Discussion and Details

The RV-10 is a low wing, four place, metal aircraft. It is being designed to accept engines in the 200-260 hp range. It is intended as a moderately fast touring airplane that will carry four real people, a reasonable amount of baggage and about 60 gallons of fuel. It will not be aerobatic, although we are working hard to endow it with enjoyable handling characteristics, including the typical RV characteristics of excellent low-speed handling and control. With a 260 HP engine, we are hoping for cross-country speeds approaching that of a 180 hp RV-7/8. With more economical 200-220 HP engines, cruise speeds would be about 15 mph lower, but take off and climb performance should still be good. Given the intended mission only a fixed tricycle gear is planned.

The tail will consist of a constant-chord horizontal stabilizer and elevators with riveted trailing edges, similar to the current RV-9A. The vertical stab and rudder are typically RV. Engineer Mike Schwartz has designed some innovative ribs that should make the control surfaces easier and quicker than ever to build.

The wing, at least at the moment, is a constant chord design with a 31.5’ span and single slotted flaps. The wing area calculates out at 147 sq. ft. which yields an aspect ratio of 6.75. This is greater than both the 4.76 of the RV-4, and even the 6.34 of the RV-9. The higher aspect ratio is desired (necessary?) to enhance climb and glide performance of a heavier airplane. The airfoil section we have chosen will (heh, heh,) remain a secret at this time.

The fuselage bears a passing resemblance to the rest of the side-by-side RV family, and provides forward facing seats for four reasonably sized adults. After considering sliding canopies, hinged hatches, transporter technology licensed from Starfleet, and other options, we settled (although we may still change our minds) on doors, one on each side. We’d prefer a single door, for simplicity and fuselage strength, but are afraid buyers would disagree.

The firewall forward portion is open to a variety of available engine options. We are tentatively planning on a 260 HP Lyc. IO-540 engine for the prototype. Other 6 cylinder engines, from the lower HP Cont. IO-360 and PZL Franklin 6A-350, through the larger Cont. IO-470 and IO-520, are possibilities. A lot will depend on used engine prices and availability, and on customer preference. Though there are a lot of possibilities, we’ll have to limit the number of firewall forward options which we can practically offer.

The kit? The metal portions of the kit are planned to be totally matched-hole, similar to the RV-7/9A kits we are selling today. We hope to make the standard kits even easier to build, and of course, there will eventually be RV-10 QB kits. Realistically, with an airframe at least 25% larger, twice the number of seats, doors, a baggage door, etc. will take noticeably longer to build than a comparably technology RV-9A or RV-7. Kit cost? It's much too early to speculate with any accuracy. As with our other kits, we'll be striving to make this one a good value.

Total cost? the latest Trade-A-Plane shows several used O-540s in the $10-15K range… so a new RV-10 with a simple panel and a used engine turning a good c/s prop might cost about $65,000. This is a wild preliminary guess and those who take it as gospel have only themselves to blame if it proves inaccurate…but just for grins, triple it, and compare the result to any new four-place airplane of even remotely similar performance. The new (again) Tiger at over $200K? A Cirrus SR22 at $276K? A Columbia at $275K? I expect that the truly "budget" RV-10 will be uncommon and that more of them will be fitted out as well-appointed touring machines, with appropriately higher price tags. In keeping with Van's original (and current) philosophy, the expensive decisions are left to the individual builder, not built in at the factory.

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From the RVator. Fifth Issue, 2001 posted 12/03/01
Please see the RVator for additional details.

CHOOSING A WING

the best for one airplane may not work for another

Van

Recently, we announced that Van's had begun work on a 4 place kitplane, the RV-10. Since then we have received some letters and E-mail praising our efforts, a few condemning them, and several suggesting design features the writer felt would be desirable. These letters are always interesting…if nothing else they demonstrate how varied the demands of the market can be…one reason why all airplanes are flying compromises.

One writer suggested a short list of design features he thought appropriate, along with his rationalization for "doing it that way." In addition answering his letter, I felt that maybe a discussion of a couple of his suggested points might be of interest to all of you; so that you can better understand why we are following the design path we have chosen.

His suggestions:

- 1. Use a short span, low aspect ratio, "thick" wing, much as we have done on most of our previous designs. He reasons that such a wing does not impair wing drag or lift and that the RV's good climb rate with short wings is achieved because of a low wing loading. Such a wing would also provide better spar depth and strength, the wider chord would mean less sensitive C.G. limits and it might achieve a greater angle of attack at stall.
- 2. Use a sliding canopy — at least as an option.

Let's take a look at the reasoning in the first suggestion, point by point. It is true that we have used low aspect ratio "fat" wings very successfully on most RV designs. However, those airplanes were designed for a job the four-place will not be called upon to do. They were airplanes designed for aerobatics and sport flying. The short wing was easy to build, and the short span meant low bending moments, increased strength and rapid roll acceleration. But now the job required of the RV-10 is different. Will a wing that serves the sport RV work as well on an easy-to-fly, efficient-cruising, people-mover?

First, a few definitions:

- *Wing loading* is, of course, the area of the wing divided by the weight that it must lift. An 1800 lb airplane with a wing area of 100 square feet has a wing loading of 18 lbs/ft^2.
- *Span loading* is calculated by dividing the wingspan by the weight. An airplane with a weight of 1800 lbs and a span of 25' has a span loading of 72 lbs/ft.
- *Power loading* is the weight of the airplane divided by the power propelling it. An airplane weighing 1800 lbs being pulled along by 200 hp has a power loading of 9 lbs/hp. *(By some twisted semantic reasoning, a "high" power loading is a lower number…an airplane with a power loading of 15 lbs/hp is said to have a "higher" power loading than one with 20 lbs/hp. This was probably dreamed up by the same guy who decided that larger AWG drill sizes would have smaller numbers…).*

	RV-3	RV-10 (with RV-3 wing parameters)	Low aspect wing RV-10 with 147 sq. ft. area	High aspect wing RV-10 (current thinking)
Power (hp)	125	321	200-260	200-260
Wing area (ft^2)	90	231	147	147
Wing span ft	20	32.05	26.44	31.5
Wing chord (in)	54	86.5	66.8	56
Aspect ratio	4.44:1	4.44:1	4.44:1	6.75:1
Gross Weight (lbs)	1050	2700	2700	2700
Span Loading (lb/ft)	52.5	84.2	102.1	85.7
Power Loading (lb/hp)	8.4	8.4	13.5-10.4	13.5-10.4
Wing loading (lb/ft^2)	11.67	11.67	18.37	18.37

First, consider climb rate. Basically, climb rate is linked most closely to power loading. It is determined by the engine horsepower or thrust available *in excess* of that required to maintain level flight. But span and span loading come into play as well. Everything else being equal, a shorter, lower aspect ratio wing has a higher induced drag, especially at low speeds, than a wing with a greater span and lower span loading. The shorter wing requires more horsepower just to maintain level flight at low speed. Since the power available is finite, this means less power remains for climb.

The RV-9A is another example of how, sometimes, power loading is more important than wing or span loading at climb speed. Although its longer wing gives it a lower wing loading and lower span loading than the RV-6A, its climb rate (for a same size engine) is not dramatically better. But, if these airplanes were flown at 50% power (or at high altitudes where power output diminishes), the benefits of the RV-9A's lower span loading would become more noticeable. Handling qualities or control feel are also considerations. At low speeds, the RV-9A is noticeably better because of its lower span loading.

Even though the induced drag is higher at typical climb speeds with a low aspect ratio wing than it is with a high aspect ratio, most RVs have a good climb rate because they have a lot of horsepower per pound of flying weight; around 10 lb/hp or better. This more than offsets the induced drag of the short wing.

It is only when airplanes with low power, or low power loadings, are considered that the relationship of span loading and climb rate become primarily important, even critical. Consider my DG-400 self-launch sailplane. It has a span of 57 ft., a flying weight of 1000 lbs, a whopping 43 HP, and a respectable 600 fpm climb rate. Interestingly, its weight is almost the same as the RV-3. How well do you imagine the short winged RV-3 would climb with only 43 HP?

Now, let's apply some of these considerations to a potential 4-place airplane. The table shows some rough examples of specifications a 4-place airplane might have if its wing design were driven by various goals. In the left RV-10 column, and in Fig. 1, we have a hypothetical airplane with the same aspect ratio and the same wing loading as an RV-3. Just doesn't look right, does it? From the structural viewpoint, there's a lot of problems here. Such a wing would require a much bigger horizontal tail, it would be difficult to attach to a sleek fuselage, etc. And on the performance end, we have calculated that, to have climb rates equal to an RV-3, such an airplane would require 321 horsepower. Bad news… the real world hasn't provided us with a practical engine choice in this horsepower range. We are designing around engines that are readily available, betweem 200 and 250 horsepower, so we are essentially back to the "low power" scenario. Our power loading is going to be much lower than the RV-3, and if we are to achieve a respectable climb rate, we need to have a longer span/lower span loading. The induced drag the short wing assumes a proportionately larger role, and there isn't enough power to overcome it.

The middle RV-10 column (see Fig. 2) describes an airplane with 147 square feet of wing area (our working number on the RV-10), but with the same aspect ratio as an RV-3. In the right column, we have our current RV-10 thinking.

Either of the lower wing area (147 sq. ft.) examples should yield a higher cruise speed. By choosing a higher aspect ratio wing, we can maintain the same span loading as we would have had with the large, low aspect ratio wing. Thus, despite the higher wing loading, we expect a climb rate as good as could have been achieved with greater wing area. However if we chose the low wing area along with the short span, the climb and descent rates would suffer. Since our wing loading is considerably higher, the stall speed will be higher, although we expect to limit the stall speed through the use of long, efficient flaps.

The flip side of climb performance is glide performance. With a high enough power loading, you can have a good climb rate even with a high wing loading and short span, but such an airplane won't glide well. While we want to climb at the highest possible rate, we don't want our power off descents to be at an excessively high rate. The same aerodynamic factors that cause an airplane to climb poorly cause it to glide poorly also. We want to avoid the "streamlined brick" syndrome, so we can end up with an airplane with descent rates and angles that minimize piloting skills and workload. Thus, a wing with a greater span and lower span loading is perhaps more important for glide performance than climb performance. For example, take the Space Shuttle. It's all thrust and no wing on the way up, all wing (what there is of it) and no thrust on the way down. It is a dreadful glider that requires great precision to fly safely. The designers had to make awful aerodynamic choices to accomplish the mission.

How about next point: greater spar strength, wider chord for less sensitive C.G. limits and a greater angle of attack at stall?

Basically, we agree. However, while the wider chord does improve the C.G. range, measured in inches, the expanded range requires larger trim forces. This means, for a given wing area, either one needs more spacing between the wing center and the horizontal stabilizer, or a larger stabilizer or both. Either way, it means more drag. Regarding the higher angle of attack at stall: there doesn't seem to be any particular reason that is this desirable. In fact, it may just permit the pilot to prematurely hit the tail on the ground upon landing.

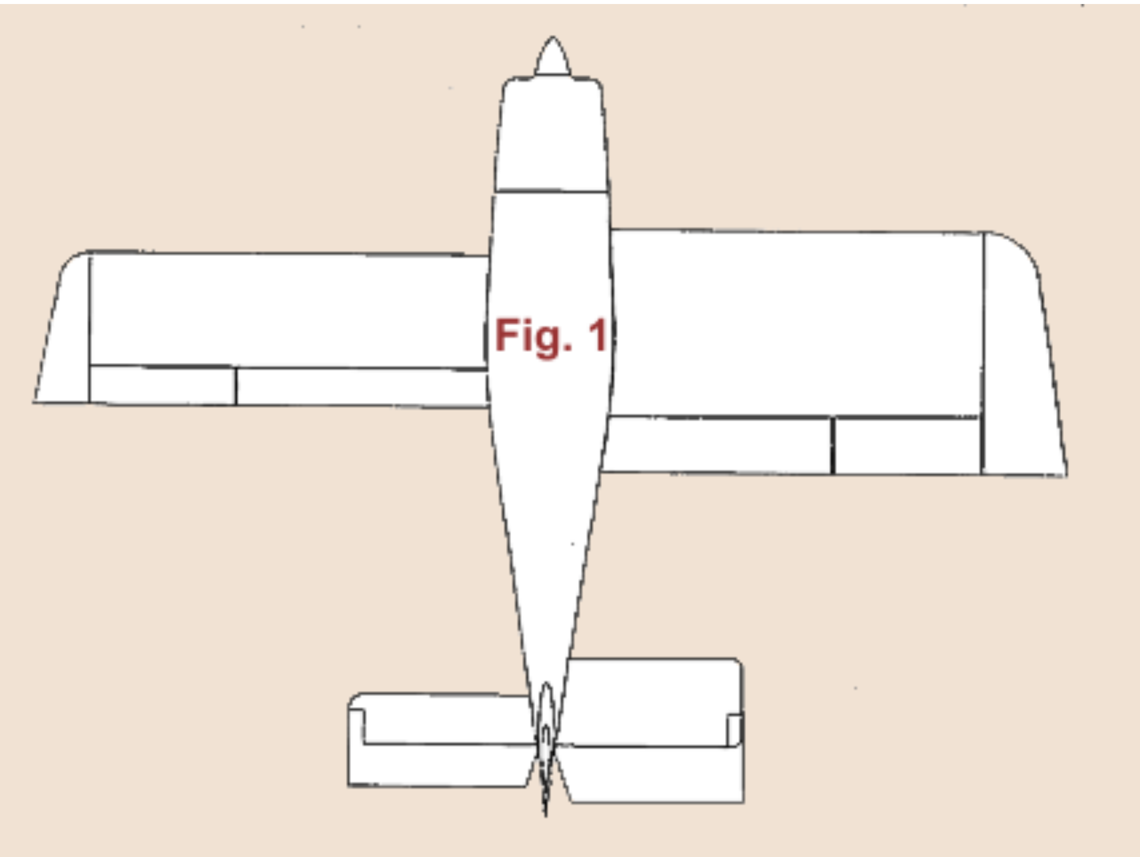

Figure 1, above, shows a wing with the RV-3 wing loading and aspect ratio, scaled up to fit the proposed RV-10. Notice that the horizontal tail area must be increased as well.

Figure 2, below, shows a wing with the proposed 147 square feet of area, but with the RV-3 aspect ratio.

Neither wing will really do the job the RV-10 requires.

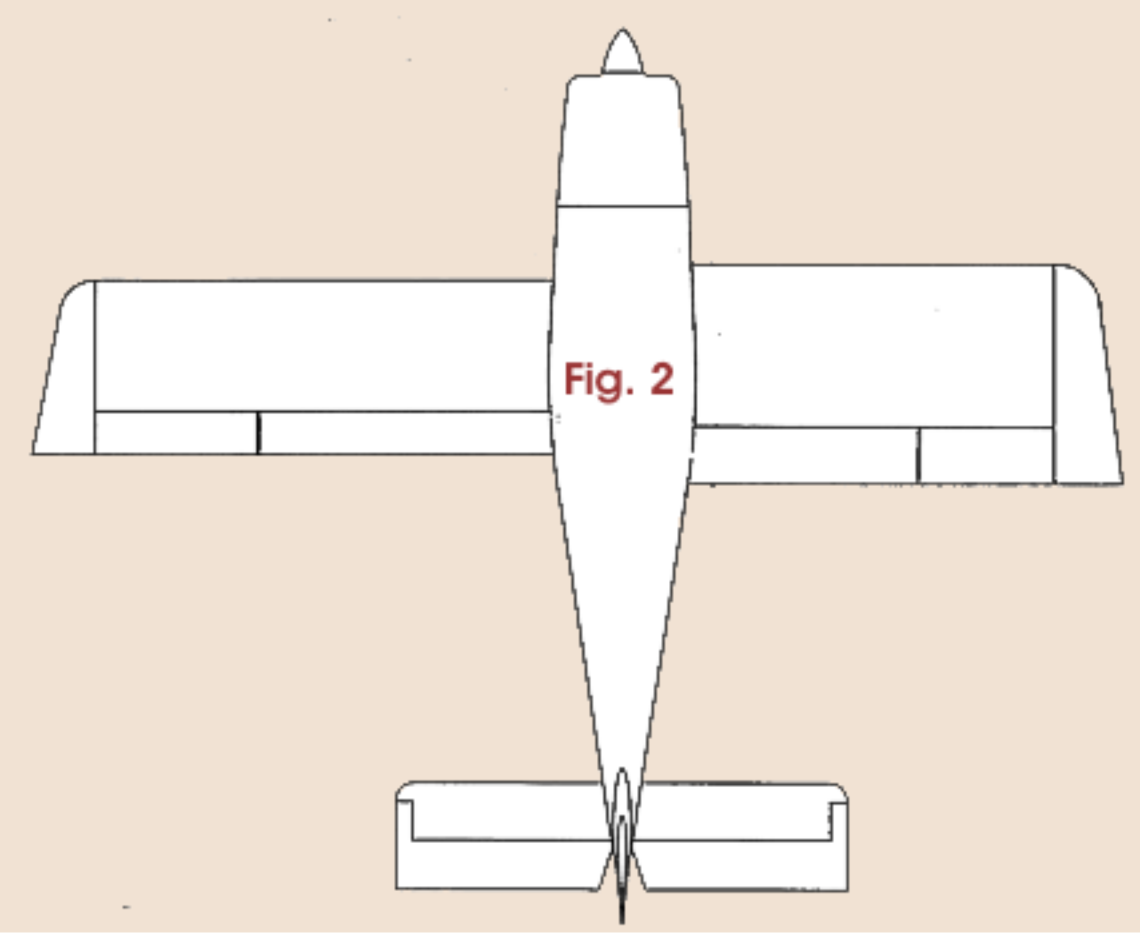

Fig. 2

What about the assumption that a "thick" wing does not impair wing drag or lift?

Here, we must disagree, at least in principal. From the studies we have done, and from the experts we have consulted with, thicker airfoils *do* have higher drag, and they *do* have reduced lift**.*** The ideal thickness seems to be approximately 12%. We can see an example in sailplane racing. While sailplanes may not normally be viewed as racers, that's exactly what they become in soaring competitions, and low drag is everything to a racer. Historically, sailplane wing spans kept getting longer and aspect ratios higher. This was the way to improve performance, which for sailplanes, meant glide angle or Lift/Drag ratios, and climb rates. Airfoil thicknesses of 18% were common in order to achieve the spar depth required to get the necessary strength with the wood and aluminum materials of the day. One high performance sailplane of the 1960's had a 20% thick wing! The benefits of the greater spans and aspect ratios offset the losses of the thick airfoils. With the advent of fiberglass construction, greater strength permitted thinner airfoils. Not much thinner, because spars needed to be made over-strength to achieve sufficient stiffness. Now that carbon fiber, which is much stiffer, is more affordably available for use in spars, airfoils have been getting much thinner. Some of the highest performance sailplanes now have airfoil thicknesses of around 13%. For a typical 15 meter ship, this means a wing root thickness of about 4 inches---only 4 inches deep and it stretches out almost 25 ft. on each side…a tough construction problem! If the drag of thicker airfoils was not a penalty, then leading sailplane manufacturers would not be working so hard to make them thinner.

However… drag rise and lift loss do not vary in direct proportion to thickness. Usually, relatively little is lost through a thickness increase of a few percent, so designers often use a thicker-than-aerodynamically-optimum airfoil. The weight savings of a deeper spar and the added internal volume (for fuel or retractable landing gear) are reasonable trade-offs for slightly impaired efficiency.

For the RV-10 airfoil we have struck a compromise between the thickness needed for spar strength and a reasonable drag coefficient. The dust settled at 16% thick. With a custom-designed airfoil section, we hope to achieve a somewhat wider range of laminar flow than with the NACA 230 airfoils we have been using. We hope this will keep the drag down even with the thicker section. We know that the lift of a 16% thick airfoil is less than that of a thinner section.

Through the use of carefully designed flaps, we should be able to neutralize this loss, too. As of now, the design calls for a flap span of 51% of the total span, after fuselage width, aileron and tip spans are subtracted. So, since the benefit of the flap affects only half of the wing, we still lose a little, overall, because of the thicker wing.

Sigh! Compromises and more compromises. Even with the span and aspect ratio we have chosen for the RV-10 wing, it will not be a fabulous glider. It's a compromise, but we feel that it is a wise one.

Now. About that sliding canopy.

We have ruled out a sliding canopy because we feel that doors will permit easier cabin (don't say cockpit) entry for the wider variety of passengers expected to use a 4 seat airplane. A sliding canopy may actually be easier to design and manufacture, but considering the size of a canopy necessary to cover a 4 seat cabin, building it and achieving a good seal might be an obstacle for the builder. Anyway, we are progressing in the direction of gull wing doors.

We thank the respondent for his thoughtful input. While we disagree with some of his design detail conclusions and recommendations, his input did prompt these ramblings which I hope will be of some interest and enlightenment to our readers. Our usual disclaimer is in effect for the super whiz-bang aero engineers within our readership: the above is meant as fodder for the masses; not as a doctoral thesis, so please don't grade us too harshly.

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Cockpit \ Cabin mock-up

For several days, our prototype builders found themselves using table saws, wood rasps and air nailers borrowed from the crating shop. The result was a cockpit mock-up, simulating the cabin of the RV-10…maybe. We needed to see if the ideas that looked good on paper actually worked in three dimensions. While computer modeling can easily define and modify dimensions, it can't tell you that a six-foot tall human has to make a difficult to twist into the seat if the door sill is yea high, or that short people have nothing to grab when trying to pull themselves up and out of the rear seats.

The mock-up also allows us to try variations quickly and easily. A few seconds with a battery drill and a handful of drywall screws can move a seat ½", which may be all it takes to make the difference when you are trying to get a knee under the instrument panel.

One of the biggest current questions on the RV-10 fuselage is the control system. The new Lancair Columbia and Cirrus airplanes use side-stick controllers, which allow easy entrance into the airplane, lots of leg and "wiggle" room, and a clean instrument panel. And, since they are used on high-tech airplanes like the F-16 and Airbus airliners, they have a certain cachet…modern, sexy, etc.

We'd like to be just as sexy as the other guys, but the control system is a big deal. There is no back-up. It must work, and it must function reliably. The simpler it is, the easier it will be to manufacture, and the better it will work. Fixing on one idea and "making it work" is not a good design technique. In the RV-10 we are tentatively planning gull-wing doors with low sills. The problem comes in running the control rods down the side of the airplane. The low sills make it easy to step down into the cabin from the wing, but don't leave a lot of room for pushrods.

We have also played with conventional sticks between knees, and a short stick on a center console, ala Velocity or (for you Aussies/Kiwis) Victa Airtourer.

Phil Duyck has spent some time tack-welding and riveting various combinations of tubing together, building different systems to measure exactly how the rods move, what kind of room they need and where they might interfere with airframe or seating structures. No clear-cut winner has emerged yet.

This is just one of the many aspects of the RV-10 that must be worked out before we can commit to production. At this time, many details of the airplane are undefined. We don't know the exact dimensions of the landing gear, the precise shape of the cowl, or the number of cabin cupholders. We cannot predict when the prototype might fly, or even exactly what it might look like when it does.

Click on the photo for a larger image.

We recently tested a possible RV-10 wing in the prototype shop…all 31.5 feet of it. Construction is similar to an RV-9 wing. There are three spanwise J-stiffeners. Two are on the top, one forward of the spar and one aft, and another on the bottom between the main and rear spars. The main spar is dimensionally different, but conceptually identical to the spars used in the RV-7/8/9–a channel bent from 0.063" 2024 aluminum, milled bars top and bottom, and a "waffle plate" providing additional cap strip area and all the necessary vertical stiffening. Skins and ribs are perfectly ordinary. For test purposes, we did not use an actual wing tip, because shot bags slide off the curved shape. Instead, we extended and braced the bottom skin to provide the tip surface area.

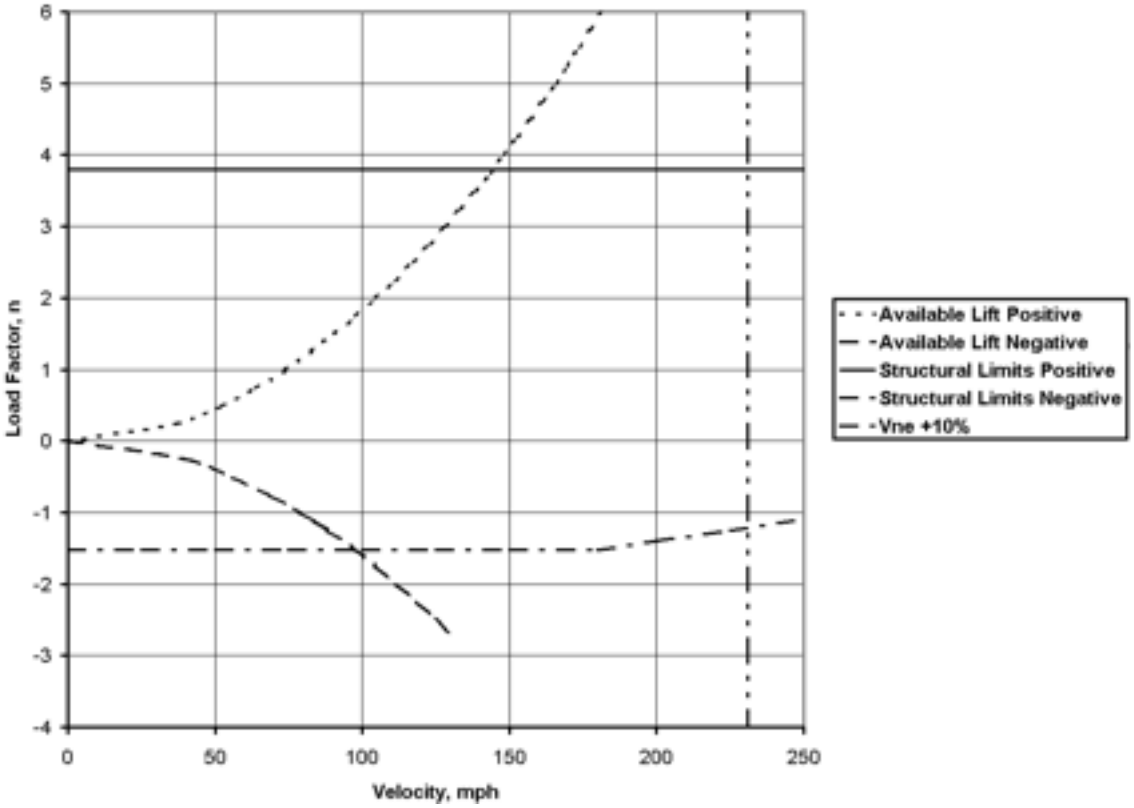
The total load that the wing must support is:

- the weight of the aircraft
- multiplied by the load factor (in this case, the 3.8Gs necessary to qualify the airplane for the "Standard" category)
- plus or minus the tail load for a particular flight condition (the center of gravity location was varied from most forward to most aft to determine the tail load to add [or subtract] from the wing load.)

That’s the total load. Now, how the load is distributed across the wing varies with the flight condition. Speed, angle of attack and control surface deflection all contribute to variations in distribution. It might be possible to put an unacceptable strain on one point of the wing without exceeding the total load. Loads are not constant from root to tip, nor from leading edge to trailing edge. From all the flight loads considered, we selected three "worst case" load conditions to test. If the wing is strong enough to survive these loads, then it will be strong enough in all the other flight conditions.

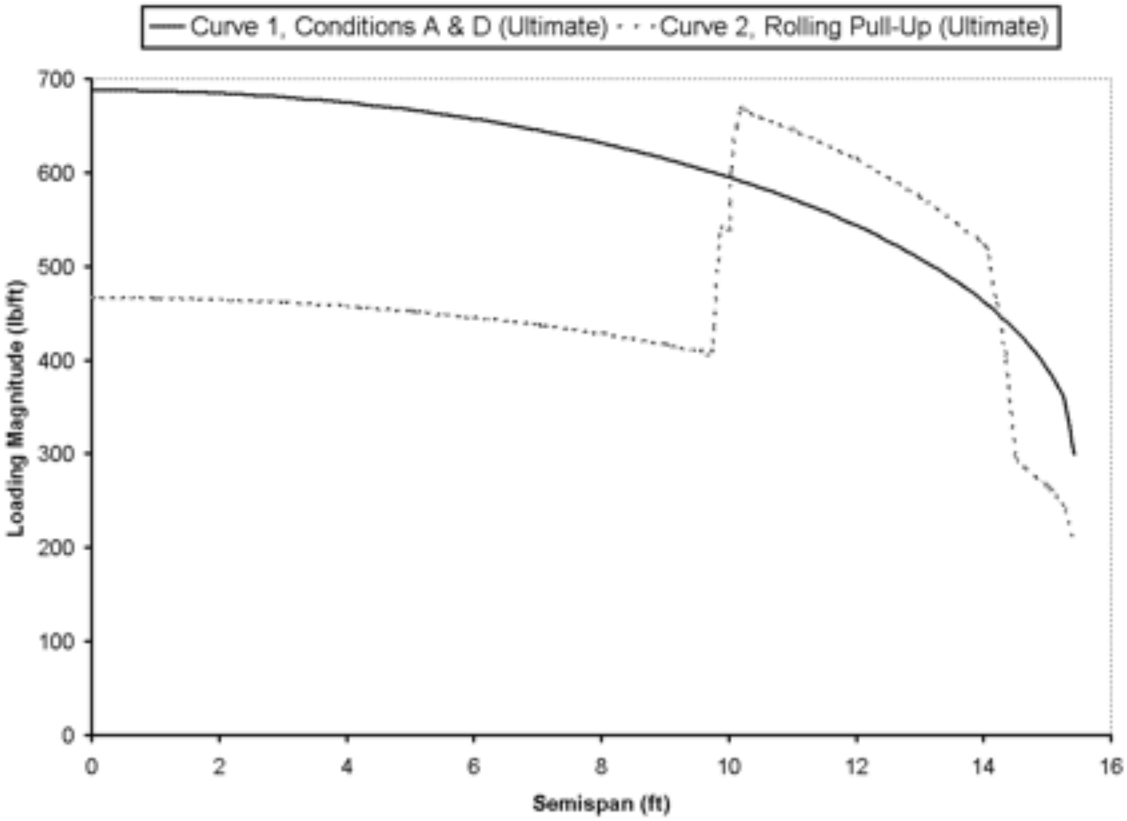
The first test case that we selected corresponds to the upper right corner of the V-n diagram in Fig. 1.

FIGURE 1
RV-10 V-n Diagram



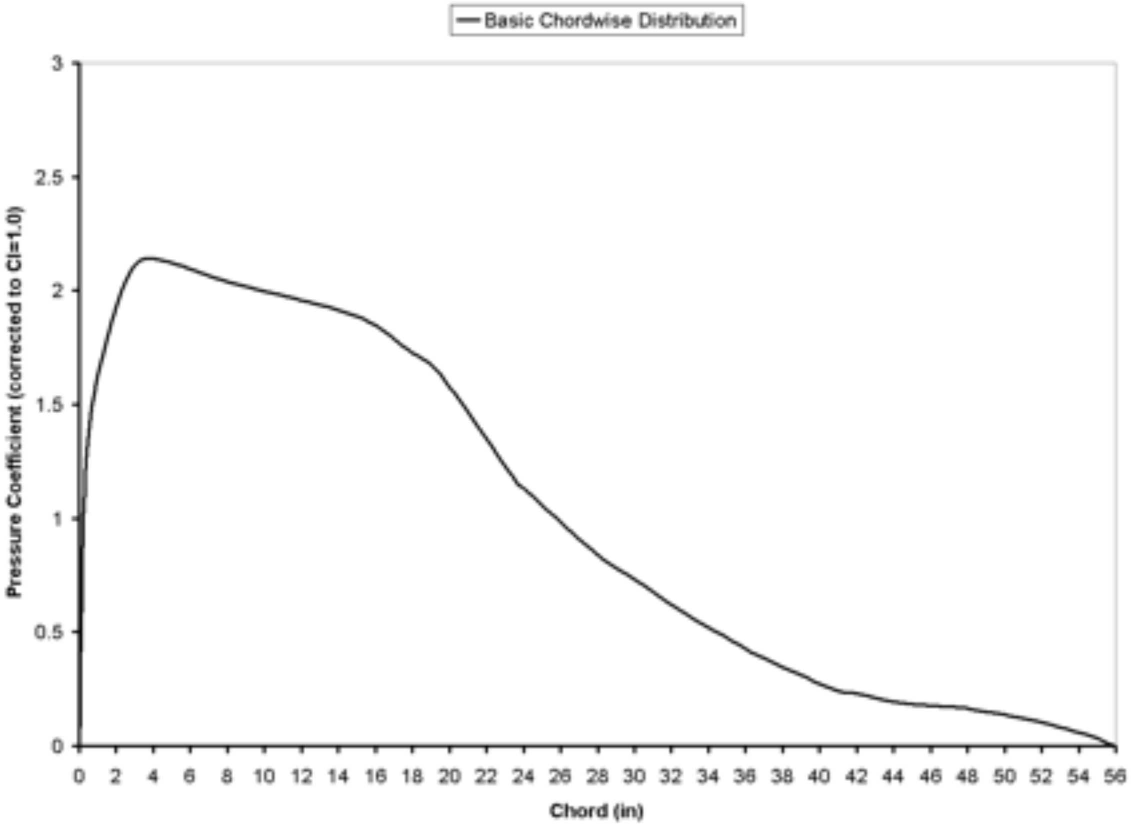
This is the result of a 3.8G symmetrical pull-up at 10 percent over redline airspeed. The wing angle of attack (AOA) for this case is 5 degrees. When the worst case tail download is considered, this puts the largest total load on the wing/center section and imposes the "worst-case" total bending load that the wing must carry. We design the wings to meet the standards of FAR Part 23 where this case is labeled "Condition D" so we have adopted the same terminology. You can get an idea of the spanwise load distribution for this case in Curve 1 of Fig. 2.

FIGURE 2
RV-10 Spanwise Loading



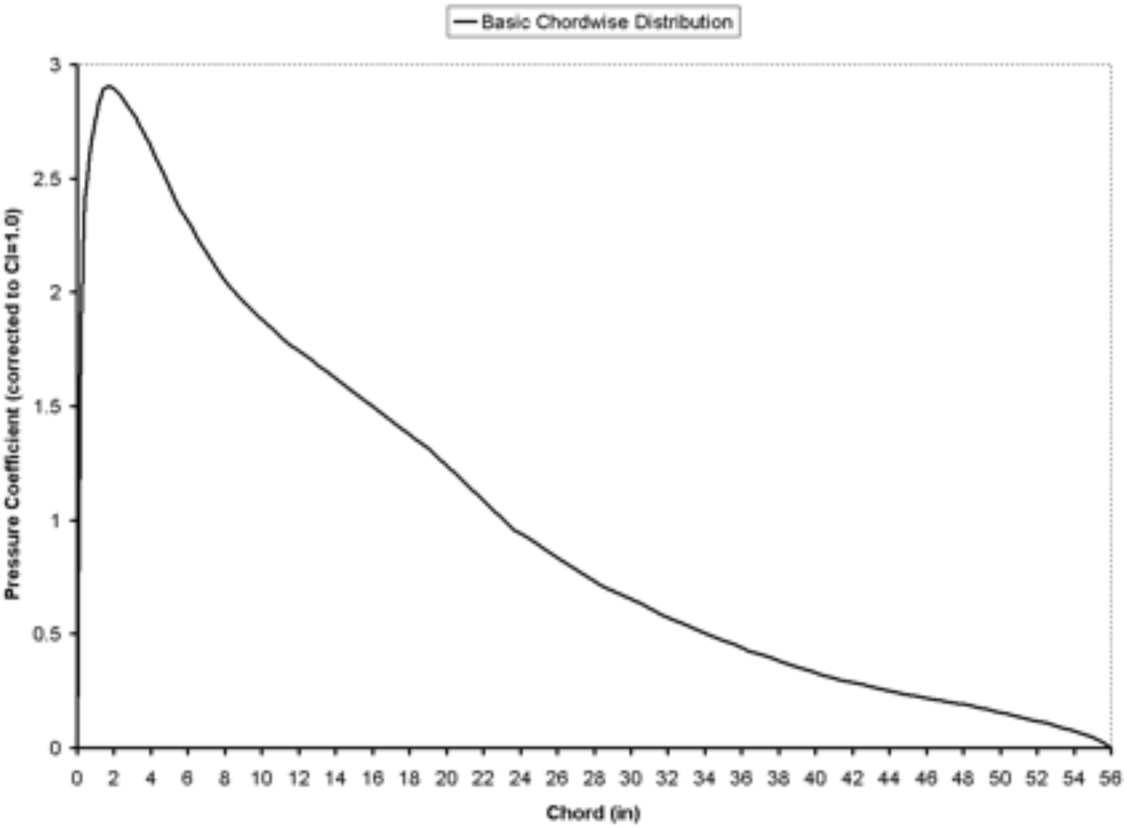
Chordwise distribution is shown on Fig. 4. Notice that the majority of the load on the forward one third of the chord.

FIGURE 4
RV-10 Chordwise Load Distribution - Condition D



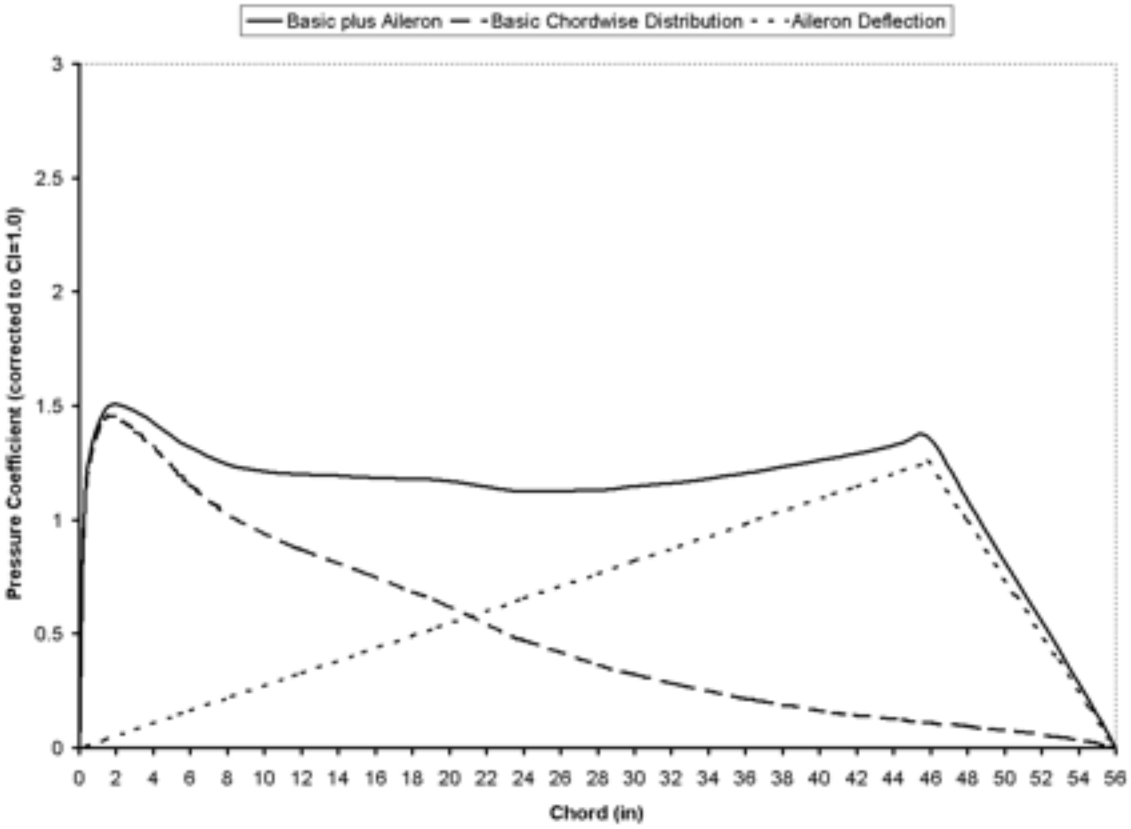
The second test case that we selected corresponds to Condition A, (again, an FAA label we have adopted) the upper left corner of the envelope shown in Fig 1. This would result from a 3.8G symmetrical pull-up at maneuvering speed. While this is not the worst-case *total* load, it occurs at a 15 degree angle of attack. The spanwise distribution is shown on the upper curve of Fig. 2, but the interesting stuff happens elsewhere. At this AOA, the load on the wing forces it forward as well as lifting perpendicular to the chord plane. This results in a tension load on the joint between the rear spar and the fuselage. The chordwise load distribution for Condition A is shown in Fig. 3, where we can see that this condition results in most of the load being applied very near the front of the wing, which tries to twist the leading edge up. In engineerspeak it "places a large leading-edge-up torsional load on the wing." The wing is subjected to bending in two planes (forward and up) and twisting at the same time.

FIGURE 3
RV-10 Chordwise Load Distribution - Condition A



The third test case we selected corresponds to a symmetrical pull-up at two thirds of 3.8G at maneuvering speed *plus* full trailing-edge-down aileron deflection. You can't read this case directly off the V-n diagram, but it is a good example of how combinations of loads must be considered. The wing angle of attack for this case is 10 degrees. The load for this condition is centered quite forward on the chord of the non-aileron portion of the wing (Fig. 3). The additional lift due to aileron deflection on the outboard portion of the wing (see the lower curve on Fig. 2) places a large bending load on the outboard wing. Because this lift is centered further aft (Fig. 5) it exerts a large trailing-edge-up twist as well.

FIGURE 5
RV-10 Chordwise Load Distribution - FAR 23.349b



We obviously can’t duplicate a dynamic situation in the shop, so we have to figure out the load distribution and simulate it with simple weight. If you superimpose the spanwise and chordwise load distributions on top of each other, you end up with a reasonably accurate picture of the total distribution of load over the entire wing root to tip and leading edge to trailing edge.

The best way to keep things straight is to divide the wing into a grid system with each "cell" getting a different amount of lead for each load case. Over 280 cells were loaded to accuracies within one pound to achieve the exact loading for each condition. The sum of the loads in each cell of our grid closely approximates the total flight load *and* distribution. When we test the wing, we mount it upside down in a rigid steel frame, simulating the fuselage, and cover the bottom surfaces with thin plywood, marked with this grid.

Loading shot bags on the bottom simulates the load the wing will see in normal flight. It takes some equipment, (ie., a forklift!) some muscle (someone else's, if I can arrange it) and careful attention to be sure the right amount of weight is applied in the correct location.

Part 23 requires that the wing support 1.5 times the limit load of 3.8G (*i.e.*: 5.7G) for 3 seconds in all conditions. It allows the use of a different test article for each condition. We used the *same* test article to test for all conditions. Ours is a more severe test, because the wing could be weakened by one test before the next is run. As full load is reached, the wing creaks and groans and wrinkles run like heavy seas across the top skins. Engineers start using some strange body english and holding their lips all funny. When the last few shot bags are loaded, the atmosphere can be pretty tense.

We were very pleased to find that our calculations had been correct and the wing passed all the requirements of Part 23.

Please, watch the *RVator* and this website for details of RV-10 development, but don't call and ask us how it's going. When we know, we will let you know and we will know sooner if we spend less time on the phone.

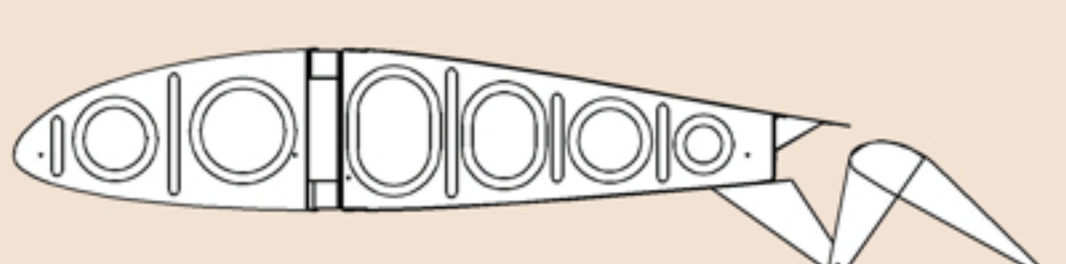
THE REST OF THE WING STORY: THE AIRFOIL

In a previous *RVator* we discussed some of the choices and decisions we'd made when designing the RV-10 wing. We were a bit coy about the airfoil we'd chosen, implying that it was a deep, dark secret. Actually, the only secret is that it is a new airfoil that hasn't yet flown, and is making its debut on the RV-10. It could be a disaster, or it could be revolutionary breakthrough.

In reality, it will probably be neither. Airfoil design technology has progressed to the point where results are reasonably predicable. Airfoils are designed and tailored to correspond to the performance and handling goals of an airplane. With modern tools, it is often possible to do better with a new "tailored" airfoil than with an "off-of-the-shelf" airfoil. But not much better! Considering the tools available to them, the NACA engineers of the 1920s and 1930s did a remarkable job of designing a family of general-purpose low (subsonic) speed airfoils. These are the airfoils used on all of the production airplanes you have flown, and on most homebuilts like the RVs, other than the RV-9A. There are some relatively new airfoils which have been widely acclaimed and tried in recent years. We did not choose one of these because the mission they had been designed for is not our mission.

The stall speed of an airplane is dependent on the maximum lift coefficient of the wing, so it is desirable to choose an airfoil which offers a high maximum lift coefficient. The problem is that airfoils designed for maximum lift also have very high drag. Most airfoils in common use are low drag "cruise" airfoils which we convert to higher lift coefficient airfoils by designing hinged flaps which can be deflected to approximate the shape of a true high lift airfoil.

Designers are constantly in search of the "miracle" high lift/low drag airfoil. The hard truth is that it doesn't exist. Neil Willford, in a recent *Sport Aviation* article, calculates the wing area needed for a hypothetical Light Sport Airplane class design. He assumes a lift coefficient of 2.0 for a flapped wing. Interestingly, if you read my article on LSA in the 5th 2001 *RVator* issue, you will note that I assumed a lift coefficient of 2.15 for my hypothetical airplane. I recently checked the specifications and performance of several production airplanes including the new Cirrus and Columbia. Based on their listed weights and stall speeds, their maximum lift coefficients calculated to be nearly identical: just over 2.00. In the real world, a lift coefficient of 2.0 is an about as high as is achievable with a good general-purpose airfoil and fixed hinge flaps. Since homebuilts and ultra-lites don't have to verify their performance claims, very optimistic stall speeds are often listed. I am reminded of a conversation over 10 years ago with a fellow kit designer who was expressing his amazement over the 28 mph stall speed quoted for the then-new Avid Flyer prototype. He had done some simple math and concluded that its airfoil had a maximum lift coefficient of something over 3.5. I was surprised by his naiveté for assuming the stall speed was *really* 28 mph, rather than my position of questioning the reported stall speed based on the improbability of such a high lift coefficient. In reality, the stall speed was probably a few mph higher, and the lift coefficient was a more realistic 2.5 or so.)


The airfoil and flap arrangement chosen for the RV-10

AND THE FLAPS...

All RV models prior to the RV-9A used very basic flap systems. Their relatively low wing loadings and short wings limited the advantages to be gained with more elaborate flap designs. With the RV-9A, lower landing speed was a primary goal. So, we designed a single slotted flap system, which along with the greater flap span possible with the longer wings, yielded very good results. The higher gross weight and wing loading of the RV-10 suggested that we use a good flap design, at least as good as that of the RV-9A, to keep landing speed as low as reasonably possible. While we did choose a slotted flap design, we decided to stick with a fixed hinge point rather than the more idealized and complex flap track system common to "Fowler" flaps. With a flap track, it is possible to tailor the flap movement so that the position and angle of the flap is idealized throughout its travel. For a flap with a simple displaced hinge pivot point, that pivot point is located so that the flap swings back to some idealized position at maximum deflection. For intermediate positions, exact flap position and angle are slightly less than ideal. We consider this to be a minor compromise for the simplicity of the fixed hinge point.

IN THE FUSELAGE

In an earlier RV-10 report, we talked about experimenting with side-stick controllers. After frustrating prototype efforts and discussions with knowledgeable users and designers, we have (for now) settled on conventional between-the-knees sticks for the pilot and co-pilot. The mechanism and geometry needed for a side stick controller proved too complex. Our experience entering and exiting our cabin mock-up (the Pine Pigeon) has shown that our original concerns about cabin entry difficulties with this configuration were unfounded. We find that we can step into the front seats and over the control sticks in a manner similar to entering our 2-seater’s cockpits. Actually, it is even easier because of the low door sills. Most side-by-side 4 seat production airplanes have used control wheels and columns. One reason is that for cabins with a door on only one side, entry and exit would be very difficult with floor mounted control sticks. However, we feel that the control stick is a little more natural and "sporty", plus being easier to design than a control wheel arrangement.

From the RVator. Second Issue, 2002 posted 05/15/02

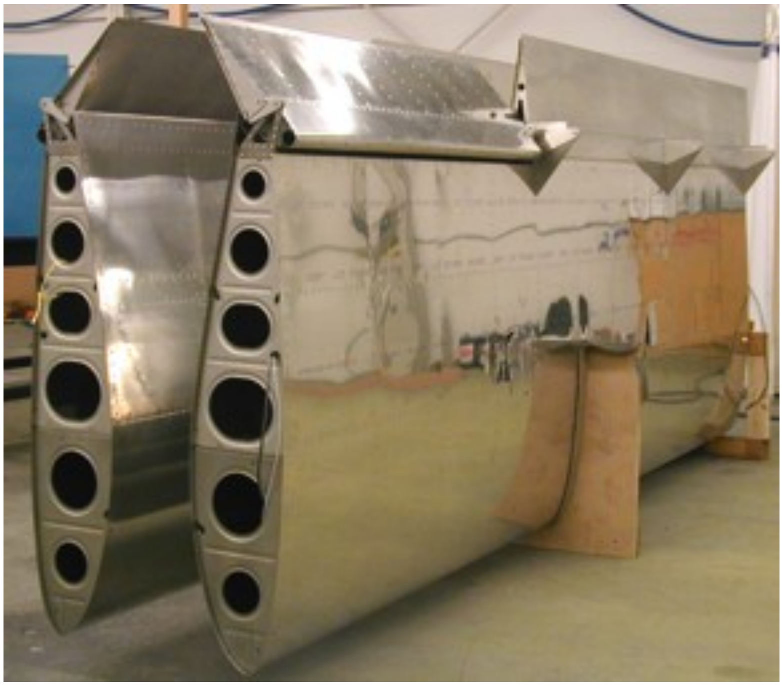
RV-10 PROGRESS

The wings and tail for the prototype RV-10 are going together in our shop. Now that the RV-9 is flying, the shop crew of Miles Towner, Scott McDaniels and Phil Duyck have more time to dedicate to the four-place airplane. We expect they will finish the Ten components they have on hand quite quickly. RV-10 wings, from the builder’s viewpoint, are very much like RV-9 wings, although the prototype flap is impressively long: an inch over eight feet. When the first assemblies are finished, we do what every builder does…hang the tail on the rafters.

On the engineering floor, Mike Schwarz, Ken Krueger, Van and draftsman Phil Rivall are all pursuing different aspects of the airplane…fuselage, landing gear, engine mount/cowling, etc. Ken noted "The last major milestone that we passed was, of course, the wing static test. We now are working our way through the many, many details that will define the fuselage. You won't be hearing much about this because there aren't many "milestone" type events that are associated with that part of the design. Progress on the fuselage will be slow, again because of the number of details that must be worked-out along the way." That's the truth! For the next several months, don't expect much in the way of progress reports. When we do have something to "show-and-tell" it will be posted on the website and appear in the RVator.

From the RVator. Third Issue, 2002 posted 06/25/02

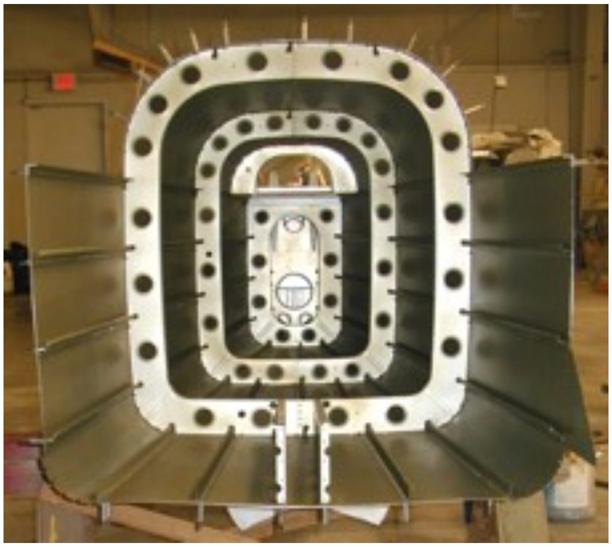
Ken Scott



The wings for the RV-10 prototype are now sitting in our shop.Other than the size, the different airfoil and the big flap hangars extending out the back, they look like a typical RV wing…a big plank. There are a pair of spanwise stiffeners running from the root to the tip. This is a light, simple way to add some strength without going to thicker heavier skins.

The pivoting slotted flaps require 3 big hangers. These are made of heavy aluminum and riveted to the rear spar and wing ribs. They run through the bottom wing skin and establish the hinge point of the flap several inches below and aft of the bottom of the wing.

The fuselage tailcone is now going together. The pre-punched parts fit just as nicely as they do on current kits…but there are a lot of them. The tailcone is relatively simple…just an initiation to the biggest challenge on the airplane – the cabin area with the seats and doors. We are still pondering different methods and techniques of getting that job done.



Several potential RV-10 builders have inquired about 300 hp or even bigger engines. Perhaps such questions are inevitable, but it is slightly frightening when people ask for more power on an airplane that hasn't flown yet. The answer is that we are designing the RV-10 for a maximum of 260 horsepower and assuming that to be an 0-540 Lycoming. All our stress calculations, performance calculations and reserve margins are predicated on an engine of that horsepower and weight. If someone chooses to install something else, we cannot offer builder or engineering support.

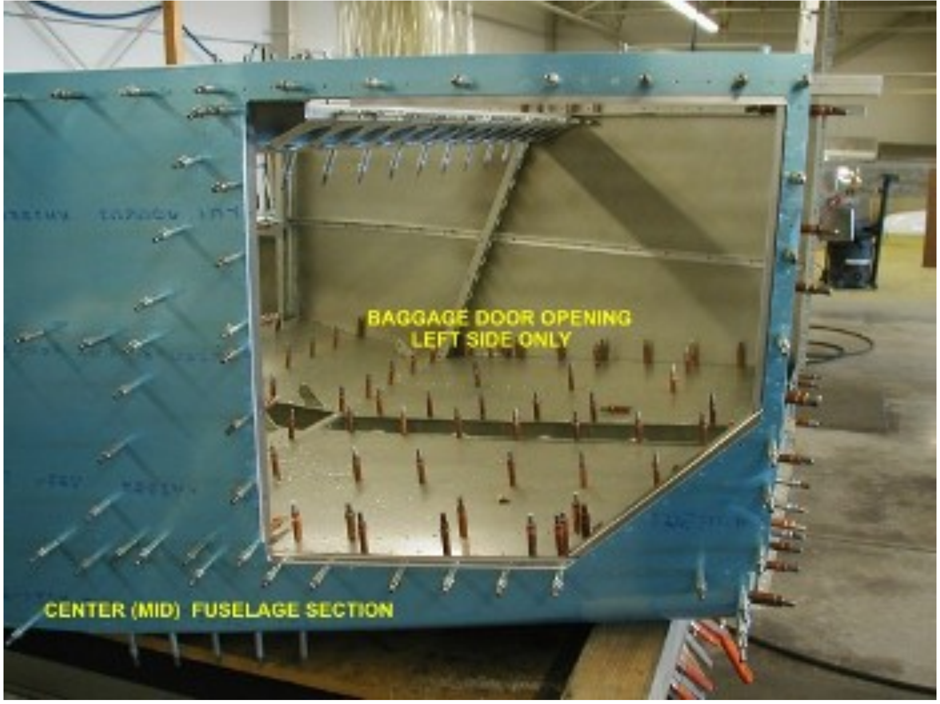
The other most frequently asked question is "when will it fly?" Well, we've never built one before either, so any answer is just guessing. My best guess is June 21, 2003 at 11:21 a.m. – and I've got just as good a chance of being right as anyone else.

The prototype shop continues to work on the fuselage. Scott McDaniel is making the plug and mold for the empennage fairing…a tedious task involving much sanding and careful finishing.

Click on the photo below to enlarge it.

Miles Towner and Phil Duyck are working on two versions of the mid-cabin. One is intended to be mock-up we will take to airshows. It will be a true representation of the cabin, baggage area, seats and wing root, so people can "try the airplane on for size." We hope to have this at Sun N Fun next April. What is known in engineerspeak as the "flight article" –in other words, the actual flying airplane -- is a few steps behind the mock-up. It incorporates many refinements and suggestions garnered from experience on the mock-up.

Click on the photo below to enlarge it.



Click on the photo below to enlarge it.

Forward of the firewall, the big news (literally) is that we have acquired an engine. If you are used to four cylinder Lycomings, this IO-540 is one big hunk. We used a lift truck and pallet jack to get it upstairs and put it on the floor behind Rian Johnson’s desk. He has the job of converting the engine into a dimensionally accurate solid model in his computer. Judging by the muttering and snorting, along with *sotto voce* questioning of various software writers’ intelligence and ancestry, coming from his cubbyhole, this is not a trivial task.

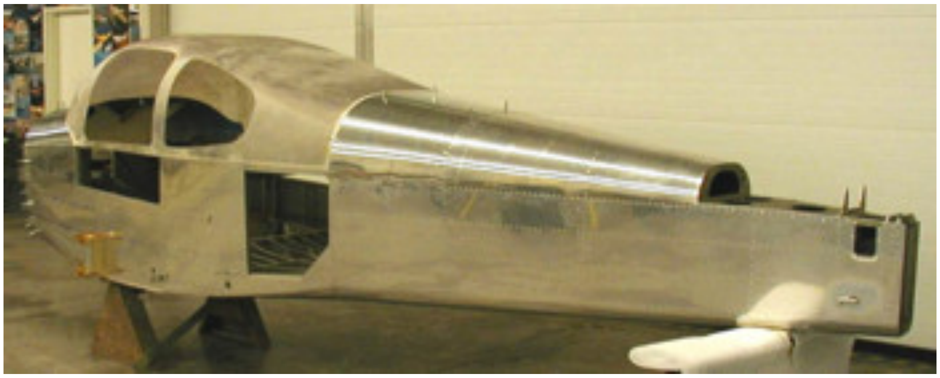
Once he's done, though, we will have the basic tool we need to design the cowl, the baffle system, etc.

On November 4, the tailcone and cabin sections of the prototype RV-10 were permanently joined. A mock-up composite cabin top was pulled off the upper cabin plug and temporarily installed on the fuselage. This will be used to refine the exact location and shape of the windows. At least on this prototype the rear window, shown behind the rear seat passenger's heads on some preliminary drawings, will not be installed. The baggage door is fabricated but hasn't been installed yet…we plan to use the access to help finish the baggage floors.

Click on the photo for a larger image.

The prototype cabin will sport Oregon Aero seats in the front, on rails so they can slide forward to let the rear seat occupants enter. Tentative plans for the panel include an ACS engine monitor, TruTrack 2-axis auto pilot, and VFR flight instrumentation.

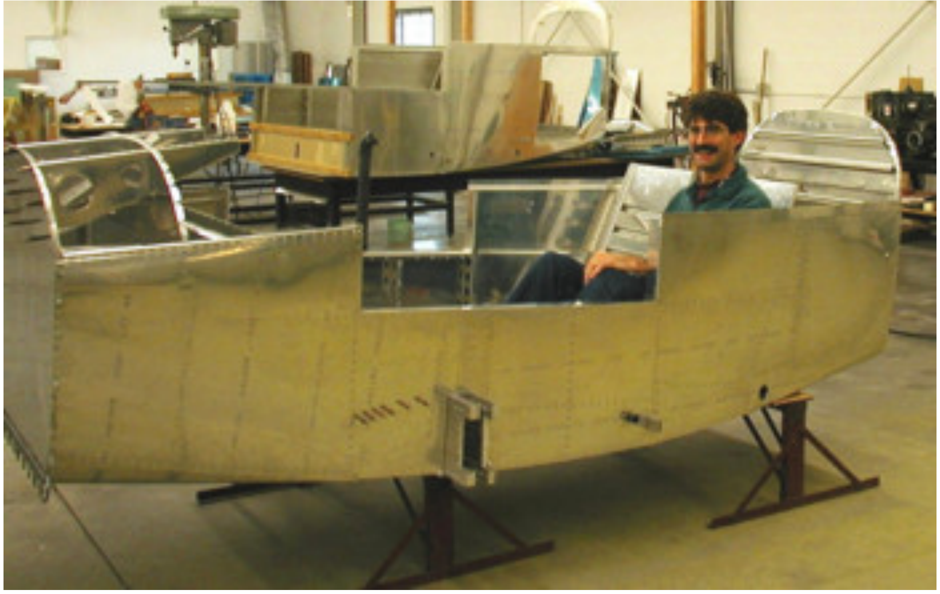
Landing gear components and the engine mount will be in hand in the near future.



Click on the photo for a larger image.

Component weights so far are encouraging, and we seem to be meeting our original goal of a 1600 lb. (727 kilogram) empty weight.

We are getting perilously close to the point where it *looks* like an airplane. But, as anyone who has built an airplane can tell you, at that stage there is still a long way to go. There will be a lot more long days, and maybe a few nights, before this airplane flies.



Click on the photo for a larger image.
Ken Krueger (above), trying out the back seating.

Well, here it is March 3, 2003. The RV-10 is once again in pieces in our prototype shop…but that's a good thing, as it allows several things to happen simultaneously.

Notice that there are no tail surfaces mounted. That's because the stabilizers, elevators and rudder are in the paint shop! Right. We are painting, which is a sign that the end of the tunnel is at least faintly visible. You get two guesses as to what colors the airplane will be. Hint: look at our last few prototypes. That big assembly strapped to the RV-10's butt is a rocket, but it's not there to make it go faster. Quite the opposite. Some intrepid soul is going to take this brand new airplane and put it in a spin. Lots of spins, actually, at different loading conditions. If, for some unforeseen reason, the airplane won't recover, the rocket will deploy a parachute, stopping the spin and stabilizing the airplane in a straight dive. A blade actuated by a manual cable, much like a glider tow release will cut the chute away and allow the pilot to recover the airplane, if not his equanimity.

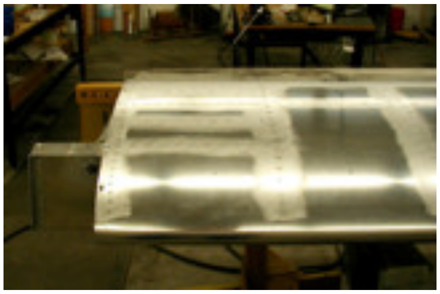
Click on any photo to view a larger image.

In the cabin, Miles is slowly and carefully making up all the wires behind the panel. It's a big job – this airplane has lots of radio stuff (MX-20, GX-60, SL-60, 4 seat intercom, Pegasus Flight Data Recorder, CD player and more) so there are a lot of wires! At least, in the 4-place airplane, there's more room to work.

Scott is tuning up the wings, getting them ready for the paint shop. Here's a couple of views and you can see some differences between the two and four-place wing. That torque tube suspended from bearings on the inboard end will take control inputs from the stick (remember, in the four-place the sticks are well forward of the main spar) and take them to the spanwise pushrod tube going out to the aileron. In this view, you can also see (if you look carefully) that the spar will bolt to the fuselage outside the fuselage side. This makes mounting the wings and control system simpler.

Click on any photo to view a larger image.

In the front view, there are several spanwise stripes on the inboard edge of the tank. These are wing walk stiffeners riveted into the top skin…again, feet are going where they don't on the two-place airplanes as the front seaters walk up to the leading edge to get in.

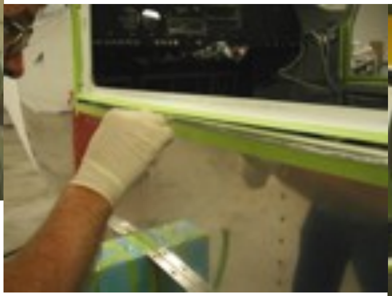


Here's a shot showing the altitude-hold autopilot servo mounted behind the baggage compartment. It drives the bellcrank and elevator pushrod with a small pushrod of its own.

In mid April we received the first cabin tops from our fiberglass supplier. After a careful inspection, Scott McDaniels began fitting one to the prototype RV-10 *(yes, it's an* ***RV-10****. We'd vacillated for some time whether to call it an RV-10 or RV-10A – after all, it does have a nosewheel – Van expressed his preference for the simpler designation. That settled the matter, and from now on and forevermore, it's an* ***RV-10***). It was exciting, seeing the "line" of the airplane for the first time.

Click on any photo to view a larger image.

As you can see from the photos, the "lid", as we call it around here, has recesses molded in for the windows, windshield and doors. The bottom door sill is molded into the lid, too, so fiberglass surrounds the entire door opening and gives the gullwing door a place for a positive seal. The door sills will be backed up by wood or plastic blocking to protect them from people climbing in and out. After initial fitting, Scott removed the lid and took it to our paint booth for filling, sanding and finishing. The materials are identical to the cowlings we've used for several years, so these processes were familiar…. tedious, but familiar. The lid was ready for permanent installation in about two days. Once the finishing work was complete, the lid was bonded and riveted to the metal cabin – about a four or five hour task.



Molded plexiglass blanks for the windshield, door windows and cabin windows will be provided in the kits. Although that big windshield looks intimidating, Scott had it measured, trimmed to fit with the edges finished and partially installed in a

day. Based on this experience, we expect that installing the windows in the lid will be considerably quicker and easier than fitting a canopy on the two-seat airplanes.

Today, as Scott works on the fairing around the front of the windshield, Miles is starting to fit the doors, with their hinging and latching mechanisms. This will be more involved than simply bonding in windows, and we anticipate some fit-and-try work on the prototypes. Of course, the more we learn on the prototype, the better the kit components will fit

Click on any photo to view a larger image.

Engine installation is complete, the cowling is finished and installed and a Hartzell prop is waiting patiently for the day when it will grace the nose. Plugs and molds for the gear leg and wheel fairings are well along.

photos below posted 05/09/03

Putting on the Tail

You know it's a different type of RV when you need to use a step ladder to work on the tail. Proto shop lights are reflecting off of the painted fuselage.

Click on any photo to view a larger image.

Above: Scott (blue coveralls), and Mike (green shirt) installing the elevators.

Below: Phil working on the engine.

Click on any photo to view a larger image.

photos below posted 05/14/03

Wings, Vertical Stabilizer, and Rudder

photos below posted 05/16/03

N410RV

The doors should be placed on soon.

photos below posted 05/28/03

Doors on and outside

Click on any photo to view a larger image.

posted 05/29/03

First Flight

Ken Scott

ALL GOES WELL ON THE FIRST FLIGHT OF THE RV-10

If you called Van's about 8:30 in the morning on May 29, and the phone rang and range…well, we have the best possible excuse. Most of the company was standing along the taxiway watching Van taxi the new RV-10 to runway 35. At about 8:40 the big six cylinder spooled up (quietly, with that big muffler) and the airplane was in the air in about 450 feet. Takeoff and climb out certainly looked like an RV!

With Ken Krueger and Scott Risan in the RV-8A flying chase, Van circled the airport for about half an hour, monitoring engine temperatures and feeling out the controls. They were just small dots at 5000', but those of us on the ground could all agree on one thing: it sure climbs well! Over the radio, we could hear Van describe the ailerons as feeling very good – not much different than the RV-9, which is a good thing. Pitch control was positive. He didn't exercise the rudder extensively, but initial impressions were very good. It was powerful, but not twitchy. Approaches to stall, at least at the weights and CG positions of this first flight, resulted in a descending mush without a definite break. Van says that he didn't really work the ailerons hard in this condition, but always felt he had positive aileron control, even when the wing was mushing. Low speed handling was reassuringly solid.

The RV-10 has a trim tab on both elevators. The one on the right elevator is linked with the flaps in an effort to minimize trim requirements as the big flaps go up and down. The ratios were well chosen, and the system will require only minor tweaking.

The only squawk on the whole flight was a vibration in the left gear leg at fast taxi speeds. The shop guys are investigating the brake disc and wheel balance.

As he climbed out, Van described the RV-10 as a very pleasant airplane to fly We tried to get him to show the RV Grin….the photos are being developed this afternoon (check back this evening or tomorrow morning) so we will see if we captured it on film.

We will have more performance data and flight impressions as flight testing continues, but right now nobody here really cares about the absolute numbers. The RV-10 flies and flies well, and there are a lot of people who have spent a good chunk of their recent lives involved in this project. They're all smiling this morning.

Click on any photo to view a larger image.

On the ramp starting the engine.

Taxi testing.

Employees watching the takeoff.

First flight 05/29/03

Click on any photo to view a larger image.

Taxiing in from the first flight.

Van with the RV grin after the flight.