Flying the New Elite!

Beautiful, elegant, and stylish to look at, and what a joy in the air! Scott took me up for a demo flight, and of course I loved every minute of it. Whenever any of you get the building blues, my prescription is for you to get in a Velocity and go flying. It’s good for at least another 200 hour burst of building time!

One look at Velocity’s new “Elite” explains why the factory’s prototype 173 RG Elite was such a big draw at Sun N Fun. People literally had to hover in line to get a chance to sit in it from either door. Once inside, everyone really liked the easy entry with the new gull wing doors. The Elite’s features include two gull wing molded doors, full length center console, canted panel, larger front window, & four moveable bucket seats, to name the obvious.

What is not so obvious is the testing that the factory has performed on its new model. “We here at Velocity elected to hang the plane by the wing attach brackets and then load the fuselage to simulate the amount of load the FUSELAGE sees at VNE X a factor of 2. We had previously calculated the amount of fuselage deflection we should see and this test verified our calculated numbers. We then rigged a measurement device in the airplane, and test flew the airplane to see if the deflection in flight agreed with the calculated and measured numbers on the ground. They did agree and as a result we feel very comfortable with our initial test result,” explained Duane Swing.

“From an engineering standpoint, the Elite is better/stronger than our standard. We use the continuous center console as a keel to support the landing/twisting loads and added carbon door posts for...”

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New Elite

Continued from page 1

strength and rollover protection,” continued Duane.

I had hoped to report the final numbers on the flight and load testing. But as things usually happen, there were some unexpected delays in the delivery of parts that the Swings needed to complete the flight instruments and avionics package. The Swings still have a few more flight tests to run. Duane will then release the final test results for publication in Volume 4.

Easy entry “gull wing” doors are among the new features of the “Elite” option

Three Velocities shown off at Sun N Fun

Scott gives the thumbs up for the New Velocity 173E RG, which was the focus of attention at the Velocity Booth!

Factory “Check-outs”: Be Prepared

Many of you who are reading this have spent a couple hours with Scott or me in the left seat of N81VA. Getting a check-out is an important first step in preparing for a long, trouble-free love affair with your Velocity. Nothing can ruin your day faster than a carrier like (ie almost crash) landing in front of friends, family, and other pilots. There is, even with a check-out, a good possibility that a bad landing is in your future. Why does this happen? Is there anything that can be done to improve your chances of not doing damage to your aircraft with a poor landing? The answer to this is a resounding YES.

Some of you arrive at Velocity for your check-out poorly prepared for what’s ahead. Poorly prepared means not current in anything, physically or mentally tired for any number of reasons, and most important, the attitude that “I can fly anything”. The Velocity requires a lot of concentration during the landing phase. Much more so than most airplanes. Concentration not only up to touchdown, but, beyond. Anticipation as to the tendency of the nose gear to fall through after touch down, and how to prevent this from happening. We can show you how to prevent this from happening, but, practice and CONCENTRATION are extremely important ingredients. A recent article by Le Roy Cook in Private Pilot points out many reasons why we don’t make good landings. I think it important that we review this article.

“There is a considerable difference between an adequate landing one that is safe and under control, if not viscerally satisfying and a smooth landing. The first type is skillful, the second is artful. If you want to get better, you have to

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analyze your performance, learn from your mistakes, watch for conditions that brought embarrassment the last time and seek fulfillment in the slightest improvement. Eventually it all comes together. Perfect landings are a matter of getting the details right all of them. That’s all there is to it, I’ll explain. You must understand what the airplane wants before it rewards you with a smooth landing. It begins, as your first instructor taught you, with a good approach: On speed lined up, power set, (speed brake out) and all stabilized, no changes until the descent is arrested at the flair. Why? Because a stable approach allows you to CONCENTRATE on the job of bringing the airplane into a touchdown attitude, something you can’t do if you’re wresting it back to the center line or fiddling with the throttle. Next, get the speed right. Most of us are flying too fast or too slow when we reach the ground. Get to know the proper speed for your aircraft and compensate for heavy loads, gusty air, cross winds, etc. Keep the plane close to the runway during the hold-off portion of the landing. You can’t allow it to stall onto the pavement from three feet up without a shiver of anticipation, followed by an expletive. Before takeoff, note the appearance of the runway in the windshield and side window. Try to stay just a bit above that during your landing. Next, work on eliminating side drift and misalignment, two things that can ruin an otherwise nice landing. Many pilots drop a wing unconsciously as they make a flare. The touchdown then occurs with lateral movement across the runway. The same thing happens in a crosswind. If you don’t lower one wheel to the runway just a fraction before the other, the current of air will drift the airplane during touchdown. Apply aileron and rudder to battle a crosswind during the rollout: Keep flying the airplane. Remember, the word is details. Smooth, grease-job landings are not the result of luck, they are the result of plenty of work, practice, and concentration.”

Well, this just about says it all. The Velocity is different but easily managed if you’re prepared. If your pattern is not the standard type: ie; diamond shaped or not much pattern at all, then how can a standard type approach be made. I have had private pilots fly a downwind so far out that we cannot even see the airport. On the other hand, I’ve had some that fly the downwind so close that any turn to base results in missing the final approach by a mile. I’ve had some who will not start a descent from pattern altitude until well into the final approach and a go-around is the only option. Speeds will vary from 80 knots to 140 knots “IN THE PATTERN”. Altitudes will vary + 500 feet “IN THE PATTERN”. These are things any private pilot should be able to handle easily. If you can’t, you need more training in your 172 PRIOR to seeing us. We are not here to teach you how to fly. We’re here to show you the difference necessary for a safe transition into a Velocity.

Work hard on your own. Make yourself follow precise pattern and speed control. Practice NO FLAP landing in the 172 or Cherokee, You’ll be much better prepared when you see us. It’s been said that a successful flight is one that all the landings equal all the take offs. Perhaps true but lets make those landings memorable because they are sooo good.

Duane

It’s hard to believe I’m preparing yet another letter for our Velocity views. We have survived Sun-N-Fun since the last newsletter, and those of you who were there could see, first hand, the reaction of the visitors to our new Elite. Yes, we made it. In spite of the many critics who said “no way,” we did it. Our sales roster is full thru November as a result. By the time you read this we will have completed all the testing on the Elite.

Our annual Velocity dinner had a record 122 people in attendance. We had planned on having the dinner hall all evening for fun time, however, we were told at the last minute we would have to leave due to a large waiting list on seating. Next year we have made arrangements for a much larger room with a catered all-you-can-eat help yourself meal. We will have it for as long as we want with more time to answer questions and have fun. Our Oshkosh dinner is scheduled for July 28th and will be held at the Oshkosh Hilton. Be sure to RSVP with us at the factory, or stop by our Oshkosh booth (which will be in the “main aircraft display”) at least 24 hrs prior. The Osh Velocity Forum will be held on July 27th in Tent 3 from 11:30 - 12:45.

We have added another employee to our growing list, his name is Martin Hadley. Martin will be heading up the radio and instrument part of our business. He will be responsible for the pre-wire of radio stacks along with complete instrument panel layout and installations of just about anything your heart and pocket book can handle.

Call Martin if you want a quote on any or all of your needs. Martin has also just completed the building of a Velocity, so he is very knowledgeable about building and placement of goodies so everything will fit.

We are also making a change in our engine instrument supplier. We will no longer be offering the DPS brand. I have worked out a deal with J.P. Instruments and will now have all their products at prices less than any other source you could find. J.P. makes a very “panel friendly” line of instruments called the Slimline. 1” X 2” and stackable, along with engine monitors etc. Call us for prices before you order from any other source.

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Factory News

When installing the elevator counterweight fairings, set them forward far enough to clear the counterweight as it goes through its motion. The fairings are not big enough to cover the weights with the elevator up (nose down). They are there to deflect the air with the elevator in the neutral position.

The Matco Brake system caliper mounting plate has been somewhat of a mystery, but I think we have it figured out. After talking to them, it turns out that they have been packaging two brake systems for the same side. This will not work in any application and I asked them about that. They said that you have to flip the plate and grind off the bushing to get things to line up. This was not acceptable to us and I am sure not to you. They told me that if you, the customer, have this situation, they will take care of it directly. The only thing you should have to do to the system is drill out those two holes and maybe file a place or two. Matco telephone: (801) 486-7574.

The Matco brakes have the potential to be much more powerful than we need, but since the amount of fluid we have to move has increased, this extra braking has been hard to get. Getting more travel out of the system has worked in the past, and this is how it is done. Pull the roll pin out of the push tube assembly. Back the push block off the threads until only half of the block is threaded on the rod. Slide the pedals back until the push block is exposed or even hanging out slightly. On the sides of your fuselage, make some stops that limit the pedals from coming back any further. These stops can be made out of two 3” pieces of the I-beams that you have. Turn those “I”s into “T”s and taper the web. Screw them onto the side of the fuselage with four #10 sheet metal screws on each side. This will give you more pedal movement. You may have to adjust the cables to get everything working properly. Make sure you don’t bottom out the cables to the rudders. If it seems you don’t have any choice, then find some real HEAVY springs to put in line. This will allow extra movement without damaging the cables or rudders. We have found something interesting when bleeding the brake system. If you have a brake that feels like it has air in the line, but you can’t find any, have someone push the brake down slowly while you look at the tubing coming out of the master cylinder. Sometimes air gets trapped in the master cylinder that normal bleeding techniques just won’t cure. The only way we have found to get the air out is to push the brake down slowly and, as the air becomes exposed, loosen the fitting and let the air escape, then tighten. Don’t stop the pedal movement as this will not force the air out. After this procedure is done, re-check to see if you got all the air out.

A few of the modified overcenter linkages were shipped out without being checked for proper operation. All this means is that the alignment and pin grooves were not checked under load to insure that no binding would occur that would prevent retraction. When you fit your linkage in the plane, you should check this operation by putting a load inboard on the locking arm and making sure that the arm goes up and down smoothly. We check them for smooth operation but you should re-check them as they are installed in your plane.

With the new molded keel and canard bulkhead, the mounting of the brake master cylinders is a little different. The rudder pedal assembly will sit on the top of the keel and, to get cylinders to line up, they need to be mounted as high as they will go on the molded-in box. The marks are already on the box, so this should be clear. If you have to, you could groove the keel and re-glass with 4 BID, in order to lower the pedal assembly slightly.

When ordering parts, whether it be checking on a backorder, getting something new, or getting a replacement, ASK TO TALK TO DAREN. This doesn’t include radios, since this can be more involved. When more than one person is handling this, things can get mixed up.

All of the ELITE instructions (wording) are finally done. The drawings are being inserted now, then it will go to Jim Foster for integration into the plans. Those of you that are pushing forward may want us to send you a set (like the set going to Foster) so you can go on with more direction. Please let us know.

There has been some question about the speed brake on the Retract airplanes. We have decided to make the speed brake an option on the Retracts. When the gear is down in a retract, it produces more drag than the fixed gear with the speed brake down. This will lessen the complexity and make it simpler to build. This option will cost about $125-150.

Kit Plans Changes

“KPCs”

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When installing the bottom strakes, the plans mention the leading edge being “no more than 2 inches;” (standard), or 3” (173), above the bottom of the main spar etc. On the standard airplane, you should put it at 2” ± 1/8” and on the 173 model, at 2-7/8” ± 1/8”. The original statements were not specific enough.

The markings on the bottom fuselage for the nose gear door cut out are slightly skewed to one side at the rear. The front seems to be okay. This has not been a problem, but you should plum down to the center of the fuselage, drill a small hole, and check and modify the pre-marked
Mail your technical questions for Scott Swing to Velocity Views Newsletter. Both your question and Scott’s answer will be published in this section in our next volume.

Q: From John Bros
The enclosed article from the June ’95 Kitplanes entitled “Caution: Modify at your own Risk!” reports that the removal of the removal of the lower winglet created an unexpected problem. What is Velocity Co. position on leaving off the lower winglet?

A: This letter is concerning the lower winglet removal and the flight characteristics that follow:

Back when we lived in Ohio, we built our Velocity without the lower winglets because we saw other canard type airplanes without them. We also knew that if the effects of such a modification were undesirable, we could always add them. After we flew the plane, and others with the winglet bottoms in place, we couldn’t tell the difference. Logically speaking, you should have a little better yaw stability with the bottom winglets but pitch stability should not be in question.

After purchasing the company, we didn’t change the policy that the original owner had which was, leave the winglet bottoms on. We have never done extensive testing on a plane without the winglet bottoms. Doing stalls (pitch bucks) which have been done, is not considered extensive. We would have put the bottom winglets on the prototype Elite but we were short on time and left them as Dynamic Wing assembled them.

Those of you who do not put the bottom winglets on, are on your own. Even though we haven’t seen any problem with this change, sufficient testing has not been done to allow us to say - do it. We will probably do some more testing in the future to see what characteristics, good or bad, come as a result of this change. The testing has to be done on the same airplane since each airplane can be different enough to give different results. When we do this, we will be sure to include it in a newsletter.

The statement “As I understand it, Velocity Co. now approves of their builders leaving off the lower winglet on either of the wing models”, is not the case. We have never made this statement.

I hope this clarifies our position on this matter.

Q: From Brent Bourgeois
Is it possible to mount an IO360 A1A or any prop side fuel servo engine without the ugly belly scoop? How about a way to deliver efficient ram air to this type of engine? Any ideas for an air filter in this type of installation would also be appreciated. Drawings or pictures would help.

A: It may be possible, however, not having done it it’s impossible to give you instructions or pictures. One of the real pleasures of building your own airplane is to solve this kind of problem and then pass on your “expert” advice to others who have the same problem. We don’t see too much of this happening in our Velocities, everyone wants someone else to do it first.

You also are asking for an economical source for prop extensions & crush plates, Lord mounts, and Weldon fuel pumps.

I know no place you can purchase these items less expensively than here at Velocity. Our Weldon pump sells for $389.00 vs. Spruce at $472.00. The Lord mounts are $143.00 per set - the same as Spruce and the prop extension is $525.00. Spruce doesn’t offer an 8” extension, but, all prices I’ve seen are at least the same. We had one customer machine his own and lost his prop 30 hours later. It is possible to find a lot of these items in an aircraft junk yard if used parts are OK with you.

Q: Someone asked about either pre-molding the strakes or, at least, marking the side of the fuselage so builders would know where to put them.

A: Here is the dilemma as easily as I can explain it: We could pre-mold the wingstrake/fuel tanks and deliver them tested and ready to install. This would cost a lot of money and the price of the kit would rise. All of the strake baffles would have to be pre-molded with a flange, jigs would have to be made to index these parts, allowances would have to be made for the wheel wells, split molds would have to be made to close the tanks, etc...a lot of work.

The other idea about marking the side of the fuselage is also a problem and here is why. If we had the marks on the fuselage side, you, the builder, would have to level the airplane based on the mark. Since the leading edge of the mark is on the top fuselage, you would have to install the top fuselage in order to level the plane. If you didn’t do this, and you leveled the airplane without considering the pre-drawn lines, the angle of your strakes may or may not be right. No matter where your fuselage is, your wing strake angle of attack needs to be right in relation to your wing. If and when we decide to do either one of these things, we will come up with a way that you, the builder, can’t do it wrong. This may involve the factory putting a level in the fuselage before it gets shipped out, or another level jig. Whatever it is, we will be sure it is going to work right before we do it. I hope this answers the question. What sounds like an easy thing to do isn’t always that easy.
I spent a day with Alan and Dale Shaw at the Dynamic Wing Company in Melbourne Florida. As you can see, I took lots of photos which show their professional techniques for building a wing in a vacuum mold.

Wings everywhere you look! Note the carbon fiber (black) that shows up in the wing root and well.

The benefits of having Dynamic build your wings include saving builder time, good cosmetics, and stronger wings. Their wings are stronger for a number of reasons:

- Vacuum bag mold construction pulls everything in tighter
- Additional glass used in key stress areas (double overlap on winglet leading edge as an example)
- Use of carbon BID (15oz) in all well areas (wing roots, aileron, rudder, elevator wells & attach areas), provides better stiffness and strength.

Alan Shaw said that at 200 MPH you get a 600 lb side load on the winglet. “When something breaks, it first Sheers, then buckles, then the top side breaks,” he explained. Dynamic adds a Sheer Web (use tri-ax) in the thickest part of the winglet (cut down the middle with a ban saw, 8” from LE at bottom & 4” at the top. They also double overlap the leading edge.

Mixes in Cab O Sil with Microballoons to make a slurry mix that is strong, light but will not ouze. Example of uses: between the spar/top skin (shown above) or for fuel strakes.

Dale shows us the nav antenna fit into the LE wing foam core.
Dynamic Wings
Continued from page 6

John Fleming applies a Safe t epoxy slurry to the mold surface.

An Alpha slurry is applied to all foam cores

Shear web going on to the winglet, transfer layup with triax

LE foam cores placed in the mold as this incredible display of teamwork, planning and organization puts it all together! They use a checklist to be certain that every detail is attended to.

The Winglet foam core halves are matched up with the shear web in place down the middle.

Wing spar is fitted into the mold as the team races against the clock to keep on schedule. Note that the spar is pre slurried.

Wing attach bolts & layup for hard points, 2 BID, put a cab o sil slurry around the wing attach area for a smooth connection.

Glass is wet out prior to fitting the foam cores into the mold

Glass is wet out for transfer layups once the foam is laid in the mold, in this case the winglet skin.

Winglet skin is transferred to the mold (glass pre wet on plastic)

The team races to bag both wings!
A Letter from Alan Shaw of Dynamic Wing Company

We need to let your readers in on what’s been under development here at the “other” Velocity factory. Our goal is the same as our partners, the Swings, that is to continue to make a great airplane even better. What’s different is that we are focused on the wings and builder training.

A few years ago when Duane & Scott bought Dan’s 90% of Velocity I flew my old (88’) Velocity from L.A. to Oshkosh to help out and get to know my new partner. Having not worked at Velocity for about 4 years because Dan had stopped all development and marketing I was elated with Duane’s capabilities and intentions. During that show week we both agreed that the wings where too labor and skill intensive. We also recognized that some of the new builders needed a training program. Since I was tired of building high tech tooling and airplanes for other people thousands of miles from home I said I would come back and tackle these problems.

Duane and I both agreed that existing molded wing processes were just too complicated and resulted in a structure just like a metal wing which does not utilize the advantages of composite sandwich properly. So initially me and some of my old Velocity crew began by trying to streamline the hand made method. The only development was better sanding and filling technics. It was vast improvement but not the break through we were looking for. While sanding and sanding and sanding some more, as you well know, I had time to think. Recalling some windsurfer molds I made in the mid-80’s I didn’t know why it had never occurred to us that we could build wings this way also.

John Fleming (my wife’s little brother) and Malcom Collier (my airplane assembly and tooling buddy) both agreed...why not! The wings are bigger and have more pieces but have only singular curves. Windsurfers have complex compound curves which made the core fit critical. On the other hand the wing cores are thicker and more rigid so would they conform to the mold under vacuum pressure?

We started with the canard because it would be easy to mold and it is always difficult to make them by hand that are straight, not twisted and of consistent camber. I jigged one up with lots of camber, the same way I’ve been building and flying them for years, because I like the safety of the lower landing speeds and shorter take-offs. Then John, my best contour man finish it out, I flanged it, scribed it and we pulled a mold. Then we made our first molded solid core wing. It came out beautiful except one problem. The vacuum pressure assembled it so tight that it was 1/4” short in cored length. That was easy to fix so we built two dozen more and sold them. Our canard weighs 32# compared to the standard’s 30# because even though the vacuum mold pulls out several pounds of resin I’ve added to the lay up 5 more uni’s tapering towards the wing root and carbon full length on both sides. So much for flapping canards and rocket landings. A great airplane just got better.

Soon as the first few canards were popped out we had the confidence to try wing molds with the winglet attached. Since 173’s were selling good and there 20% greater size requires 50% more sanding time we decided they would be useful molds. When the molds were done we had a big investment and I still wasn’t sure how well something this large and complex was going to be orchestrated. In pre-pregs it would be easy but with wet layup we only had two hours to wet out 3/4 of the total wing and winglet structure and get the vacuum bag sealed and down tight. We did dry runs including a vacuum bag to be sure everything fit and we could get the required minimum 1,500 pounds / sq. ft. of pressure. Then I spent an extra week going over proposed procedure outlines trying to anticipate problem areas. Finally I told the crew let’s do it. To our amazement it went like clockwork with 27 in. vacuum (1,944 lb./ sq. ft.) inside of 90 minutes. The next day we pulled the bag off like kids under a Christmas tree. Wow... everything was so tight to the spar. After a little clean up we installed the rudder conduit, antennas and winglet knuckle brace. On the third day we did the bottom skin, outside winglet skin and final winglet attachment layups. This was also bagged but we used a bleeder sheet and only 16 inches of vacuum (only 1,152 lb./ sq. ft.) to get the ideal fiber to resin ratio. In both these of these procedures the winglet and wing skins where overlapped and co-cured under high pressure with the nine layer attach reinforcement. I also added 33% fiber content and a simple spar to the winglet to further increase the winglet load capability. This along with the rigid carbon ailerons connected with 4130 steel torque tubes and our stiff canard up’s the Vne for 300 hp engines.

Once the wing was all done we waited an agonizing two day’s before popping it to see what we really had. I didn’t want to pull it out to green because the trailing edges might bend slightly. Finally we gently coaxed it out of our new mold and flipped it over. Unbelievable, it worked. In 30 seconds months of reservations evaporated. Who said hard work can’t be exciting! Somebody said, “Hurry up get it in the scale” 96 pounds, not bad for a wing of this size and strength. Now all we had to do was trim it up, fill and contour sand the bottom. What a luxury, the wing twist was set and all three winglet angles were set by the mold. I cannot believe the work we could have saved everybody if we had figured this out a decade ago when Dan and I built the first set.

Well now that we had a 173 mold everybody was ordering standards. Rat’s, back to goop and grind. So we made a few sets of

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experience, long hours of work, and a substantial investment don’t guarantee success. The hard fact is that all the wings sold to date cost approximately 20% more to produce than what we sold them for. With our present production rate running somewhere between 2 to 3 sets per month, we should be breaking even on what we are producing now. This leaves us with some tough decisions to make regarding future pricing and development.

Presently we are working on a new tooling process that should complete the whole wing in one step. We are also completing resin coupon test and have built our first wing with the sole intent of breaking it. We have all the components and are completing construction of a hydraulic device similar to what is used to achieve standard certification. It has more than 15,000 lb. capability and will be most effective for doing multiple high “G” load deflection test on composite wings. In theory, and according to calculations made from coupon test, our pressure molded wings should be stronger.

Looking back at the last two years we are proud to have delivered 40 quality sets of wings. But – like most people in the business – standards with the stone age technique and pulled a mold off one of them. This gave me some more sand and think time that got me thinkin’ about what pain in the butt ailerons were to make. Since there are so many critical steps and it took me years to learn how to really build them right I never bothered to try and teach any of my employees. Elevators are not as simple as they look either. So I got a new idea (for me anyway). Why not build a hinged clam shell mold and put the whole thing in an envelope vacuum bag. It worked. They came out so light and stiff, always balancing nose down. The lay-ups are continuous, from the trailing edge right around the leading edge and back again. Everything is co-cured with no secondary splices or stress risers that could fatigue and let go at high velocities. A very safe airplane just got safer.

Looking back at the last two years we are proud to have delivered 40 quality sets of wings. But – like most people in the business –

**CSA Fly-in to Tailwinds**

On Tuesday April 11th (Sun N Fun week), Velocity Builder Jack Fehling sponsored a CSA canard pusher fly-in to his beautiful home in Jupiter Florida. Jack’s home is just off the approach end of runway 27 at Tailwinds Airpark. I counted 31 canards that flew down from Sun N Fun for a great lunch fly-in. This was truly a first class event appreciated by all attendees! Only 1 Velocity (Mike Hampson) made the trip. Hey guys, lets hurry up and finish those Velocitys so we can make a good showing at these CSA fly-ins!

The Fehling’s home, just off the approach end of runway 27 at Tailwinds. Jack’s Yellowbird Vari EZE “N444EZ”, parked in front of his hangar (some hangar!), nervously monitors Jack’s progress on his Velocity RG.

28 Long & Vari EZs & Cozys all bow their heads to Mike Hampson’s Velocity.

Jack shows his home made sanding board that has given him a great looking finish on his wing.
Good things start off small!

Velocity Bahamas Fly-in
First Annual Event!

by Judy Lavoie

Those who joined the first annual Velocity Bahamas Fly-In have already signed up for 1996! Our rendezvous at the Coconut Cove Hotel resort in George Town, Great Exuma, surpassed our expectations. Hosts Pamela and Tom Chimento made us feel like royalty, with plush white terry guest robes over our bathing suits serving as the most popular attire. At Coconut Cove, we had it all – comfortably furnished guestrooms with lots of extra touches, exceptional breakfasts and dinners enjoyed “al fresco” on the wide porch, poolside thatched-roof bar with bartender Fuzz’s exotic rum concoctions, and steps away to the private crescent-shaped beach and clear Bahamian water. Rain showers dampened some plans for scuba diving, but those who snorkeled reported colorful reef fish and even a ray around the coral formations just off the beach.

In between Pam and Tom’s unending pampering to our needs, Tom had a chance to show us his Velocity. Checking on Tom’s progress were Florida pilots Jean Prudhomme (flying his Velocity 173 RG) with his assistant builder – and sidekick – Gus Cardin, and friend Danny Lassarde; Rick Lavoie (building a Velocity RG and currently flying a Long EZ) and his wife Judy; and Ken Traylor (Long EZ builder and pilot) and his wife Lynn (Velocity wanabees). Much to our surprise, we learned that neither Tom nor Pam had ever flown in a Velocity, and both are currently in training for their private pilot licenses. Jean treated Tom to a right-seat tour in N242JP, and Tom was reportedly sanding his wings faster than ever for the rest of that day! The buzz and sight of three canards over the island brought guests and hotel staffs running out onto their beaches and made Pamela’s phone ring with local sightings from the marina in town.

The new Exuma International Airport at Moss Town, with its 7000’ runway, proved to be one of the nicest facilities you’ll find in the Bahamas. The friendly service we received at Customs reflected the kindness of everyone we encountered on this tropical island.

The second annual 1996 Velocity Bahamas Fly-In is scheduled from Friday, May 17th with departure on Tuesday, May 21st. Pamela has blocked off all ten rooms at Coconut Cove, so make your reservations early by calling 1-809-336-2659. Feel free to alter (early or late departures) the schedule to fit your needs. You do not have to fly in a Velocity to attend. You just need to be part of the Velocity family (builder, etc.). For particulars on room types, etc., please refer back to Volume 1, page 9. If you plan on attending, book ASAP by calling Tom or Pam at Coconut Cove. Once the 10 rooms at Coconut Cove are full, Tom will book any overflow at the “Beach Inn”, which is right next door to Coconut Cove. Also, be sure to let Rick know that you plan on attending the ’96 fly-in.
OVER THE YEARS, THE MOST FREQUENTLY ASKED QUESTION FROM HOMEBUILDERS HAS BEEN, ‘WHERE DO I START WIRING MY ELECTRICAL SYSTEM? IS IT BETTER TO START AT THE SWITCHES AND WORK OUT FROM THERE, OR START AT THE ENDS AND WORK TOWARD THE SWITCHES?’

My answer has always been the same. “Your aircraft electrical system starts in a comfortable chair with a cool drink beside you, and a notebook and pencil in your lap.”

Sound too good to be true? Well then, you’ll be floored by this. You can do 85% of your electrical system in the comfort of your own home, sitting or standing, which ever your workspace is best suited for. Here is how you do it...

Take your notebook and on the first page make a list of everything in your airplane that has a wire going to it. List each radio, indicator, interior or exterior light, gear warning system, everything. If you have cabin lights, list them separately so your don’t overlook one. Nothing is more frustrating than to have wired your airplane and realize that the wire for the aft cabin light was left out! You will be referring back to this list often so don’t forget anything. Let your list set for a day or so, if necessary, and then check it for any omissions.

Next, draw a line under your list. Virtually every pilot I have known who has owned an airplane has added something to his plane by the third of fourth year of ownership. This is our “Wish List”. (If you are building your plane to attempt a world class speed record you may omit this step.)

If you’ve ever had the opportunity to stick your head up under the panel of an older airplane, you know first hand how bad an electrical harness can get. It’s often called a ‘rats nest’. It gets this way, a lot of times, because one system after another was added to, and on top of, the original harness. The goal here is to pre-wire your aircraft for realistic ‘wish list’ items that will be installed in the next few years. What this also means is that when you do get around to adding your ‘wishes’, you won’t have to tear your airplane apart to route wires and coax. Just connect the proper connectors to your stowed harness and mount the hardware. The argument that current radio equipment and electrical systems will be different in a few years might be true, but the current generation of radios such as the King KX 155 and the NARCO MK-12 D&E have been around for most of the last 15 years. Same goes true for such systems as the Whelen strobe lights. In any case, you know you will need the basics such as power, ground, dimmer, and in some cases, audio wires. You are the one to decide whether or not you want to do this step. If it is done with reasonable optimism, you’ll be glad you did it.

Once you have determined what is going to be in the airplane, you need to make sure you have the proper wiring diagrams, or interconnects, for your specific systems. There are numerous manuals for basic aircraft electrical systems such as Nav/Position Lights, Landing and Taxi lights, and so forth. Getting diagrams for your radios and such can be a little harder. Most new radio equipment will come with wiring diagrams. If not, contact the manufacturer of the radio system you are going to use. Tell them that you wish to prewire your plane for that system and most manufacturers will help you out.

Now, you have established what is going in your plane and you have the proper wiring diagrams to do it. Most diagrams will specify the proper wire sizes needed to do the job. However, if they do not, there is one source you can use to determine the wire size you need for anything, provided you know two things:

1. How far am I going to run the wire?, and
2. How much current (amps) does the circuit use?

This one source is also the best $15.00 you will ever spend on your aircraft. I promise. That source is from the Government Printing Office (GPO) and is called AC 43.13-1A and -2A. It is the aircraft bible of an airframe and powerplant mechanic (A&P). The GPO has outlets in most major cities, however, any bookstore can order from the GPO.

What you have accomplished so far is about 20% of wiring an airplane. Armed with the information you have generated yourself, you are ready to get down to business. Please, stay seated unless you need to refresh your drink!

Draw a likeness of your airplane, canard or conventional, whatever. With your ‘checklist’ and your diagrams, draw in the ‘wires’ for your left wing. (This whole process may take more than one piece of paper.) If you have a composite or wood and fabric airplane, remember that you will need to run at least one ground wire out for lights, pitot heat, whatever. A separate ground should be run for each item on your list. For whatever reason, one wire providing ground for an entire wing could break and all systems would quit working. If you elect to run just one ground wire, remember to size it for the total current (amps) of all the systems that will be grounded to it.

Once you have determined what wires are needed for the left wing, do the right wing, the aft cabin or engine/cabin (in the case of a ‘pusher’) and forward of the instrument panel. As soon as it is convenient, take a tape measure and measure the route in which these four separate harness need to go, noting distances between bends, such as where the harness might go down to the floor from the instrument panel to where it bends to go aft, and where any given system wire has to ‘break out’, such as a pitot heat in a wing harness. Whatever you do, measure ‘comfortably’. Remember, we don’t want these harnesses bow string.

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tight. For reasons that will be clear when you go to install your harness, take the measured distance and add 10%. Trust me on this one. It is easier to cut off a foot than to add 2". (And butt slices in a new electrical system look... well, just do it right the first time!) You are now 60% complete with your electrical system! You have done two major things so far. First, you have established the ability to make what is called a wire schedule. You don’t have to guess how much wire and what sizes you need to buy. You know exactly what sizes and you can total the lengths so you don’t have to buy 300 feet too much (or 100 feet too little!). Contrary to popular belief, one size does not fit all! Second, and most important of all, you have already wired up your plane in your head! With all of this accomplished in the comfort of your own home!!! The only thing left to do is the mechanics. You can still do the next 25% of your electrical system in an environment of your choice. Once you have purchased your wire and your RG 58 A/U coax (I’ll discuss materials at the end of the article), find a clean workbench about 8 feet long and wide enough to reach across, and several “C” clamps and/or nails. What you are about to do is prewire and secure (lace or ty-wrap) your four harnesses (left, right, fore, and aft). At one corner of the bench, attach a “C” clamp. For harnesses over 8 feet, secure a second “C” clamp at the other end of the bench. If your harness is over 16 feet, attach a third “C” clamp near your first clamp. For a 24 foot harness, attach a fourth “C” clamp near your second clamp, and so forth. When you go to lay your harness out you will run (zig-zag) the wires between clamps on the opposite ends of the table. If, for example, we need two 18 AWG wires for our Nav light (1-18 feet to our switch, 1-22 feet to our ground bus), two 16 AWG wires for our pitot heat (1-14 feet to our switch, 1-18 feet to our ground bus), and three 22 AWG wires for our gear position switches (all 9 feet to your warning lights), in our left wing, this is how we make the harness... The first clamp we put on the bench represents the end of the wing where the Nav light is. Secure two 18 AWG wires to the clamp, 1-18’ long and the other 1-22’ long. Run (zig-zag) the wires around the second and third clamp and tape the ends to the top of the table. (If you can visualize this, you can see how easy this is going to be!) Since our Nav light and Pitot switches are located in the same area on the instrument panel, you start your pitot heat switch wire (16 AWG -14’ long) were your Nav light switch wire is taped to the table and run it with the Nav light wire toward “the end of the wing”. The wire you just put in the harness should go around the third clamp, back around the second clamp toward the first “C” Clamp, for those who haven’t quite got the picture yet. The ground for the pitot goes to the same place as the Nav light ground so tape it down at the same place where the Nav light ground is taped down. This wire should now be routed along with the other wires in the bundle. By referencing where grounds, switches, and harness ends are, you can make your own harnesses up on the bench. This is a lot simpler than laying on your side or your back, trying to route one wire at a time. When you have finished laying in all the wires that you need, you can start securing your harness. This can be accomplished in three ways... First, if you are using conduit in your plane (Nylon tubing, Aluminum, fiberglass, etc.) all you need is masking tape. Put two wraps of tape at the ends, three wraps at key breakout points (i.e. where the pitot heat wires breakout from the main harness to the pitot heat), and two wraps at approx. 1 foot intervals. As you pull, or push, your harness into the conduit in your aircraft, remove the tape. The whole idea behind conduit is for easy installation of, or removal of, one or more wires. If you leave the tape on and you need to remove one wire, guess what?

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first 8’, remove the harness from the first clamp and swing the harness around so that you will tie your harness ‘in a straight line’. If you tie your harness up as it is wrapped around the clamps, it will want to keep that shape. (With that in mind, and some good planning, your can actually tie your harness so that it will shape itself for the bends you will need to route your harness comfortably in your airplane. A straight harness will route adequately, its just not as professional looking.)

You will probably want to ‘tag’ your wires before you tie your harness up. At this time, masking tape works great. Once your harness is in the airplane you can remove the tape so it won’t be as messy under the panel. I’m often asked then, “How do you know what wire is which then?”. If you take your tags off after you have hooked the wires to the switches, circuit breakers, or whatever they are going to, the wire going to the Nav light switch certainly can’t be for the fuel boost pump! If you like, get some small white shrink tube and a fine point permanent marker. Write your wire name (or number) on the shrink tube and then shrink it on the wire approx. 1 1/2” from the end of the wire. This works great inside the plane but won’t last forever in an oily, greasy environment such as the engine compartment. In this fashion you can permanently ‘tag’ your wires.

Your harness(es) is/are now tied and tagged, but not quite ready for your airplane. Wires that are going to the switch panel can be ‘broken out’ individually, tied, and terminated (ring terminals installed) so that all you have to do in the airplane is hook up the proper terminal to the right switch. Say, for instance, your switches are spaced 1” apart on your instrument panel. If you have already determined what switches are for what system, then it is just a matter of breaking out your wires to correspond with your switch placement. The same can be done with your ground wires, instrument dimmer wires, etc. You should always leave enough wire length to allow at least three terminal replacements (approx 1 1/2 inches).

Congratulations! You have just completed 85% of your wiring job in the comfort of your own home. All you have to do is route the harnesses in your aircraft, secure them to the airframe, and hook up the loose ends. Instead of spending two weeks running one wire at a time, you’ll spend, at most, two days routing and connecting wires to the appropriate system fixtures.

A professional job is one that evolves out of good planning and good technique. Just a little effort can make the difference between a rats nest and “GOOD JOB!”

ABOUT MATERIALS

BUY aircraft quality electrical supplies. Period. You can buy a cheaper gyro, you can shop for a good price on your radio, you may have to purchase a less expensive leather for your interior, but none of these items are as prone to starting a cockpit fire as the quality of your wire, terminals, switches, and circuit breakers. Yes, this is the experimental market. But when it comes to building in, not potential, but probable, electrical failures that might be VERY costly, the money you spend up front may be the best life insurance you ever bought.

The argument that there are alternatives, that these products or those products are OK to use, might be good with both feet on the ground. I personally want to stick with supplies that have been designed and tested for aviation use. Wire, Coax, Circuit breakers or fuses, terminals, and switches, these are items that I want to discuss.

Wire: There are three types of wire that you want to use, all of them are Mil Spec wire. Of the three types, there are about 10 to 20 variations of each type. The variation is not important, the type is. FIRST; MIL-W-22759/16-XX. This wire is a single conductor, multi-strand type, that is the most popular aircraft wire on the market today. The only part of that number that really concerns you is the 22759 and the XX. The XX is the gauge wire size (AWG). For instance, if the XX was 20, then the wire size would be 20 gauge. If XX was 2, then it would be 2 gauge wire (battery cable) The number “16” indicates the variation of wire. There are 21 variations of ‘22759’ listed in AC 43.13-1A. All are suitable for aircraft use. SECOND; MIL-W-81044/- —XX. Here again, the only number that really concerns you is the 81044 and the XX. As before, the XX represents the wire size. The number represented by the “- —” indicates the variation of wire. This wire is also of the single conductor, multi-strand type. THIRD; MIL-W-27500/ZZ-XX-N. This wire is a multi conductor wire, with shielding. As before, the XX represents the wire size. The ‘N’ represents the number of conductors in the shield. The number represented by the “ZZ” indicates the variation of the wire. If we order MIL-W-27500/16-22-3, we have asked for 3 conductors of 22 gauge wire in an ETFE Teflon insulation and shielded wire. From a wire standpoint, these three are the cats’ meow. It just doesn’t get any better than this. For all of you who want to use ‘automotive wire’, just keep in mind that it won’t be the flames that’ll get you, it’s the toxic fumes PVC insulation gives off that will do you in. Teflon stinks like no stink I can describe, but you can still breath.

COAX: RG-58 A/U. Unless a manufacturer specifies something different, this will do the trick. Just like wire, there is about 15 variations of RG-58 coax. A/U is the best of the RG-58 coax for our purposes. It has a dense shielding, and a quality insulation around a multi-strand center conductor. Radio Shack will sell you RG-58 C/U all day long, but if you don’t use the best of techniques to install it, it will give you problems in the long run. It is not as durable under heat, primarily. While I am addressing coax, let me mention coax connectors. Save yourself from long term problems and use crimp on BNC connectors. If you don’t have the proper tooling, get your local radio man to crimp them on for you. If he tells you he solders all of his BNC’s, do yourself a favor and look further. Over a period of time, solder type BNC connectors have a tendency to pull apart, or at the very least,
lose good grounding to the shield. If your can rotate the connector on the coax, it is bad. Cut it off and replace it.

CIRCUIT BREAKERS and FUSES: I'm often asked if I have a preference. It all depends on the type of flying that I am doing. Fuses are fine if all you are going to fly is Day/VFR and not in congested areas. Otherwise, fumbling for a replacement fuse as you are being vectored to the final approach, or at night with a flashlight in your mouth, can lead to an awkward, if not fatal, situation. And half the time you grab the first fuse you can find, only to find you’ve installed a 1 amp fuse instead of the 10 amp fuse that you needed. I personally like pullable circuit breakers. On one occasion I was flying between Houston and San Antonio, Texas, when I noticed smoke filling the inside of my turn coordinator. In a Cessna 172 (factory equipped) there is a nice, neat row of pullable circuit breakers. Unfortunately, you can’t pull them to disable the circuit. “So there I was” at 4500’, one eye out the window looking for a place to land, one eye on my turn coordinator hoping not to see those fingers of flame. I’ve got another eye on my comm radio to make sure I’m on a frequency that will do me some good (being I am in no-mans land), and one more eye on the circuit breaker, praying that it will pop out soon. This, all the while knowing that procedure says turn off my master switch, turn everything off, turn my master switch back on and then my systems on one at a time to isolate the source of the smoke....excuse me, I knew the source of the smoke, it was just that I couldn’t ‘turn it off’ without turning everything else off. I couldn’t pull out the circuit breaker. Ask me sometime how much it would have been worth to me to have been able to reach over and pull out the circuit breaker. Trust me, I would have paid more than the cost difference between resettable circuit breakers and pullable ones!

IF YOU MUST buy used circuit breakers, PLEASE... test them before you install them. Used circuit breakers are usually old. What you won’t see is that the contacts are corroded together, and instead of popping at 5 amps like the little button says, it’ll take 20 amps before it will pop. If that is the case, the next time it pops will be at about 2 amps (if at all) because the heat sensitive mechanism inside has been fried. Of all the money you spend on your airplane, new circuit breakers don’t cost, they save. They save you from frying your electrical systems. Burn up the power supply in virtually any piece of avionics and what it will cost you to have it replaced will easily have paid for your circuit breakers! They may even save your life.

TERMINALS: What is commonly called an ‘automotive terminal’ is so sub-standard for aviation use, it isn’t funny. Even the term ‘automotive terminal’ is an oxymoron. Those type terminals haven’t been used in car for the last 40 years! Here’s the problem with them. They have a soft copper alloy base that is tin or nickel plated. That, in itself, is not bad. It is the properties of that metal that make it bad. When those terminals are exposed to a temperature range of as low as 0 degrees in the winter to 180 degrees under the cowling or behind the panel in summer, that metal expands and contracts with the temperature. Over a period of time, the metal becomes brittle, it no longer contracts, and you have a permanently loose electrical connection! If you haven’t done it, ask anyone who has a lot of electrical experience if they have ever been able to pull a wire, or has seen a wire pulled loose, from a terminal or butt splice for no apparent reason. Now you know the reason. An aviation grade terminal has the same basic metal terminal, but it also has a second sleeve around the crimp portion of the terminal. This second sleeve is a stronger copper alloy with nickel plating that has to reach a much higher temperature range before expansion and contraction comes into play. The amount of compression you put on your aviation quality terminal today is the compression that will be on it in years to come.

SWITCHES: There has been a lot of discussion, of late, about switches. Is it really good to use an AC rated switch for DC purposes? Possibly. I don’t recommend running down to ACE hardware to buy switches for your airplane. They do, however, carry some that would suit the bill for some applications. Your safe bet is to get a DC rated switch if possible. Most all switches have ratings printed or molded onto the side of the switch housing.

Your best bet for securing aircraft quality electrical supplies is from your aircraft supplier. I’d venture a guess you didn’t go to ACE hardware for your gyro’s, fabric, or aluminum sheeting. Why would you go there for your electrical supplies? Virtually every major aircraft supplier carries aviation grade electrical supplies. (Although not everything they will sell you, in my opinion, is worthy of putting in an airplane.)

TOOLS

Whatever type of project you are dealing with, there were probably some specialized tooling that you had to purchase to do your construction. Most people don’t have epoxy pumps just laying around the house or a 3X rivet gun with a good assortment of Cleco fasteners. The majority of homebuilders have had to obtain some special tools for the construction of their airplane. For under $150.00 you can buy NEW tools that will enable you to do all your aircraft electrical AND coaxes in your airplane except your battery cables. If you know exactly what you are buying, you can find used tools that will do the same job for under $75.00.

If you inspect a piece of MIL-W-22759, your will find that the center conductor is made up of very fine wires. Compressing a terminal onto these wires is critical. If I take a bundle of pencils and wrap banding around them just right, I can’t find any loose pencils in the bundle. If I wrap them just a little too loose, I can remove pencils from the center of the bundle (which would equate to a poor electrical connection INSIDE my wire). If I wrap the outside of my bundle of pencils too tight, I will break the outside layer of pencils. Alternately, if a 22 AWG wire has 26 strands of fine wire and only four or five strands are broken, then the integrity of the wire has been compromised by 20%. The best general crimper that you can get is an
The major advantage of these crimpers is in the design. These crimpers have a spring that is triggered by a resistance of compressive load. If I insert either a 22, 20 or 18 AWG wire into a red terminal, having different size diameter of wire, I would get a different compression ratio if the jaws of my crimper came to the same place each time. This tool does not always close to the same ‘place’. It senses the compression being applied to the terminal and the wire, and once the proper compression is reached, all your squeezing of the handle is transferred into the spring. You cannot under or over crimp your terminations unless the tool is out of calibration. Calibration can be checked by the user periodically with the use of what is known as a go/ no go check. (See Note 1). You can purchase this go/ no go device from AMP whenever you want or need to. Provided you don’t use the tool for a hammer, or drop it from the roof, chances are you’ll never use the tool enough to justify a go/ no go check. This tool also provides for two separate crimping patterns in one step. It provides for a rectangular crimp around the wire for a more uniform compression across the wire, and a circular pattern around the insulation of the wire to provide a built in strain relief. It is very undesirable to have anything flex right next to a point of compression. There is a high probability of fracture. By providing strain relief, even 1/16th of an inch from the fracture point, there is less likelihood of breakage. These crimpers will crimp red, blue, and yellow terminals, or 22 to 10 AWG wire. Virtually every wire in your plane except your battery cables. And for the record, when using Aviation Grade Terminals, red terminals are for 22, 20, and 18 AWG wire, blue terminals are for 16 and 14 AWG wire, and yellow terminals are for 12 and 10 AWG wire.

Another advantage to this crimper is that it has removable “jaws”. For a reasonable price, a second “jaw”, or die, can be purchased to crimp on AMP BNC connectors. The BNC connectors that I use are AMP P/N 225395-1 (Male) and 225396-1 (Female). It is unfortunate that one tool can’t crimp all manufacturers’ terminals and BNCs. (Its just as bad that Chevrolet parts won’t fit on a Chrysler.)

(Note 1: A poor man’s go/no go can be done by crimping a terminal on a wire, and then suspending at least 5 lbs on the wire with the terminal supported above. The problem with this is that it can’t check for over compression.)

Just like crimpers, there are a lot of wire strippers out on the market that are great for using on household wiring. Not too many are good for aviation use. Just remember one word;

STRIPMASTER. No better stripper available for the price. One can find these strippers at most commercial electrical supply outlets. New price will range from $15 to $40. There are a lot of “copies” out there, so look for the Stripmaster name on the spring cover at the center pivot point.

For those of you who wish to do your own soldering, when it is required, a 25 watt pencil iron from Radio Shack will do quite nicely. Be sure to get a ‘flat’ tip for it (approx 1/8” wide). Pin tips generally don’t apply enough heat, quickly enough, to the area needed for the type joints one will usually encounter in aircraft systems.

To complete a well rounded assortment of electrical tools, you will need a flush cut pair of wire cutters. There are several types of cutters, diagonal, semi-flush, and flush are the most popular. The main reason for wanting flush cut cutters is that when you go to trim your ty-wraps, if your not using a ty-wrap tool, diagonal and semi-flush cutters will leave sharp edges on the ‘tail’ of your trimmed ty-wrap. These edges will be present even if you try to cut as flush to the locking mechanism as possible. This won’t pose to be a problem until you have to reach up behind the panel. Ever pick blueberries without a long sleeve shirt? I personally hate sharp edges on ty-wraps!

Anyone who makes a living with their hands will tell you that the right tool for the job makes all the difference in the world. Wiring an airplane is frustrating enough for most people. Having the right tools will make the job a lot easier.

SOLDERING

A few tips on soldering. First, contrary to popular practice, no matter how hard you press on your solder joint with your iron, it won’t get any hotter. It’ll just bend the iron tip or deform the connector pin or both.

Heat is transferred through the solder. Be sure to have a moistened sponge around when you solder so that you can continuously clean your tip as you work. Mearily stroke the tip lightly across the sponge (both sides of the tip) and ‘wet’ the tip with solder. Wetting the tip means applying just enough solder to the tip to lightly coated. If you have a big ball of solder on your tip, all that will be accomplish is a big mess around your solder joint.

Second, ‘tin’ the wire end and the socket. This is done by applying just enough solder to the wire to penetrate the strands of wire. If too much solder is applied it will ‘wick’ up underneath the insulation. That is not desirable if it wicks too far up under the insulation. A socket should be filled approx. half full with solder. Once both the wire and the socket are tinned, it is just a matter of holding the wire at the mouth of the socket, apply heat to the socket, and when the solder in the socket becomes fluid, insert the wire and allow the two to ‘flow’ together.

If tinning your wire or socket, or soldering your wire into the socket, takes more than just a few second, check your technique. First, is your soldering iron clean and properly wetted? Second, is the wire or the socket corroded or oxidized? The metal surfaces should be clean. Flux can be used, but sparingly. And be sure to clean any excess flux from your joint after you are finished soldering. Flux, when left exposed to air for a period
of time, becomes corrosive. Isopropyl Alcohol can be used to clean the excess. Last, make sure you are not trying to heat too big a surface with your iron. All things being right, if it takes more than 5 seconds to properly heat the surface that you want to solder, you really need a hotter iron. Your 25 watt iron will do most of your wiring. (Don’t try to solder your battery cables!) Don’t...apply heat too long to a surface. Don’t...apply too much solder to a surface. Don’t...try to solder dirty, corroded, or oxidized surfaces. Don’t...solder wire ends and then crimp terminals on. Don’t...crimp on terminals and then solder the wire end. Don’t...solder any connection that is not ‘solder specific’. Most connectors use either a crimp pin or a solder type pin. Do...make sure that your tip is properly maintained. Do...make sure surfaces are clean and brite. Do...Solder with discretion. Solder joints are tone of the biggest problems that I have to deal with when I troubleshoot someone else’s work. Do...Practice soldering before you tackle your radio harnesses. It’s a lot easier to do a job right the first time than to have to do it a second time.

Editor’s Note:
ABOUT THE AUTHOR
When I was at Sun N Fun, talking with Hugh Hyde, I confessed that electrical was one of my biggest weaknesses. Hugh told me about this great electrical workshop that Martin Hadley was running and recommended that I attend. I did and for me it was the best workshop I ever attended at Sun N Fun. Knowing that there must be other “Velocities” needing electrical help, I pleaded with Martin to write up a detailed article which followed the same format as his outstanding workshop. He did! Thank you Martin for spending the hours it must have taken to commit this all to print!

At the time I met Martin, he was self employed “Hadley Aircraft Services, Inc. of Palm Bay Florida. To my con-tentment, I recently learned that Martin will be joining the Velocity family in Sebastian. He will soon be working for the Savings, providing electrical services, including sales, support, and technical assistance.

Martin is loaded with experience beyond aviation electrical. He is an aviation enthusiast, A&P mechanic, a com-posite homebuilder, and a private pilot. He started his aviation career back in 1974 as a Flight line mechanic for Cessna Aircraft Co. Within 5 months he had changed direction and became a Radio electrician. He then moved to Houston working for a Cessna dealer and became the avionics shop manager. In 1985, Orlando, Fl. beckoned Martin as he took over the installation department at the local avionics shop. 5 years later he was given an opportunity to work full time on not only warbird restorations, but part time as a mechanic on a TF-51. That is the dual trainer P-51 Mustang that is owned and operated by Stallion 51 Corp. During the next few years he spent working on everything from Waco’s to B-24 bombers, from bi-winged, round motor aircraft to F-86 jet fighters. In 1992 he started his own business doing nothing but aircraft electric systems restoration and radio installations. He later decided to get into the experimental market full time.

Having worked on several different types of homebuilts since 1987, he decided to concentrate in the composite construction market and offer consultation services in the field of electrical installations.

You can reach Martin through Compuserve e-mail (102034,2467), by phone, or Fax at 407-952-0254, or by mail at POB 100681, Palm Bay FL 32910. And best of all, by the time this newsletter is printed, you can reach him at the Velocity Factory!

NOTE: Skycraft Parts & Surplus, Inc. located at 2245 W Fairbanks Ave, Winter Park FL 32789, the northeast corner of I-4 and Fairbanks Ave in Orlando Metro. This is a good source for those of us that live in Florida. They are “walk in” only (no mail or phone order).

Types of Aircraft Antennas
by Bill Butters, Technical Coordinator Advanced Aircraft Electronics Inc.

Let’s now take a look at the types of antennas that you might select. There are two basic types that are practical, so we’ll highlight these. The first type is called the quarter wave ground plane and the second is the half wave dipole. Each has features which lend themselves to certain types of installations.

Ground Plane Antenna
This is the traditional antenna that mounts outside on our aluminum airframes. It requires a metal base to mount on and to work against. The illustration (figure 1)

shows that as the RF energy interacts with the antenna element small amounts of skin currents flow in the ground plane. What is often ignored, is that not just the local area under the antenna works as the ground plane, the total airframe responds to these ground plane currents. The sum of all of these currents are induced currents. They are equal and opposite to the antenna currents and are depicted as the dashed lines to indicate the phantom or mirror image antenna.

The result is that there is an equal but opposite effect to the radiating element (antenna) which balances the circuit and supports RF radiation. If the ground plane is made progressively smaller the radiation capability becomes progressively less. All the radio energy has to go somewhere so when using the smaller ground plane the energy is reflected back to the radio (remem-
ber impedance matching). In receive, it reflects back into free space and is lost.

In a composite, fabric, or wood aircraft it becomes apparent that the standard quarter wave antenna won’t work well because there isn’t metal to mount the antenna. We solve this problem with the installation of a ground plane which is about one antenna length in radius.

Sometimes, when we try to use an add-on ground plane, we aren’t satisfied with the results. This could be because the ground plane is too small to fully allow the “phantom” or mirror image antenna currents to develop. Sometimes the electrical connection between the radio and the ground plane is poor restricting the currents. Even in all metal airframes corrosion at the antenna mount can cause similar problems. In other words this style of antenna is sensitive to ground plane mounting.

**Dipole Antenna**

The drawing (figure 2) shows the same radiation but notice that there isn’t a ground plane with its phantom quarter wave image. The antenna itself is complete and operates as a stand alone system not requiring the additional metal. This feature makes the dipole an ideal candidate for any structure without a metal skin.

Why not build our own antenna? It seems like a simple matter to route our coax feed to some convenient spot and connect to two lengths of metal that have been cut to the quarter wave length. Some people do this but recall the discussion about SWR and impedance match. The impedance of such an antenna does not match the 50 ohm radio system. When the coax connection is made at the antenna the impedance mis-match is large and thus the resultant SWR value goes up while the antenna efficiency goes down. To overcome the poor performance the small rings of ferrite are installed around the coax and the antenna seems to work better (figure 3).

But there is a better way to use a dipole. The two elements can be designed in a way that combines both the required frequency tuning and the intrinsic impedance for this frequency. The antenna’s impedance shouldn’t be 50 ohms however, because the impedance of the air is closer to 377 ohms and we must maintain the impedance match everywhere (even to the free space) to maintain antenna efficiency.

How do antenna people make their radiating elements to have the required 377 ohms impedance? They combine the electrical properties of the antenna element with the insulating properties of its non conducting base. The casual combination of metal antenna element and composite mounting base will have some unknown impedance which will probably not be either 50 ohms or 377 ohms.

**Balun**

Introducing the Balun. This device is an impedance matching transformer that is connected between the 50 ohm coax lead and the 377 ohm radiating element and thus preserves the impedance match.

Now with the antenna matched to the radio and to free space (figure 4) we are able to mount it anywhere we have airframe space to fasten it down. In fact, the mounting can be done with adhesive, duct tape, Velcro tie wraps, or anything that isn’t metal. This design now offers possibilities for hot air balloons, ultralights, antiques, and even under the roof of the home or wooden hangar.

Finally we are conversant in the basics of antennas lets take a look at its installation in the airframe. Recall that for optimum performance, we try to maintain the correct polarity orientation for the type of signal to be transmitted or received.

**Patterns**

Get ready for another concept in antenna characteristics called radiation patterns. In certain applications like radar, for example, the antenna must radiate and receive with a highly directional beam. In our aircraft, however, the antenna must radiate and receive equally well in all directions. The 360 degree map of the antenna’s sensitivity is the description of the beam characteristics and is called the antenna pattern.

Let’s bring in another analogy to illustrate a characteristic of the antenna pattern. Imagine that an inflated round balloon represents the amount of energy that your radio can transmit, and that the antenna is in the center of the balloon. The shape of the balloon represents the shape of the antenna pattern. Such an antenna is called isotropic in that it radiates equally in all directions.

If we want to tune the antenna to have the beam concentrated more in one direction we adjust the antenna elements accordingly. This is like squeezing the balloon down on one side to bulge it out the other. On other words, there is a fixed amount of air (RF energy) and if we emphasize the balloon shape (pattern) one direction we reduce somewhere else.

For our communications we nor-
mally like to have the ability to transmit and receive equally around the aircraft. To do this we mount our antennas in the up and down configuration, remember this is polarized mostly vertically. The pattern looks something like that shown. In three dimensions the pattern looks more like a doughnut with the hole, or minimum sensitivity area, directly above and below the aircraft. This pattern exists for both the quarter wave and the half wave antennas.

To receive the VOR signals we take either the half wave or the dipole antenna and rotate it 90 degrees to the horizontal position. The illustration shows that the pattern rotates with the antenna and this also presents a region of minimum sensitivity off of the wing tips. To fill in these gaps we bend the dipole antenna element at its center and now it looks like the letter “V”. Notice how some of the energy, or pattern, is removed from one area to fill in the ends. Note that this is the typical “rabbit ears “VOR” antenna.

Installation

Now we get to the good part, installing the antennas.

Composite (non-metal) aircraft have different options for their antenna installations. There are numerous locations within the airframe which work well.

First don’t use a ground plane antenna. It isn’t necessary. It doesn’t work as well as a dipole. It doesn’t look good. It can degrade with time.

Why isn’t it necessary? The dipole doesn’t want to work with a ground plane. It is its own self contained system.

Why doesn’t it work as well? You can’t install a foil, sheet metal, or wire mesh ground plane large enough to support all of the circulating skin currents.

What happens with time? Certain metals interact with other material systems and corrosion occurs. In the world of RF currents, which are circulating on the ground plane, microscopic high resistance paths play havoc with the antenna operation. The embedded screen wire or foils which depend on only mechanical contact for continuous electrical conductivity can easily degrade to a group of wires with random electrical conductivity.

Locating the Dipole

The location of the dipole in the airframe requires some thought and planning because the various metal conductive components scattered around cause the antenna to perform in unpredictable ways.

Back to the fishing pond again we find another analogy. Your antenna (the float) sits there waiting for a ripple to pass by. Nearby the float is a chunk of wood. As the ripples pass by they strike both the float and the wood. The float sees now the original ripples and the reflected ripples from the wood. Depending on the location of the wood and the origin of the splash the ripples add in phase for a strong signal or become garbled as the two series of ripples mix ripples. This effect is due to phase interference.

If the chunk of wood is between the splash and the float several results are seen depending on the size of the wood and the distance between the wood and the float. If the two are close the wood shadows the wave from the float as the float is positioned farther from the wood, the waves begin to effect the float (diffraction in the EM world).

It is a similar situation with your antenna in the composite aircraft. There is a main source of RF signal that is seen by the antenna and then there are weaker sources that reflect and diffract from the various metal things in the airframe. Items like control cables, metal tubing, and wires which are close (15” to 25”) and parallel to the antenna have a more pronounced effect on the operation than those things which are not parallel or are far away.

Each installation requires planning and a little trial and error. One feature of internally mounted dipoles is that they can be temporarily mounted in the finished airframe with tape and then tested in flight. If the operation is unsatisfactory, they can be moved until the operation is optimized.

Bill Butters is Technical Coordinator for Advanced Aircraft Electronics Inc., Manufacturers of dipole antennas for composite vehicles. He can be reached at

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ed in sweep to fit into the available space in the winglets, riveted in this configuration and then bonded in. Remember that graphite composite material is conductive so it must be treated as if it were metal.

Graphite structures do complicate matters for antenna installations. If spar caps are constructed of graphite materials horizontally polarized antennas should not be mounted nearby because practically no signal will be able to get past the long conductors that will act as reflectors. The same goes for any long conductors in the same alignment as the antenna such as horizontal and vertical tail spars, control cables, push rods, wires etc. Each aircraft needs to be analyzed individually for the best antenna locations.

I do not recommend any antenna on the market that has a little black box in the center of the antenna. This device is a ferrite transformer which provides a very good VSWR and a very good bandwidth but at the cost of being a very lossy device. The very best specification that I have seen on ferrite transformers is a loss of 2.5 dB and the worst goes up to 12 dB. As a reference, a 3dB loss gives an output of 50% and 10dB gives just 10% out. So if you have a 5 watt transmitter into an antenna like this, you get just .5 watt out, and it works the same on receiving. Not a bargain. An antenna you can easily make yourself would be to just solder quarter wave elements to the inner and outer conductors of the coaxial cable and go with it. Also if you were planning to go with Jim Weir of RST’s designs don’t bother with the ferrite beads. At these frequencies the beads don’t do anything that I could detect in the RF lab. A good balun would work better as a dipole feed because it balances the currents on the elements and matches the impedance at the same time and it doesn’t absorb RF energy. My antenna designs do not need a balun because I use a modified version of a feed called a Gamma match that feeds the antenna at the fifty ohm point and automatically balances the currents on the elements.

When installing any antenna remember that antennas do interfere with each other when installed too close together and that close metallic (or conductive : remember graphite) objects that are as long or longer in the same polarization/plane will reflect RF energy away from them. Close meaning one wave length or closer and closer being worse. One wave length is about eight feet at VHF frequencies. Less than a quarter wave length is really bad from both a VSWR and the radiation pattern stand point. The formula for wavelength is:

$$11803 / \text{FREQ. in MHz.} = \text{wavelength in inches.}$$

Navigation antennas being horizontally polarized require that they be mounted in an area that has a large enough horizontal area that a half wave dipole can be installed. If the elements are swept the dipole can be reduced to about 40 inches. The logical locations are the wings, canard and the top and bottom of the fuselage. There are always gotchas though and wings with large conductive horizontal structures such as graphite wing spar caps, push rods, cables etc. are not ideal locations. If the antennas in wings can be positioned so that they are about 0.2 wave lengths (about 20 inches) ahead of the spars (if graphite) or such they would have more gain from the front but would reduce signals from the rear. If mounted behind the spar or other conductive device the reverse would be true and the signal would be stronger from the rear.

If the canard is constructed of graphite of course it is not suitable for antenna installations. Other than that the canard is a pretty good location except in the case where the signal is coming from directly in the rear and has to pass through the engine and cabin area to arrive at the antenna. In this condition the signal will be weakened and the CDI needle could possibly wander. This also happens in the case of a metal aircraft with the VOR antenna on the top of the vertical stabilizer. When the airframe gets between the transmit and receive antennas as you approach the VOR station there is usually a bit of needle wagging going on.

Just a few words on dipole antennas for clarification. There are two types of dipoles, the two element type that is fed in the center, and is the type that is common and everyone is familiar with. There is also a continuous conductor type that is a continuous conductor from tip to tip for a full half wavelength. Each of these types require a different type of feed device. A center fed dipole dipole really should have a balun installed for proper operation. Without a balun on a center fed dipole fed with coaxial cable the antenna has uneven currents on the elements because half the currents on the braid side travel down the outside of the cable, the impedance is poor because the nominal impedance of this type of dipole is 150 ohms and is being fed with 50 ohm cable and the radiation pattern is bad because the radiation off the outside of the outer conductor interferes with the radiation off the elements. So a good balun does three things:

1. Balances the currents on the elements.
2. Matches the impedance of the cable to the elements.
3. Chokes off the currents that would otherwise travel on the outside of the cable.

By the way those ferrite beads that so many composite builders are using are totally useless. The beads do absolutely nothing. And the ones with the ferrite transformers in the center are very lossy. Up to 12 dB depending on the type they are using. I strongly recommend using a real balun.

The continuous conductor dipole is interesting in that the center point has an impedance of zero ohms and the tips have an impedance of infinity, or thereabouts, so somewhere between zero and infinity there is bound to be an impedance point that we could use. If we were to split the conductors apart on a 300 ohm twin lead cable and attach a conductor to the 150 ohm point on each side of the neutral center we would have a very good antenna. To feed with a 50 ohm
cable though is a bit more of a problem. What we need to do here is to connect the braid of the cable to the nutral center point and the center conductor to the 50 ohm point on one side. A problem arises in that in connecting the center conductor to the antenna element we introduce an inductive loop which needs to be balanced out with a series capacitance. When all the parameters are correct this also becomes a very good antenna. This antenna design allows control of the length, feed point impedance and capacitance/inductance relationships so can be tuned to a high level of performance. Specialized antenna measurement equipment must be used for tuning this type of antenna. Most of my antennas are designed in this manner.

The theory of how GPS operates is very similar to Loran in that it uses the time difference between three or four transmitted pulse strings from three or four sources to determine Hyperbolic equal time difference lines and calculates position from this data. Of course space based transmitters transmit the GPS signals and Loran transmitters are land based. And the frequencies of operation are very different, the Loran systems operating at 100 KiloHertz and GPS at 1.575 Gigahertz, with a secondary frequency at 1.227 Ghz. A wavelength at 100 KHz. is 9836 ft. and at 1.575 Ghz. is about 7.5 inches. These wavelengths give an indication of the size of the required antennas; a large antenna for Loran, a small one for GPS. About 3 3/4 inches for a dipole. There is a galaxy of 24 GPS satellites now in earth orbit at an altitude of about 10,600 miles which give them an orbit period of about 12 hours. They are updated as to time and position every orbit to maintain their accuracy.

Most satellite systems, including GPS, use circular polarization for their RF systems which means that the electric field rotates at the rate of the frequency being used. Or think of it as 360 degrees of polarization rotation in one wave length. Circular polarization is used because linear polarization when passing through the heavyside layer of the upper atmosphere rotates the polarization depending on the angle of passage and it is possible for the signal to completely cancel out. When using circular polarization on both transmitter and receiver antennas these effects are minimized and maximum signal may be utilized. Of course both ends must use the same rotation, either RH or LH circular polarization, or the signals could cancel out.

There are several different types of receiving antennas that can be used by GPS receivers and I’ll try to touch on each of them. All GPS receiving antennas should have a radiation pattern that optimally would look like a flattened hemisphere so that there is somewhat more gain at the low elevation angles because that is where the satellites are the farthest away. The first and most common at this time is the patch antenna. It is small and flat and can be installed easily on the outside of metal or graphite aircraft skins and inside of non conductive composite aircraft with some minimum type of mounting bracket. It consists of four small pieces of flat metal in a square pattern and each piece fed with 0,90,180 and 270 degrees of sequential phased signal that provide the circular polarization. This type antenna is usually somewhat short on gain because of being loaded with dielectric material to make it small and having a quadrature hybrid of some type to provide the phased signals which will absorb some signal. A lot of these have built in amplifiers and they are then called “active” antennas. A second type is the normal mode helix antenna. Garmin used these on their early models and still do on their handhelds and are about an inch in diameter and four inches long. A regular helix antenna radiates most energy off the end but a normal mode helix is smaller in diameter and radiates more energy off the sides. With the correct ratio of length to diameter the radiation pattern can be optimized. I have one of the Garmin handhelds and I wanted to put an antenna between the headliner and the fabric over the cabin so I built a foam conical spiral with a two inch high by two inch in diameter and fed with extra long dipole type elements that wind down from the apex to the base in a spiral manner. Works very well. Then there are Archimedian spirals, log conical spirals and bifilar and quadrifilar helices and numerous twist style types. All of which are circularly polarized with various positive and negative attributes.

The installation of all these types of antennas in a non-conductive composite aircraft, or even fabric, is simple in that none of them require ground planes and they are so small and light that they do not require much room or structure to support them. All that is required is that they be mounted in the top part of the aircraft looking up in such a manner that they can see most of the sky through the non-conductive skin when installed. In metal or conductive aircraft of course they must be installed on outside of the conductive skin of the aircraft or installed inside a fiber glass fairing of some type. On tandem type aircraft with canopies the top of the roll over structure is a great location. We will just leave the details to the builders.

These suggestions and recommendations come from 35 years of spacecraft and aircraft antenna experience and are meant to help in obtaining optimum antenna performance and do not mean that anything else will not “work”. I have seen a lot of really bad antenna installations whose owners are perfectly happy with their antenna performance. This is probably more information than anyone ever wanted to know but maybe it will help someone. I am always open to questions if there are any out there.

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Below are frequently asked questions about antennas with their answers.

Active Elements? The part of the antenna that actually does the radiating or the receiving of the RF energy.
Aperture? The capture area of the antenna. On a dipole or monopole it is the overall dimension of the active elements, on dish antennas it is the diameter of the dish.
Feed point? Generally the point at which the coaxial cable attaches to the
This is the first in a two part series concerning the finishing of you Velocity. There is a saying in painting called the three P's. Preparation, preparation, preparation.

Some people go to extreme lengths to achieve the “perfect finish” which for the most part is very impractical both in time to achieve and maintain. What I want to do for you is achieve a level of satisfaction in your own abilities so that you can produce an airplane that has a “natural beauty” that you will enjoy for years with a minimum of maintenance.

In this first part we are going to cover the preparation of the surface prior to the application of paint starting right at spreading of the micro through final sanding. In the second part we will cover choosing the right colors and their combinations, motif’ masking and application of the paint though spot repair. For a lot of pilots their aircraft is a mistress their wife or girl friend can accept you having (sometimes). So take the time to make her gorgeous because you will probably only have one or two chances to do it right! Think of it this way, if your wife or girl friend had only one pair of clothes and one shade of makeup to put on, what would want to see her in for the next decade?

There are basically two big mistakes people make with micro and that is they fail to put enough on the first time and they cannot see what they are doing in terms of removing the right amount of material and where when they begin contouring. Because of this they inevitably run into large and small low spots which must be filled in the first case and sand too far, or, not far enough in the second.

The first problem arises when they must go back and reapply micro into these low areas. What happens is the first layer of sanded micro is like a dry open sponge and when the new layer of micro is applied the yet uncured epoxy is absorbed into the open pores of the dry micro. After the second application of micro has cured the surface of the depression or low spot where the wet epoxy leached into it has also cured creating a denser and much tougher invisible patch down to match the rest of the micro if this problem. When I say large I mean an area perhaps a half a square foot or larger and deeper than a tenth of an inch, especially if there is more that one such low area. If there is only one and smaller than this wait to take care of it in the next step. Do not mix fillers with incompatible harnesses as far as there application on one another I.E.: bondo on micro, caboisol on bondo. Remember, only areas of a consistent density can be sanded successfully.

The reason people cannot see what they are doing is because the micro is generally white, the sanding dust is white, and the high and low spots are white and most people have not developed a feel with their hands for what is correctly contoured. There is a wonderfully simple solution for these problems. Before you begin sanding get your hands on some spray lacquer paint, most preferably flat black. It must be lacquer not enamel! Now hold the can away from the surface about two feet and begin spraying a light fog onto the entire surface you are going to sand. If you have a quart of automotive lacquer, reduce it about 5 to 8 parts acetone or lacquer thinner to paint for the right consistency, this material sprayed through a gun is actually much better than the can method. You only need a heavy oversprayed effect to achieve the goal, do not try to have a solid coat this is way too much.

Now when you begin sanding you will instantly have a very high contrast between what is coming down in thickness and what is still low. Now you can visibly know exactly what you have removed and what you have not. If you put on enough micro the first time all’s you have to take care of it in the next step. Do not try to have a solid coat this is way too much.

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nicks and gouges, don’t worry about these imperfections because these will be taken care of later.

At this point when most plans call for a mixture of cabosil and epoxy with a consistency of grease spread over the entire sanded micro surface, this has its own share of problems which can be eliminated. When this epoxy mixture cures it becomes like concrete and you are going to have left behind a thin little line of this material here and there as it leaked out the edge of your squeegee or trowel you were using, also a little blob here and there. It’s easy enough to do when you realize there is almost a hundred feet where the applicator must overlap when doing a wing panel. The thing is you must sand this line off which is very difficult to do with out getting into the surrounding surface. After that ordeal and believe me it is, you then must sand the entire surface so that the primer has something to stick to because epoxy cures hard and shiny.

I have found a more forgiving material for this step. I will do the same thing only substitute the epoxy and cabosil for polyester resin and cabosil. This does two things for me. One of the benefits are the thin lines of material spoken of before can be left in place and the material cures the same day leaving a slightly sticky surface. The key is to use a polyester high build primer on top of this sealing step. Apply a guide coat and begin sanding with eighty grit. As you begin sanding any thin lines of poly-cabo sand at approximately the same rate as the poly-primer, this is to your benefit. This way you have eliminated the difficult prior removal of epoxy-cabo imperfections and sanding of the entire aircraft surface.

(Note: when using this alternative system you must be sure that the cabo mixture of polyester resin is thick enough that it will not weep into any exposed blue foam. This is generally not a problem since the foam is buried in fiberglass and micro, actually the polyester cabosil mixed on the thin side such as the consistency of pancake batter gives the best results for spreading due to its faster cure rate.)

I have found the recommended U.S. epoxy primer is too transparent, expensive, more toxic and takes longer to dry than a good polyester alternative. Brand names such as Duratec or Fourseal work best, use gray so you can see what you are applying easier when spraying. You will need to thin them down a bit with acetone so that they will spray evenly. A siphon spray gun. I have drilled out the fluid nozzle on my gun so that it will pass more material because they are very thick. Apply two heavy coats.

The time to use the guide coat is every time you need to sand the surface! You will never miss a square inch of area on your airplane this way. After sanding the entire AC with eighty grit on a long board or hand block using the typical x-pattern wherever possible you will probably find those small nicks and gouges again only smaller this time and perhaps some small low spots you didn’t see or feel before. Now don’t go mixing a tiny batch of micro, please! This will only cause more problems than the micro grams in weight it will save. Do yourself a favor and buy some polyester filler called “Halftime”. This is not Bondo, it cures very quickly and leaves a tack free surface in minutes and sands approximately at the same rate as the poly-primer and fares beautifully. Go ahead and guide coat the surface again then sand it with 180 grit. After this you are ready for the second priming, you may not need to re-shoot the larger areas of the fuselage. Spray these Halftime areas first then the rest of the airplane.

Guide coat after it cures and you should be ready for the final sanding prior to paint. If your good you will only need to prime the AC twice, this is generally the minimum number of times. When it comes to cleaning your gun be religious about it. These primers can gel up rather quickly so plan your work and have every thing ready prior to shooting. When you are done pour any remaining primer out of the pot and pour in about one inch of acetone, shake this as you spray it through the gun. Pour out any remaining acetone and then wipe the inside of the pot and the rest of the gun with a paper towel soaked in acetone until they are clean. Then pour into the pot another inch or so of acetone and spray this through the gun also completely. This method should give you a clean gun with the minimum amount of acetone used. Pay special attention to the air cap and fluid nozzle orifices because these passages are critical to good operation. You should treat it as a real weapon and those of you who keep have one know what I mean.

During the time you are priming the surface you could be practicing your “gun control”. What I mean is the spray gun is a precision device for applying material to a surface, not a weapon for personal defense though you must learn to aim both well to be effective. (No, there are no shot gun methods of spraying paint that I know of I’m afraid.) There are many variables that go into proper application of paint and primers and it is much easier to fix primer mistakes that paint ones! The gun setup on the back of most professional paint system cans are good (about 50 psi line press.) and should be followed, especially the proper mixing ratios for hardener, thinner, etc. First you have air pressure at the line which feeds the gun, then you have the fluid valve and the fan adjustment. When all of these are just right the only thing it does for you is put out the same amount of material in the same amount of time and the same fan width leaving the gun. There is still the matter of distance to the surface, the speed rate at the surface, the angle of the spray pattern to the surface and the matter of overlap of spray pattern. The viscosity of the primers will not allow an exact reproduction of the way the paint will be applied but all the basics are there and should be understood prior to painting.

When applying material it will become obvious what is too “dry” and what is too “wet” but a good amount should be applied over a linear foot to a foot and a half in about one second approximately with a pattern about four to six inches wide, eight inches away for primer and seven to nine inches wide, twelve to fourteen inches away for painting. You will notice that speed of travel linearly, fluid valve...
Controlling these last variables of gun to surface geometry is a matter of maintaining the proper geometric relationship between the guns spray head and the surface you are painting, all the time, while moving it back and forth at a good rate of speed! If what works best is a vertical six inch tall fan pattern, eight inches away at X-number of feet per second at X-pints per minute with a perpendicular spray head to the surface in the X and Y axis then this is what you need to maintain for the entire surface of the color you are applying! You must think of your body and arm as if it were a robot concentrating on maintaining these last variables of gun to surface geometry to a narrow tolerance. THINK ROBOTICS! Seriously. Examine while you are spraying primer how well you are doing when it comes to how much you are putting on the surface, how much overlap there is and how the spray pattern you choose is working out with the local geometry of the surface your priming, I.E.: nose, winglet, strake, various intersections so as not to be overlapping to much. As a side note do not mask areas you are priming except critical things like windows and places where build up will cause fit problems. You don’t want to have any hard edges to blend back into the surrounding surface.

If you are not comfortable with the way you are putting on the primer then it is a good indication that you will have problems with the painting. You might want to consider having a professional go ahead and paint it for you. Remember it is the preparation that makes a paint job look great and you have complete control of that. A good painter can’t fix a bad shape. But on the other hand, if you had a good time learning how to spray the primer then you should think about painting it yourself. We will talk more on gun control in the next installment along with color, masking and how to find the right paint scheme for you.

Remember to:
• Put on more than enough micro the first time.
• Use a “guide coat” to see what you are doing every time you sand.
• Consider Polyester primer systems, save time and money.
• Always use filler materials of consistent hardness.
• Don’t “Micro” the details.
• Pretend you are painting when priming, be robotic in your movements.
• Practice good gun control and keep it clean.

### About the Author

John Harvey came to Velocity in the Fall of ’94 at the invitation of Scott Swing to help the company engineer and tool up for the Elite project. “I really enjoy the challenges that developing new products brings. Working on the Elite was just one of those special opportunities. When Scott called me in November I was very excited to have the chance to work with him,” said John Harvey.

His exposure to home-building dates back to the late seventies. During those years he was a machinist apprentice at the company which manufactured components for the Polywagon. “Starting back in high school I’ve been very fortunate to work with many talented people over the years. This enabled me to acquire many different skills all of which are directly applicable to experimental aircraft. This was all by design of course, because I wanted from an early age to design and build my own airplanes. That’s why in 1989 I started my own company, Erospace Technologies. We produce all the weldments for the Stewart S-51 along with all his metal stretch form patterns and composite needs. Currently I am working with LoPresti Speed Merchants helping to develop their Saratoga cowling and associated tooling.”

His first exposure to the Velocity program was back in 1989 when Danny Maher invited me to come and run the machine shop. “It was here I had the great fortune to meet David Lee who now over the years has become a good friend. This was during the time of Danny’s deep stall research which later became published,” continued Harvey.

He was with Bombardier Sea-Doo for a number of years where he worked with another small group of talented people. It was his job in the company to create and develop their line of personal watercraft products that were sold world wide. It was this kind of experience that prepared him for the Elite project. “Working with Scott was alot of fun because he allowed me to be involved from the ground up like I was at Sea-Doo. From the structural engineering to the hands on fabrication of the latching mechanisms and composite tooling it was a very satisfying experience indeed. Danny started a real good design, but through the foresight of the Swings they have taken the Velocity to a higher level and opened the door (no pun intended) for many more people to enjoy the benefits of this very capable aircraft. This project was a great opportunity to expand my experience and for that I am thankful. I am looking forward to the time when I can work with the Swings again.”

Note: “As a side note John is uniquely qualified in the building process of the Elite RG optioned Velocity. He is one of the few persons the factory recommends to builders seeking professional assistance in the construction of their aircraft. Located only a few miles from the factory he can be reached at Erospace Technologies Inc. 407-388-0966. If your going to be at Oshkosh this year look John up in the central exhibit hall, booth C-100 which is in the middle of the center isle.
Proper Plumbing

From Travis Young, Gainesville FL

The retractable gear manual assumes that you know how to properly plumb the hydraulic system, but many of us don’t (including myself). So, in an attempt to avoid the countless hours of having to remake all the hydraulic fittings and clean up the pools of fluid, I will share what I have learned.

Aluminum Tubing:

First you need the proper tools, which include a bender and a cutter for 1/4” aluminum tubing, you can get these at any local hardware/Sears store. The bender needs to be able to make tight turns in the aluminum, so you might want to spend a little extra and buy a better model. You will also need an AIRCRAFT flaring tool (I have been real happy with the Hi-Duty Tool from Aircraft Spruce #437-FB $67). You will also need a piece of wire, stiff like a coat hanger, about two feet long, and a razor blade.

If you decide that you are going to use an automotive flaring tool, here is what is going to happen: The improper flare is too angular, so when you put the assemblies together you in effect retorque the flare to the proper shape. This might sound good, but it is actually destroying both the properties of the flare and aluminum tubing. During the torquing down of the joints you are twisting the aluminum tubing outside of the nut and shredding the tubing inside of it. This results in a finished product that, with a few normal cycles and vibrations, will rupture and make a big mess. The bottom line is, as it should be with anything you do with the Velocity: if you are not 100% confident in what you are doing and don’t trust your life with it, immediately stop and resolve the problem.

That being said, here’s how to make your tubing:

1) Create a mock-up of the actual tube you need. Grab that piece of stiff wire and bend it until you get the shape you need, marking off where to cut with a little piece of tape. Keep in mind that you need about 3/4” of straight tubing after a bend to make the flare.

2) Bend the aluminum tube into shape. Use the wire as a guide for the tubing, making sure that your bends are smooth and made with a tube bender, not by hand.

3) Cut the tube to the proper length. Any old tubing cutter will work, just cut slowly.

4) Deburr the ends of the tubing. Using a razor blade carefully remove any pieces of metal that are hanging on the ends of the tube. Not doing this may destroy the flare.

5) Slide the fittings on the tubing. Put the big nut on, threads towards the end of the tubing. The sleeve should slide freely, if it does not, go back to step #4.

6) Make the flare. This can vary depending on the type of tool you have, but here’s how it generally works. Clamp the end of the tube in the holder (die), the angled part of the die pointing up and just a little of the tubing sticking up past the die (1/16”). The clamp should be tight so that the tube wont slip, but not too tight or you will dig into the soft aluminum. Put a drop of oil onto the end of the tubing, lock the flaring bit (plunger) onto the die over the center of the tubing, and twist away. Remove the bit and holder from the tubing.

7) Inspect the flare. The inside of the flare should be smooth, the sleeve should slide freely up to the flare, and the flare should be the same diameter or just a bit bigger than the big end of the sleeve.

8) Repeat for other end.

9) Install piece into system. The nuts should easily turn onto the attach piece, if it does not the tube needs to be slightly bent until it does. When you start tool-tightening the nut, do not overtighten! The specs say 5ft lbs of torque, which is not very much. You can use a crow foot extension on a torque drive if you want to be sure you don’t overtighten.

If you need more supplies, and don’t want to bug Velocity, here is what you need:

Aluminum Tubing 5052-4 (1/4”)
Other tubing might be too soft.
Aluminum Nuts AN818-4D (Aluminum)
Aluminum Sleeves AN819-4D (Aluminum)

To make your flex hoses, you will need to get a mandrel for the type of tubing that you are using. If you don’t use the proper mandrel, you will end up twisting the flex hose very severely when attaching the fittings. I ended up replacing the rubber hoses which come with the kit with the equivalent aircraft grade hoses and fittings (Aeroquip 303). This was not cheap (about $100 for the hoses, ends, and mandrel) but gave me great results. I would recommend the Aeroquip to anyone who does not object to the cost, but I am sure the rubber ones work fine too.

Post Curing & Resins follow up

From Alan Shaw of Dynamic Wing Company, Melbourne FL

As Dan’s co-developer of the original Velocity kit I’m very pleased that after a decade of silence a networking type newsletter has begun. This interaction should make all of
us better informed airplane builders. It’s going to get very interesting because for example even though Dan and myself had similar academic and “hands on” backgrounds we often had totally different opinions as to how to do something. Our differences were what made us innovative as our teamwork helped us learn from each other. The most important thing I learned from him was to keep it simple. If he would have let me have my way I would have tech'd and high priced us right out of the market.

As I built all the original molds I also tested several resin systems. Dan came up with a technique very different than American Standard Testing Method’s (ASTM’s) that gave us data more realistically applicable to Velocity structures. So it was determined in 1986 that Safety-poxy wet layup of Bi and Tri Knitted glass fibers was the best for the job. The Hexcel product has a high crosslink density and high heat deflection temperature without the dangerous, expensive complications of post cure heating. With the addition of vacuum bagging, strength to weight ratios are comparable to the extremely high cost pre-preg systems. Post curing is pre-preg technology requiring ovens with adequate circulation to prevent “hot spots” and heating-cooling cycles tailored to the specific resin systems. Greg Luehr, owner of Resin Research Inc., explained to me that medium high modulus wet lay-up epoxies receive no benefit from post cure past the 72 hour (77 degrees F) stage. Furthermore, post curing can make structures too brittle which is compounded by the low temperatures of turbo-charged aircraft flying high in the winter.

As far as new resin systems go I have not done any testing for about 4 years so it’s time again. Hexcel’s new product has no MDA or styrene; Jefco and Poly look interesting; and Greg has formulated three new systems for my Wing Company. We will be testing for modulus of elasticity, laminar strength, Tg and fatigue resistance. I think this post cure thing can be traced back to Germany in the 1930’s and does have merit particularly for spar caps and landing gear. So we should run some samples that way also. At any rate this stuff takes a few months to get done and documented properly. We will send our findings to interested parties as soon as possible.

If you ever have any questions, especially about wings, feel free to contact me anytime. I’ve tied in with a fascinating network of specialized engineers that try to keep me out of trouble. So if I don’t know the answer maybe they do.

Learning from Mistakes and Other People
From Hugh Hyde, Houston TX
I visited another Velocity construction site to visit with the builder and took pictures of completed areas and saw the benefits of the use of peel ply in construction. It is especially nice on triax lay-ups inside the fuselage because it gives a smoother finish for laminating without as much sanding or just for absorption of excess resin.

Travis Holland has installed two thin, flat halogen lights in a speed brake which provides excellent recognition lights for final approach as well as additional landing assist lights for night landings.

Before installing anything with AN bolts, particularly long ones, trial fit the bolts and, if necessary, ream the holes before installation. A locked-up bolt is not fun to remove.

The hole in the nose of the fuselage for measuring placement of bulkheads is not exactly centered. It probably doesn’t affect much except for nose gear retraction. When my nose gear was perfectly centered in the canard bulkhead, it hit the left side of the nose gear door. I am told this is a common problem. In my case, a spacer made from 1/8 inch aluminum (I used a strip about 4 inches long and 1 inch wide) on the right side of the nose gear channel between the channel and canard bulkhead caused the gear to retract straight through the center of the nose gear doors. Based on advice from Duane Swing, I duct taped the back of the channel and added microglass to the canard bulkhead to keep the canard bulkhead surface flat against the channel.

Tri-ax inside spar/fuel strake area
From Tom Wright of Advanced Composite Technologies (814)445-3802
Last issue (Volume 2), I sent you a description and illustration on how we used tri-ax inside of the spar/fuel strake area instead of bid. In this issue, I want to caution you on a possible problem.

After the lamination was completed, and we checked for leaks, one side was perfect, no leaks. However, the other side was leaking instantly and very fast. So what was the problem? What made one side different from the other? And how do we find all of those leaks?

First, let me describe how we safely pressure test a composite tank and secondly, how we accurately find even pinhole size leaks.

First, pressure testing can be done with the following inexpensive items: clear vinyl tubing, correct size hose clamps, an air source, tire valve, and most importantly, an altimeter. Plug all outlets except two. One will be a source for air to go into the tank, and one will be a source for air to come out of the tank into the altimeter. The plans call for 3/8 aluminum lines floxed and glassed for fuel outlets. Clamp a 318 line to one of these outlets. The plans call for 1/4” aluminum for the vent lines. When you install your vent line, leave it extra long. Four to six inches longer will work. Clamp your 1/4” line to the vent. Plumb the 3/8 line using vinyl tubing to the altimeter and plumb the 1/4” line to a tire valve stem. It is usually 1/4” in diameter. Also, the fuel caps leak, 50 tape over them with clear mylar packaging tape. Do not use duck tape as it is too porous and is not air tight. Apply several layers. Now carefully pressurize the tank to no more than a 1500 change in the altimeter. Never pressure more than 2000 feet change. You could rupture your tank.

Secondly, finding leaks: You can
use soapy water. Anything that makes bubbles. I use Mr. Bubble. I “borrowed” it from my grand-daughter. Use a sponge and spray bottle. Spray back into places you cannot reach by hand. Where you get bubbles while pressurizing the tank is where you will find a leak. After you have located your leak areas, wash the area that you have used soapy water/bubbles clean with water two or three times. Rough sand and re-laminate over the leaking areas. Re-check. You can also draw a vacuum (suction) by hooking up a shop vac to a hose and taping it all together to the tubing you used for your air source to draw a vacuum. This will suck the epoxy and or wet floc into a small pinhole leak. Once again, no more than a 2000 feet difference on the altimeter.

Now for the possible problem. Our leak was massive, but at a place that positively can never have gasoline! Right out of the forward face of the main spar. That is made of Styrofoam and it dissolves in the presence of fuel. That will destroy the spars’ structural integrity. But how did our leaks get into the core of the spar? Well, it took us days to evaluate and correct the problem.

The tri-ax is woven with three fiber directions and the fiber bundles leave very small valleys between bundles. Air was leaking out of the top edge of the diagonal rib, under the tri-ax, and down the valleys onto the spar cap flange, which also is made from tri-ax or bi-ax cloth, and into the weave through the glass right into the center of the spar.

We removed all of the tri-ax lamination and completely relaminated it. The leaks were gone. This represents a potentially dangerous situation. So, to prevent this from ever happening again, I suggest that you consider the following:

Grind rough the forward surfaces, top and bottom of your spar, spar caps, and laminate with wet floc and one ply of fine bid (7781). Peel ply. With these laminated, fuel can never get into your main spar. This is best done prior to strake installation.

Laminate the tri-ax with the major weave parallel to the spar. Be sure that the weave is against the strake skins and that the 450 way is away from the strake skins.

**From David E. Huber, Sebastian, Fl**

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**Building a Velocity S RG**

First, let me give a little background of my experience and information. I was a navigator in the USAF 1954-1958; then a pilot of C-130 Hercules in the USAF 1959-1966; then a pilot/flight engineer with Pan American 1966-1982; a pilot with PAA 1982-1984, a pilot/flight engineer with PAA 1984-1986; then a pilot with United Airlines 1986-1994. I am retired from PAA and UAL. Total- ly retired since Nov 30, 1994. I have had DMO Kit #140 since Feb. 1994. I have made great progress in my work shop set up and really dug into the velocity manual. I spent several days of a time share week in Sebastian working at Velocity as a volunteer. Just at lots of little odd jobs, in the fall of 1993. In January of 1994 I moved to Sebastian, Florida. My wings, canard and elevators are foamed. I have acquired several of my instruments: for engine and flight. I have a Lycoming engine. I have a Century autopilot. I have my antennas for comm, nav, and ILS and Transponder. I have been dealing with a Bob Nuckolls from Kansas regards aircraft electrics.

In addition to the above; my building partner and myself decided...
there would be many advantages to having a different re-tractable landing gear than the Swing designed one. Ours would be on all metal struts. The main gear would have its trunions near the outboard end of the strakes. It would swing up and inboard. The nose gear would swing up forward. We would use standard 6.00-6 main wheels (about 17” in dia) and nose tire: 5.00-5 (about 14” dia.) to give better flotation on grass runways. We have had a retired aircraft engineer design a retract system IAW with FAA design criteria. The advantages should be improved shock absorbing capability for both the main and nose gear, no plasticsizing of the main gear strut from overheating of the brakes. approximately an 11’ track between the main wheels down, improved ground handling, no large holes cut into the fuselage for main gear action, less noise in the cabin. We have just about completed our redesigning of the strake area for the reinforcing needed to support the new location of the trunions. Another advantage of the wider main gear track is a much reduced chance of catching a wing tip in a cross wind landing.

To be informative and be fair, I must make clear that the Swing designed Velocity retract gear has many features that I feel are advantages over the landing gear we have had designed. The present RG and its hardware is very light weight for its strength. It has its trunion located in the strongest most stable part of the aircraft. It is a proven reliable and tested arrangement. In flight, all the mechanism that make the wheels go up or go down and locked, is accessible to the pilot or co-pilot to work on in the unlikely circumstance that it is necessary. From the cabin, with some upholstery pulled aside, you can see directly if the landing gear legs are over center down and locked. This RG system, because of its trunion location and stiffness and the shorter moment arm being worked by side loading and wheel spin up forces during cross-wind landings probably far exceeds the capability of our newly designed gear. I am doing lots of other modifications to my standard Velocity. They include: Gull wing doors (not like the Elite) my design will not modify the strake. Both doors will have their lower door sills where the old standard door closed, above the strake. Floor stiffening, Thicker windows, No center console as such, No forwarder seatback bulkhead, a supplemental roll arch all the way around the fuselage instead of the fwd. seatback bulkhead, fold down split seat backs forward and aft, sump tank to under the front seat and rear seat. Alan Shaw type carbon fibre control surfaces and internal rudder horns.

NOW, about the Manual: There are multiple sections I, II, III, IV, etc. They should be redesignated as Chapters and/or Parts and/or Sections. There should be a mini-index at the start of each segment of the manual with page numbers as well as a master index at the front of the manual with page numbers. There should be a cross reference by page number to help locate other information pertaining to the same thing. There must be six little areas pertaining to building and fitting the canard and elevators. They are in several areas of the manual. From Danny Maher’s schedule and its chronology of events and when they should take place. That is fine, but finding them all; I emphasize all, without cross-referencing is a little painstaking.

The text in my manual does not make it explicitly clear just exactly what reference points to select to do the initial level ing of the aircraft (refer to page 407). Leveling the fuselage fore & aft as well as side to side is something one must do time and time again. It is a pretty vital effort to perform accurately if you want a good end product. Where to find the procedure is not indicated in an Index, nor is the procedure indicated on the lead sheet for “Section IV”. It is found under BULKHEADS. Now: my INSERT on Water Levels: Just vegetable dye works fine in the warmer parts of Florida to color the water and could be added to the antifreeze + water to increase the contrast where the water level will have to sustain freezing temperatures. See tools pp 113. I just came from talking to Scott Swing. The way to level the lower hull is with a water level. Place the lower fuselage hull so the imaginary point under the flange at flight station zero at the very nose of the aircraft is aligned with water in one end of the water level; and the very aft most portion of hull, (which will become the lower cowl) in the center measuring from side to side: the lowest point of the opening on the bottom outside of the lower cowl skin will align with the water in the other end of the water level. It would be ideal to have this level very accurate, but an error of 1/4” equals less than 5 minutes of angle (1/12 of one degree). A water level can be accurate to less than .03125” (1/32”). The diagram on 406B should help you define these points. Once that is done, level the lower hull side to side. It is important to now do the following to save much time and effort later and to maintain a level reference for future use. At some point, long before you must continue to have the hull level to progress with the project, you will be cutting off the rear portion of the lower fuselage (the lower cowl); losing the rear level reference. So; now: while the lower hull is still accurately level, & BEFORE your rear level reference is cut away do the following: At many points around the lower hull make level marks with a pencil using a water level. Mark directly on the lower hull, or mark with pencil on masking tape. Each foot on the outside, both sides of hull. Also while the lower hull is now level; definitely mount two inexpensive plastic string levels (one forwarded and aft and one side to side. Use hot glue or bondo. Mount them so they are accurately level. Mounting two sets of these string levels at non symmetrical locations is advisable. To build, will probably necessitate removing one or more of the levels; but it will help to have a pair remaining. It will save time later when the plans calls for leveling the aircraft one, or two, or more times. Two people make water leveling much easier. Be patient. The water level takes a second or two to stabilize (more if the diameter of the
above the level mark made earlier on the bottom hull. If you attach something to the bottom hull to mark on, place another horizontal line two inches higher than the level line, made earlier. This upper line will fall about an inch above the hull flanges. This last line is the one to align the leading edge of the strake with. If the fuselage cannot be leveled and still have the top of the incidence jig level; then level the incidence jig on the wing and then use the water level to locate a level line about 76-78” forward of the X main spar level with the bottom of the X main spar at the fuselage. It is more important to have the strake align with the wing than to be overly concerned about other dimension stated in the manual. The 2” dimension is very important; but it is relative to having the incidence block on the wing; level. All that other info in the rear part of the manual, pp 37 & 38, can be considered extraneous and downright confusing. One should be able to establish the 2” dimension and attach the strake within + or - 1/8” of the mark or better! Aim for the “or better”. For information: an eighth of an inch off here equals an angle of about .0987 degrees (six minutes of angle). Please disregard any manual statements of - 0.5 degrees, or + 1 1/2 - 2 1/2” IS OK. ONE CANNOT HAVE BOTH A SPECIFIC and then a sloppy tolerance as well. It is easier to do the best job possible the first time around and the product will end up much better.

Another topic: Yesterday I was talking with another Velocity builder who had cut a fuel tank cap hole in the top of his upper strake just overhead where his landing gear was going to reside when retracted. What a waste in time money and aggravation. Why can’t the manual give adequate warning to the RG kit builder in appropriate spots to prevent this type of goof? Another thing he mentioned: Almost all BID glass cloth is cut on a 45 degree bias. After each procedure this builder squared off his roll of BID wasting many square feet of BID material. The manual could make some statement early on to prevent this type of waste. We have heard of people using hardware not selected, tested and approved by Velocity. That is foolhardy. It can cause inadvertent problems. Check first! The bolt may be of some poorer grade than required for the task you have selected it for. Nuff said!

CHECKLISTS: This may embarrass the Swings a little, but I think it is important to use them as a base line, since they fly Velocities more frequently than most of the Velocity owners. They also have more time in Velocities than most owners. Most all honest pilots will admit to many goofs and all pilots with substantial time have had an abundance. Goofs should be learning tools. The same goof twice approaches stupidity. With a proper take off or after landing checklist, IF FOLLOWED, we could pre-vent take offs with the speed brake extended or take offs with the pitot tube cover still in place. Build a checklist for your operation to include Pre-flight (walk-around) Cockpit Pre-flight or Set-up; Eng Start; Pre-taxi; Taxi; Before take off; After take off; Climb; Cruise; Before descent; Descent; Before landing; Go around; Taxi in; Parking; Shut down. Emergency and Abnormal checklist to cover all kinds of navigational problems with equipment or mechanical problems: to include engine loss or other kinds of survivable structural failure. All these check lists should have expanded portions so that you can scan them for review purposes: to help maintain currency. Then if you don’t recall in detail the proper sequence of how to handle the abnormal or emergency situation; a small aircraft handbook should be available to answer the specifics in question. All big flying organizations have check-lists. They have proven to be a very helpful tool in standardizing operation, reducing incidents, and accidents, and dramatically improving SAFETY. The Velocity fleet is anything but standard; so one checklist is not for all velocities. A generic check list for Velocity owners would need editing by the velocity owner.
Aircraft Appliques with New Velocity logo

We are working on incorporating the design for aircraft appliques for the various Velocity models. The goal is to have the design available for sale as:

- Logo templates (as a template for painting or air brushing)
- Vinyl stick on decal.

Here is a list of all the logo options for various Velocity models:

<table>
<thead>
<tr>
<th>Wing type</th>
<th>Fuselage</th>
<th>Gear</th>
<th>Logo Applique</th>
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<tbody>
<tr>
<td>Standard</td>
<td>Standard</td>
<td>Fixed</td>
<td>Velocity</td>
</tr>
<tr>
<td>Standard</td>
<td>Elite</td>
<td>Fixed</td>
<td>Velocity Elite</td>
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<td>Standard</td>
<td>Standard</td>
<td>Retractable</td>
<td>Velocity RG</td>
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<tr>
<td>Standard</td>
<td>Elite</td>
<td>Retractable</td>
<td>Velocity RG Elite</td>
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<tr>
<td>173</td>
<td>Standard</td>
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<td>173</td>
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<td>Standard</td>
<td>Retractable</td>
<td>Velocity 173 RG</td>
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<tr>
<td>173</td>
<td>Elite</td>
<td>Retractable</td>
<td>Velocity 173 RG Elite</td>
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To the right is an example of the applique for the Velocity 173 RG Elite. Please call either Bonnie Swing or me with your input (good idea, bad idea, etc.). If enough of you like the idea, then I’ll proceed to line up a company to produce the decals & templates.

Rick L.
to fit his particular Velocity; the one he built or owns. If you have not been to the hanger or flown for six weeks, you need a checklist. There is no question. YOU NEED A CHECKLIST! If you disagree, I suggest you are a robot with all circuits in perfect order or you are missing rungs in your ladder.

AIRSPEEDS: Let me first state that what is in the manual must be quite reasonable or we should be hearing many more horror stories. Maybe this flying community (Velocity builder Pilots) is too proud to tell of their “GOOFS”.

Charting some important speeds:

If you are to do some of your initial flight testing your self, and you do not have two or three hours of current time in canard aircraft; first of all get some time. If you don’t seem to be able; please, have someone else do the first flight test. Definitely have another Velocity hands on builder/pilot check over your aircraft with a “fine tooth comb”. Spend your dime, as they say, call another Velocity pilot and have a good long chat. Call Velocity in Sebastian and talk to Duane or Scott. They will have many specific suggestions and time tested questions and comments. They want the greatest success for their Velocity buyers and builders. It is part of their success story. They are very serious in their efforts to provide the best information to the builder to make the builder the safest best Velocity builder out there. Reread the portions of the manual and the New Velocity Owners Flight Manual which should be available before too long, which pertain to testing and flying the Velocity. Review your checklist! It will be included in the flight manual. You have spent too much time and money to mess up your whole life, and your beautiful new VELOCITY, because of limited preparation, or poor skills, or lack of currency. A few days now is nothing compared to the months or years of work. Be sane! Keep your emotions under control. Use your common sense. Let someone else’s brain rule, if you don’t seem to be functioning in a rational manner. If you have done your own Hi speed taxi tests and are going now to flight test: be aware of the weather. If you have a 10 knot or greater wind you should consider adding half of that wind to your planned lift off speed. The rotation speed you probably noted during the Hi-speed taxi tests is not a stall speed. THAT IS BECAUSE OF GROUND EFFECT. Ground effect provides for additional support below the wings when very close to the ground. That is why you can rotate below the stall speed you will record in still air at altitude. For the Velocity there is a formula which can be supplied. I do not have the formula; but at wing height above the runway of about 8-10’ you will leave the area of ground effect. For a 1600 pound gross weight Velocity a safe rotate speed should be 70 knots. Perhaps a little less for the Velocity 173 and Elite versions, Maybe 67 knots IAS for this first flight test. Do not forget to add a “safety supplement” for any substantial wind. Stall speed + 5 knots. For no wind conditions and low gross weight Stall speed should be the aiming speed to commence rotation. We do not know the STALL speed of YOUR Velocity. I am attempting to provide a take off speed for a very first flight which will be SAFE. Initial Hi speed taxi and flight testing will determine lift-off speeds at light weight. As continued flight testing progresses keep changing the fuel loading from 20 gallons to 35 to 45 to 55 to full tanks. (the numbers of gallons are non-specific. They represent approximate one hundred pound changes) With each of these various fuel loadings take the aircraft to 6,000-8,000 feet above terrain. With the power off and with the power you would use for a go-around or missed approach stall the aircraft with the gear both up and down. Record the weight and as accurately as possible the indicated airspeed at which the stall occurred. Do three stalls in each configuration. Record the data for each and average. Also record the fuel remaining to help in understanding the center of gravity and loading and their relation and how those data may affect the stall speed. Next, load the cabin with weights in the seats to simulate people. Start with a light fuel load (20 gallons) and add weight to co-pilot seat of a normal sized person (170 lbs.). Preset the elevator trim to down position of 1 1/2” - 2” (NOSE UP). Make a take-off. Determine the back pressure on the stick and the take off speed and distance. Make a couple more take-offs, at least, to determine best elevator pre-positioning for optimum (minimum lift off indicated airspeed and runway used). CAUTION: Do not exceed a positive pitch angle of 8 degrees as you do not want to chance a prop tarmac contact. Record the speeds and distances. Now; repeat the stall sequence at altitude as for just one pilot and fuel from above. Increase the simulated pax. to two (340 lbs + you and a fuel load of 35 gallons). Record all the distances and speeds. Do another stall series. Record that information. When doing go around manuevers at altitude, take note of the slight pitch down tendency as power is added. Note the required amount of elevator trim to correct the pitch down tendency, when power is added. Record this information: How long you had to hold the elevator trim switch and how much the elevator moved. Now load the cabin with weights to simulate four people + luggage (750 lbs total). Then top up with the fuel to bring the aircraft to a maximum gross weight (about 40 gallons in a standard & maybe up to 50 in a “173”. Do a full stall series. Perform all the same manuevers as before recording the required data. Each time you take-off at a different weight record the take off distance. Determine the very light weight take-off distance. That length plus two thousand feet should be the very shortest runway ever selected for a landing at that same or less weight unless you have an emergency. Add 2,000 feet to all the other recorded take off distances for the heavier tests and different loadings. For those weights that will provide the minimum length strip to pick for a landing. With all the stall speeds recorded for the varying weights and loadings build a chart.
Multiply each of the calculated stall speeds by 128%. the result will be a V reference speed for the particular gross weight at landing. This is the basic speed to which adjustments are made for the varying conditions to arrive at a safe final approach speed. To the appropriate Vref, one should add one half of the steady wind reported and all of the gust factor reported up to a maximum of twenty knots. To the result add an additional 5 knots. Example: wind 300’ at 8 gusting to 14. Stall speed 54 Knots. From your charted speeds you see 69 knots as the Vref. Add to that one half the steady wind, 8/2 = 4 + 6 (all the gust) + 5 knots. The result is 84 knots. If the wind corrections add up to 20 knots, do not add an additional 5 knots. The total amount added to Vref should not exceed 20 knots. This is the safe target speed to fly final approach using the specific conditions indicated. In addition to the above, you should seriously consider a maneuvering speed. That is: bank angle should be limited to not more than 15° until maneuvering speed is reached for the specific circumstances. Commercial jets use a speed of 140% of stall speed for a condition to determine maneuvering speed. FAA limits them to never exceed a bank angle of 30˚. We velocity pilots frequently have a tendency to use bank angles exceeding 30˚. Therefore, for safe operation we should consider a maneuvering speed at 150% of stall. For a light weight aircraft with a stall speed of 54 knots; a maneuvering speed of 81 knots is minimum. For a heavily laden aircraft with a stall of say 70 knots; the minimum maneuvering speed would be 105 knots. For best fuel efficiency a loitering speed would be an additional 5-10 knots. An efficient climb speed would work out to be about 20 to 25 knots above minimum maneuver speed. 100 knots for the very light weight aircraft and 125-130 knots for the heavy aircraft. If you lose an engine during any flight first determine your present weight. Go to your chart and determine maneuvering speed for that weight. Attain that speed + 25 knots for a reasonable glide angle. Trim for that speed and determine where you may be able to land. If you are 10,000’ your glide ratio should give you about a 25 nautical mile radius of action. That is about ten minutes of time. Plenty of time to do all the things necessary to improve survivability.

One more comment: This is not a tailplane aircraft. No attempt should be made to make stall type landings. You may walk away. You may get a prop. The nose may drop thru at the last minute and strike the surface first, causing a porpoise type landing that will be certain to scare the living daylights out of you if you don’t bend or break something as well. The reason a porpoise landing is so attention getting is that the oscillations continue to increase in amplitude, and the gyrations of the air-craft panic many pilots into freezing on the controls, usually stick full aft. The oscillations are more rapid than can be believed. Apply power and go around and relax the back pressure on the stick and apply a little nose up trim. Plan to have no less than 5 knots above stall speed when touching down. That is approaching dangerous if there is any wind of five or more knots. Mother nature does not guarantee a continuous steady wind for each of our landings. The headwind can begin to decrease just as we are flaring causing an almost instant decrease in indicated airspeed and a very rapidly approaching stall. For safe operations carry that little bit (5 knots) extra airspeed.

Duane Swing Comment:
The effort of Dave Huber is to be commended as he is one of our “first time builders.” Many of the plans comments made are certainly true and require revisions to eliminate possible error. As you know, we are making a concentrated effort to correct this manual problem. His landing gear change, if all works as planned, should be a beautiful design. On the negative side is the unknown. How much is it going to add to the empty weight? How will it effect touchdown in a crab? Our own experience with a wide gear vs. narrow gear resulted in more tolerance in a crab touch-down with a narrow gear. There are still a lot of questions unanswered and a finished, flying aircraft should provide them.

One of the great things about this ‘experimental’ aircraft movement in the US is our ability to make change without government intervention. Most of us don’t have the knowledge or desire to do what Dave is doing, just knowing we can make a big difference.

Owner’s Flight Manual almost done!

The Velocity Owner’s Flight Manual, complete with all check lists is almost finished. General descriptions, operating limitations, various procedures, weight & balance procedure, aircraft characteristics, performance information, as well as various check lists for first flight, maintenance & inspection (25, 100 & annual), preflight & inflight, and emergency.

Every aircraft is required to have 5 items onboard: Airworthiness Certificate (with the attached letter of limiting conditions), Registration, Radio Station License, Operating Limitations, Weight & Balance. The Owner’s Flight Manual will assist the Velocity builder in complying with 2 of these 5 (Operating limitations and Weight & balance data) requirements.

The manual should be ready for distribution by August 30, 1995. You will receive one at no cost if you purchased your kit after Jan of ‘95 or if you will be upgrading to the new builders construction manual. Otherwise it will be available at a nominal cost to cover out of pocket expense. Call Pat at the factory if you would like to order one.
INPUT PLEASE!
The focus of this quarterly newsletter is on things of interest to Velocity builders and pilots.
- Builders Tips & Suggestions
- Technical Questions
- First Velocity Flights
- Stories about Velocity Builders
- Builders’ Buy, Sell or Trade
- Social events & fly-ins

We need your help now!

Listed below are 4 options for submitting your input.
Please send us photos or line art too!
Graphics and photos are always more interesting than just words!
1) Send it on a 3-1/2” computer disk (Mac or DOS), saved as text or ASCII. This saves us from re-typing all that text. Don’t format your text, just give us raw text, with no underlining, bold, or any other type of formats. If you don’t know how to save as text or ASCII, that’s okay, just let me know what software & version # you used and I can most likely convert it at my end.
2) E-Mail me via Compuserve to User 76545,1726, or via Internet: 76545.1726@compuserve.com
3) If you don’t have access to a computer, then we can scan in your typed page.
4) If you print neatly so we can read it clearly, we’ll input it on our computer for you!

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New subscribers coming in mid year will be provided with back issues for that calendar year.

Publishing a quality newsletter with a small base of builders to draw on means that we need just about 100% participation to make ends meet financially. Inputting, editing, writing, graphic design, camera ready layout, scanning photos & art, lino output, printing, labeling, and postage all need to be covered by your subscriptions.

Look at the top of your mailing label for the final volume number your subscription covers.

To help keep our costs down, no invoice will be mailed to you. Simply mail a check each year to keep your newsletter coming.

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