of the packing and shipping planned.

Next I needed to have a look at the trip from Chino to Oshkosh.

I spent a few days looking over WAC charts of the USA. I wanted to have a general idea of the trip to OSH before I go just to see how I can break it up. I don't want to spend any more than about 2.5 hours in the plane on any one day and want to be well and truly parked up by mid-day. That will give us the afternoon to look around and the evening to plan the following day or maybe stay an extra day if we really feel like it. That breaks it up into a five- to seven-day trip which is great so then if we

allow nine we should be very comfortable and have an enjoyable trip. The trip back will be a bit more fluid. At this stage I'm thinking southerly routing to get to OSH and northerly to get home.

Also for all the planning I've been trying out various iPad apps. I've settled on Fore-flight and so far really like it. Duane suggested FltPln also, which I've found terrific so that's pretty much what I'll use for all the planning etc.

From a bureaucracy point of view, I had covered the FAA which so far has gone very well. I have also covered customs in that I have obtained a Carnet which allows me to ship my Falco to the USA for under one year and return to New Zealand without paying taxes. Its been a bit of a learning experience for a lot of people there, but it should work.

The largest hurdle from that perspective so far has been TSA approval. In order for me to fly a New Zealand registered aircraft in the USA I require an International Airspace Waiver. From what I understand, this has come about since 9/11. This means that to fly in the USA I need to hold a piece of paper which lists and approves the airfields I will be traveling to, the people on board and how I

know who they are. It also requires me to be on a flight plan. All this needs to be approved in advance. It complicates things somewhat as it doesn't allow for any flexibility in weather planning, and I unfortunately won't be able to wake up and think "let's go over here" or offer to take strangers for rides. That will ruin the fun somewhat but being an alien to the USA, I understand I can't expect too much.

One thing I've found along the way is these systems aren't well understood. People are happy to talk on the phone and all are very helpful but often they give incorrect advice. If you want to email someone, forget it. I can only assume they don't like putting things in writing.

I must say—and I don't mean to upset anyone here—that I find this system a little odd. As a pilot, I can apply for and get a US PPL based on my New Zealand ATPL. From there I can hire a plane and go anywhere without really being tracked. But my plane, which surely stands out since it has a foreign registration, must have this airspace waiver. To my way of thinking it is the person who would pose a potential threat not the aircraft. However, as they say, it's not my train-set.



As I was dismantling my Falco, the Auckland wharfies had a large labour dispute. There were lots of delays in and out of Auckland and anything loaded in Auckland was being left on the ships overseas so I needed to come up with an alternate plan. So I shifted my departure port to Tauranga. That involved transporting the container by truck for about three hours—more money!

Another little thing that came up in the planning was the requirement to operate out of airfields with very high density altitudes. Now to Americans this will seem funny, but we don't really have any fields higher than about 1500' so when I saw 7500' with DA's approaching or exceeding 10,000' it gave me pause. I know the Falco performs well but the high DA stuff is so new to me that I really don't want to operate the aircraft any heavier than I need to. This obviously can mean reduce fuel load, etc but it also bought to attention my own weight. Getting close to 100 kg was starting to get unhealthy so I decided to go on a diet. I told everyone it was for health reasons since going through a fence on takeoff is decidedly unhealthy. I set to and lost 12 kg. I needed to do it anyway. I feel great now, and I bought myself an extra half hour of gas.



April 1 saw the aircraft come apart. All went pretty much to plan. It went in the container just like I measured it, with about 6mm to spare. Tying it down in the container was physically exhausting since there is very little room in there with everything else so I spent the day climbing up and under everything. I slept well that night.

April 12th it left Parakai and on the 15th it was loaded onto the Cap Pasado con-

tainer ship bound for Long Beach. I now wait for it to arrive in the USA around May 4th and be processed by customs. I will travel up on June 2nd to take delivery at Chino.

Once I get to the United States, we will be posting regularly on the Facebook page for Sequoia Falco, the Falco website and also on my website at [www.falco.co.nz](http://www.falco.co.nz).

# The Glider

## Part 28 of a Series

by Dr. Ing. Stelio Frati

translated by Giovanni and Francesca Nustrini

### 62. Determination of the Tail Plane Loads

For the tail plane dimensioning, we follow a process similar to that used for the wing. The loads, as we saw for the fuselage, are calculated according certification standards.

**Horizontal Tail Plane.** The minimum load  $P_c$  on the stabilizer-elevator assembly must be such to balance the wing pitching moment. Its minimum value is therefore:

$$P_c = \frac{0.20 \cdot 2n \cdot Q \cdot l_{nc}}{\alpha}$$

with their known meaning. For the required strength this value  $P_c$  shall not be lower than:

- 80 kg/m<sup>2</sup> for gliders
- 120 kg/m<sup>2</sup> for normal sailplanes
- 150 kg/m<sup>2</sup> for acrobatic planes.

As we could see earlier, in normal gliders, the load  $P_c$  required to balance the wing moment is lower than that resulting from the required minimum point load.

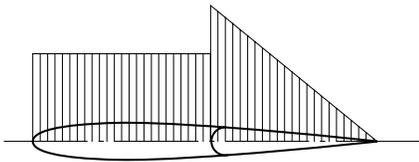


Figure 9-49

The load  $P_c$  must be shared between the stabilizer and the elevator in proportions according to their areas and with a rectangular distribution for the stabilizer and a triangular one for the elevator.

In actual practice though, the spar, or spars, of the stabilizer are dimensioned for the total load  $P_c$  on the entire tail plane, considering of the greater bending elasticity of the elevator, which thus transmits its load, by means of the hinges, to the stabilizer.

The elevator, on the other hand, is dimensioned for the load bearing on it, proportional to its area.

We do not think it is necessary to give a calculation example, since the method is exactly the same that we used for the wing. We only need to add that, since the loads on the tail plane are the same both up and



Duane Root, Ernesto Valtorta and Stelio Frati in 2004, before the infamous drive.

down, the spars will be made with equal sized spar caps, and not different, as we did for the wing.

**Vertical tail plane.** Also for the vertical plane a minimum point load is fixed, where the required strength is:

$$P_v = 2n \cdot \frac{Q}{S} \text{ kg/m}^2$$

and that shall be no less than the value of:

- 80 kg/m<sup>2</sup> for gliders
- 120 kg/m<sup>2</sup> for normal sailplanes
- 150 kg/m<sup>2</sup> for acrobatic planes.

*Example.* For a normal sailplane  $2n = 7$  with a wing load  $Q/S = 16.5 \text{ kg/m}^2$  and a point load on the vertical tail plane shall have a required strength of:

$$P_v = 7 \cdot 16.5 = 115.5 \text{ kg/m}^2$$

This is lower than the required minimum of 120 kg/m<sup>2</sup>, which we shall use.

Although, if the wing load was, for example, 22 kg/m<sup>2</sup>, the load on the tail plane would be, for the required strength:

$$P_v = 7 \cdot 22 = 154 \text{ kg/m}^2$$

and this would be the load to consider for dimensioning the vertical plane.

For the distribution of this load  $P_v$  on the fin and rudder, what we said for the horizontal tail plane applies and structures are calculated in a similar manner.

### 63. Calculation of Wing Attachments

The structural components of an aircraft are joined together by means of metal connections.

Among the most important ones for gliders, we have the wing attachments. Generally, in aircraft with cantilevered wings the half wings are joined together with steel plates bolted to the wing spars and connected together by means of pins, which may be cylindrical or conical. The wing is then connected to the fuselage, by means of small pins, with slotted fittings on the lower plates.

In a similar connection diagram, the maximum bending stress is maintained by the plates and the main pins, while the weight of the fuselage, hanging from the wing, is born by the slotted fittings with secondary pins.

Let's say for now—and later we will see through calculation—that the stresses on the union pins of the half wings are considerably higher than those connecting the fuselage.

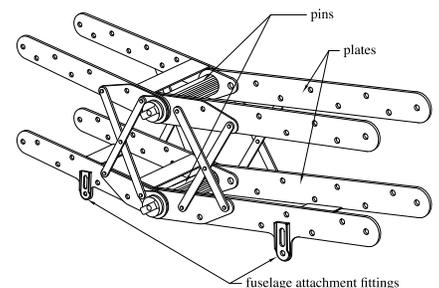


Figure 9-50



**Frati driving on the way out to Asti, passing a semi truck. Not a relaxing drive!**

*Example.* Let's proceed with calculating the wing attachments.

Let's suppose they are made up by four plates per half wing, two on the upper spar caps and two on the lower one. The distance between pin holes is 20cm and the associated wing bending moment is a load of 2500 kgm.

**Pin-Plate Eyelet.** The load on each pin comes from the stress along the axis of the spar cap calculated from the center of gravity in line with the pin. This stress is:

$$S = \frac{M_f}{h} = \frac{2500}{0.20} = 12,500 \text{ kg}$$

where:

$M_f$  = bending moment acting on the pins;  
 $h$  = distance between the pin centers.

Assuming the pins are cylindrical, we calculate the required diameter.

The shear load, considering that there are two resisting sections, one per plate, is:

$$\tau = \frac{S}{2A} = \frac{S}{2 \cdot \frac{\pi}{4} \cdot d^2}$$

where:

$S$  = total shear load on the pin;  
 $A$  = area of the pin with a diameter  $d = \frac{4S}{\tau}$ .

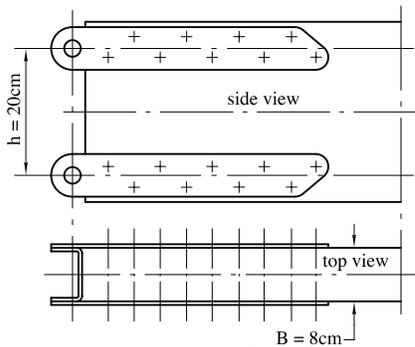


Figure 9-51

Given an admissible breaking stress of the material used:

$$R = 50 \text{ kg/mm}^2$$

by solving the relation seen with regards to  $d$ , we have:

$$d = \sqrt{\frac{S}{\pi \cdot \tau / 2}} = \sqrt{\frac{12500}{3.14 \cdot 50 / 2}} = \sqrt{\frac{12500}{79}} = \sqrt{158} = 12.6 \text{ mm}$$

Allowing, for the time being, this value as the actual one for the pin, let's now determine the thickness of the connection plates.

The section most stressed is that in correspondence with the hole, *i.e.* the eyelet. Given a plate height of 50 mm, and the unknown thickness  $s$ , the tension load  $s$  in section A-A is given by:

$$\sigma = \frac{S}{A} = \frac{12500}{2(50 - 12.6) \cdot s}$$

and given for the plate material

$$s = 40 \text{ kg/mm}^2$$

we have the thickness:

$$s = \frac{12500}{2 \cdot (50 - 12.6) \cdot 40} = \frac{12500}{3000} = 4.16 \text{ mm}$$

Let's now calculate which is the *specific pressure* (that is the unitary pressure) acting on the pin and on the plate eyelet.

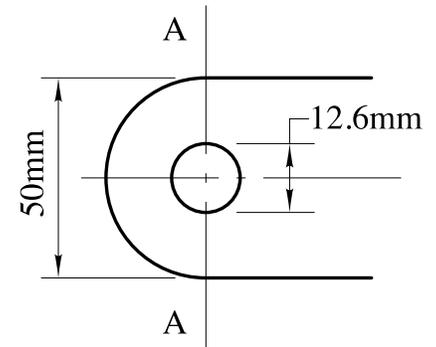


Figure 9-52

The diametric projection of the pin supporting surface is:

$$A = 12.6 \cdot 4.16 = 52.4 \text{ mm}^2$$

and the load weighing on each plate

$$\frac{12500}{2} = 6250 \text{ kg}$$

Therefore, the resulting specific pressure is:

$$p = \frac{6250}{52.5} = 119 \text{ kg/mm}^2$$

An excessively high value, as for moving parts, such as pins, we cannot exceed, for normal carbon steel, a specific pressure of 25 - 30 kg/mm<sup>2</sup> to avoid hole ovalization or pin scoring.

Thus, in our case, we will need to increase the eyelet surface both by increasing the thickness of the plate in correspondence with the hole, and by increasing the diameter of the actual pin.

Let's take its diameter  $D = 24$  mm and, so as not to increase its weight too much, we shall make it hollow, with an internal diameter  $d = 16$  mm. Its resisting section is now:

$$A = \frac{\pi}{4} (D^2 - d^2) = \frac{3.14}{4} (24^2 - 16^2) = 250 \text{ mm}^2$$

and the point shear stress is:

$$\tau = \frac{6250}{250} = 25 \text{ kg/mm}^2$$

By increasing the plate thickness to 7 mm, the supporting surface is

$$A = 24 \cdot 7 = 170 \text{ mm}^2$$

and the specific pressure

$$p = \frac{6250}{170} = 36.5 \text{ kg/mm}^2$$

still has a high value.

To increase the supporting surface without further increasing the thickness of the entire plate, let's weld a washer with a thickness of 5 mm on the eye. We now have:

$$A = (7 + 5) \cdot 24 = 288 \text{ mm}^2$$

and the specific pressure

$$p = \frac{6250}{288} = 21.6 \text{ kg/mm}^2$$

now has an acceptable value.

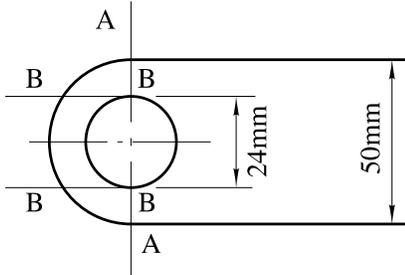


Figure 9-53

Let's verify again, based on the 7mm thickness of the plate, the tensile eye in section A-A without considering the washer contribution. The verification in section B-B is superfluous, since in this case the shear resisting area is greater than the tension resisting area.

The resisting area of section A-A is:

$$A = (50 - 24) \cdot 7 = 182 \text{ mm}^2$$

and the tension stress  $s$  becomes, being 6250 kg, the load weighing on each plate:

$$\sigma = \frac{6250}{182} = 34.4 \text{ kg/mm}^2$$

an acceptable value.

**Spar connecting bolts.** The pairs of plates are connected to the wing spar with through bolts that strongly press it against the wood. These are, therefore, stressed simultaneously in tension along their axis and in shear for the axial stress on the plates. In practice, though, the axial load on bolts is ignored, as it is always small, and also no consideration is given to the contribution of friction between the plates and the wood that helps to decrease the total shear load that the bolts must bear.

Thus, let's suppose to put eight bolts for each plate for connection and calculate the required diameter.



In the ditch and with the tow truck just arriving.

Each one must therefore bear a load of:

$$Q = \frac{12500}{8} = 1560 \text{ kg}$$

and since there are two shear sections for each, by using a point shear stress of 40 kg/mm<sup>2</sup>, their diameter shall be:

$$d = \sqrt{\frac{Q}{\pi \tau / 2}} = \sqrt{\frac{1560}{3.14 \cdot 40 / 2}} = \sqrt{\frac{1560}{62.8}} = \sqrt{24.8} = 5 \text{ mm}$$

The bolt works into the wood for 80 mm, so the supporting surface is:

$$A = 80 \cdot 5 = 400 \text{ mm}^2 = 4 \text{ cm}^2$$

and the specific pressure on wood is, therefore:

$$p = \frac{1560}{4} = 390 \text{ kg/cm}^2$$

that is not a permissible value for fir or spruce, which the material normally used to make spar caps. The maximum value for these materials that must not be exceeded is about 200 kg/cm<sup>2</sup>.

Let's then obtain from the previous relation the required supporting surface, by fixing the specific pressure to 200 kg/cm<sup>2</sup>:

$$A = \frac{1560}{200} = 7.8 \text{ cm}^2 = 780 \text{ mm}^2$$

thus the bolts diameter shall be:

$$d = \frac{780}{80} = 9.7 \text{ mm}$$

For this we shall adopt eight bolts having a 10 mm diameter.

**Plate dimensions.** Finally, let's define the dimensions and thickness for the plates.

The distance between the bolts in the connections with wooden parts is usually kept at 4 - 6 times their diameter and they are alternated by height.

Let's keep a horizontal distance of 40 mm between the bolts and a distance of 50 mm of the first from the pin axis in order to have a sufficient margin of spar material, since this ends before the pin hole. The total length of the plate is of 370 mm, given a radius of 15 mm at the end.

We have earlier determined its thickness in correspondence with the eye, where the stress is greatest. Let's now consider the stress in three other sections: C-C, D-D and E-E.

The load of the sections for each plate is half that weighing on the bolts outside the plates (assuming that the load on the bolts is the same for all, which in actual fact is not completely true).

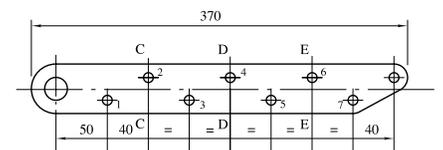


Figure 9-54

In section E-E, this load is therefore:

$$Q = \frac{3 \cdot 1560}{2} = 2340 \text{ kg}$$

in section D-D is

$$Q = \frac{5 \cdot 1560}{2} = 3900 \text{ kg}$$



See “Stelio Frati Flips Over Falco Builder’s Wife” at [www.seqair.com/Frati/FratiFlips](http://www.seqair.com/Frati/FratiFlips)

and in section E-E is:

$$Q = \frac{7 \cdot 1560}{2} = 5460 \text{ kg}$$

Considering that the plate height is 50 mm constant along the entire length, let’s obtain the thickness of the sections considered (having first fixed a stress of 40 kg/mm<sup>2</sup> for the material used)

Section E-E:

$$s = \frac{2340}{(50 - 10) \cdot 40} = \frac{2340}{1600} = 1.45 \text{ mm}$$

Section D-D:

$$s = \frac{3900}{(50 - 10) \cdot 40} = \frac{3900}{1600} = 2.45 \text{ mm}$$

Section C-C:

$$s = \frac{5460}{(50 - 10) \cdot 40} = \frac{5460}{1600} = 3.40 \text{ mm}$$

In glider construction for simplicity and low cost these metal elements are almost always made of welded steel sheet, thus eliminating as much as possible the need for machine tools (especially for milling).

In our case, we could build plates with several elements, overlaid and welded together: the first set with a thickness of 2 mm, the second to bolt 5 also 2 mm thick, and the third to bolt 2 with a thickness of 3 mm, as we can see in the figure below.

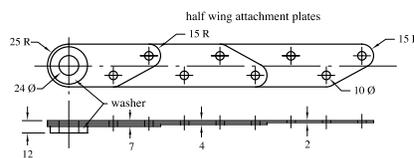


Figure 9-55

With regards to the specific pressure on bolts, we shall verify it where thickness is smaller, i.e. 2 mm.

The bolt supporting surface on each plate is:

$$A = 10 \cdot 2 = 20 \text{ mm}^2$$

and since the load is

$$Q = \frac{1560}{2} = 780 \text{ kg}$$

the specific pressure shall be:

$$p = \frac{780}{20} = 39 \text{ kg/mm}^2$$

an admissible value for fixed elements such as the connection bolts in this case, considering also the contribution given by the friction between plates and wood, which actually reduces the load on them.

**Wing-fuselage connection ears.** As we said, the wing is connected to the fuselage through ears on the lower plates.

The load weighing on them, for each half wing, is given by the maximum cut of the half wing in the first hypothesis (maximum lift). Let’s suppose that the maximum required shear strength per half wing is:

$$T = 825 \text{ kg}$$

and that the geometrical center of the half wing is 3.05 m from the centerline. Let’s then say that the two pairs of ears of the two half wings are 46 cm from each other.

For a symmetrical load on the wings, we will obviously have a load on each of the two pairs of ears equal to that of the half wing of 825 kg, that is

$$q = 825/2 = 412.5 \text{ kg}$$

per ear.

But a much greater load occurs when we have an asymmetrical stress. Certification standards, for the heaviest condition, require a load dissymmetry of 70% of one half wing compared to the other.

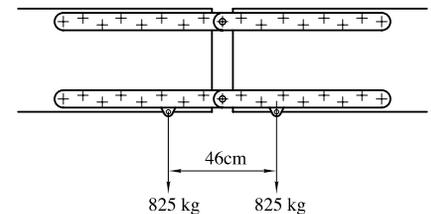


Figure 9-56

To illustrate, we can consider the wing as an only beam resting on two points, the unions in question, and loaded at the ends (corresponding to the half wing geometrical centers) with two different loads: one of 825 kg, and the other of:

$$825 \cdot 0.7 = 578 \text{ kg}$$

From the Figure 9-57 diagram, we obtain through simple calculation that the maximum traction rises up to 2344 kg and for this load we shall dimension our unions with the fuselage.

Let’s set a pin diameter

$$d = 10 \text{ mm}$$

to which corresponds an area of the section:

$$A = \frac{\pi d^2}{4} = \frac{3.14 \cdot 100}{4} = 78.5 \text{ mm}^2$$

and since there are two cutting sections, the unitary stress is, therefore:

$$\tau = \frac{2344}{2 \cdot 78.5} = 15 \text{ kg/mm}^2$$

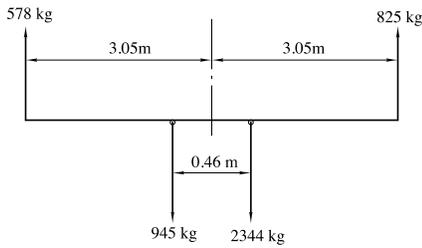


Figure 9-57

Let's set a width for the ear of 35 mm, and a thickness of 3 mm.

Section A-A resisting to traction is, for each ear:

$$A = (25 - 10) \cdot 3 = 45 \text{ mm}^2$$

and the stress becomes:

$$\sigma = \frac{2344}{2 \cdot 45} = 26 \text{ kg/mm}^2$$

Let's calculate the specific pressure on the pin. The supporting surface is:

$$10 \cdot 3 = 30 \text{ mm}^2$$

so the specific pressure

$$p = \frac{2344}{2 \cdot 30} = 39 \text{ kg/mm}^2$$

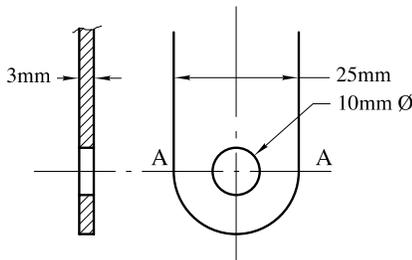


Figure 9-58

To reduce this value, also in this case we shall have to use a washer with a 3 mm thickness. The supporting area is now 60 mm<sup>2</sup> and the specific pressure decreases to:

$$p = \frac{2344}{2 \cdot 60} = 19 \text{ kg/mm}^2$$

With this example, we have seen in a simple manner how to proceed to the dimensioning of a metallic connection.

Summarizing, let's remember that we must verify:

- the tension effort  $s$  in the various most critical sections of the connection;
- the shear stress  $\tau$  for the eye, pins and bolts;
- the compression loads on pins, bolts,

with plates;

- the compression loads of bolts on wood.

#### 64. Calculation of controls and related transmissions.

**Control stick.** According to standards, the loads that stress a control stick are: on the longitudinal plane (elevator control): 100 kg for the required strength in both directions; on the cross plane (aileron control): 50 kg for the required strength in both directions.

These efforts are limited to the members that precede the appropriate limit stops, while the rest of transmission is calculated based on the efforts generated by loads on the maneuvering surfaces (ailerons, elevator).

*Example.* Let's suppose that the control stick has the dimensions shown in the Figure 9-59.

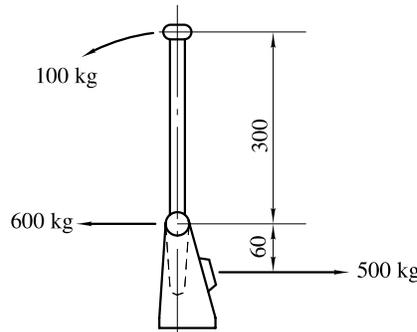


Figure 9-59

With a simple calculation, we obtain the effort on the stick pin of 600 kg and on the limit stops of 500 kg. A bolt with a 6 mm diameter is enough for the stick pin. The resisting surface is, in fact:

$$A = \frac{\pi d^2}{4} = \frac{3.14 \cdot 36}{4} = 28.4 \text{ mm}^2$$

and since the surfaces resisting to cut are two, the unitary stress shall be:

$$\tau = \frac{600}{2 \cdot 28.4} = 10.5 \text{ kg/mm}^2$$

For a stick support of 1.5 mm thick, the pin supporting area is, therefore:

$$A = 6 \cdot 2 \cdot 1.5 = 18 \text{ mm}^2$$

and the specific pressure will be:

$$p = \frac{600}{18} = 33.2 \text{ kg/mm}^2$$

that is too high a value. Let's take the pin diameter to 8 mm and the support thickness to 2 mm.

We now have:

$$A = 8 \cdot 2 \cdot 2 = 32 \text{ mm}^2$$

and the specific pressure

$$p = \frac{600}{32} = 18.8 \text{ kg/mm}^2$$

has an acceptable value.

The reaction on the limit stops is of 500 kg. Assuming that plates are 1 mm thick and 20 mm wide, the section resisting to traction is

$$1 \cdot 20 \cdot 2 = 40 \text{ mm}^2$$

and the stress

$$\sigma = \frac{500}{40} = 12.5 \text{ kg/mm}^2$$

**Aileron transmission.** The point load on the ailerons is, according to certification standards

$$0.6 \cdot 2n \cdot \frac{Q}{S} \text{ kg/mm}^2$$

and never below the required strength of:

- 60 kg/m<sup>2</sup> for gliders
- 80 kg/m<sup>2</sup> for normal sailplanes
- 100 kg/m<sup>2</sup> for acrobatic airplanes.

*Example.* Let's assume that we are dealing with a normal sailplane, with a wing load of 18 kg/m<sup>2</sup>, the load on the aileron is:

$$0.6 \cdot 7 \cdot 18 = 76 \text{ kg/mm}^2$$

This is lower than the required minimum of 90 kg/m<sup>2</sup>, a value that we will consider for calculation.

Let's suppose that the aileron has these dimensions:

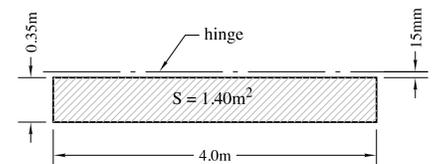


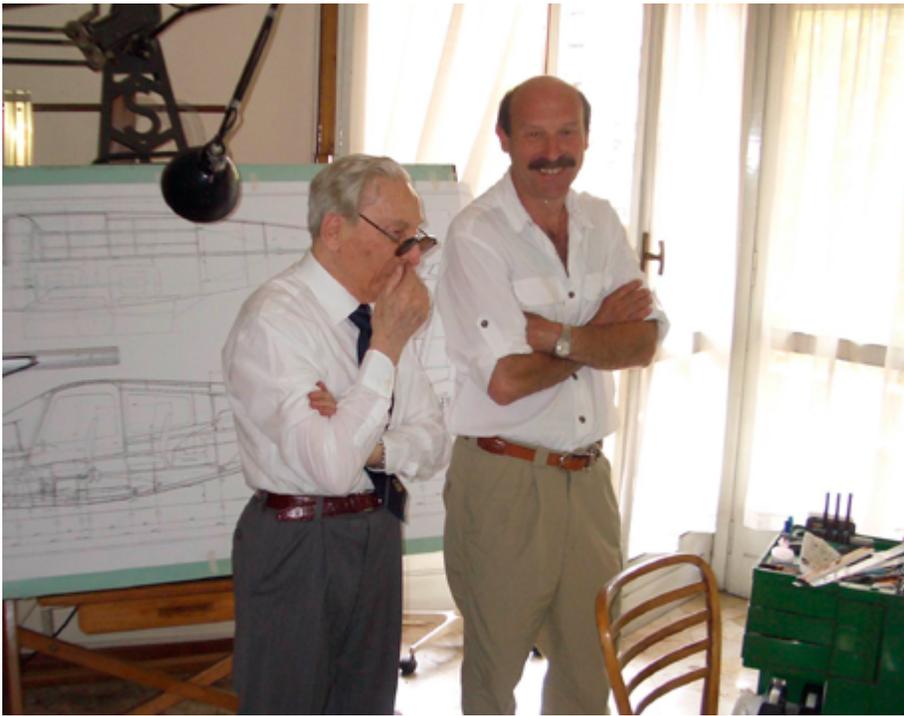
Figure 9-60

so the resulting surface will be 1.40 m<sup>2</sup>. The load weighing on it is, therefore

$$80 \cdot 1.40 = 112 \text{ kg.}$$

Since the distribution along its chord is triangular, the load center of gravity is at one third of the chord, that is at a distance

$$\frac{35}{3} = 11.6 \text{ cm}$$



with a distance from the hinge of 11.6 cm + 1.5 = 13.1 cm.

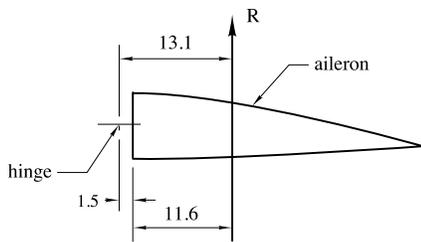


Figure 9-61

The hinge moment is, therefore

$$M = 112 \cdot 13.1 = 1450 \text{ kg/cm}$$

By setting the aileron lever radius at 12 cm, the effort on control cables (or on the control stick, if rigid) is:

$$S = \frac{1450}{12} = 121 \text{ kg}$$

The 3 mm cables that are generally used for the controls on these aircraft are amply sufficient to support such loads.

*Rigid transmissions, Buckling load.* If the transmission is rigid, with aluminum tubing, they also work by compression, they must be verified for the *buckling load*, i.e. for the compression *critical load*  $P_{critic}$  that a solid with a rectilinear axis with a constant section may support without yielding and bending.

This verification of the buckling load is necessary when the solid, loaded by compression, has a very high *slenderness coefficient*. Said coefficient is the ratio between

the solid free bending length  $L$  and the *inertia radius*  $\varrho$  of the normal section:

$$\frac{L}{\varrho} = \textit{slenderness coefficient}$$

where the inertia radius  $\varrho$  is given by:

$$\varrho = \sqrt{\frac{J}{A}}$$

where:

$J$  = moment of inertia of the resisting section  
 $A$  = area of the resisting section.

To calculate tubular rods loaded on their tip, where the slenderness coefficient is greater than 80 - 100 (long struts) Euler's formula applies:

$$P_{critic} = \frac{K \cdot \pi^2 \cdot E \cdot J}{L^2}$$

while for rods with a slenderness coefficient smaller than 80 (short struts) the formula by Johnson shall apply

$$P_{critic} = C - \frac{C^2 \cdot K^2}{L \cdot \pi^2 \cdot E \cdot J}$$

where:

$E$  = modulus of elasticity of the material  
 $J$  = moment of inertia of the section  
 $L$  = length of free bending  
 $C$  = yield strength of the material  
 $K$  = coefficient according to the end constraints.  
 For hinged ends  $K = 1$   
 For restrained ends  $K = 2$ .

*Example.* Let's consider that the transmission rod of the aileron in the previous calculation is a pipe made of aluminum

with an external diameter of 20 mm and a thickness of 1 mm, and has a free bending length of 3 meters.

The moment of inertia of the resisting section is (being diameter  $D = 20$ mm and the internal one  $d = 18$  mm):

$$J = \frac{\pi}{64} (D^4 - d^4) = 0.05 (20^4 - 18^4)$$

$$J = 0.02 (16000 - 102000) = 5200000$$

and being the resisting section  $A$ :

$$A = \frac{\pi}{4} (D^2 - d^2) = \frac{\pi}{4} (20^2 - 18^2) = 0.785 \cdot (400 - 324) = 59.5 \text{ mm}^2$$

$$\varrho = \sqrt{\frac{J}{A}} = \sqrt{\frac{2750}{59.5}} = \sim 6.8 \text{ mm}$$

The slenderness coefficient will be:

$$\frac{L}{\varrho} = \frac{3000}{6.8} = 440$$

therefore, we are no doubt in the field of applicability of Euler's formula. In our case, let's set:

$$E = 6800 \text{ kg/cm}^2$$

$$K = 1$$

$$L = 3000 \text{ mm}$$

$$J = 2750 \text{ mm}^4$$

We shall have:

$$P_{critic} = \frac{K \pi^2 E J}{L^2} = \frac{\pi^2 \cdot 6800 \cdot 2750}{3000^2}$$

$$P_{critic} = \frac{9.85 \cdot 6800 \cdot 2750}{9,000,000} = \frac{184,000,000}{9,000,000} = \sim 20.5 \text{ kg}$$

The load bearable by the rod is, therefore, considerably smaller than the load weighing on it, which is 121 kg.

To increase resistance without increasing the rod dimensions, we shall reduce the free bending length  $L$  by placing two supporting bars, equally distant from each other. This way, the free bending length is now  $L = 1 \text{ m} = 1000 \text{ mm}$ .

The slenderness coefficient is:

$$\frac{L}{\varrho} = \frac{1000}{6.8} = 147$$

and we shall apply again Euler's formula:

$$P_{critic} = \frac{9.85 \cdot 6800 \cdot 2750}{1,000,000} = \frac{184,000,000}{1,000,000} = \sim 184 \text{ kg}$$

A value that is now definitely higher than the stress.

In a similar way to the buckling load, we can calculate the wing stanchions stressed by compression in the sudden landing condition.

## Somewhere Over Kansas

Wherein Navy and Air Force Pilots Rendezvous for Some Falco Fun

by Doug Henson

One day a few weeks ago, I received an email from Gary Noble. Gary owns Falco N644F which was built by John Devoe. He had seen our YouTube video and was interested in my perspective on performing acrobatic maneuvers in the Falco. During our conversations over a few email exchanges, we discovered that both of us would be in the midwest with Falcos during the same week in April—talk about Karma! So I suggested we get together to exchange flying techniques and fly some formation.

For me, flying formation is a very precise and pre-planned event requiring strict adherence to safety protocols and flight procedures—and it is an adrenalin-pumping event I thoroughly enjoy. So I had visions that the two of us (Gary a Naval Aviator, and me an ex-Air Force pilot) would be a great pair for some Falco formation flying.

Gary keeps his Falco based at Cedar Rapids, Iowa, and was willing to meet me in Lawrence, Kansas, where I was visiting friends and relatives. When he arrived we did the normal thing all Falco owners do—we thoroughly examined each others' Falco from top to bottom. Gary has been doing a few things like adding a nosewheel door, reducing the cowling air intake openings, preparing it for other upgrades, etc. I also noticed that Devoe's stars-n-bars scheme had been removed. Gary tells the story of how John was nearly apoplectic as those Air Force decals were unceremoniously peeled off. I realized there are some things a Navy man just can't abide.

We first flew in my aircraft to conduct some over-the-top maneuvers. In particular, Gary wanted to see loops and barrel rolls. I demonstrated several loops, then gave the controls to him. There are, of course, differences in Navy and Air Force jargon, and we had an exciting "oh s--t" experience on top of his first loop due to that difference. I had reminded him that stick back pressure must constantly relax during a loop because one cannot pull 4 Gs when the air-

**Top: Doug Henson's Falco at West Coast Falco Fly-In.**

**Center: Doug Henson and Young Eagle.**  
**Bottom: Gary in N644F leading the flight to Runway 19 for takeoff.**





*Above: Falcos gathering on the ramp at Lawrence, Kansas*

*Center: Gary Noble and his Falco.*

*Bottom: Gary in right echelon.*

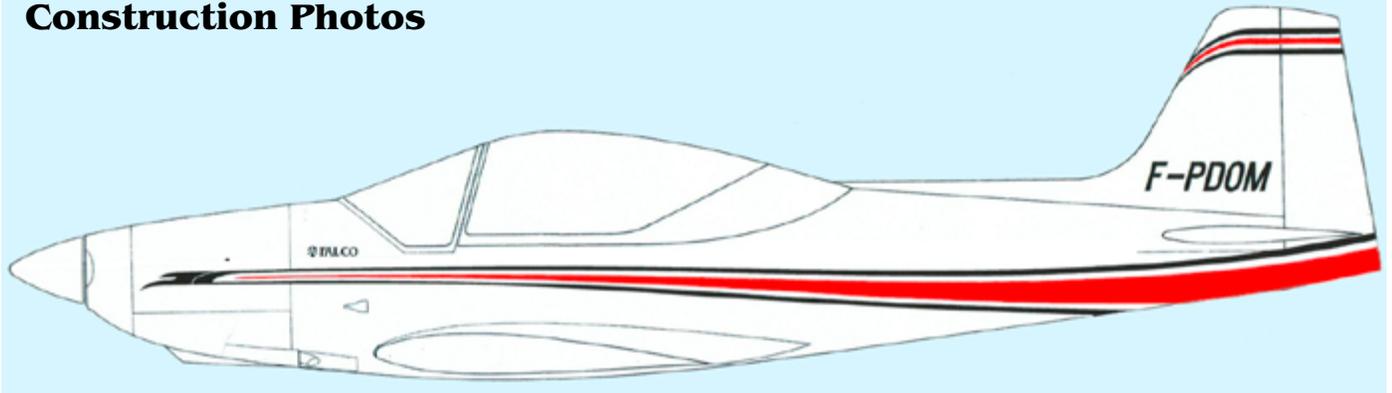
speed is near stalling at the top of the loop. Gary's first loop was great until we reached the inverted position at the top. "Relaxing back pressure" in Navy parlance apparently means negative Gs, which we did! As I saw the airspeed rapidly approaching stall speed, I had visions of an inverted spin. I took control and recovered. After clearing up that small snafu, subsequent loops were perfect. We recovered to a nearby airport for fuel, then executed a few barrel rolls on the way back to Lawrence.

We then briefed a formation sortie which included basic turns, climbs, and descents in fingertip formation followed by an overhead pattern and landing. Departure and maneuvers were led by Gary with me on his wing, then we switched leads. I led him through similar maneuvers and the recovery. Although it had been several years since Gary had flown on someone's wing, you would never have known it—he was glued to my wing. We experimented a bit with airspeeds and power settings due to differences between my IO-360 and his IO-320. What a pleasure it was to have a wingman that followed every motion I took as we executed our pre-planned events. You can't do that on the ground.

Back on the ground we were both beaming about our successful mission. In usual military fashion, we debriefed by talking about what we did right as well as what we did wrong or needed improvement. After that was complete, we voted, and it was unanimous that more of this type of Falco fun was called for in the future.



# Construction Photos



Dominique Francois, France



## Coast to Coast with Susan

Should you ask for directions to the office of Sequoia Aircraft Corp., I will give you the street address and then tell you to look for a huge Sequoia tree at the front of our building. We are located in a large business/warehouse district and this tree is the only tall tree in the entire area. It is probably 60 feet tall and definitely noticeable. The front of my office is all glass and everyday I can look at this magnificent tree not 15 feet from our front door.

I once had the pleasure of visiting Muir Woods in Northern California. This area is the home of the historic Redwood/Sequoia forests with trees that are taller than life and some are hundreds of years old. You do not see these trees on the East Coast of our country. So, how did our tree show up in front of our office?

Over 20 years ago, Alfred and his wife, Meredith, were given a Coastal Sequoia sapling by a friend. He says it was barely two feet tall. It was at the time Alfred was generating the beginnings of the F:8L Falco through his new company, Sequoia Aircraft Corp. So, they took a leap of faith and planted the young tree where it now stands so grandly.

Time has passed, a lot of Falco kits have been sold and turned into beautiful airplanes and this tree has grown with them. Alfred says that for the first few years, the tree grew little. After all, it was not at all where nature would have intended it to grow, much like an Italian designed airplane being promoted in Richmond, Vir-



*Susan with 'the boys', regulars here at the office.*



*Furio #3 first flight, escorted by Furio #2.*

ginia. But, as you can see in the picture, it did and it continues to flourish despite hot summers, frigid winters and serious droughts. It stands alone and not within a quiet forest but it endures.

By the way, my buddies in the picture are Alfred and Meredith's Black Scotties, Dougal and Angus. They like coming to the office and hanging out with us and often "visit" the big tree instead of the fire hydrant on the corner. I don't think the tree has much to fear.

Sorry to report that my hopes and expectations to create an economical way to use United Parcel Service for shipping overseas has not worked out. We just could not get

the pricing scale in place that we needed. So, we will continue to send smaller orders to you via US International Priority mail and use UPS for stateside orders.

Please note that we have posted a new kit price list on the website. We are maintaining our kit prices without changes, but we have had increases from Hartzell and our canopy manufacturer.

Did you know that we are now on Facebook? We have "made friends" with a lot of Falco fans and builders so it is working out to be a good format for you to share your projects and adventures. Have fun with it and blue skies!—Susan Arruda

## Mailbox

Falco N988RP became 10 years old on May 5th and is doing well and flying great. No major problems with anything including no problems with landing gear. I did update my very old Century I autopilot with a Pictorial Pilot from TruTrak which is so much better than the old technology Century I.

Total time is only 361.2 as of yesterday.  
Bob Brantley  
Pamona, Missouri

You should never buy a *Trade-A-Plane* when you have money in your pocket. That's when I caught the ad for Steve Bachnak's Falco #19. As it turned out, it was located just south of Chicago where I was at the time and that was close enough to go look. That was back in 2004.

Steve Bachnak met me at a bus stop and put me up for the night, more great Falco hospitality. A few trips around the patch with Steve, and I was more than a little anxious to head home, checked out and totally hooked. The next day we did a few touch-and-goes just to make sure I could land it, then after a cylinder check and gear swing, off I went for Washington State at 4:00 p.m. in the afternoon.

Falco #19 hadn't been out much in the previous years so on the trip home for about 500 miles or so she seemed to have trouble getting horsepower to altitude for cruise. As I progressed the performance got better and better. Maybe it was old fuel, or just running the cobwebs out, I am not sure. I did make some maintenance stops along the way and had the magnetos set twice. I think in hindsight it was having both carb heat and mag problems and she needed to be run.

I found myself sitting on top of the Falco over North Nebraska badlands cruising like I was on some kind of a flying carpet. You could probably see my smile at 9,000 feet while I was marveling at how it just seemed to be a part of my thoughts. Just think left, and you go left. It's the same for all control inputs they are so soft, once you bond to this airplane and get comfortable with the speeds. I can only describe flying the Falco as a completely natural extension of the mind's direction.

There I found the other change that was going to be mandatory when I got home and that is in my humble opinion these planes need an autopilot for cross country flight. That is if you like to look around like



*Steve Crisp has been converting Steve Bachnak's Falco into a modern beauty.*

I do. On one occasion I got looking left just enjoying the day for what seemed like only a few seconds and found my self over five miles off the GPS course centerline.

Crossed the Rockies and landed in Idaho Falls for the night and woke up to 30 knot head winds in the morning. After having the mag's set again due to experiencing an unsettling roughness on the landing, I took off into the headwind and over Boise turned north. By this time she was flying well and I was up to 15,000 and still climbing going over the hump.

I put the nose down and crossed over Lewiston Idaho at about 5000' direct on course to Chewelah. That headwind had now turned into a tailwind, 30 minutes later I was on the ground. What a Joy, nothing like it ever!

Now after six more years of off-and-on work just getting it the way I want it, it is about ready to launch again, and I think it is going to be fast.

My conclusion is that there is no such thing as a bad Falco. At least nothing

that can't be overcome with some TLC and planning. Alfred once said it is like a Swiss watch, and I completely agree. Having one complete to look at while doing something has its advantages and also its disadvantages. Sometimes I truly thought I could build a new one from scratch faster than doing one this way. I think that was because I was reluctant to just strip it out and go for it. In the end that's essentially what has happened to #19.

Probably the hardest thing to do was figure out how to do all the upgrades and for that matter which ones first. Everything is so interrelated that there just is a shortage of premium space so you have to get it right. What you end up with, is you have to have everything here to do the job and hoping it will all fit into the final package. The autopilot ended up resulting in a complete panel replacement and it just went on from there. In retrospect I think I could do it much quicker the next time. Then again, I like building things and now I have the shop, all the tools necessary, the know how to use them and a great Falco too! That's a win-win in my book.

Steve Crisp  
Chewelah, Washington



I enclose some photos of Furio number 3 to take to the air. I thought of you and the Falco when we got the picture of the Furio being towed down the drive in between the trees! Somehow reminds me of the first Falco being towed by the donkey to the airport!

Giovanni Nustrini  
Auckland, New Zealand

Do you know who has all the drawings that were at Mr. Frati's? I have not been able to speak with anybody about that.

Also when he initially gave you the drawings he never gave you the Series Two with the wing rubber fuel tanks?

Some years ago I asked Mr. Frati to design for me a new wing with fuel tanks. Of course I paid the consultancy and after a couple of months he gave me a full set of



**Andrea Tremolada messing with Falco drawings and demonstrating good taste in airplanes, art and friends (Hilary Swank).**

drawings for wing fuel tanks, but I don't like them as they are full length metal fuel tanks and are held in the wing with hundreds of screws. It's probably a "Frati experiment" but I'm not convinced as the bottom of the wing would be the fuel tank, and I feel there is a different torsional resistance between steel and wood. I would rather prefer to find the original drawings for the rubber fuel tanks.

Can you confirm Luciano Nustrini canopy is slightly lower than ours?

Andrea Tremolada  
Milan, Italy

I heard from Frati's niece Cecilia Negrini shortly after he died that she planned to keep a few drawings for herself and turn the rest of them over to a museum. But I've heard nothing more about this from anyone, and I've lost touch with her.

We did have some other drawings from Frati, but as I recall the wing tanks in the Series II Falcos were rubber bladder tanks in the wing and these were used instead of the aft fuselage tank. They complicated the wing construction and detracted from the rate of roll. So I think the decision to abandon that design was a good one.

We got the drawings for the Nustrini canopy design from Luciano Nustrini so the overall design is the same, but he cut down the original canopy design which was made in three pieces and was not as 'rounded' as our canopy so his may have had a slightly lower height at the centerline of the aircraft, but it is the same design in all other respects.

Andrea reports that he has been working on getting more speed from his Falco. We should have a full report in the next Falco Builders Letter.—Alfred Scott