Finishing the Europa
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I fall back on my previous paint experience with epoxy composites I learned while stationed in California in the Mojave Desert, not far from Burt Rutan's Scaled Composites. I was surrounded by scratch builders and the Canard Forum and Ken Rand techniques were my primary learning experiences from the 80's and 90's. The methods were slow and the use of micro was irritating to my lungs and eyes. However, talcum powder for fillers was better on me physically but not as durable for a finish. Later in 2000 while at Flight Crafters, I found AzkoNobel Expancel was much safer when mixed with epoxy as a filler and far less irritating, but it required mixing ratios that rarely came out exactly the way I wanted. Later I found Poly Fiber SuperFil was actually tolerable, and more consistent but significantly more expensive over Expancel and epoxy.

I began working with Flight Crafters in 2000, to learn fiberglass techniques for an airplane I was planning to build from scratch. They were building components for Europa fast build items and a customer wanted to finish his plane there in Florida. I searched for a painter and Johnny Hardacher was recommended to us. Johnny was a Corvette painting expert. He did the paint on the Florida Miss Budweiser Unlimited racing boat, show cars using polyester filler products common to the auto body business. After completing the first aircraft for us although some mistakes were made, the plane won an award at an airshow for best finish. A few years later I bought out the Flight Crafter Europa builder assistance and soon I was finishing a number of Europa kit aircraft with my clients now as Custom Flight Creations. Johnny stuck with me I'm happy to say and the rest was history.

Johnny Hardacher was my painter for some 16 years, and I learned a lot of things to do and not to do. He applied hand formulated paint mixed by a Europa client who owned a paint business, base coat clear coat auto paint, PPG experimental paint (similar to Omni) and Imron. Every paint and system required a particular method and technique. But the real thing I learned was how to properly prep a composite aircraft so filler and primer would work the first time, every time in various conditions. Johnny's shop was a typical dusty body shop strewn with autos in parts and bits in various stages, but the paint booth was clean, and he had a large section set aside for my Europa's in finish. Often times, the prep and primer task was accomplished in the dust filled body shop section with no climate control in varying temps and humidity and it always came out well. I gave Johnny my requirements for finishing over epoxy and he contacted Poly Fiber to learn the technique of their process and accomplished the final finish painting of 15 or more of our clients aircraft. The best finishes were done in Dupont Imron and were superb. The special made paints and auto paints were OK but the paints didn't hold up as well as a true aircraft paint or even plain old Imron industrial. I found auto paints, were difficult to maintain in the wear and tear of daily operations and the finish generally marred easily and faded which was a disappointment to those insisting on using the auto products rather than aviation products to save money.

With that set of learning experiences, I settled on three types of final finishing methods for composite aircraft but only one way to do the initial prep and fill of the surfaces prior to that last smoothing finish prior to the final finish paint. In a nutshell, clean, scuff, apply epoxy filler, block and fill, guide coat, block and fill, and prime. Then you enter in the most challenging final step, the final pinhole and primer preparation for that glass smooth finish.

Good old hand work is necessary to prep your newly assembled raw composite aircraft filling to get the contour of the joints and glass layups ready for finish:

FIRST, WASH every surface with DETERGENT to get rid of any release agent, shop grit, grime, and greasy fingerprints. Acetone and Scott Towels wiping every square foot helps. Find and dig out any voids in the gelcoat, open them up and scratch up the void, then fill the voids and any uneven joint problem areas with your epoxy filler of choice. Smoothly put on a slightly higher amount of filler than the surface joint or imperfection overlapping by some inch or two for small voids and six inches overlap over the joints onto the surface contour you eventually want. Do not underfill. Remember, any filler over 1/8 inch thick must be reinforced or it will eventually crack. Normally on a large surface discontinuity, I put a thin layer of epoxy filler, then lay in some 2 oz. glass, then more filler. This works well on humps between the fillet and wing where a pilot could step on the edge of the fillet and crack the finish. A little glass helps prevents those cracks. On any filled surface, sand down the filler after cure starting with 80 grit only to knock off the very high spots and then block down with 150 grit. DON'T WORRY ABOUT WEIGHT BUILD UP. NOTICE THAT 90% OF THE FILLER IS ON THE FLOOR. Once close to your contour, use guide coat or a cheap primer, then sand again and fill any low spots found. Use your Mark One eyeball and your hand to aid you in your detecting the imperfections and mark them. Surprise, you still have pinholes and deep sanding scratches left from the 80 grit although the basic contour is there. The pin holes are normally air bubbles in your filler or the factory gelcoat that have been exposed during the sanding, so don't panic. I realize that the glass layup control surfaces are filled completely and have many pinhole and problem areas that are a finishers nightmare. Hinges, glass overlaps, trailing edge joggles all require attention to detail. Many use heavy grits to work fast, but the scratches are severe. These scratches require more filling. Always avoid sanding along the longest surface. Block with 150 grit initially and keep the control surface on a flat surface when sanding. Use guide coats to detect your low spots and imperfections. Fill again and use primer or a guide coat and block one last time. Look for low spots. Avoid heavy grits to prevent scratches and making more low spots. Remember, as the temperature changes so does the shape of the glass aircraft, and every rib will show at different temperatures and sun heating. Don't overfill or underfill these minor skin depressions or movements. It is a fact of life we contend with in composite aircraft.

In short, if you want a fast filling job, remember to clean, scuff, invest in an epoxy filler like Poly Fil or learn to get a smooth consistent Epoxy/Expancel mix and become proficient with a spreader to smoothly apply your filler and get the contour feathered out nice and thin. Knock down the initial fill after cure with 80 grit to scuff the surface bumps and then block to a pleasing contour. Use a cheap lacquer primer or guide coat between sandings to get a good visual of the contour and highlight any low spots. Then final surface finish with one of three methods below.

Caution:

Stay away from high build primers to fill scratches greater than 220 grit and pinholes in a one coat application attempt over your filler issues. It sands down looking very smooth, but you have a very soft and fluffy filler in the hole. As soon as the topcoat hits the soft primer, the topcoat urethane VOCs eats right into the soft filler primer that was hiding/filling the hole and the scratch/pinhole shows through marring your attractive topcoat finish. Your aircraft will be fine looking from 50 feet away, however, to fix it, suicide is preferred at this point, as sanding the hard topcoat off and starting over is worse than doing the final finishing right the first time!

Normally, one educates himself by on-line searches for finishing a composite aircraft and many techniques and procedures are available to elaborate on these techniques. I have found in the initial contour filling, there is only one method, but there are three basic techniques used in final finishing process across the industry to smooth and prep the surface for a smooth flawless finish. These final finishing processes are: Epoxy coat filling, UVSP or Smooth Prime, and Glazing.

The original method I have used is from what I learned from a couple of aircraft builders at the Mojave, Scaled Composites facility. Their techniques are well documented on-line. Once the initial contour is acceptable and the filler is feathered nicely into the desired surface, coat the entire surface with a thin layer of epoxy applied with a squeegee or plastic body spreader. The epoxy fills the pinholes rather than bridging, it also fills those small scratches. Apply the coats allowing each to tack up, then apply another wet coat over it. (The true craftsman will do 5 coats but epoxy sands like iron.) Use a similar method as finishing a base coat clear coat finish called cutting. Each coat fills in the voids with thin laminating epoxy, and when finished, it looks like a clear gel coated surface, and when cured is actually lighter than a heavy filler primer and there are virtually no pinholes, but a lot of dust bumps and spreader marks remain so sanding/cutting is necessary. A smooth and glossy surface normally remains, however, epoxy cures very slow and tends to collect dust. In humid conditions the thick epoxy coats may cure tacky and be impossible to sand for days without putting the part out in the sun and baking. West Systems laminating resin, with a fast cure hardener, is a non-structural epoxy, but even in high humidity it cures hard over night, but in coating and recoating and curing, it collects dust so you must sand with 220 to remove the dust bumps then 320 to 400 and often times you are ready for primer and finish paint after cutting the multiple epoxy coats down smooth. Any time you sand through the epoxy, to the filler, you expose more minor voids and expose more pinholes, so another coat or two of epoxy may be necessary. This process worked on my RC planes and a couple canard wood and composite show planes received high honors at Oshkosh. It is a slow process due to epoxy cure time. The pros preferred using raw epoxy as opposed to a filler epoxy primer, because the filler used in the primer would bridge over the pinholes rather than filling like the raw epoxy does. Problem is, again, it takes multiple coats and is slow to cure. It is also not UV tolerant so it must be coated with a UV resistant high solids paint. Do not use a base coat clear coat over this method unless assured the plane will not be left exposed to the hot desert sun.

Next is the Ultraviolet Smooth Prime (UVSP) finishing method. Follow Poly Fibers Instructions as they have changed twice in 10 years:

UVSP needs a good "tooth" of 150 grit to stick well to gelcoat or it will peel and flake off the surface. UVSP is not a filler. It is soft and absorbs water, sweat and oil very quickly which will eventually ruin your finish. Use an epoxy filler for bad low spots and joints as stated above. It takes about two to three coats of UVSP to get a white cover initially using a roller. Roll on the first coat using heavy pressure or a squeegee to force the UVSP into the holes. Roll on one or two more coats until uniformly white. After cure, sand until the filler starts showing through the white UVSP. Again, using a roller and squeegee, reapply with a foam roller to get the bare spots filled and a smoother finish as you will most likely sand through in spots. Sand again. Blow it off and reapply a final coat with a spray gun for a smooth coat. Allow to dry forever, and sand with 320. Smooth prime should be coated with a primer consistent with the topcoat IAW Poly Fibers instructions. Never apply your final topcoat directly to UVSP unless terribly brave or using a paint formulated by Poly Fiber for overcoat of UVSP. Poly Fiber recommends an epoxy primer be applied over the UVSP then sanded again. Avoid using a water-based type epoxy primer (common in the marine industry) as the water-based epoxy primer over the smooth prime adds more moisture lengthening the cure time. In humid Florida or damp environments, it takes weeks or months

to cure smooth prime. Luckily, we have a lot of sunshine in Florida to help. My final sanding was done to nearly a transparent look. Frankly, I treated it like a guide coat. It was allowed to cure fully, then it was shot with a urethane primer known as 2K that was compatible with the finish coat to seal the water based UVSP to the surface. If you leave a thick fully white smooth prime finish sprayed on, I can't tell you if it will hold up or not unless dried well. It depends on your prep and the cure conditions of the UVSP while drying to achieve good results. Ensure you have proper primer and top coat compatibility. I do like how UVSP is easy to sand. It covers those few 80 grit scratches you left and fills the pinholes if forced in the surface. It must be top coated with an epoxy primer. It is a UV blocker but so are high solids paints. I don't find the UVSP to be any faster than the method below, which is quicker.

My latest Glazing Compound Technique:
A review first of the filling procedure. After you finish, your aircraft assembly. CLEAN AND SAND. Use an 80 grit to get off any epoxy or Redux stalactites or stalagmites then go to 150 to 220 grit on a Dual Action (DA) air sander on low speed to get the sheen off every component. Scuff sand your raw weave with a 150 grit then a coarse Scotch-Brite pad to get down in the valleys a bit. Don't expose the weave.

Fill about 1/16 inch to 1/8 inch with Expancel filler or PolyFil uniformly over the surface joints/weave. Ensure you fill slightly proud of the surface as smooth as possible. Allow it to cure on a flat surface.

Block and sand using 40 grit to knock off the mountains or big bumps only, then 80 grit to initially block the next humps to get a recognizable aircraft shape. Block sand with 150 grit until the surface starts to show through on the high spots, and you start to achieve a feathered edge.

Prime with a non high build filling primer of sufficient color contrast to the aircraft surface for a visual reminder of the difference between primer and surface. Lacquer based primer is fine. Block again with 150 to 220 to remove or highlight all deep scratches and pinholes highlighted by the block sanding and any initial low spots and repeat until you get to the initial contour desired. Fill the serious low spots and imperfections that are still colored by the primer if deep. Re-prime and block out again.

Prime again.
Block with 220 to 320 and note if the primer is being removed at a consistent rate. By this I mean if you block and see the primer is smoothly coming off both the underlying filler and gelcoat equally, stop. Blow off the surface, holding the air nozzle 90 degrees to the surface to expose pinholes and scars. Prime with an etching primer or two-part urethane primer. This primer is a bit tougher than lacquer. Now look for pinholes and scratches. Some will still show. Now we start the finish glazing process.

Fill pinholes with what we call a polyester two-part glazing compound. I like 3M® 31180 - Platinum™ Plus Glazes, which when spread with a plastic spreader or even a squeegee, can be pushed into the pinholes, and scratches and even fill those not so smooth glass to gelcoat transitions you made. Do not apply glazing with the putty spreader in one direction only as half the pinhole gets filled, go in both directions and if necessary, apply lengthwise, then chord wise in a crisscross manner with firm pressure. This layer is applied just thick enough to nearly transparently cover the primer color, and the good news is it doesn't sag on vertical surfaces and does not require multiple coats. Never put glazing directly on epoxy as it is polyester. (The rule is never put polyester over epoxy directly.) Prime first. Like UVSP, glazing it is not a filler, just a firm but sandable cover for the pinholes and scratches.

Sand the humps left in your spreading down with 180-220 or so, then block with 320 down to the primer. All that is left is the glaze in the scratches, real minor low spots and pinholes. This glazing stuff

is soft somewhat like smooth prime and is easy to sand and frankly a lot cheaper and faster. The big news is, dry time is about 20-30 minutes, rather than hours and weeks, and glazing fills scratches left from sanding and pinholes far better than smooth prime. This method even works in cool damp or hot and sticky climates and cures fast. Many square feet can be done in a morning. Work in small patches and spread fast.

After blocking with 320, prime again to seal your glazing. Block sand again with 320-400. Blow it off and find out if you got all the pinholes. If all is well enough, seal with a good primer sealer compatible with your topcoat to get a uniform color to final paint over. Sealer has a semigloss sheen, so any imperfections tend to "shine" through making inspection easy. It also leaves a uniform color for the finish coat. Topcoat with an aircraft quality two-part urethane topcoat.

Note:
Get the best final primer for the best topcoat you can afford. Cheap auto paints are not aircraft paint unless going for short term sale. Invest the money, it saves time in the long run.

I used Imron industrial paint on 12AY and other of my aircraft, but it is hard to get a smooth final finish due to orange peel without the proper technique. But it is industrial tough, shines like the sun, and wears like iron. Paint designed for aircraft is much more forgiving to apply and gives a more out of the gun fine high gloss finish but costs 4 times as much. In the US and worldwide we have many suppliers of aircraft paint. Stick with the manufacturer's recommendations for final primer and finish coat recommendations. When you stick with the manufacturers recommendations, you get factory support from the manufacturer and if it doesn't work as described (and sometimes it doesn't) they many times give you a different batch of the product and I have even had a factory rep come to my painters shop to demonstrate and correct what we were doing wrong for our painting conditions.

No one likes to do paint prep on composites. But I find, the initial filling to be fairly easy and quick for most to learn quickly. It is getting that last bit of final filling and sanding to my liking that is so hard for the amateur and experienced builder alike. We amateurs tend to fill too little and sand too much and we repeat and repeat. Do yourself a favor and if you don't know what final filling process will work for you, pick a small part like a rudder, wheel pant, or similar and buy small quantities and go ahead and finish the part to final and coat it with a top coat. Use a lacquer topcoat to see if the finish will eventually be to your satisfaction. Lacquer is high gloss, cheap and soft to sand off. Then when ready to go final sand off the lacquer topcoat back down to primer when you decide on your urethane topcoat. You will be saving time and money and learning your craft and only need to by quarts rather than gallons of your finishing materials to practice with. You may consider getting a sample quart of your expensive final topcoat paint and spray out and then cut and buff as necessary to learn both the spray technique and the finishing buff out of that paint. Don't buy your final topcoat paint at different times. Buy it all at once at the end of the project and mix the two gallons together (boxing) to assure consistency of color. Expect the learning process on that one or two parts to be slow, but once you are practiced, the rest of the plane goes faster as you will be more confident in your practiced procedure. A pro painter can fill and block a fuselage and wings in a week. Control surfaces take another week. Normally, Johnny's boys could fill, block and prime in three weeks if pushed and no other cars got in the way. Expect the process to primer to take a month. For final paint, find or make a paint booth that is dust free and for God's sake, wear protective respirators to protect yourself.

Best Regards,
Bud Yerly