

The Falco Project

by John Corkill



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The many attractions of this hobby include not only the opportunity to fly model aircraft in the pleasant company of other club members but also to build the models, from kits, plans or from scratch. In the case of the latter, the aircraft may be a scale model or one's own design. Then there's the choice of radio gear to be made and engine/motor to be selected. Last, and certainly not least, there's the requirement between flights to sit round the table at the field, exchanging views with club members and putting the world to rights.

It's a fact of life, as my very understanding, patient and wonderful wife (and proof reader) will testify, that whilst I'm flying one new model I'm usually building the next, designing its successor and planning the fourth after that, all at the same time. Some put this down to extraordinary keenness on my part; others attribute it to a probable genetic disorder.

One consequence of the above is that, when I'm flying my new model the problems associated with its build have been already forgotten, displaced by other more pressing ones related to current designs and builds. My mate Gordon Towell is always complaining that I spend much time sorting out problems while building the model only to cover it all up and forget about them, and he's long been pressing me to document and record a build.. Also, our new Webmaster is keen to get articles for the website. So, here's my attempt to put pen to paper (so to speak) and try and log a complete build, from concept to take-off.

Selecting an aircraft to build is not that difficult. Most aeromodellers, I'm sure, have their own mental "library" of planes that have just *got* to be modelled at some time in the future. These libraries never get smaller with time so the problem is not so much finding an aircraft to model as deciding which one from many. Some ideas you carry around since you were a child until for some reason one suddenly pops up. Remember, "*Growing old is compulsory; growing up is not*".

What I'd like to describe in the following pages is NOT a what-to-do-and-how-to-do-it for building model aircraft but rather what *I* do, or did, based on my experience of what works (and what doesn't). Everyone may have a different way of doing the same thing and no one way is "right". Like most, I tend to find methods and techniques that work for me and then stick with them

Something that may surprise is the amount of preparatory work that seems to take place before the construction proper commences. I can't recommend too strongly that all changes during this phase are accompanied by a drawing of some sort, whether they involve designs, components or installations. This is where the real problem solving should take place, at the planning stage and not during the actual build.

And, finally, there's no timescale for a project like this. It may proceed at a fast or slow rate, depending on circumstances, and will probably be suspended several times whilst something more pressing is dealt with - another build, for example. And, the weather may unexpectedly improve meaning one may have to do one's duty and go flying !

1) Choosing an aircraft

The last “real” scale model I built from scratch was probably my 1/6 scale RE8 way back in the last century. At around the beginning of 2010 I was contemplating another scale project, either from scratch or using available plans. It had to be something uncommon but interesting and good looking but not too difficult to ‘engineer’.

One full-size aircraft I had always liked was the Sia Marchetti SF260 Warrior two-seater military trainer / light-attack aircraft, an Italian design by Stelio Frati which first flew in 1964. Whilst researching this aircraft I came upon its less-well-known predecessor, the F8L Falco, also designed by Frati. This first flew in 1955 and was originally produced in Italy, by Laverda. In the 1980s the design was acquired by the Sequoia Aircraft Company (Seqair), in Richmond Virginia who produced it as a home-built design, supplying anything from plans up to major module kit packs..

There are some aircraft that just look “right”. A glance at the photo selection below shows the attractive lines of this aircraft and the features that make it so distinctive. One is the very large side-by-side canopy and producing this would obviously take some effort if commercially made samples were not available. Further research would show other “problem” areas which would also require some thought.

However, problem solving is half the fun of the hobby so, as a starting point, some plans needed to be acquired. One possibility that had occurred to me was to buy a full-size set of homebuild plans from Seqair (at about \$400) which really would help produce an accurate scale model. The consequences of my wife finding these full-size plans and my having to explain my intentions could be a problem.

Common sense (sanity) prevailed and those I finally got were originally drawn by Robert C Schweitzer and are now marketed in the States by Jerry Bates⁽¹⁾. At ¼ scale they would produce a very practical sized model.

The full-size aircraft overall dimensions are : Span 26’ 3” Length 21’ 4”
At ¼ scale this would give a model 64” long with a span of approximately 79”, not a very large model by any standards. Nevertheless, even at this size the canopy is 10½” wide, 5” high and 21” long ! The cowl, housing a Lycoming engine in the full-size, is large enough to fit almost any model engine and the SC160 flat twin I’d had for a few years was an obvious candidate.

So, a decision had been made on what aircraft to model, and some suitable plans acquired. The next step was to review the plans to identify and resolve any potential problems before even cutting the first bit of wood. This is where a lot of the work (or work avoidance) associated with the build occurs.

As usual, a search was made on Google to find and store as much information and as many photographs as possible. Many full-size builders have logged and documented their builds and such articles were very useful – same problems as models, just on a different scale. Superb example of build and videos here⁽²⁾, browsing *definitely* recommended. Seqair also produce excellent pictures and videos ⁽³⁾.



Fig. 1 Pictures showing various Sequoia F8L Falco homebuilt light aircraft.
(see also ‘ <http://www.seqair.com/Videos/index.html> ’)

2) Plans review

The plans arrived protected by a very robust cardboard tube and, although not CAD drawings, were very highly detailed, easy to understand and very comprehensive. In addition to construction plans they included decal and cockpit details and dimensions and comprised five sheets, three of them about 11’ long and the others 7’6” and 5’6” long, all about 3’ wide. That’s nearly 140 square feet of plans ! Finding room to spread them out just to view them was not easy. Perhaps a set of full size plans would have been just a little too much for my 10’x12’ building shed.

First impressions :

- Some details would be obviously be changed as a matter of course. For example engine installation and tank position must reflect the type of engine to be used.
- This type of model just *has* to have retracts. Both scale and non-scale types were shown on the plans and it was apparent at an early stage that the installations shown would not work. There was no way that the wheels could retract to the scale position and angle using the leg and pivot geometry shown so some investigative work would be required.

- Looking in detail at the wing in plan view and the templates for the ribs, it was found that there was a dimensional discrepancy in the rib chords in these two views. Since these were both on the same sheet it was not due to (say) humidity affecting the drawing size. Again, this would have to be addressed.
- It was established that a cowl *may* be available via the UK importer of Jerry Bates' plans, and one was placed on order.
- As far as could be ascertained, a suitable canopy was not commercially available and producing this could be a significant part of this article.

So, the aforementioned problems were identified at this early stage. These were not serious in the grand scheme of things but some work was necessary before building could start. Better to find these now since, no doubt, others will arise during the build.

3) Engine installation

Using a completely different engine involves not only determining the correct position and offset angles but also determining how it all fits within the cowl and where the routing of control linkages and exhaust system. One useful tool here is Adobe Photoshop (or Elements) and two pictures below show the first stage in this.

The relevant parts of the plans have been scanned in, as jpegs and the old engine 'removed' (cloned out). The new engine was photographed from the top, front and side and copied in on its own layer. This was then be moved around until the engine was in the right place and the mountings etc. were then be filled in by hand around it. The only tricky bits here are ensuring that both the scanned images and engine photos are the correct size and have matching pixels per cm before copying and pasting.

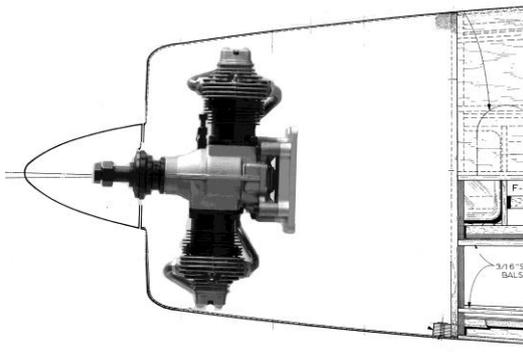
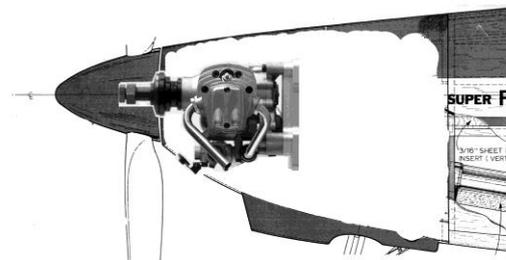


Fig. 2 Plan and side views of the nose area with the original engine removed and photos of the SC160 horizontally opposed twin inserted



4) The wing ribs

These are a major component of the model, affecting strength, appearance and flight characteristics and I always like to take time to get them right. A quick check on some rib chords in plan and side view showed up to 5mm difference. Whilst small differences are usual, especially when the original drawings are likely to have been traced, a difference this large was enough to make construction potentially difficult. Trying to sort out problems such as this during the actual build is not recommended.

Several options were available. These were (in increasing order of complexity) :

- i) Use the rib, wing plan and side views as reference and decide which dimensions are (probably) the correct ones. The wing is highly tapered so this involves checking *all* sixteen rib chords and multiple spar positions and sizes, and redrawing the inaccurate ones by hand. Quite a lot of tedious work and time but it is achievable without any special tools and is worthwhile.
- ii) Use a commercial rib plotting program, e.g. Profili ⁽⁴⁾ . If the wing section used in the plan is not already available in the Profili library then create it by using graph paper, add it to the library and re-plot the ribs using your PC
- iii) Use a home-grown computer-based programs to create and print the correct wing sections, together with spar and u/c positions and other details.

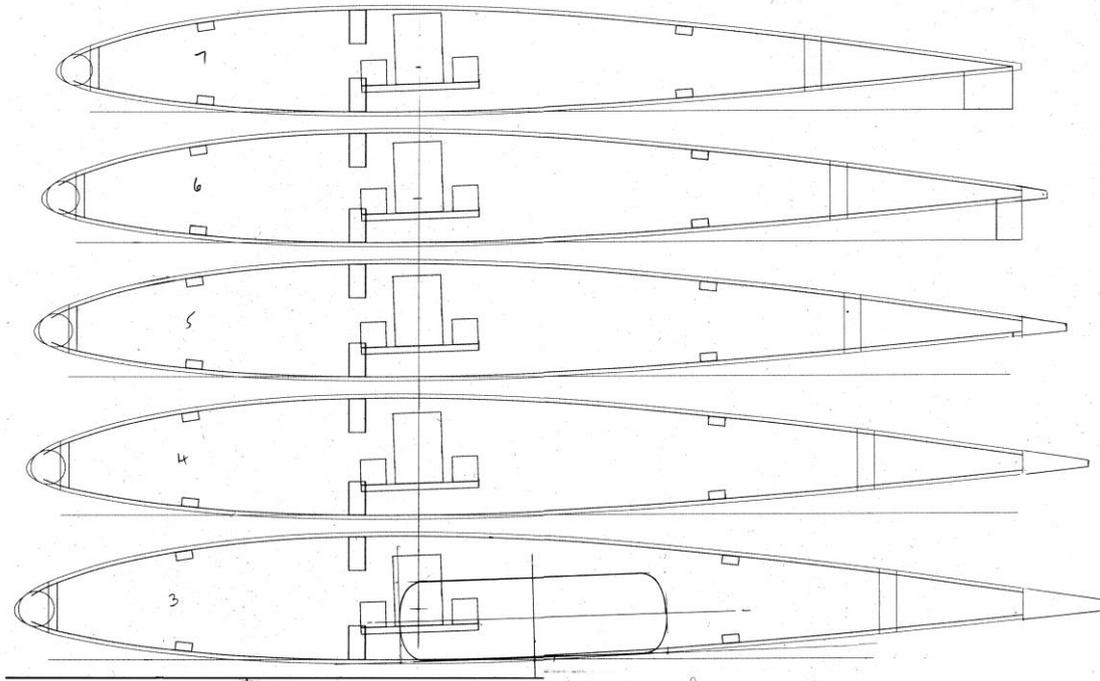
I was able to choose option iii) since, fortunately, over the years I'd developed computer programs for my own use from which I can draw on a library of sections, or create new ones where necessary, and output these to an Epson inkjet printer to use as rib templates. These are very accurate and also permit output to be finely adjusted to suit the strip-wood sizes actually available. (One of my pet hates is kits with spar slots that are too large for the strip-wood supplied.).

Whichever method is chosen the final result will be an improvement over any plan inaccuracy. The latter two options also permit output in the form of CAD files which could, if required, be sent to a commercial Laser Cutting company, e.g. Belair ⁽⁵⁾, to produce a set of accurate ribs with minimum effort, or done by oneself.

Note : Laser Cutting companies usually work from CAD files, but they can scan in hand-drawn plans such as these and produce complete sets of laser cut components. These save a lot of time but if the drawings are not fully checked beforehand the result will be very accurate reproductions of *all existing inaccuracies* !

Doing this yourself also allows rib-located components such as alternative retract units and wing servos and their mountings and linkages to be accurately positioned and drawn onto the ribs at the same time. For this sort of work simple drawing packages such as the 'Draw' package included with Microsoft Word are an aid (examples are shown in the Retract section that follows). Doing it yourself also allows you to build in the correct washout rather than rely on twisting the wing, and to include the appropriate building tabs, servo lead access holes and wing joiner slots/holes, where required..

Fig. 3 Example of output of “home grown” rib plotting program generated using method iii) above (also showing retract and wheel locations).



The above shows a sample printout of some Falco ribs. Maximum chord is about 16” at the root. Details include main- and sub-leading edges and spars. Once printed, the paper templates can be simply stuck to the wood and used to cut out the ribs by hand.

The rectangular object behind the spars is an end view of the intended retract mechanism and the 2nd rib from the top is the span location where the unit is actually mounted. There’s not much spare room here so better to get this right at this stage than to try to fit the retracts retrospectively to a partially completed wing.

Note : wheel is shown retracted flush with wing underside in both spanwise and chordwise directions. More on this in next section.

5. Retracts

A feature of the full-size aircraft is its maximum speed (202 mph) on just 160 hp and one feature contributing to this is the thin wing. The full-size root chord is about 64” (thickness 8”), and at the tip the 10% section is about 32” chord and 3¼” thick. At ¼ scale this allows no more than 1½” *between the wing sheeting* at the location of the retract mechanism, so there’s little flexibility in locating this.

The intended retracts will be E-flite electric units (90-120 size) which, fortunately, are fairly compact and retract in about 3-4 seconds, which is quite scale-like. They are based on an integral electric motor driving a worm screw and, thus, require no extra room within the thin wing for air reservoirs or retract servos. The main leg is 3/16” dia. which is quite robust and the units are commendably free from backlash.

The full-size Falco uses trailing link main legs. These provide a relatively large amount of suspension movement and help make model operation from grass more practicable. Shock absorbers from r/c buggies are being investigated for suitability. The target weight of the model, about 12 lb, is always being borne in mind.

The retract dilemma

The plan u/c area illustrates very nicely what is often a common problem when building a model from scratch – deciding between conflicting available information!

The wheels retract inwards and the retracted leg is above the wheel. With the pivot in the position shown and the retracted wheel parallel to the wing underside, the wheel could not be flush with the wing but would have to protrude, as shown in fig. 4a below.

However, the scale plans and online Falco build projects indicate that the wheel retracts flush, and parallel with, with the wing underside. This would require the u/c leg and pivot to be higher, much closer to the inner upper surface of the wing.

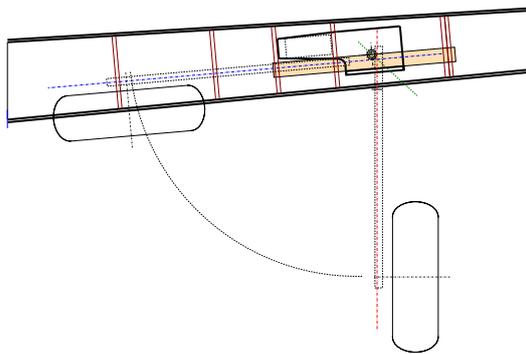


Fig. 4a
Wheel retract angle is 85 deg,
wheel remains proud. A greater
retract angle would lift the
wheel but it would not be parallel
to, or flush with, wing underside.

One option I considered was to use a small offset in the leg to 'lift' the wheel into the wing when retracted as shown in 4b below. This is quite often used on full-size planes but is this right here? It would provide more material around the trailing link pivot.

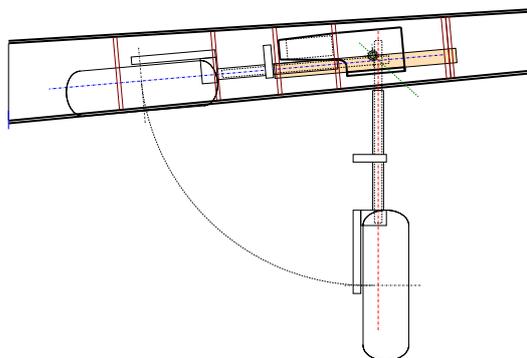


Fig. 4b
A drawing showing the effect
of using an offset in the leg.

Another option would be to locate the pivot near the top of the wing and use a link to a remote retract unit but there's not much room for linkages here.

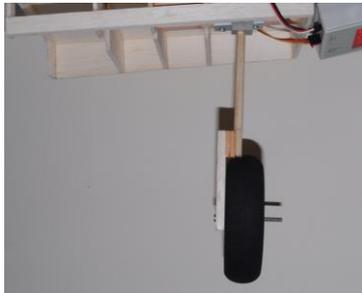
Use of a 90 deg. retract unit would, of course, lift the wheel up higher when retracted but it would not then be parallel with the wing surface. Problems ... problems.

Retract test rigs

To make sure I was not missing something obvious I constructed two simple rigs from balsa consisting of just the wing region containing the retract mechanism and wheel, with leg offset. One had an 85 deg. retract angle and the other 90 deg. Legs were made of wood for easy of modification. The following photos illustrate these.



Typical photo of test rig with servo tester to drive electric retract unit. Constructed wing segment is from mainspar rearwards only and spans just the relevant rib bays.



85 deg unit with offset leg (extended)
Wing dihedral is 5 deg, leg is vertical.



85 deg unit with offset leg (retracted)
Wheel is both flush and parallel.
View from front through mainspars.



90 deg unit with straight leg (retracted)
showing wheel is not now flush or
parallel with wing lower surface.
Note change in bearer alignment.

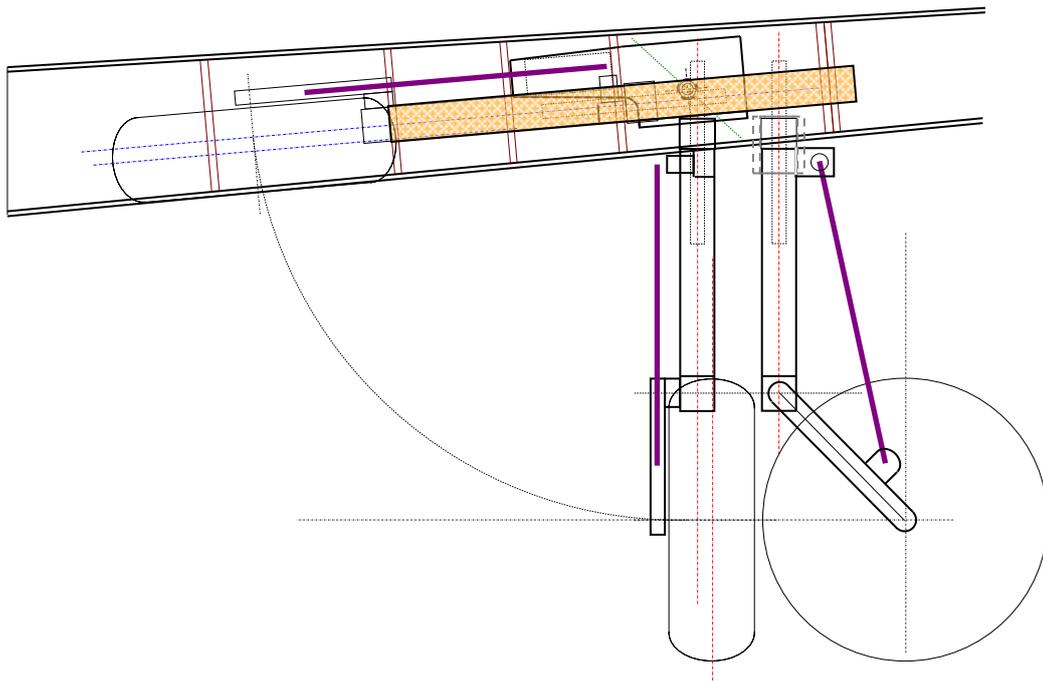
The above rigs also provided useful information on the clearances required for the retract units and the legs, trailing links and suspension units prior to cutting the ribs.

This requires more research watch this space.

Update to retract installation

Following the testing described previously the setup shown below was judged to be the best option to date to install model retracts to suit the full-size wheel position. An opportunity to inspect the u/c on a full-size Falco may help to resolve this issue and I'll be keeping my eyes open for one.

The trailing link is shown with a small offset to help raise the wheel into the wing. The main legs will be machined from dural. Front and side views of the main legs are shown. The purple line is the location of the spring and damper assembly which will either be a modified model car one or made from scratch.



The above drawing looks like a CAD drawing but is, in fact, drawn using only the draw package in Microsoft Word. This provides lines, rectangles, curves and other basic shapes from a library and allows the very useful facility to “group” these, allowing the group to be moved around, rotated and scaled as a single component.

For those so inclined, it is possible to buy a very competent CAD package, for example Turbocad, online for about £25 from Amazon if you're happy to make do with not the very latest version.

6. Wing control surface mechanisms

I always try to assess the wing control mechanisms e.g. ailerons, flaps, servos and linkages, for factors such as cost, weight, size, battery consumption, aerodynamic loads, friction, slop, linkage geometry and any special servo characteristics.

The wing is one-piece and the plans show a 'traditional' installation with one aileron servo using pushrods and bellcranks and one flap servo using torque tubes. How does this compare to 'modern' installations with one servo per control surface and with very short pushrods ?

Traditional type

Only one servo per function but relatively high peak torque may be required. Located in wing centre section where section thickness is useful. Aileron aerodynamic forces are balanced at the neutral position so average current is lower. Linkages and bellcranks have many pivots with potential for either friction or slop.

Multi-servo type (one per surface)

More servos required, but they may be lower torque ones. Servos are becoming cheaper, lighter and smaller which assists installation in the outer wing. Aileron neutral aerodynamic forces are not balanced so average servo current is higher. Short, direct, and fewer, linkages increase stiffness and reduce slop..

I decided to go for the multi-servo type of installation with additional features. For flaps, Hitec programmable servos provide adjustable range and speed and offer high torque in a standard sized servo package. Setting the servo range to near 180° rather than the more usual $90\text{-}120^\circ$ ensures the servo arm/pushrod linkage can "lock out" in a straight line at both extremes of movement (see fig below). Programmable slow movement (say 3-5 sec) is much more scale-like.

Servo torque

Servo choice reflects the torque required. At 30 mph (say) the extended flap torque will be around 4-5 kg.cm. Aileron and flap aerodynamic torques in high 'g' manoeuvres depend on speed but will be in the range 2-7 kg.cm. Something more than standard servos (approx. 4 kg.cm) are needed so higher torque units (12-15 kg.cm) must be used. Setting the geometry as shown below ensures peak servo torque may be less than peak flap torque.

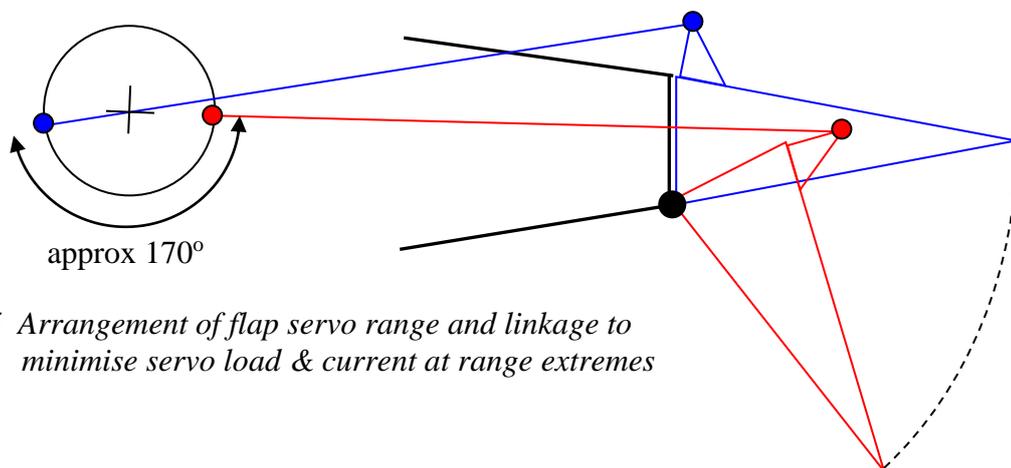


Fig. 5 Arrangement of flap servo range and linkage to minimise servo load & current at range extremes

As with the retracts, I like to test ideas before committing to using them in a real model (saves much grief). I have used this type of flap linkage (fig.5) in other models where a 4x scale (i.e. larger) model of the linkage, made using lengths of balsa and self tappers, confirmed that the geometry of the linkage throughout the range was ok.

For one of these other models I also constructed a 12" section of wing, as shown below, in order to test and confirm the flap servo loads. The plates on the ends simulate the remainder of the wing by helping prevent any flow around the ends. The foreground platform is for a mini digital scales and a long lever is attached to the flap pivot dowel..



The idea was to hang this out of the window of a car (as a passenger I should add !) and measure the flap forces by viewing the force of the lever on the scales at various flap angles. As it happened, using the passageway between my house and the next as a wind-tunnel I was able to confirm my calculations were ok so the car was not needed.

Any simple test like that above that verify any calculations I tend to refer to as a "sanity check". That was until I mentioned to Gordon that I was going to arrange one.

"About b****y time too", came the reply.

7. The cowl

Along with the canopy this, also, is a major component of the aircraft with a large influence on its appearance. For plans such as these there is no specific professional manufacturer of such components. Everything has to be made from scratch and it is often the case that an individual modeller will make a unit for his own use and also make a few more at the same time to sell to help cover costs. Supply of these is, obviously, sporadic.

An email to Jerry Bates established that there were some cowls available. The UK importer of Jerry Bates Plans is now Phil Clark of Fighter Aces⁽⁶⁾ and another email (wonderful things) confirmed that one could be acquired within a week or so. Being aware of the uncertain supply situation, I quickly ordered one, which duly arrived.

In view of the size of the cowl and the fact that it had to be imported, the cost was very reasonable and compared very favourably with the alternative i.e. starting from scratch to make a dummy, then making a female mould and then laying up one or more cowls (depending on how successful each one was).



The above pictures do not do justice to the size of the cowl. It is approximately 10" wide, 10" long and 8½" deep. Just for fun I measured the volume : 1¾ gallons !

I can now sit and admire the cowl and imagine the remainder of the model attached. The build has officially started !

8. The colour scheme

The range of colour schemes for the Falco is truly inspiring. From Ferrari Red (of course) through blues, whites and very nice yellows you really are spoilt for choice. Fortunately, choice can wait until later but the decision will not be easy ...

That's about enough for starters. Time to chew over the potential problems before I find any more.

Links

1. Jerry Bates Plans
102 Glenwood Street
Mobile, AL 36606
US
Tel. 251-478-6720
web: www.jbplans.com
"Jerry Bates" jerrybates@comcast.net
2. Build and videos of Falco i-aldi
www.aldini.it/index2.htm
3. <http://www.seqair.com/Videos/index.html>
4. Profili
www.profilo2.com
5. Belair
www.belairkits.com
6. "Phil Clark" phil.fighteraces@virgin.net