Custom Speed Kit Installation

By Bud Yerly
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Custom Flight Wheel Pants background:

Many Europa owners were perplexed by the fact their aircraft was significantly slower than most others. I authored a number of emails which culminated in Drag Reduction 103, on techniques for reducing the drag of their Europa Aircraft that have worked for me and my customers. However, most folks detested the standard wheel pants and the many screws and problems with after-market speed kits. It was tedious to install, remove for maintenance and frankly only added a few knots. I attacked the problem by first determining the best installation methods to attain excellent drag reduction. Next we looked into how to make the speed kit easy to remove for ease of maintenance. First we attacked the wheel pants.

At Custom Flight Creations, we felt that too much time was wasted on the tedious task of unscrewing wheel pant halves to get access to the wheel for preflight servicing, inspections and for trailering the aircraft, as most of us tie down the aircraft via the landing gear on our trailers. It is my experience that the time consuming multiple screw turning requirement necessary to remove split half wheel pants for filling tires, inspecting brakes, tire changes and securing the aircraft for trailering mean often times proper maintenance and inspections were not accomplished.

A simple wheel pant removal system was needed. The tried and true method of cutting a huge hole in the bottom of the pant and using a one piece pant has been done by the certified manufacturers for years but the huge hole made for wheel pants that often added no speed at all and only increased aircraft weight. Hence most civil light aircraft fly with no wheel pants at all.

In the 1930 and 40s streamlining techniques were tested by the NACA (National Advisory Council on Aeronautics now called NASA) to improve aircraft aerodynamics for introduction into production aircraft. (See References.) However, to achieve minimum drag, the wheel pant aerodynamics prevented easy maintenance, inspection or proper clearance when using grass runways.

Some interesting ideas were tried. Many of these ideas are still in use today.


At CFC we decided on using the NACA series six airfoil of roughly 26 percent thickness and use that shape to build a low drag pressure recovery shape. A 26 percent thickness airfoil of about 30 inches long would cover the entire tire/wheel of a 5x5 tire and still be wide enough to cover the brake caliper. To take advantage of this very low drag shape, the angle of attack of the wheel pant needed to be very close to zero at flight cruise attitude. The wheel pant also needed to cover the tire as much as possible leaving only enough exposed tire to allow normal landings, full aircraft rotation without dragging, and be able to allow a small wheel chock to be used under the pant for parking. Also the hole in the bottom of the pant for the tire needed to be as tight as possible. Normally a 5x5 tire will flatten out under a firm landing by nearly ¾ inch. So a clearance of the tire to pant needs to be at least that distance.

To allow access to the tire and brake for inspection and servicing, the pant must be easy to remove. That is easier said than done. One cannot make a large hole in the bottom without penalizing drag due to turbulence. The pant can be made hinged either vertically or horizontally but again, clearance for the tire and brake, and support for normal air and ground loads must be considered. The shape of the wheel pant makes for hinging problems.

In order to quickly remove/swing the pant clear of the tire to allow inspection, with the fewest fasteners (three is the limit of my patience) a hinged pant using a short horizontal hinge and three fasteners (one on the outboard side and two on the inner side) was chosen for the main pants, and a off vertical hinge was chosen for the nose pant.

Our final concept uses an inverted horizontal T shaped support, attached to the brake caliper support to provide lateral and horizontal support and a horizontal hinge support at the top of the inverted T that attaches to the wheel pant for a pivot point and also for support. The wheel pant is secured for flight with three #10 AN 525 screws (two on the horizontal portion of the inverted T and one on the outer axle end). When the screws are removed, the pant can be hinged upward (or sideward on the nose gear) to expose the tire, valve stem and brake for easy access. In the case of the main gear, the gear can be secured to a trailer in seconds without removing the wheel pant as they hinge up out of the way, or the hinge pin can be removed to remove the entire wheel pant.

We didn't wish to stop with the wheel pants. We found that the gear leg actually is higher drag than a full wheel. A simple 25% airfoil shape for the main gear leg was made, and the nose gear was covered with a simple smooth shape to allow a cleaner penetration. Transition fairings make for more security and a less drag plus they are good looking. It is important to note, the gear leg cover must be secure and not flap about, as this would be a huge amount of drag. Europa's idea of just taping the gear leg on is nonsense.

The wing outboard flap brackets are very draggy. Europa aircraft created a fairly simple to install cover for the mono wheel including the inboard brackets, however the Trigear covers were not secured well.

We designed a simple shape for the inboard covers which are nearly the same as one would see on an airliner, and the outboard flap bracket was truncated to allow not just for flap movement but for inspection. We fasten the flap bracket covers using only a couple of screws and simple bath caulk to secure them.

Finally, we molded our pants and covers with transparent gel coat. It may not look pretty as the glass and flox can be seen, but you can see where you are drilling and check clearances a lot easier. You are going to paint and fill anyway. So just scuff the gelcoat, fill any oopses and get on with it. It's fiberglass.

Custom Flight Trigear Wheel Pants Installation Kit:

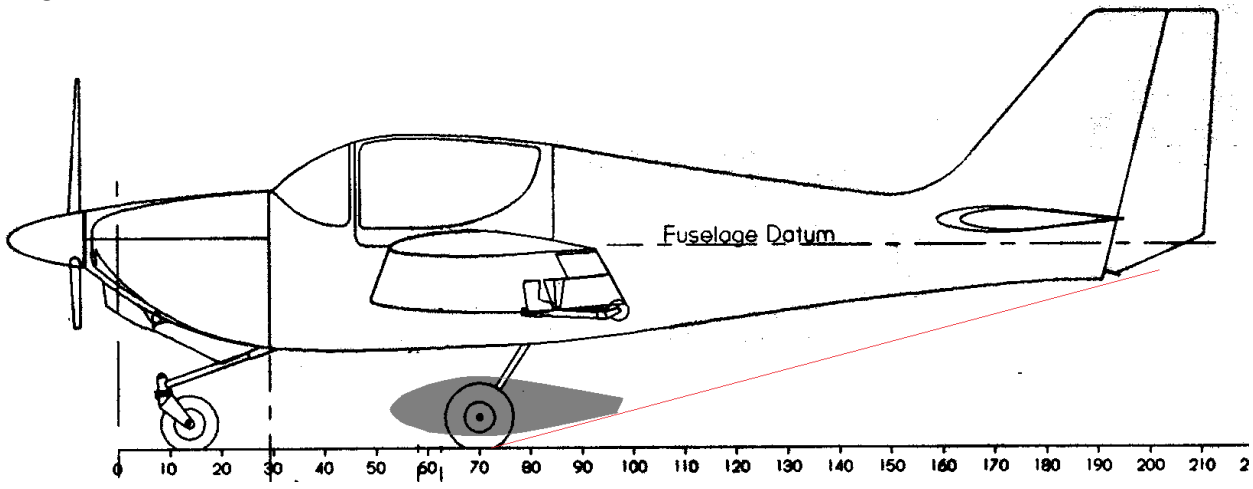
The kit includes the following:
Two main pants
Two inner main pant covers
Two main gear leg covers
One nose gear pant, usually with the nose cone taped on to it.
Nose gear leg cover,
Six wing hinge bracket covers. 4 for the inboard and center, and two for the standard outboard bracket.
Main and nose gear metal supports.
Four nylon spacers for the main gear hinge and pant supports
Three 4 inch hinges
Appropriate nuts, bolts and screws.
No rivets, nutplates or decorative screws are included as your taste will determine which you want to use.

Preparation:
The main wheel pants need to be installed with the wheel pant level with the door sill or flight attitude and aligned with the centerline of the aircraft. This means the centerline of the aircraft must be marked, the aircraft leveled, and the weight removed from the wheels to remove bending forces on the gear allowing the wheel pants to be easily aligned in the shop.

Most builders are reluctant to jack the aircraft to level, align and relieve the gear in an installation. Start by simply removing the wings and tail planes for ease of moving about. Successful installations have been done by placing the unrefueled fuselage (wings and tail planes removed) on the flat hangar floor and simply lift the tail of the aircraft with a helper by the stab tubes until all the weight is off the mains, then, set the aircraft down on the mains slowly. Note the gear barely moves. Sand paper glued to the floor is another way to keep the wheels and gear from sliding or springing outboard under the weight.

Next, find the centerline marks on the fuselage. If the aircraft centerline marks are no longer visible due to finishing activity, use the center of the tail post bottom. If a tie down was installed on the aft centerline, and is clearly centered that may be used also. Drop a plumb bob from the center of that point to the floor and mark it carefully. On the front of the aircraft, drop a plumb line from each side of the cowl line used in the weight and balance (vertical joggle line on the fuselage side for the cowl) and connect the points and find the midpoint. Again, successful installations have also used just the center point between the two foot wells marked on the engine frame. Connect the front and rear marks for your centerline.

On the normal Europa XS or Classic, the pilot's side door sill is sufficient for determining the level flight attitude at an average gross weight. If being installed on the high top, use the lower fuselage bonding joggle if still visible. If not use the cockpit module top as it is as close as you will be able to get with the wings off.



Installing the wheel pants :
First prepare the moldings by light sanding with 180 grit. The gel coat is clear for easy viewing of internal components so drilling is quite easy. The wheel pants are only two layers of 8 oz. cloth so the edges may be a bit sharp. Lightly break the edges to make them more comfortable to handle. Each wheel pant must be reinforced after fitting with forward and rear bulkheads of two layers of 8 oz. glass(prevents mud and debris from filling the wheel pants) as well as the hinge attach point, screw

holes and the lower opening edges. Once complete with the bulkheads, wheel pants are very light and quite strong. So make up some flat two ply layers of 8 oz Rutan bid and allow to cure at this time.

Note that there are two marks on each wheel pant which define the level aerodynamic minimum drag line. The wheel pants are clearly left and right and the cutout has been made on the inboard side and just clears the standard 5x5 tires of the Europa. Check the fit. Next, set the pants and the inner panel which covers the inboard side on the bench and if necessary, add a bit if heat to get the closeout to fit the main wheel and allow to cool. Glass shrinks (as does filler) when curing, so these thin parts must be shapped.

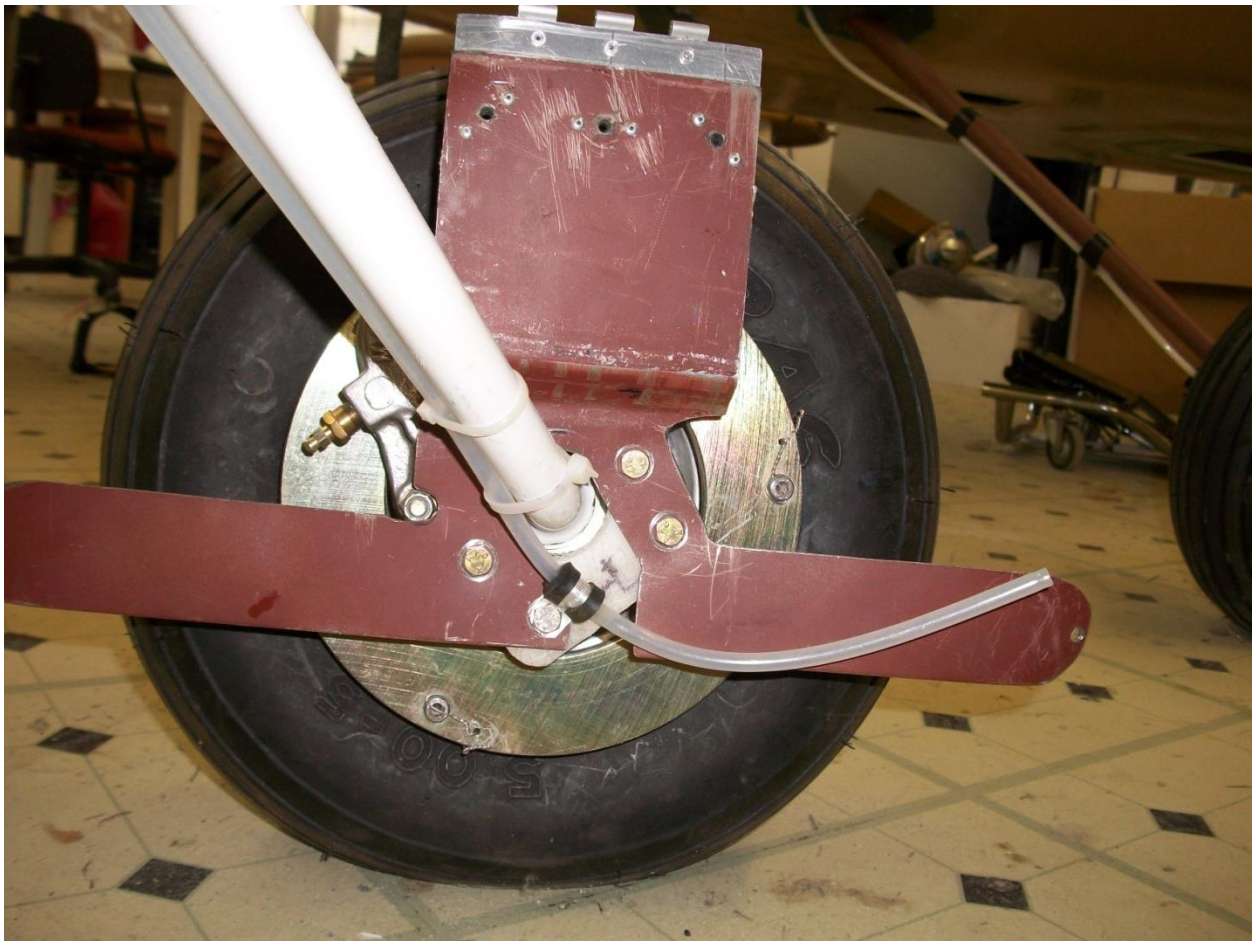
Prepare the attachment brackets.
Included with your kit is a pair of T brackets (metal tees about 12 by 12) cut to fit the main gear brake bracket support. Two matching spacers made from nylon and 8 total AN-3-14 bolts are included to secure the bracket. This portion of the install can be accomplished easier if the wheels are removed and the mains supported on wood blocks as it is more convenient to drill and install the bolts, but not faster to install due to the reassembly of wheel and tires and the time to assure the brake caliper does not impact on the bracket.

The wheels and brakes must be reattached at this step. The bracket must be attached and bent to clear your particular wheel brake caliper. IT IS IMPORTANT TO HAVE NEW BRAKE PADS INSTALLED OR ACCOUNT FOR THE PAD WEAR. It is easiest to install the nylon spacer from the front inboard with the slot pointing upward and aft to align the predrilled holes in the nylon with the two existing holes in the brake caliper support which is bolted to the gear leg. Fit the metal bracket by bringing it in from the aft inboard side and sliding the slot over gear leg and against the nylon spacer. Note that a bend must be made to the vertical support to clear your particular brake installation. Each plane is slightly different, so mark where the metal bracket touches the caliper and then note the amount of space the bracket must be bent for clearance. Mark the metal, remove and bend on the bench and reinstall.

Note: If the bracket is installed hard against the caliper the brakes will not release properly and drag, causing premature wear, a spongy brake feel and cause ground steering problems due to unequal brake drag. Once the metal support bracket is temporarily installed actuate the brakes to check the bracket is clear of the caliper or at a minimum, force the caliper to its most inboard position possible.

The picture below indicates the bend is normally a horizontal bend made in a vise, of 45 degrees, for about ½ inch then bent about 5/8 of an inch back to vertical. The brake line does not have to be removed normally.

It is far easier to remove the wheel to attach the bracket bolts, but it is fairly easy if patience and a magnetic tool is available to retrieve the inevitable dropped nut into the wheel housing. Using the predrilled holes, it is easy to install the bracket with the first two bolts, but four bolts are needed so two additional upper bolt holes must be drilled.



Once the bracket is bent to allow clearance, it is time to attach it.

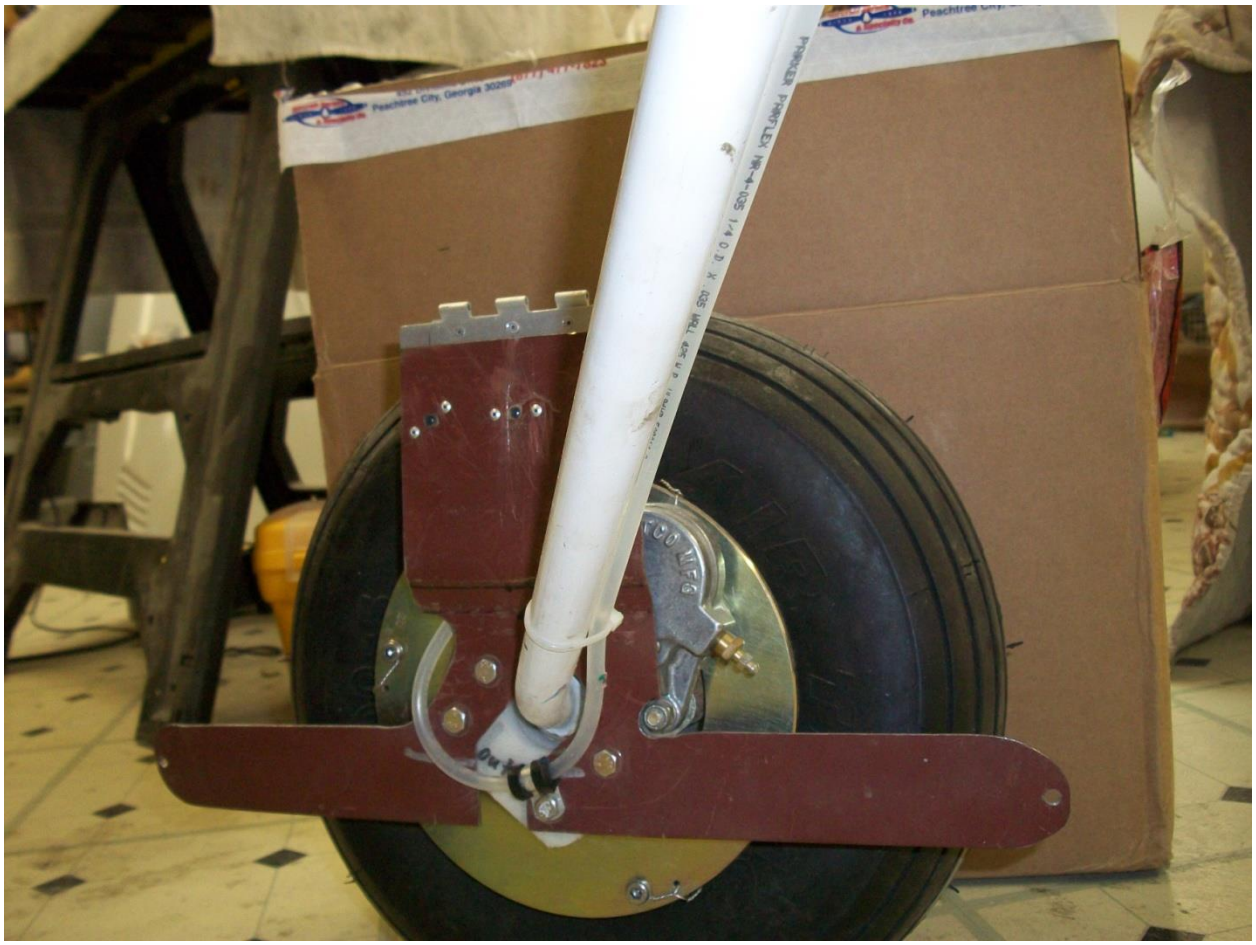
The gear brackets are vertical to the ground (or nearly) but the gear leg is at an angle as shown above, and at a camber so getting a precisely drilled hole is a bit difficult. During the drilling, instead of bolting up the bracket hard, I will cut off the heads of four 3/16 bolts or use a 3/16 rod as an alignment pin to set the position. A drift is just as handy. Remove the bracket and spacer to prep for the new holes (it's an airplane, if you don't take it apart and put it together at least 5 times you're doing it wrong.). Now it is time to mark your wheel brake caliper support. Note that the hole must be placed so as the nut and wrench will clear the spindle and the hole edge will not be less than 3/16 inch from the edge of the bracket.

If the wheel is removed, mark the hole position with a center punch and drill through the caliper support on the gear using a 1/8 drill bit to drill the first hole and deburr to serve as a pilot hole. Install the spacer and bracket. Then drill from the inboard side through the nylon spacer and metal bracket.

If the wheel is left on, it is best to measure, mark and drill the innermost nylon spacer first with a 1/8 hole then carefully match drill to that hole through the other nylon spacer. Set the now drilled nylon spacer on the matched second ½ inch spacer (normally the nylon spacer is two ½ inch nylon blocks to allow some slop in drilling but some are 1 inch). It is then easy to use the two spacers to align your bit and drill the hole through the metal main gear bracket. Once the 1/8 inch holes are complete, drill them

out final to 3/16. It is important to use the drifts, cut bolts or pins in the lower predrilled holes and simply ream the holes with the 3/16 bit for a good fit.

At this time, make sure the brake caliper, brake lines and brake line bends are clear and will not chafe. It is necessary to plan and fit an Adel cushion clamp to assure brake line security and hold the line so it cannot chafe against the bracket, the bolt heads or caliper to prevent a worn line and possible leak in the future. It may be necessary to make small cutouts for the caliper slide bolts by relieving part of the bracket as the photo depicts.



More than one Adel cushion clamp may be necessary to provide adequate clearance. If the brakes are worn, it is necessary to manually move the brake caliper out to its full compression to assure the metal bracket does not push against the caliper.

Prepare the bracket for wheel pant installation by touching up with primer and install with temporary nuts to allow easy install and removal. Have a magnet handy to pick up the pieces as they fall into the wheel and brake disk. Repeat install on the other gear leg.

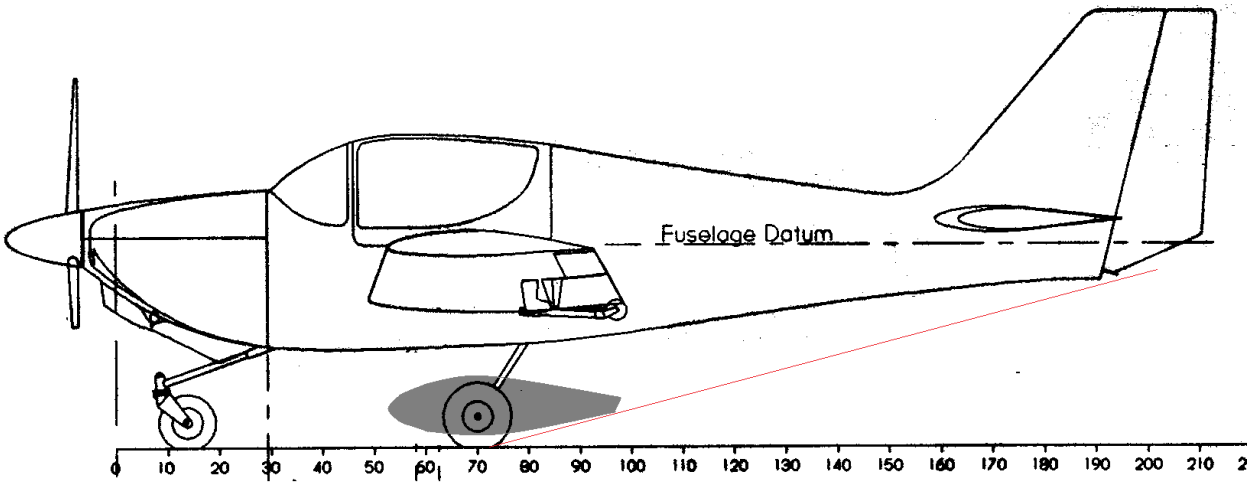
Note: The plastic lines used in most experimental aircraft will in extreme brake use get heat soaked and become brittle, or if the brakes get very hot like when taxiing in a strong cross wind for a mile, may even begin to bulge. Metal lines from the caliper to the gear leg then plastic the rest of the way can be used.

Installation of the wheel pant:
Pull the cotter pin out of the axle nut and install the supplied drilled nylon dowel. Many use the RV axle nut instead, but then a wood or similar dowel must be glassed on the pant to act as the spacer.

Place the wheel pant over the wheel and tire by rotating the pant on as if it were hinged to the upper bracket. Note how the wheel has outboard camber but the wheel pant must be placed nearly vertical as measured with a square from the floor for proper clearance all around. Place 2x4 lumber under the pant as blocking to hold it level with the floor. For vertical, use a brick and check with a square.

The height of the wheel pant depends on the surface of your runway. For turf runways it is best to position the bottom of the aluminum wheel rim level with the bottom of the pant. For hard surfaced runways and for lower drag, lower the wheel pant to a point which allows 2.5 inches from the surface to the bottom of the wheel pant (with the tire inflated to 35 psi). The wheel pant bottom aft line is shaped to just clear the ground at full nose high on landing roll out.

We pull a string from under the wheel to the tail and clamp it in place to check that the back and bottom of the wheel pant clears the string by at least ½ inch. See drawing below:



The pant must clear the tire by a minimum ½ to ¾ inch all around the inside and top of the tire. The pant must be aligned with the flight path vertically and horizontally. Make longitudinal chalk lines parallel to the centerline of the aircraft to assure alignment. View from above from the nose to the tail of the pant that it is aligned properly. Once the basic position is set, note the horizontal arms of the bracket and where they rest on the pant. Note the position of the outboard center of the axle by looking through the pant(you may need to move the brick). Simply adjust the drilled nylon dowel in and out to just contact the inner skin of the pant for easy viewing.
Move the pant fore and aft to center it up on the approximate axle mark. The axle mark on the outside of the pant is not a vertical position, it is only for fore and aft positioning. Since the axle is not perfectly straight, the eyeball must be used to get the alignment set. Your vertical portion of the bracket arm should be nearly centered in the slot at the top inboard section of the gear but still be aligned properly. It will be necessary to bend the top of the hinge inboard a bit to allow easy positioning of the pant. Once the vertical bracket arm of 4 inches is centered on the cutout, the two lower arms can be bent to allow them to rest on the outside of the pant rebate squarely. Simply use two small spring clamps to hold the bracket to the pant. The metal bracket must be trimmed off for a good fit into the rebate. Clamp up the inner bracket arms and then mark the wheel pant inner and outer points where the nylon axle dowel and brackets touch the pant.

Next turn your attention to the top of the 4 inch arm of the metal bracket and note where it falls on the wheel pant. The metal bracket should be trimmed to 1/8 but no more than 3/8 inch below its hinge point slot in the wheel pant. Be sure the pant at the proper height. Note the hinge is attached to the steel bracket and then is bonded to the wheel pant itself and riveted in place securely.

A photo below shows how the hinge is reinforced to the glass and bolted to the bracket at the attachment point.

Once the bracket is trimmed position the hinge aligned nearly level to the floor with sufficient contact with the pant and the metal bracket. Drill at least three no more than four 3/32 inch holes through the hinge halves on each side and then prepare to match drill to the bracket. Carefully bend the vertical metal support to be just inside the pant, align the hinge and mark the hinge location. Carefully set the hinge on the outside of the pant and drill the hinge to the wheel pant. Then move the hinge to the inside of the pant and cleco in place.

Once the hinge is clecoed, check for level and tilt, then the ends of the metal tees can be final marked for trim and predrilled for attachment. Once trimmed, reclamp and check position, then drill through the wheel pant flange. Cleco it all together and check the position of the wheel pant. Once satisfied, remove the pant and prep for the fiberglass reinforcements.

Fiberglass Reinforcements:
The hinge is in the curved portion of the pant. This area is very weak and the flat hinge won't fit without filling and reinforcement. This hinge is not a structural support holding the pant on, but is necessary to keep the pant solid in the vertical and when open, and prevent fatigue of the three screw attachments when closed. This is a light wheel pant, it needs to be properly supported.

The hinge has to be supported by first scuffing the hinge area out about one inch past the hinge ends. Apply 4 layers of glass (6 inches by 2 inches) and floxing over the glass. This additional reinforcing is required for the hinge support and edges. Cover the hinge with release tape, open the rivet holes and set the hinge into its place. Align the hinge not with spring clecos but by screws or hand clamp fixture holders similar to the European style clecos to just hold it in place until the flox and glass cures. Spring clecos will bend and distort the pant. Allow to cure.

The attachment points for the three attachment screws must be reinforced also. The nutplate reinforcement for the inboard support requires 4 layers of glass measuring 1.5 by 4 inches. The outboard reinforcement is a 4 inch by 4 inch 4 layer bid reinforcement. Now, for those desiring a taper head screws without Tinnerman washers for the support screws , the thin outboard skin must be made thicker and stronger. If no Tinnerman washer is used on the outside, add a AN970-3 or 4 or similar washer to the inside and flox and glass into position. Countersink as desired.

Note, we use an AN4 screw for the outboard as it is stronger for grass operations and many prefer to use a Van's RV axle nut with a MS21042-4S nutplate in its center. It is a matter of taste.

The edge of the wheel cutout is to be reinforced by a 2 inch strip of two layer glass around the perimeter. Any debris or grass on the runway really cuts a low slung pant so be sure to reinforce this area. The wheel pant will fill with mud and debris if bulkheads are not fitted in the front and rear of the pant.

Fashion the bulkheads as follows:
First mark the extreme forward and aft position of the tire in the wheel pant by simply looking through the opaque pant. Remove the pant and Using ordinary paper, make a template of the inner and outer

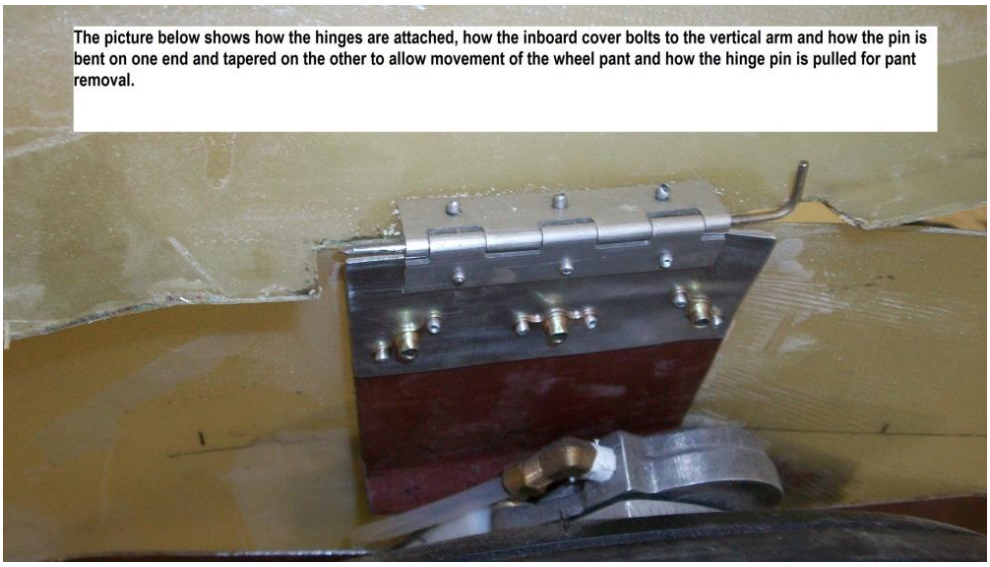
bulkheads when placed with at least 1 inch from the tire position. Make them as near vertical as possible.

The bulkheads are made from two layers of bid and peel plied as stated above. Allow to cure, and trim to fit using your templates. Drill a hole for a cleco near the center to help hold the bulkhead in place. Once fitted, mark and then scuff the inside of the pant and apply a two inch wide 2 ply bid tape around the bulkhead and allow to cure. These bulkheads add rigidity to the thin lightweight pant. I always make a hole in the bulkhead and use a centered cleco to help position the bulkheads and tack with thick super glue prior to applying tapes. Then remove the cleco so that as the tapes cure, the wheel pant does not distort.

When the reinforcements are cured, drill out the holes from any flox or glass covering them and cleco in place again. Once satisfied, drill and countersink the hinge holes in the glass and drill out the bracket ends from 1/8 inch to the final 3/16 inch for the screws.

Remove the wheel pant again and fit the inner bracket cover to the wheel pant and trim for a snug fit. Use heat to flex the inner cover for a tight fit if necessary. Clearance the hinge line at the upper inboard area, this is so the hinge does not bind or flex against the skin. Clearance the hinge as on the ailerons on the pant. The lower bracket arm holes can be drilled at this time. Look through the pant inner cover and note where the axle hole is and mark where the axle hole goes through the inner cover and drill.

Inner cover installation:
The inner cover must be cut with a slot to allow it to slide over the gear leg and install the wheel pant for maintenance. Align the inner cover over the wheel bracket and trim to fit the rebate on the wheel pant. Once trimmed it is easy to see where the bracket holes are and install clecos to hold the inner cover to the two lower holes in the bracket. Now three holes must be drilled to secure the upper part of the inner cover to the bracket. You may note the inner cover may be curved and not fit flat to the metal bracket. Scuff sand the inner cover and use expand cell or filler on the inner cover (cover the bracket with release tape and cover the brake caliper and slides) to make a spacer so the screws do not deflect the inner cover when tightened to the bracket vertical arm. We put the three upper bracket screws about ½ inch below the hinge flange to allow nut plates to be installed.



On some installations, the hinge is not riveted to the bracket but is secured using the riveted nutplates. This is a slick install also but more eyeball work is needed. See photo above.

After cure, it is prudent to smooth the filler and then add two layers of glass to the inside of the inner covers for a more ridged inner cover support. After the slot is cut, I like to add a full two layers of glass to the inside to stiffen this cover from distorting and allow rougher handling during filling operations.

Finally, add nut plates to your holes drilled in your main pant arms to secure the inner cover to the pant and arm. Next comes the nose pant.

Nose Wheel Pant installation:

The Custom Flight Nose wheel pant is an exact duplicate of the Europa pant shape, well, nearly. It is slightly longer and it is a bit flatter on the bottom. Obviously it has a totally different nose cone shape. We also built it to accommodate our custom flight wheel axel shaft and tow bar.
One can see the right side has a cut from the pivot shaft opening to the bottom, sloping slightly aft and is hinged. Note the distance between the cap and the wheel pant. (Note: I forgot to cement the gear leg cover to the leg to prevent it from riding up. That was fixed ASAP.)

On the left side one can see the nose cone cut is quite raked aft. It is raked to allow the nose cone to open via three screws and pivot to allow access to the valve stem. Be sure to install the tire with the valve stem on the left.

Begin the install by installing the two V shaped supports on the axle bolt. Trim the Europa supplied axle bolt to be just inside the pant. The nose gear brackets are only slightly different than the Europa ones. Note in the photos above, the axle shaft has a bolt head to allow for a tow bar to be attached. The tow bar axle bolt is not required. See CFC custom tow bar mod.

Caution: Support the nose of the aircraft with a hoist or weight on the tail to keep the nose wheel off the ground safely when removing the axle bolt and installing the V supports. Once the axle bolt is reinstalled lower the aircraft nose to the ground.

Do not tighten the axle bolt more than snug. Allow the V supports to move. With your hands, spread the open section of the aft wheel pant half to clear the axle bolt and position it temporarily over the axle shaft. The wheel pant hole at the top is undersized. Your task is to make the bottom of the wheel pant level with the flight path or door sill and as vertical as possible. (During shipment the pant may be out of alignment, so heat it, if it is "leaning".) The wheel pant should be no lower than the bottom of the wheel rim lip or it won't open properly. Trim the vertical pivot shaft hole to make that alignment happen. Mark the inside or outside of the wheel pant and make the axle access hole if you wish this to be open. Most guys do to check the axle shaft on 25 hour inspections or use our tow bar.
Remove, drill and reinstall.
Once satisfied with the fit, note the V shaped supports. They must be positioned to only hold the aft section at this time. Note that the front holes of the V are on the aft pant section but within 1/2 inch of the front.

From the outside, mark the forward and aft 3/16 inch holes for #10 525 10R8 screws. We cleco the pant on and check alignment again.
When satisfied with the alignment, tilt and pitch, install the nose cap. Again, some fitting may be required. Open the top pivot shaft hole to clear by at least 1/16 inch, and tape the cap in place.

Look over the alignment. Mark where the hinge will go (basically the middle of the starboard side), then mark where you want to drill the three holes for the port side. Drill 1/8 inch holes to start.

Carefully drill the port side holes. If you can, predrill your hinge with 3/32 inch holes. Align the hinge with the hinge line and place the hinge on the outside of the pant, drill two holes on the starboard aft side of the hinge and two on the forward side of the hinge using 3/32 inch clecos.

Check the pant alignment and fit. When satisfied, remove the nose cover and aft portion of the pant.

Install the nose cap AN -3 hinge. Trim the glass just as you would an aileron hinge using a 3mm rebate on each side of the hinge line. Attach the hinge using at least 3 4-40 screws or 4 3/32" rivets (TLPK 36 rivets work great). Remember, the hinge line is set so that the nose cap will pivot and clear the ground when the pant is set no lower than the wheel rim lip. It will look like this below when open.

When satisfied, open the nose cone and tighten the axle bolts with open end wrenches.

Finally, drill and cleco the wheel pant with the proper sized holes (3/16 or #10 for the aft pant and # 27 drill for the #6 screws.) The nose pant needs reinforcements just as the main pants. Apply the same sized 4 ply pads for the bolts and nut plates. For the hinge, reinforce front and aft with a 4 ply one inch by at least 6 inch tape. Many of our clients prefer Tinnerman washers and #6 screws for the hinge and port side, and #10 countersunk screws and Tinnerman washers for the pant supports. AN 525 work just as well.

Finishing and installing the gear leg covers.
One must make transition fairings for the nose and main. We supply gear leg covers of a simple airfoil shape for the main gear leg cover. However, the gear legs covers will all need transitions to support that gear leg cover and shaped to suite your taste. That is where the time can come in.

This is one transition, but it had too many screws. We have found it is much easier and just as clean to make a short transition that only goes about 1.5 inches up the gear leg cover.

You can see the wheel pant inner cover below is pretty simple and small. It has 4 screws to hold it firmly, but more importantly, remember, you won't take this inner panel off to open your pants, and frankly only remove it for annual inspections to see the gear leg to inspect for cracks. Remove these 4 small screws and the entire cover comes off and remove the hinge upper support screws to pull the inner cover off when doing brake pad maintenance or during an annual inspection.

Clay is normally used to get the shape of the transition from the pant inner cover to the leg. We prepare the cover with release tape. We then add clay and shape it. When satisfied with the shape, apply four layers of glass to make the transition shape. Since glass will shrink 1-2 percent and not leave sufficient space for paint and filler. We fill our gear legs and prime them first. Then add 4 layers of painters tape over our gear leg cover and release tape over that to assure the glass will not shrink and be too tight. (We fill the gap after cure with a thin piece of insulation foam tape as used for window gap insulation obtained at any hardware store.) With the cutout of the inner cover, one might ask how do you cut the clay and glass off after cure. First, drill a small hole in the front and aft layer of the transition as well as the cutout section to hold it in place during the next action. Then carefully, mark your cut lines. The front of the transition should be about ½ inch aft of the leading edge, and the aft about an inch. Using a fine Dremel diamond cutoff wheel and patience, cut the transition off. See the photo above for how the transition is cut up the leg. Once cut, remove the covers and clean up the clay.

These transitions are not for looks, but for aerodynamics and to hold the gear leg securely aligned with the airstream. They are not strong enough to do this task at this time. Scuff sand the inside of the transition pieces. Reinstall the transitions and the upper section to the inner pant cover. Fit the cut leg cutout portion in place and clearance as required. Remove them both. Cover the cutout cover with release tape and tape to the upper transition paying attention to alignment. Lay 4 layers of glass lapping the inside of the upper section by at least ¾ inch over the inside of the cutout cover (which is covered in release tape, and on to the other side of the upper section. Allow to cure. Once cured pull the cutout cover from the glass and trim for a ½ inch flange. Drill and prepare for clecos. #6 screws are fine.

Once cured and cleco'd, it is time to reinstall the flange to the inner gear cover permanently. They are removed prepped by sanding and floxed onto the inner cover and cleco as required. Allow to cure. The flox is fairly strong, but will crack under flexing so remove the clecos, scuff the glazed areas and apply 2 layers over the whole transition floxed area. This will be rugged and carefree.

The upper gear leg to fuselage transition setup is done as the inner cover but the trailing edge made in place and cut, or overlapped on the aft end to allow it to be stretched over the gear leg. Finish paint and cement in place with silicone. For the purist, you may want to glass the transition in place and make it so the gear leg slides under it but much fine cutting must be done to get the gear leg to slide on without having to pull the wheel assembly off to get the gear leg on. I prefer to use small attachment screws along with the caulk to hold the transition on.
Caution: Do not drill into the fuel tank!

Try to keep it thin and with enough gap to allow the gear to flex. This cover has ¼ inch at the front and back (more important at the back) and 1/8 inch on the outer side for the gear to move and flex without cracking the gear leg transition. The plane fully loaded above shows the gear leg cover just touches the gear leg. You can also glass the transition to the fuselage, but the gear leg must be shaped to slide into it or if you decide to butt them together, a gap must be left for gear movement.

The nose gear leg cover is just a set and fit it on. If you don't glue the leg on, it can ride up and leave an unsightly gap between the pant and the gear leg cover as shown in the photo below. Normally I leave about 1/8 to ¼ inch gap between the cap and pant, to allow preflight inspection to make sure no grease is on the plastic disk. It can be smaller of course, but secure the nose gear cover so the cap doesn't drag on the pant.

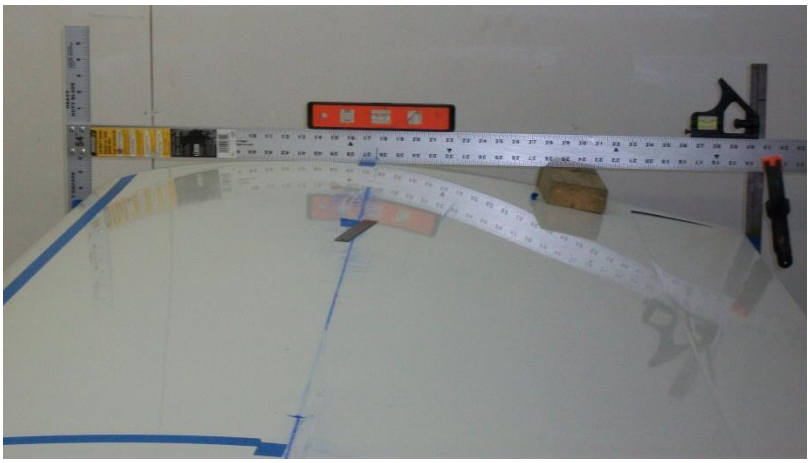
Apply a little tape on the nose gear leg and make a transition lip to better clean up the flow around the leg. Believe it or not it works.

Wing Flap Bracket Cover Installation

The wing covers go on similar to the Europa kit. The only difference is in the attachment, and the width of the covers is slightly different. The CFC molded covers have a slight pressure recover taper for the inboard covers and the attachment method is slightly different. The flanges on the bottom are slightly recessed so filler can be added to get a very good fit to the wing.

Pay attention to your wing flap bracket aerodynamic covers. To help align them with the flight path, mark a line on the wing along the spar line with a chalk line to use as an alignment device to ensure the covers are dead on the zero sweep line and parallel to the slipstream or you will have six rudders out there slowing your plane down.

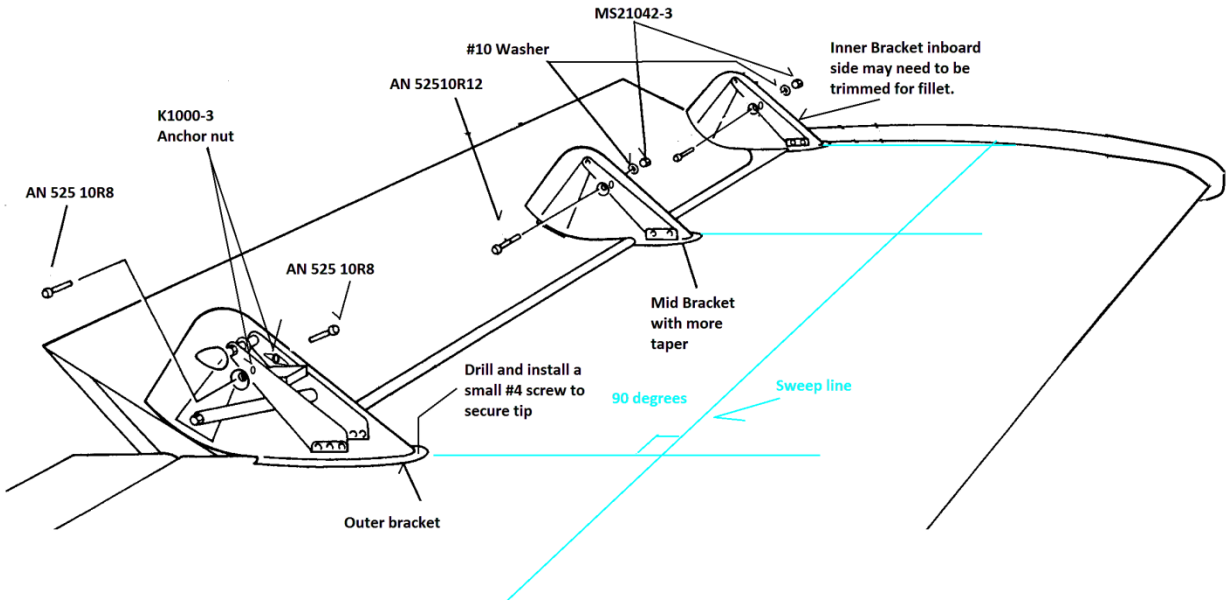
If you are a purist, and your wing sweep is not exactly zero, drop a line tip to tip at the spar line, (check your longitudinal axis to assure square) then mark the tips where your spar tips are (accounting for the overlapped spars) and snap a line tip to tip. This should be as close as you can get to your true flight path line.



Normally Europa uses one screw and some caulking to attach your wing covers. This makes alignment and removal a pain as the single screw attachment does not assure proper alignment. The inboard cover is a cover to wing alignment problem. Note that the wing fillet may be smooth and angled or may be a joggle. The installation may or may not require additional trimming or depending on your preference, cut the existing flare and glass a smooth transition to suite your particular wing.

For a more secure installation, put two #10 nut plates in the outer flap bracket to hold the cover firm to the outboard bracket. The inner is marked, checked and a single 525 is drilled through with a #10 MS 21043 nut and washer. To assure alignment check the leading edge of the cover with your chalk line and a long square.

The flares at the wing may need filler to make a nice fit. Cover contact area with release tape and flox or fill in the flare inside to get a good fit. Trim and sand.



To hold your front edge of the cover in place and to assure alignment while the caulk cures on final assembly, we recommend that the installer drill the front flange of the cover and continue through the wing skin also. Install a small screw, such as a #4 x ½ inch taper head screw through the cover and into the skin. On an existing build with a finished wing, the skin is very thin and foam filled, so we recommend the screw be coated in grease and a small drop of epoxy (or super glue) be placed in the hole to stiffen the foam core and secure the threads of the screw from pulling out. For a new build, we attach a nut plate to a 970-3 washer and glue it to the inside of the wing for a very secure cover attachment. Double check your alignment by installing the screws as the #10 screws in the side will flex the cover slightly. If the cover flexes too much, fill the space between the cover and the flap bracket with a spacer. Once assured of your alignment prior to final prep and paint, drill a least an 1/8 inch hole for drainage at the lowest point in the cover bottom. Finally, move the flap and check that the aft end of the cover does not rub on the flap. Trim as required.

Remove the cover and paint then cement the covers on the wing with silicone or similar adhesive caulk of your choice. Bathroom caulk works fine and is recommended as it is easy to clean off. Marine sealants are slow to cure, and adhere so well, they are difficult to clean. Bath tub caulk only takes a razor blade and a few seconds to cut the soft sealant for maintenance.

I typically take 40 hours to install a speed kit, and transitions. Filling, sanding and painting is extra...

Enjoy the ease of wheel service access and more importantly the speed increase and economy.

Our full speed kit took a Trigear fixed pitch Jabiru powered plane from 108 to 137 knots at the same power setting. It took a 912S Trigear from 117 to 134 at the same power setting. Patience, proper alignment and clean transitions make a significant difference.

References:
NACA Test Reports: 485, 518, and 582.
Drag Reduction 103 by author.