Falco Builders Letter

Well Drilling and Falcos

Larry Weldon, the old well man checking in.

It has been quite an exciting year, drilling water wells and flying the Falco 811LW. I want to pass a little information to anyone owning property that may have good quality ground water. It could be worth quite a bit of money.

I will tell you a little story about a well I drilled this year. I was hired by a water system called Loachapoka Water near Auburn, Alabama to try to locate a water well that would pump 200 GPM continuous. I hired a geologist, a graduate from the University of Alabama who specializes in ground water.

He used satellite photos and infrared to read ground water temperature. We located a site just south of Auburn and contacted the land owner to ask if he was interested in drilling test wells and selling water, and

he was. I will make a long story short. We drilled three test wells, and on the third, we drilled into a limestone fracture that produced 3000 GPM continuous.

The guy who owned the property will receive about a half million dollars per year. If you own property, it may be worth more than you know. So much for well drilling.

What I really want to tell you about is the Falco. It has been 14 months since the first flight. It took about five months to work out all the little bugs. The communication antenna in the tail did not work very well, so I made a bracket and a short antenna about two-feet long, fastened it underneath the aft gas tank pointing aft. It works very well. The S-Tec 30 autopilot was the most time-consuming, but finally works perfect.

Brett Currenton, the test pilot and flight instructor flew with me until I was comfortable with the Falco, which took about 20 hours.

I had been flying a 172 Cessna, it was quite a change.

I struggled with the landing on the first few days, but finally learned, turn final at 90 knots, pick out a place on the runway, cross the fence, about 75 knots, leave in a little

power and don't over-correct and it lands very smooth.

Sometimes it's hard to get away from the airport. People want to look at it and talk about how it is built. One guy there who never talks very much, came over to the Falco and said, "I know you probably hear this all the time, that is one good looking airplane" and walked away without another comment.

I recently did an annual, and while the Fal-co had all its covers off I had a few builders to look at the construction and the plans. They all talk about how well it is built and how good it looks.

Every time I take off, I get a rush of excitement. It is a great, fun airplane to fly.

Recently I landed at Tallassee, Alabama. I announced my arrival, "Tallassee Traffic Falco 811LW, left down wind for runway 31 Tallassee."

I get a call back, "Falco man, I am enroute to Florida, would like to look at your Falco."

After landing, looking it over and talking for a while, he said "I have seen a few Falcos, and they always seem to have more quality than other homebuilts."

I said to him, "Even an old well driller can build a good looking Falco with Sequoia Aircraft and their plans."

Shop Class as Soulcraft

Matthew Crawford is a motorcycle mechanic. He runs a bike shop called Shockoe Moto, in, of all places, Alfred Scott's Richmond. Crawford also has a philosophy degree from the prestigious University of Chicago, and he is an interesting writer. That unusual combination has produced his new book Shop Class as Soulcraft: an Inquiry Into the Value of Work, and it is something that every Falco builder will appreciate. Disregard the slightly woo-woo title; this is no Zen and the Art of the Motorcycle, which was a prissy piece of pretentious, barely readable buehlchit, as Gordon Baxter would have put it. (I remember one reviewer calling my book The Gold-Plated Porsche "better than Zen and the Art... which I thought damnably faint praise.)

Crawford's book is a querelous examination of how and why we have given up any interest in the skills of the craftsman or even the simple integrity of the committed do-it-yourselfer and instead have become a culture of "change 'er out, not worth troubleshootin' it" techs. We've all come to believe the mantra that Time is Money...which means some of our Falcos are worth more than a used 737, if you multiply hours times the going hourly day-job rate of many of our builders.

My daughter Brook, a brand-new San Francisco homeowner, asked me whether to buy an extended warranty on her new washer and dryer. Quite aside from the super-scam aspect of extended warranties, I explained to her that such appliances are in fact incredibly simple machines that can be gutted by the removal of a few sheetmetal screws that typically expose a motor, belt and drum or a motor, pump and hoses. Internet how-to sites plus the substantial toolkit I had assembled for her Manhattan-apartment days would suffice.

I think Crawford would agree, and more to the point would agree that the mini-education thus attained would stand Brook in good stead forever. I'm old enough—73--that I indeed "took shop," and to this day I remember the specific differences between a crosscut and rip saw, which I think was Lesson One. But some time around 1990, educators decided that we'd moved into the Information Age: if you were retarded enough to need shop class, you could always go to the local BOCES and become a butt-crack plumber. Otherwise, the future was computers, and high schools across the land dumped their industrial-quality lathes, bandsaws and welding rigs onto the used market. You can today find them all over eBay.

That resulted in a vast sea of cubicle dilberts—people doing things that they neither cared about nor understood, but they were provided with the patterns to follow to
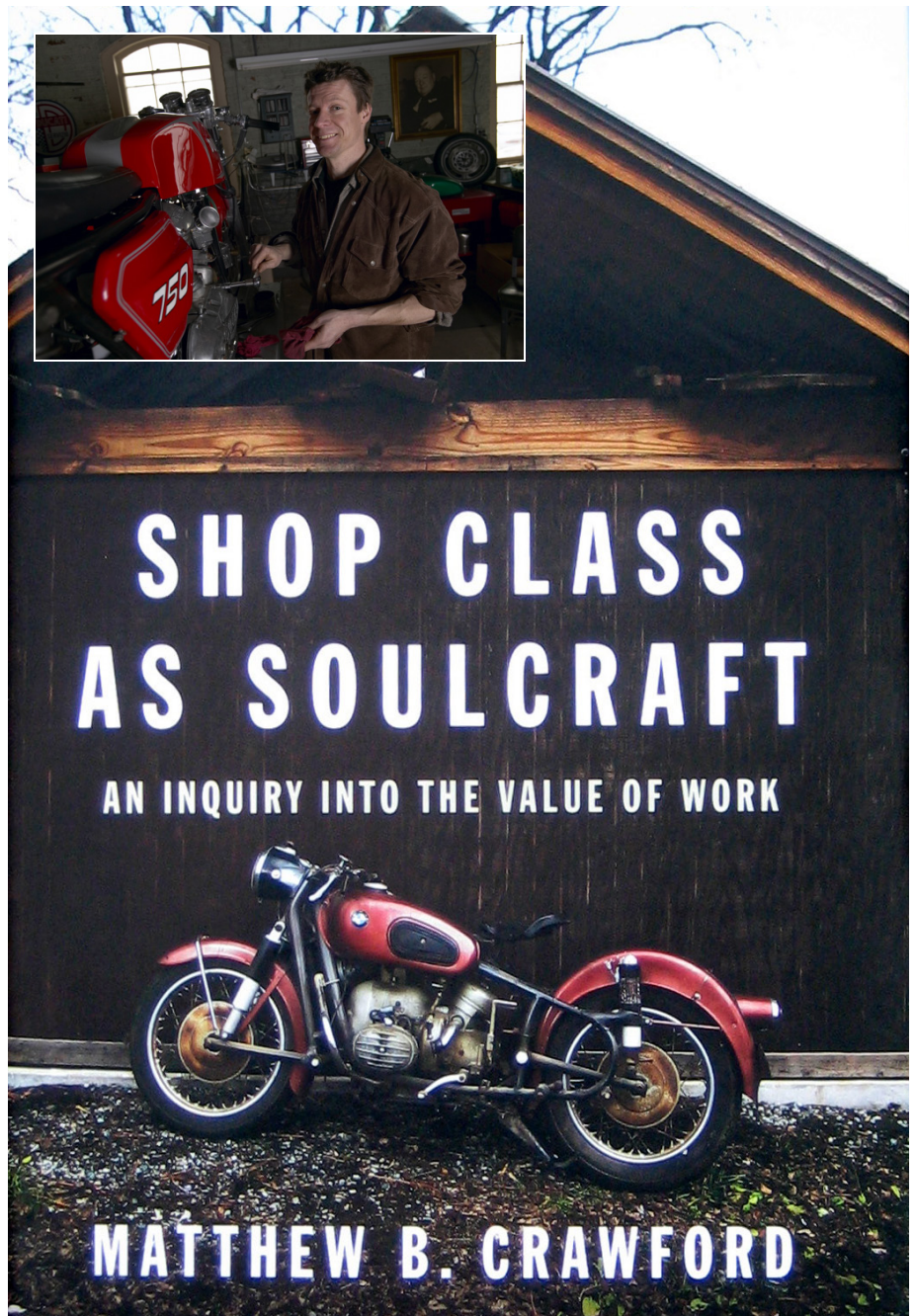
accomplish their jobs. (Actually, this started a long time ago. The popular myth is that Henry Ford paid his workers twice as much as they'd otherwise have earned in order to make them affluent enough to buy Model Ts. The truth is that when Ford perfected the assembly line—each worker turning one bolt or fastening one bracket all day long—these former bicycle and carriage craftsmen quit in droves, and the only way Ford could find mindless workers was to overpay them. Their accession to Model T ownership was an unintended consequence.)

Take your new Porsche to the dealer with an infuriating cold-start problem. In 1969, it would have been solved by a mechanic who perhaps grew up in Stuttgart making a camshaft from a steel billet with a hand file to satisfy his apprenticeship.

Forty years later, you'll be in the hands of a technician who reads out the computerized OBD (on-board diagnostics) fault code that he or she then finds on a list. As Crawford points out, that tech is like the Information Age student who has learned how to do a square root on their calculator but was never taught what a square root means. A single botched keystroke can turn the root of 36 into 18 rather than six, but they won't have the knowledge or experience to say, "No, that can't be right." Nor will the Porsche tech tumble to the fact that if the sparkplugs are carbon black, the engine is running rich even if the fault cold insists on lean.

Read Crawford's book. Skip some of the heady philosophy—I did—and you will still be reassured that building a Falco imparts treasure beyond measure.—*Steve Wilkinson*

The Glider
Part 27 of a Series

by Dr. Ing. Stelio Frati
translated by Giovanni Nustrini

58. Verification of the shear strength of the wing spar.
Having verified the bending strength of the spar, we now have to calculate the shear loads, which are supported by the plywood webs that connect the spar caps. We remember that if there is a shear load t in a certain direction, there always is an equal t in the perpendicular direction to the first, thus in the spar webs, we will have both a vertical and a horizontal stress as a result of the caps trying to slide relative to each other.
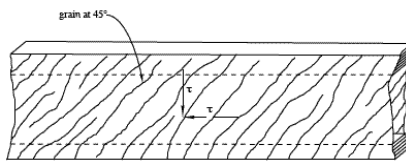

Figure 9-34

The plywood, therefore, should be installed with the grain direction at 45° to the spar axis so that it can support both the vertical and horizontal t loads, and it shall never be installed with the grain running lengthwise, as it would do little to resist the shear loads.

The maximum shear load t is given by:

$$t = \frac{1.5 \cdot T}{d \cdot h}$$

where:

T = shear load in the section (kg);
δ = web total thickness (cm);
h = web height (cm).

From the formula, having fixed the maximum admissible shear stress τ value, we obtain the required δ thickness:

$$d = \frac{1.5 \cdot T}{t \cdot h}$$

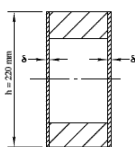For birch plywood, we can use a shear load τ of 120 kg/cm² as an average value.

Figure 9-35

Example. Let's determine the thickness of the two plywood webs for a wing where we would have:

Flight simulator X-Plane now has a Sequoia Falco. Shown here is the Falco over Innsbruck, Austria

T = 700 kg.
τ = 120 kg/cm² (plywood at 45°)
h = 0.398 cm.

the total thickness is:

$$d = \frac{1.5 \cdot 700}{120 \cdot 22} = \frac{1050}{2640} = 0.398 cm$$

thus the thickness of each of the two plywood webs is 2 mm.

The permited loads of the plywood used for the spar webs increases if there are stiffening blocks that prevent buckling: in such case, the stress may vary from:

$$\tau = 120 \text{ kg/cm}^2 \text{ up to } \tau = 180 \text{ kg/cm}^2$$

with fibers at 45° angle and for a distance d between the stiffeners from:

$$d = 3\,V \text{ up to } d = 1.5\,V$$
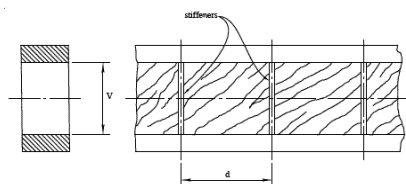
where V is the free distance between the spar caps.

Figure 9-36

59. Verification of the torsional strength of the wing structure
In gliders, the wing structure that resists torsion is made up by the section formed by the leading edge skin and closed at the back by the spar web.
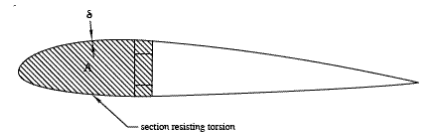
Figure 9-37

This structure is calculated with the Bredt formula regarding torsion stress of solids with a thin wall hollow section. It is given as:

$$t = \frac{M_t}{2 \cdot A \cdot d}$$

where:

M_t = applied torque
A = area enclosed in the section
δ = section walls thickness

For birch plywood, the shear strength may be used as

$$\tau = 120 \text{ kg/cm}^2$$

Since the torsion in a wing tends to twist it negatively, it would be appropriate to always place the plywood at a 45° angle, in the direction shown, and this is what is done in many cases. However, installing plywood at a 45° angle on curved surfaces involves greater construction difficulties; therefore, one often prefers to place it with the grain in the wing span direction.

Figure 9-38

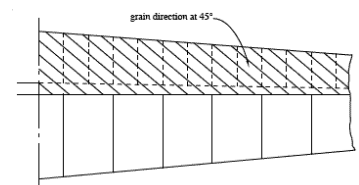In this case, though, we must use a shear load of about 85% of that with fibers at 45°, that is:

$$\tau = 100\ kg/cm^2$$

We must remember that these values for plywood shear loads are influenced by the stiffening for preventing buckling. It is for this reason that on the leading edge, the wing ribs are closer together than those aft of the spar. Their purpose is, in fact, to prevent an elastic yielding of the plywood, which would consequently no longer resist the torsion loads.

Example. Let us determine the thickness of the plywood skin in a given wing section where:

M_t = 220 kgm = 22000 kgcm
A = 6 dm^2 = 600 cm^2

and the permitted shear loads, by placing the plywood at a 45° angle, is:

$$\tau = 120\ kg/cm^2.$$

With the Brendt formula, we obtain the thickness

$$d = \frac{M_t}{2At} = \frac{22000}{2\cdot 600\cdot 120} = \frac{22000}{14400} = 0.153 cm = 1.53 mm$$

Because plywood sheets on the market are generally available in thickness increments of 0.5mm, we could adopt a thickness of 1.5mm (though that is a little short) or 2mm. Instead, if the plywood is not at a 45° angle, we would have use the permitted stress of:

$$\tau = 100\ kg/cm^2$$

and the thickness will be:

$$d = \frac{22000}{2\cdot 600\cdot 100} = \frac{22000}{120000} = 0.183 cm = 1.83 mm$$

and we would use 2mm thick plywood.

Torsional stiffness. With regard to torsion, in addition to the verification of the plywood thicknesses that resist such stresses, we must also verify the torsional stiffness of the structure. Certification regulations, in fact, require that the maximum torsional distortion—or twisting—at the wing tip, stressed by the elastic torsion coefficient (1.25 n), must not exceed 4°. In very long wings, such as those of gliders, this condition is often more limiting than that for the actual torsional strength. The $d\phi$ torsional angle of a wing element that is dx long, is given (in radians) by the relation:

$$df = \frac{M_t\cdot P}{4A^2\cdot d\cdot G}\cdot dx$$

where:

M_t = applied torsion
A = area enclosed in the section
G = tangential elasticity modulus of the covering material
δ = covering thickness
P = section perimeter

The total torsion ϕ angle at the wing tip is equal to the sum of the elementary angles $d\phi$, in other words, it is the integral of the expression of $d\phi$, extended to the entire half wing span. Therefore, we shall obtain the values of elementary $d\phi$ angles in radians, for various wing sections (those already being considered for determining the various shear stresses, torsion and bending), and we shall report them in a

diagram. We then calculate the area of this diagram by means of graphic integration, or simply by measuring it with a planimeter or graph paper.

Once the diagram area is known, we obtain the value of angle ϕ, which represents the actual area, by multiplying said area by the scale of abscissas and by that of ordinates of the diagram itself. The angle will be obtained in radians; its value, multiplied by 57.3 (angle of a radian in sexagesimal degrees) will give us the ϕ angle sought in degrees.

Example. Let's calculate the maximum torsion angle of a wing being stressed by the elastic limit torsion (1.25 n), supposing that the distribution of the moment is that of the example in Figure 9-24 because the diagram values are those for strength (2 n), it will suffice to multiply them by the ratio 1.25/2, that is 0.625, to obtain those with the elastic coefficient.

Let us suppose then that we have obtained the area enclosed by the section and the perimeter of the latter, including the rear side of the spar, from the wing rib drawing, in the sections being considered for the moment. Assuming that we have already performed the torsion strength calculation and determined the δ thicknesses of the covering plywood, we can calculate the elementary angles $d\phi$, as we have all the required elements. The tangential elasticity modulus G for plywood is:

$$G = 40,000\ kg/cm^2.$$

Let us carry out the calculation for section 1, whose values are:

M_t = 151 kgm = 15100 kgcm
A = 925 cm^2 = area enclosed in the section
A^2 = 855000 cm^2
P = 130 cm = section perimeter
δ = 0.20 cm = plywood thickness

which, replaced by the formula

$$df = \frac{M_t\cdot P}{4A^2\cdot d\cdot G}$$

gives us:

$$df = \frac{15100\cdot 130}{4\cdot 855000\cdot 0.2\cdot 40000} = \frac{1970000}{27300000000} = 0.0000725$$

By repeating the operation for the other sections, we shall have the values contained in the table.

Wing rib	M_t (kgcm)	A (cm²)	P (cm)	δ (cm)	$d\phi$ (radians)
1	15100	925	130	0.20	0.0000725
2	12400	870	128	0.20	0.0000658
3	9900	765	121	0.20	0.0000640
4	7650	670	114	0.20	0.0000602
5	6000	580	107	0.20	0.0000600
5	6000	580	107	0.15	0.0000800
6	4600	495	100	0.15	0.0000780
7	3150	400	92	0.15	0.0000755
8	1820	315	81	0.15	0.0000654
9	1150	240	71	0.15	0.0000590
10	550	175	60	0.15	0.0000450

Note that in wing station 5, where we have a change in plywood thickness, there are two values corresponding to $d\phi$ which are then shown as a sharp change in the diagram. This diagram is built by entering the wing span, in a 1:50 scale, on the horizontal axis, that is

$$1 \text{ cm} = 50 \text{ cm}$$

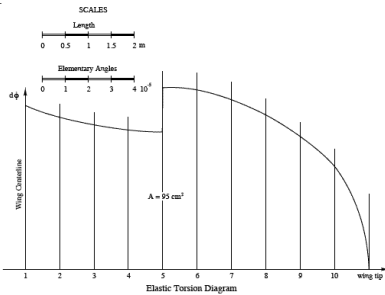and the elementary angle $d\phi$ on the vertical axis, still in scale

Figure 9-39

The diagram area is, therefore 95 cm², which multiplied by the horizontal and vertical axis scales, gives us the total torsion angle ϕ in radians:

$$f = 95 \cdot 0.00001 \cdot 50 = 0.0475$$

and, finally, in sexagesimal degrees, we have:

$$f° = 0.0475 \cdot 57.3 = 2.7° = 2°42'$$

which is lower than the limit required by certification standards, and therefore the plywood thickness of the leading edge skin, established for torsion strength with the Brendt formula, is final.

60. Determination of the fuselage structural loads

The fuselage of common gliders, and generally all aircraft, is a tapered shaped body with the double purpose of containing the crew and the load, and to rigidly connect the wing, or wings with the tail surfaces required for longitudinal and directional stability.

The wing aerodynamic torsion—or pitching moment—must be balanced by an opposite moment by the horizontal tail surface. These moments that are relative to a fixed point, for example the wing leading edge or the aircraft center of gravity.

On the horizontal tail surface, therefore, the negative lift P_c is multiplied by the distance of its center of pressure from the wing leading edge, or from the center of gravity, produces the tail stabilizing mo-

Bjørn Brekke is making good progress in Bødo, Norway.

ment. Therefore, the fuselage is subject to a bending load in the vertical plane.
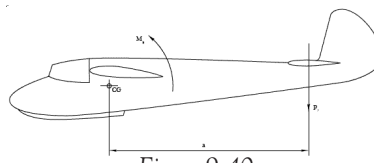

Figure 9-40

It may be thought of as a beam fixed with its wing attachments and stressed by a bending moment that varies in a linear manner from a zero value corresponding to the pressure centre of the horizontal plane to a maximum value corresponding to the fixed length being considered.
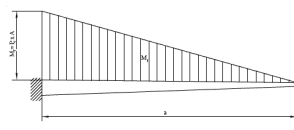

Figure 9-41

Because of the loads in the vertical plane, we also have a bending load on the fuselage in the horizontal plane. Furthermore, because the load on the vertical tail plane is almost never on the fuselage axis, but it is on top of it, a moment is produced that tends to twist the fuselage.
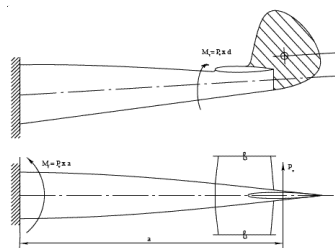

Figure 9-42

This bending moment, produced by the P_v force by the distance of its application point from the fuselage axis, is constant for all the fuselage sections, from the vertical plane to the wing attachment points on the fuselage.

These bending stresses, in the vertical and horizontal planes, and the torsion on the tail planes, are generated from the inertia of the aircraft mass and the air flowing over it, which oppose the rotation of the aircraft from the aerodynamic forces on the tail surfaces. Therefore, we must also consider the stresses that come from the inertial forces.

For example, in the forward part of a normal glider's fuselage, we will have that the loads of the pilot, equipment installations, instruments, etc., as well as the weight of the airframe itself. This part of the fuselage may be considered as a bracket that is fixed in relation to the wing attachment to the fuselage and stressed by vertical loads pushing downward.

In a steady horizontal flight condition, the loads are the actual weights; while in a sudden pull-up at maximum speed, the loads are represented by the centrifugal reactions of the weight of the fuselage and the weights of the pilot and equipment. A similar thing occurs in the aft section of the fuselage with mass reactions, in addition to the aerodynamic loads on the tail surfaces.

Hypothesis of load on the fuselage. By following, as we did for the wing, the certification standards, let's examine the various load conditions for the fuselage.

Same town as Bjørn Eriksen and using same sequence of building the fuselage first.

The flight conditions established are: a) a sudden pull-up after a nose dive, to which the bending stress in the vertical plane corresponds and b) a load on the vertical tail, determined by the rudder maneuvering during flight. This condition results in bending stresses in the horizontal plane and in torsion.

Condition a).
The loads we need to determine are: 1) the initial limit load that is acting on the horizontal tail surfaces (stabilizer-elevator assembly), and 2) the centrifugal reactions from the mass of the fuselage and the loads contained in it.

The aerodynamic load P_c on the horizontal surface balances the wing maximum pitching moment, which we have seen as being:

$$M_t = 0.20 \cdot 2n \cdot Q l_m$$

therefore, since a is the distance from the elevator hinge to the aircraft center of gravity, the load P_c will be:

$$P_c = \frac{0.20 \cdot 2_n \cdot Q \cdot l_m}{a}$$

In any case, the load P_c on the horizontal plane shall not be less than:

Kg. 80   per m² for gliders
Kg. 120 per m² for normal sailplanes
Kg. 150 per m² for acrobatic planes.

The centrifugal loads in the fuselage are determined by multiplying the weight of the fuselage and that of the individual loads that are contained in it by the safety factor $2n$ that we previously defined.

In this load condition for the fuselage, the bending stresses in the vertical plane, from the aerodynamic load and centrifugal forces, are not contemporaneous. In fact, at the beginning of pull-up, we have the maximum load on the horizontal tail surface, which is the one determining the pull-up. Once the maneuver has begun, centrifugal reactions are generated, but the aerodynamic load on the actual tail surfaces diminishes until, when maximum acceleration is reached and therefore the centrifugal reaction maximum value, the aerodynamic load on the horizontal tail plane is reduced.

So, with regard to the bending in the vertical plane, the fuselage is designed for the greater of the loads created by bending moments from the aerodynamic load on the horizontal tail plane and the centrifugal reactions of masses. This applies, of course, for the aft section of the fuselage. For the part in front of the wing, the stresses result only from the centrifugal forces.

In this condition *a)* that we have just examined for the fuselage, both the loads on the horizontal plane and the mass reactions are directed from the top to the bottom.

Example. **Stresses on the vertical plane from the load on the horizontal tail plane.** Let's consider the aircraft of the example in Figure 7-3 where we have partial loads in the fuselage, and let's calculate the maximum bending moment in the fuselage vertical plane. We start by calculating the shear loads and the moment due to the aerodynamic load P_c on the horizontal tail plane. Supposing that the wing average chord is:

$$l_m = 1.10 \text{ m}$$

and the aircraft total weight is

$$Q = 250 \text{ kg}$$

the wing bending moment is:

$$M_t = 0.20 \cdot 2n \cdot Q \cdot l_m = 0.20 \cdot 7 \cdot 250 \cdot 1.1 = 385 kgm$$

that must be balanced by the tail moment

$$P_c \cdot a = M_t$$

in which the distance of the aircraft center of gravity from the elevator hinge is:

$$a = 3 \text{ m}$$

from which the load on the plane is:

$$P_c = \frac{M_t}{a} = \frac{385}{3} = 128 kg$$

Now we need to verify if this load is greater or smaller than the minimum load resulting from the load required by certification standards. Supposing that the plane surface is

$$S_c = 2.10 \text{ m}^2$$

because the minimum load required by the standards is 120 kg/m² (for normal category), the minimum load must therefore be:

$$P_c = 120 \cdot S_c = 120 \cdot 2.10 = 252 kg$$

which is definitely greater than that strength required to balance the wing pitching moment and, therefore, it is this that we must consider.

Figure 9-43
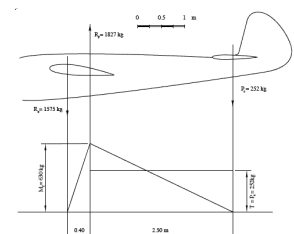
Such load P_c generates a bending moment on the fuselage with a triangular trend in which the maximum value is corresponds with the aft wing attachment point. The distance from the horizontal tail hinge to the aft wing attachment section is 2.50m and the bending maximum moment is, therefore:

$$M_t = P_c \cdot 2.50 = 252 \cdot 2.50 = 630 kgm$$

The torsion, however, is constant and its

value is, in fact, that of the load on the plane:

$$T = P_c = 252kg$$

The bending moment decreases to 0 at the forward attachment of the wing with the fuselage, which is 0.40m from the aft one, as we can see in the figure. Therefore, we can calculate also the stresses on these attachment points. In facts, the relation R_a on the forward attachment point must be such that its moment, in relation to the center of the rear connection coincides with that given by the load on the plane, which is:

$$R_a \cdot 0.40 = 630$$

from which we have

$$R_a = \frac{630}{0.40} = 1575kg$$

and it is directed to the bottom, which is to say in the same direction as load P_c.

The reaction on the aft wing attachment R_p, therefore, will be the result of P_c and R_a:

$$R_p = 252 + 1575 = 1827 \text{ kg}$$

because for the balance of forces, the result of P_c, R_a and R_p must be null, which means that R_p must be equal and opposite of P_c + R_a. Furthermore, their moment must also be null, compared to any point.

If, for simplicity, we choose a point in the center of the aft wing attachment, the tail moment must be equal to that of R_a (because that of R_p is null, as its arm is null), which means:

$$P_c \cdot 2.50 = R_a \cdot 0.40$$

that is the relation from which we obtained R_a.

Stresses in the vertical plane due to the centrifugal reactions of masses. Let's now calculate which are the shear stresses and the moment in the fuselage vertical plane, due to the masses reactions by the effect of a pull-up.

The maximum moment for the fuselage rear part in the section, already considered, of the aft wing attachment will be given by the addition of the partial moments of the various loads and the partial weights of the fuselage actual structure. In a similar way, we find the maximum moment, relative to the section corresponding to the forward wing attachment, for the forward part of the fuselage.

In Brazil, Juliano Napolle is building two Falcos with a friend.

So, we transcribe a table the values of the individual weights, the distances from the aft attachment sections for the weights of the aft end, and from the forward attachment for the forward end of the fuselage. The products of these weights for the corresponding distances give us the partial moments with a coefficient 1 (see Figure 7-3).

N	Name	Weights (kg)	Distances (m)	Moments (kgm)
12	Vertical plane	4.0	2.86	11.40
11	Horizontal plane	7.0	2.35	16.45
10	Fuselage ends	4.0	2.40	9.60
9	Fuselage rear part	5.0	1.54	7.70
8	Fuselage rear part	7.0	0.62	4.34
	Fuselage rear part:	Total shear 27.0	Total moment	49,49
	Fuselage bow:			
1	Dash board	6.0	1.24	7.45
2	Pilot cabin	5.0	1.00	5.00
3	Skid	19.0	0.64	12.20
4	Pilot	5.0	0.61	3.05
5		80.0	0.58	46.50
	Fuselage bow part:			
		Total shear 115.0	Total moment	74.30

Therefore, the maximum bending moment in the aft part:

$$M_f = 49.49 \cdot 7 = 346kgm$$

and in the shear:

$$T = 27 \cdot 7 = 189kg$$

which, as we can see, is quite smaller than for the corresponding values deriving from load P_c.

For the front part we have:

$$M_f = 74.30 \cdot 7 = 520kgm$$

$$T = 115 \cdot 7 = 805kg$$

Based on these calculation results, we will verify the fuselage structure, in particular, for the aft part, we will keep into account the stresses deriving from the aerodynamic load P_c on the horizontal plane, while for

the forward part, the loads are only those resulting from the centrifugal mass reactions.

Condition b)
In this load condition for the fuselage, we have bending in the horizontal plane and torsion due to the aerodynamic load on the vertical tail surfaces. This load for strength is, for gliders:

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

where:

Q/S is the wing load.

Such load shall not be lower that the value of:

Kg. 80 per m² for gliders
Kg. 120 per m² for normal sailplanes
Kg. 150 per m² for acrobatic planes.

Example. Let us determine the bending stresses in the horizontal plane and torsion for the aft part of the wing of the fuselage, supposing that:

Q/S = wing load = 18 kg/m²;
S_v = vertical plane area = 1.2 m²
d = distance of tail plane centroid from the fuselage axis = 0.35 cm;
D = distance from the attachment of the fuselage to the vertical plane CG = 3 m.

The aerodynamic unitary load P_v on the vertical tail plane is:

$$P_v = 2n \cdot \frac{Q}{S} = 7 \cdot 18 = 126kg$$

which is greater than the minimum re-

quired for normal category aircraft (120 kg/cm²).

The total load on the tail plane is, therefore:

$$P_v = 126 \cdot 1.2 = 150 kg$$

which is then the shear value, constant for the entire part of fuselage being considered.

The bending moment in the fuselage attachment section is:

$$M_f = P_v \cdot D = 150 \cdot 3 = 450 kgm$$

which has a triangular trend.

The rudder torque is:

$$M_t = P_v \cdot d = 150 \cdot 0.35 = 45 kgm$$

and it is constant for the entire length of the fuselage up to the wing attachments.

60. Verification of fuselage stability

With a procedure similar to that used for the wing, we first examined the various load conditions of the fuselage, and then we determined the stresses generated in this hypotheses. This how we arrived to the step regarding dimensioning and the stability verification of the fuselage structure. Of the various hypotheses we did not consider that concerning landing, which for gliders is generally less serious.

To summarize, we have said that the fuselage is stressed: by bending in the vertical plane, deriving from the aerodynamic load on the horizontal tail plane and from the centrifugal reactions of mass; by bending in the horizontal plane and by torsion deriving from the aerodynamic load on the vertical tail plane. The fuselage forward section containing the pilot's cockpit is stressed in bending in the vertical plane by mass reactions and it must be dimensioned for this load.

Simple polygonal fuselage. As our first instance, let us suppose that the fuselage is formed simply by four longitudinal stringers, connected by braces and covered with plywood on the four sides.
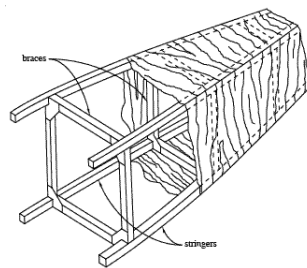

Figure 9-44

For stresses in the vertical plane, we can consider the two vertical sides, each made up by the upper and lower stringer: (Figure 9-45-a), while for stresses on the horizontal plane, we will consider the horizontal sides, made up by the two upper stringers in one case, and the two lower ones in the other (Figure 9-45-b).
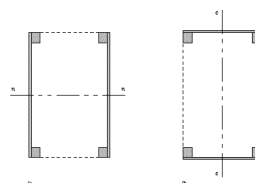

Figure 9-45

The calculation, therefore, is reduced to that of one beam formed by the two caps connected by a web, as we saw for the wing spar. Thus, the stresses due to the bending moment will be supported by the two stringers, while the shear stress will be supported by the plywood webs.

Example. In the wing connecting section of a fuselage having a rectangular section, we have a bending moment of:

$$M_f = 750 \text{ kgm}$$

and shear load of:

$$T = 270 \text{ kg}$$

in the vertical plane, and:

$$M_f = 480 \text{ kgm}$$
$$T = 160 \text{ kg}$$

in the horizontal plane, and a torsion load of:

$$M_t = 65 \text{ kgm.}$$

The section dimensions are:

H = height = 80 cm
L = width = 48 cm
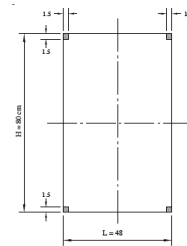
Figure 9-46

Let us suppose that the stringers are made of spruce and having a 15 x 15mm square section, and that the side skins are made of birch plywood, 1.5 mm thick. Let's verify now the section for shear loads and bending moment in the vertical plane. As we said earlier, we are considering the two vertical sides, which shall, therefore, support half the moment and shear, in other words:

$$\frac{1}{2} M_f = 375 kgm$$

$$\frac{1}{2} T = 135 kg$$

From the already known relation:

$$s = \frac{6 \cdot M_f \cdot H}{B(H^3 - V^3)}$$

where in our case we have:

$H = 80$ cm
$B = 1.5$ cm
$M_f = 375$ kgm $= 37500$ kgcm
$V = 80 - 3 = 77$ cm

we obtain the bending load on the stringers:

$$s = \frac{6 \cdot 37500 \cdot 80}{1.5 \left(80^3 - 77^3\right)} = \frac{18000000}{1.5 (512000 - 456533)}$$

$$s = \frac{18000000}{1.5 \cdot 55467} = \frac{18000}{87} = 207 kg/cm^2$$

Given the relatively low value of the load, we could reduce the stringers size taking it, for example, to 12 x 12 mm.

The new values would be:

$V = 80 - 2.4 = 77.6$ cm
$B = 1.2$ cm

and the load would be:

$$s = \frac{18000000}{1.2 (512000 = 467288)} = \frac{18000}{1.2 \cdot 44712} = \frac{1800}{53.6} = 335 kg/cm^2$$

The σ stress could be increased more, but it is not convenient to further reduce the stringer size for several construction-related reasons, and also in consideration of any accidental local loads.

The torsion load τ is given by the relation:

$$t = \frac{1.5T}{H \cdot d}$$

where:

T = shearing stress $= 135$ kg
H = web height $= 80$ cm
δ = web thickness $= 1.5$ mm

By replacing the values, we have:

$$t = \frac{1.5 \cdot 135}{80 \cdot 0.15} = 16.90 kg/cm^2$$

thus the shear load is quite low.

We can reduce the plywood thickness to 1 mm, so that the torsion load will be:

$$t = \frac{1.5 \cdot 135}{80 \cdot 0.10} = 25.4 kg/cm^2$$

which is still a very low value. We must keep into account that plywood buckling would be very likely with thin plywood and would result in a considerable reduction of the structure stiffness. Therefore, it is a good practice not to adopt a plywood thickness that is too low and less than 1mm (also as they are not easily found on the market) and covering distances not exceeding 30-35 cm, so as to avoid such buckling, which occurs more easily if the panel is flat, rather than curved.

Falco at the Schaffen Diest Old Timers Fly-In in Belgium.

Let us now verify the structure for loads in the horizontal plane, having for each horizontal beam:

$M_f = 240$ kgm
$H = L = 48$ cm
$B = 1.2$ cm

First, we calculated the sides as beams made up by two caps connected by a web in a manner similar to that used for the wing spar.
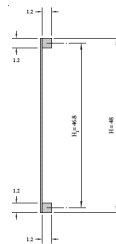

Figure 9-47

In such cases, though, where the caps—stringers—have very small dimensions compared to the H height of the beam, we can proceed with calculation in a much simpler, but not less exact manner, by considering the area of the stringer section as concentrated in its centroid, or center of mass. By dividing the bending moment by the height H, we will obtain the tension or compression loads on the stringers between the stringer centroid, and then, by dividing this value by the area A of the section, we will have the load.

In our case, the height between the section centroids is:

$$H_1 = 46.8 \text{ cm}$$

therefore, the axial stress on the stringers will be

$$S = \frac{M_f}{H_1} = \frac{24000}{46.8} = 513 kg$$

The stress in the stringers is, therefore:

$$s = \frac{S}{A} = \frac{513}{1.44} = 356 kg/cm^2$$

where:

A = stringer section area $= 1.2$ x $1.2 = 1.44$ cm^2

For the shear loads, we have:

$$t = \frac{1.5T}{H \cdot d} = \frac{1.5 \cdot 135}{48 \cdot 0.1} = 42.2 kg/cm^2$$

This value is still low for birch plywood. Finally, we must verify the structure stability for torsional stress. This is done by simply applying the Brendt formula:

$$t = \frac{M_t}{2A \cdot d}$$

where:

M_t = rudder torque $= 65$ kgm $= 6500$ kgcm
A = section area $= 80$ x $48 = 3840$ cm^2
δ = plywood thickness $= 1$ mm $= 0.1$ cm

and the skin shear load will be:

$$t = \frac{6500}{2 \cdot 3840 \cdot 0.1} = \frac{6500}{768} = 8.5 kg/cm^2$$

The F.14 Nibbio had 80% parts compatibility with the Falco, but something was lost.

Here we see how the tangential stress, deriving from torsion, is particularly small, as were the shear loads, both in the vertical and in the horizontal plane.

Nevertheless, we must note that since the shear and the torsion values are constant for the entire aft part of the fuselage, we will have the maximum loads where their traverse dimensions are minimal, that is at the aft end.

Let us suppose that the dimensions in the minimum section are:

$H = 25$ cm
$L = 18$ cm

so that area A is

$$A = 25 \cdot 18 = 450 cm^2$$

In this case, torsion load is:

$$t = \frac{M_t}{2A \cdot d} = \frac{6500}{2 \cdot 450 \cdot 0.1} = 72 kg/cm^2$$

a value that is not excessive, but neither excessively low as in the connecting section.

From what we have seen in the example, we can deduce that we should reduce the thickness of plywood from the end to the connection of the fuselage with the wing. But as the thickness required at the end is generally no greater than 1.5 mm, for these aircraft, the thickness is kept constant.

On the other hand, with regards to the longitudinal stringer dimensions, it might seem convenient to reduce the section as we go toward the rear end of the fuselage, since, as we have seen, the bending moment decreases (Figure 9-43).

But if we consider the dimensions that these stringers will have, we see that the weight savings is meaningless, while the tapering work becomes complicated. The section is, thus kept constant for stringers as well.
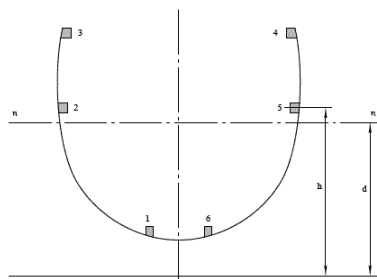

Figure 9-48

Shell fuselage. What we have seen in the example applies to a fuselage of a very simple shape, such as a square one. Nevertheless, even in the instance of more complex polygonal sections, we can still end up considering a simple shape structure, while ignoring other elements during the calculation, as if their task was only that of contributing to the shape. The actual contribution that they will add to the total strength of the structure will be an advantage to safety. Instead, if we want to consider the example of the real contribu-

tion of all the stringers, we can proceed as follows.

Example. Let us verify bending in the section of the fuselage front part, in correspondence with the pilot cockpit, with six stringers having the same section of 12 x 12mm. The bending moment is $M_f = 280$ kgm.

To make things easy, let's enter in the table the stringers distances h from any chosen reference plane, the stringers sections S, and the products S x h of the areas by the distances, which are the *static moments* in relation to the reference. Then, by dividing the sum $\sum$S x h of the areas static moments by the sum of the areas, we can obtain the distance d of the neutral axis from the reference plane. Knowing thus the neutral axis position, we have the distances H of its stringers. We then enter in the table all the H, H^2 and the products S x H^2.

String.	S (cm²)	h (cm)	S x h	H (cm)	H²	S x H²
1	1.5	0.45	0.68	32.15	1030	1545
2	1.5	42.8	64.50	10.20	104	156
3	1.5	55	82.50	22.40	500	750
4	1.5	55	82.50	22.40	500	750
5	1.5	42.8	64.50	10.20	104	156
6	1.5	0.45	0.68	32.15	1030	1545
	$\sum S = 9.0$		$\sum S$ x $h = 294.16$			$\sum S$ x $H^2 = 4902$ cm⁴

$$d = \frac{\sum S \cdot h}{\sum S} = \frac{294.16}{9} = 32.6 cm$$

From the table, we have obtained d and then the products SH^2, which are the *inertia moments* of the stringers sections in relation to the neutral axis. Their sum is, therefore the inertia moment J of the fuselage section in relation to the neutral axis:

$$J = \Sigma SH^2 = 4902 cm^4$$

because the bending load is

$$s = \frac{M_f \cdot y}{J}$$

its maximum value will be in the farthest stringers, which are the 1st and the 6th, and it will be:

$$s = \frac{28000 \cdot 32,15}{4902} = 184 kg/cm^2$$

We could reduce the fillet section, also in consideration of the contribution added by the covering plywood. In fact, in addition to the area that is directly glued to the fillet, and thus working with it, there is also an area around the fillet that collaborates for bending, because it does not suffer from the buckling given by the stiffening caused by the fillet itself. Said collaborating area is considered about 2-3 times the width of the fillet. By repeating the calculations, we could get down to a stringers section of about 10 x 10, still remaining within low stress values.

20th West Coast FlyIn

As the sun broke on September 17th one could not have asked for a better day to start the annual ritual known as the West Coast Falco–Fly-In. This event marked the twentieth gathering, which coincidentally was also the number of attendees. We had six Falco's descend on Longmont, Colorado, which no doubt established a new record for Vance Brand Airport. For once the RV crowd had reason to question if there really is another experimental aircraft out there.

We joined up Thursday night for greetings and margarita's at one of Longmont's fine Mexican restaurants. As luck would have it we were off to great start since it turned out happy hour ran all night……The next morning it was wheels up, or for those less fortunate, wheels hitting the road as we made our way to Scion Aviation, about thirty miles north of town, just outside Loveland, Colorado. This is where the new Furio kit is being assembled for sale in the U.S. It was great to see another Falco inspired design come to life. It has been slow going, as dealing with the FAA is never a speedy process. I believe it was Donald Douglas who stated upon building one of his DC aircraft that before it is all over, the paperwork has to weigh as much as the aircraft! The Scion Aviation facility looked first class, and it will be interesting to see a fly off between both airplanes.

We headed home after our tour, with those wanting Falco rides taking turns flying the different aircraft. Others traveled on to see the progress that Jack Lang has been making on his Falco project located up the road in Ft. Collins. After a barbeque lunch at the field, for those able to find it (a little planning mishap), it was time to talk aviation. In addition some of the lucky Falcophiles got to fly in a Buecker Jungmann based on the field. It was also nice to see all three up and running Falco's in Colorado in one spot. That

Doug Henson, Duane and Mary Root

evening over beers and pasta, we discussed all things Falco, and got to introduce my grandson to his first Falco event. I'm figuring at five months of age he's about ready.

The next morning it was off to Greeley for the infamous $100 breakfast, more Falco rides for those new to this program, and a chance to see some of the most beautiful scenery this country has to offer. Several attendees chose to visit Rocky Mountain National Park, a close drive from town, and the wives traveled with Mary to downtown Boulder to check out the sites, and help our local economy. Several of us met up later in the day to tour the Celestial Tea Factory, and then later that evening we all gathered at the Greenbriar Inn for delicious farewell dinner. As luck would have it our waiter apparently missed the mathematics class in grade school

and this afforded us the opportunity to meet each and every staff member as we moved up the chain of management. Slightly before sunrise we were able to finally get meals to the tables, and the finances worked out .... and to think, these people vote!

The following morning it was back to the airport as those flying made their early departures. Unfortunately for Doug Henson, an early flight out was not to be. He was having engine problems shortly after he arrived, which turned out to be a sticking valve, and some of the local witch doctors prescribed several different remedies. As typically happens, the magic sprays never pan out and with the good fortune of having the right tools and people handy Doug was able to remove the valve and clean out the valve guide. More fortuitous was his being able to leave mid day as weather turned decidedly ugly shortly thereafter!

All in all it was another great fly-in, and a chance to meet some new faces, as well as rekindle old friendships. For those who have been sitting on the fence, it would be great to see you all at the next West Coast fly-in. We'll be there!—*Duane & Mary Root*

Coast to Coast with Susan

Well, it has been decided. Alfred and I are making plans to go to the Oshkosh Air-Venture in 2010 (July 26 thru August 1) to celebrate the 55th anniversary of the F.8L Falco. So, we need to make plans with you as well. If you are marking your calendar at this moment, let me know as soon as possible so we can arrange for a block of rooms for our owners. The fastest way to do this is to email me with the dates you want to attend and the number of people in your party—how many rooms you will need. As we get closer to the dates, I will give you all the reservation details that you will need. This will be my first time to Oshkosh, and I am already excited about meeting so many of you.

I thought you might like to meet the newest member of my family. The very handsome guy in the picture is Bart's BoFlex—Bo to us. Bo had his racing career end this past February when he fell during a race and suffered a compound fracture of his right front leg. Most racing greyhounds would have lost their life at that point but, to his credit, a very caring kennel keeper thought Bo was worth saving and gave him to our rescue kennel for care. With the help of complicated surgery involving pins and wires, his leg was saved, and his life.

We were in Florida in May visiting the rescue kennel where Bo had been recuperating, and I am sure you can guess what happened. Bo and I met for the first time and that was all it took. Chemistry, love at first sight, whatever you call it, I knew he had a home with us. He arrived in Virginia the next month and actually smiled when he saw me again! The joke is that I have said for years that I would really like to have one of those exotic looking BoFlex exercising machines but never invested. Well, I guess I finally got my BoFlex, just not exactly the one I pictured.

There is one topic I need to cover with our overseas new builders. Please remember to add into your budget calculations what the possible import taxes will be on the kits or parts you are purchasing. When we ship by freight to you, I must declare a value of the items. I realize every country has different procedures and taxes, and I want to work with you on how to make it as simple as possible for you. Since you will also be paying the shipping cost, I work at making that as reasonable as I can, also.

I remain thrilled to be back in the world of aviation. But, then I stay alarmed at

Vic Maloy and Bo meeting for the first time.

the decline of service within the American airline industry. Not to be grumpy, but really now! My husband recently had to fly to Nashville, Tennessee. Because of the nature of his trip, Vic had to check a bag. Perhaps you do not know, but the new "thing" in the industry is to charge for each checked bag. He had to pay $20.00 for his one bag. The following weekend he spent an entire 24 hours trying to get back home. Between mechanical problems with his scheduled flights and then missed connections, he ended up not getting home until the day after his planned arrival. Vic was stuck in a little hotel overnight without extra clothing or any necessities—without his bag. He was not a happy camper!

The next morning when Vic checked in at the airport he was told at the counter that his plane was going to Philadelphia, Pennsylvania. We live in Virginia. Not to be defeated, he headed for the gate. There he approached the awaiting pilot who reassured him that he was flying the plane to Virginia. When I met him at the airport he was exhausted and disgusted. His remaining effort was to attempt to find his one travel bag. Guess what? It had actually made it to the airport the day before, without him. Here is the truly wonderous part. They charged him $25.00 to claim the bag from storage! It just does not get any better than that.—*Susan Arruda*

Furio at Oshkosh

Lapo Nustrini, Mary Patterson, Duane Root & Giovanni Nustrini at Oshkosh 2009

Being present at Oshkosh for 2009 was a preliminary to the official Oshkosh worldwide launch for the Furio which will take place in 2010. However Furios sales to date are well into double figures. Sales include to the USA, South Africa, Australia, SE Asia, France and New Zealand. With a lot of interest from other parts of the world including Africa and the rest of Europe.

In the USA we have teamed up with Scion Aviation to assist in the 49-51% rule and launch the Furio into this US market. It is exciting times for the Furio, with its lineage from the Falco. This majestic beauty and pedigree has been commented on widely in GA magazines around the world. The advantages of the Furio being seen in its style, strength of material and low build-time.

During the experiences at Oshkosh it was a pleasure to meet with the Falco owners present and seeing their beautiful immaculate aircraft. Duane Root from Colorado was as always a load of fun and we enjoyed sharing Falco stories and sharing the future of the Furio into the USA with Duane.

It was again, as it was the previous year a pleasure to meet with Bill and Charlie Nutt, the father and son beautiful, blue Falco owners. Thank you to all the Falco owners present at Oshkosh for their support in visiting our Furio.

It is our plan for next year to be 'very present' at Oshkosh and show 'the world' where the evolution of the Falco is going.
—*Giovanni Nustrini*

Calendar of Events

World's Only Oyster Fly-In, Rosegill Farm Airstrip, Urbanna, VA. Nov. 7, 2009 Contact: Dr. Ing. Alfredo Scoti (804) 353-1713 alfred@seqair.com

Falco at 55 Birthday Party, Oshkosh, WI, July 26-August 1, 2010. Plan to be there, and we're also looking for slogans for the event like "Still turning heads at 50."

Mailbox

There I was ... sitting on a bench eating gelato with my wife and enjoying a beautiful summer evening at Lake Como, Italy. In the distance I saw something approaching in the dark. As it neared the dock in front of us, I noticed a word on the bow. I just had to take a photo.

Doug Henson
Livermore, CA

Earlier this summer the rain stopped long enough for me to go to Hagerstown, Indiana to visit some friends I made in Afghanistan, men in the Indy Guard who were training Afghan soldiers. There was a parade and lots of beer and cheerful wives and girlfriends, the soldiers talking easily about their experiences, comfortable in the company of peers. I had some fun showing one of the guys who was a private pilot what not to try in a Cessna. The Falco is good for that. The other thing was that I could stay up for four hours and still land with VFR reserves. Thanks to the Lightspeed ignition I can run the IO-360 leaned out to 7.1 to 7.3 GPH in cruise. With magnetos that was not be possible, I think the spark was too weak. The engine would begin to run rough just barely on the lean side of peak. For me, four hours in the air is at the peak of my bladder endurance, so it works out well.

And four hours exactly is what it to to fly from Pittsfield to Hagerstown. Landing there I was thrilled to see an endlessly long (4000') grass strip, but it was quite rough and in need of rolling.

Jonas Dovydenas
Lenox, MA

Maybe I am the last person to find out, but I found a nice and very good way to seal the canopy . Most people I have seen use some sort of rubber to seal the canopy between the frame and the tracks. This rubber makes it harder to move the canopy and if you are using the tracks for support while getting in and out, the rubber isn't helpful.

A Master Class in Wheels-Up Landing

Perfect overhead join from 2000ft descending to circuit height on the dead side, speed decreasing nicely into downwind, speed pegged at 105 knots, downwind checks, mixture rich, prop fully fine, booster pump on, gear down (touch undercarriage switch, do not move it in the down position, do not check for green), canopy locked, harness locked, beautifully curved Spitfire-like base leg merging into finals, call finals (disregard the usual last check as they teach in the Air Force, 3 greens, undercarriage down and locked), full flaps, 70 knots over the hedge, descending perfectly onto the centre line of the manicured grass runway ahead for a perfect landing. Then SMACK... a sharp jolt and you are instantly in the world of silence, a perfect landing on its arse... what an idiot!

Naturally the beneficial side effects of this sorry affair, a bent prop and an engine in need of shock testing, is a modest contribution to employment in the aviation engineering industry, so hardly hit by the recession. I hasten to add that the landing gear were at all times fully protected and are in perfect order, not having taken an active part in this altercation with the ground, the rest is history.— *James Tseliki*

James and Jennifer Tseliki after their experience. Believe it or not, James says he is overwhelmed with a feeling of well-being because the engine tear-down revealed some serious internal corrosion problems. Better to find it this way than the alternatives.

I finally saw a canopy seal (on a Bölkow B209 Monsun actually) made from leather (or fake leather which is a bit stiffer and seem to work even better). I glued the fake leather to the canopy tracks and on ground it stay right up without touching the canopy frame—resulting in a easy canopy movement. Once airborne, even during climb the suction is high enough to pull the leather to the canopy frame and it is absolutely air-tight.

The seal must be wide (high) enough (mine is 5 cm; roughly 2 inch) for a good air-tight closure.

I experimented a long time with various rubber installations but I found this being the best.

A nice side effect was: All other air leaks (between the seats, at the trim wheel etc.) are gone as well. As long as the air can-

not escape, no fresh air will leak into the canopy!

Certainly one could be more elegant in not gluing the leather to the tracks but installing a proper aluminum profile attached to the side walls holding the seal or whatever individual solution one may find!

But as I said: Probably all Falcos in the U.S. already have it and I was the last one to find out?

Oliver Barth
Germany

As it turns out, I owned a Monsun for many years before I bought a Falco, and I was familiar with this type of canopy seal. My experience was not as good as yours and I remember a hissing noise when I flew the plane. I considered a design like this but decided against it because of my previous experience and also due to the fact that this type of seal could only

be used on the sides and would not help in the front or aft part of the canopy. But I'm very glad to hear of your good experience, and perhaps others will want to use it as well.— Scoti

To which Oliver replied: Indeed I was sceptical at first too. But I flew again today and I am really pleased with the seal. I am also surprised how quiet the cockpit became. I think, the key for the seal to work is its size. My 5 cm (2 inch) seem just right for my canopy and it is quite obvious that any other length will probably not work. (But then my Falco is terribly fast and so I have enough suction to suck the seal firmly into position—and don't we all have terribly fast Falcos?)

For the rear canopy seal I used foam rolled into leather and that roll was squeezed between the Plexiglas and the fuselage. I fixed it there in a position where it has firm contact with the canopy. Not very elegant but it works.

The nice thing about homebuilding is that different people find different solutions for the same problem!

Hard to believe, but there are four Falcos based at the Hilversum airfield in The Netherlands, which gives photographer Vincent Kager (left, with Rob Wolf) plenty of planes to photograph and also practice his skills in Photoshop.