

The Best Engineering Vs. Dirty Engineering

Airy musings by Tom Arnold

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One of the most fascinating aero engineering profs I ever had was a great guy of Eastern European descent who had fought in 3 armies in WW II: Romanian (I think), German, and Russian... ..yep, all three. He was shanghaied into a couple of them. He used to chain smoke while lecturing and was one of those guys who would never shake the ash off. We students used to watch with fascination as the ash grew longer and longer, and would mentally agonize whether he would ever make it to the ash tray. He always called us "boys" and told us he had gone for one solid year with no meat for food and hated cabbage. At any rate, one day we got him off the day's subject (this is a favorite sport of all students, if you remember) and got him talking about the Germans and the Russians. Being a good teacher, he turned it into an engineering lesson and introduced us to the concepts of *The Fetish For The Best* and it's opposite, *Dirty Engineering*.

The Germans loved the Fetish For the Best approach and as an example he told us if a German and Russian had to kill a snake, the Germans would develop an absolutely magnificent all-weather, all-species, high-speed snake killer. They would test it, refine it, and change it using the absolute latest in technology. Then they would bring it out to kill the snake. While they were gone, the Russian had grabbed a shovel and had chopped the snake to bits.

He carried that concept to their aircraft. The Germans had beautiful killers in the Me109 and FW190 with cockpit heating, excellent maneuverability, balanced controls, all metal construction, avionics, lots of flying instruments and so on. Their opponents believed in the Dirty Engineering path and made their equipment just good enough to get the job done and no more. The Russians had the LAGGs and YAKs with the steel tube fuselages, wooden wings, fabric covering, pilot-supplied heating, and practically no instruments in the cockpit. They looked like they had been built in a garage with common fittings and fasteners. The aircraft's life span was measured in months. When we protested this seemingly simplistic approach to engineering, he reminded us of which world-class, high tech, jet-age, military machine was in smoking ruins in 1945. It was a great class — one of many he gave us.

(Ed. Note: Local PFFT member Jerry Klingaman, who who works extensively with foreign made aircraft, particularly Russian, finds that the Russians are still using that approach to building aircraft, and finds them more sturdy, reliable and far easier to maintain than our highly refined aircraft. He also says that "the life expectancy (in terms of total airframe hours) of the Russian birds is somewhat less than their western counterparts. You can do a full, strip-down depot-level overhaul of, say, an Mi-17, but why do it when you can buy a new one for six million dollars?")

In following a number of the conversations on the internet model groups one in particular reminded me of my old Prof. It was a discussion of the value of cutting lightening holes in structure. It then went to trailing edges and gussets and all sorts of stuff as to what was the best. Lots of good stuff was brought out with passion and excellent engineering justification. All I could think about is the Russians and the Dirty Engineering and how they got the job done. When we strive so mightily to get the lightest, best flying, prettiest scale models in the air, sometimes we develop beliefs that really are very correct but in actual practice are almost meaningless. Let me give gussets as a prime example.

Gussets are those fiddly little triangular squares glued into the junction of, let's say, the trailing edge of the rib and the wings trailing edge. It gives a greater gluing area between the two pieces and increases the strength of that weak spot tremendously. That is pretty much accepted, however, what I get such a kick out of is the continued logic of the fact the grain needs to go at a 45 degree angle to the joint, i.e. parallel to the hypotenuse for the best results. This is very true BUT it is usually stuck in there with a shot of thin CA glue that soaks it all and turns it into a plastic-wood composite that will break long **after** the untouched wood has shattered. When you realize that, then any grain direction is good enough for the job. The gusset itself is the important thing.

But we are not through. With equal passion, it is argued that the gusset should be radiuses such that the hypotenuse is a smooth curve from point to point rather than a straight line. The proven engineering reason for this is that it does not concentrate any high stresses at the very end of the gussets causing a break at that point. The curved "legs" of the gussets smoothly distribute the stresses along the sides such that joint holds longer than it would otherwise. All very correct, and a radiuses gusset looks so clean and workman-like to boot. Real life tells us though that in the vast majority of cases our aircraft hit the ground with such force LOTS of things bust and a gusset area or two is pretty small potatoes. Chances are the forces are so great that any kind of gusset would fail as we don't build our aircraft to be bullet proof crashers, but light flyers.

The conversation then went on to trailing edges, sharp vs. blunt. Endurance flyers and scale flyers (and full size aircraft pilots) each cited studies and examples of why one or the other is the best. One school of thought was the air has separated from the airfoil long before it hits the trailing edge so therefore a blunt trailing edge is harmless and it offers so much more strength and less weight that it is the best. The other side of the fence, brought out the fact the blunt trailing edge encourages the air sliding along the wing bottom to curl up to the top even creating reverse airflow...and killing lift. Another chimed in with an experiment done at a competition event where the top 6 finalists were evenly split between aircraft utilizing blunt and sharp trailing edges. It was all very interesting and made even more murky by the fact the aircraft (endurance and scale) operate at different Reynolds numbers and that not a whole lot of highly expensive wind tunnel tests have ever been done at our end of the flying machine spectrum. Once again, Dirty Engineering says if you can't clearly or even slightly see it in the flight of your aircraft, why bother? Do what the spirit moves you to do. I know not

what others may do, but I will make my edges sharp because it looks like a full size aircraft.

How about this? White glue vs. dope to attach tissue. The Russians would say the goal is to attach the tissue. If welding works — do it. If nails work — do it. If spit works — do it. Dirty Engineering at its best. Both methods work fine with some advantages and disadvantages to both. Dope has flammable fumes, lots of surface preparation, difficult removal, but a nice adhesion. White glue is non-fumey, goes on with no surface prep, sticks well, removes with water, but raises the wood grain and does not look as good on the surface. The efficiency is hardly worth discussing, it boils down to what fits your workshop environment.

Of course, there is the favorite of young and old: paint. Or perhaps "surface color" would be better if you want to bring in colored tissue vs. paint vs. translucency vs. opaqueness vs. weight. I have wallowed in this pig pen for years looking for the BEST finish. You should see the collection of dead paint bottles I have. Lacquer, acrylic, watercolors, inks, dope — have been a regular Underwriters testing lab for color over the years. I finally let go of that dog when I realized that our aircraft resemble decoy aircraft made from 2X4s and canvas more than they do metal monoque fuselage flying machines anyway. Colors have gotten the Dirty Engineering application when I realized that judges at FAC contests don't have color chips to compare your aircraft against. Their eyeballs are calibrated no closer than yours. Blue is blue... .dark blue is darker than blue and that is close enough. If it looks good, it is good. I kind of like Dirty Engineering ...it is very soothing.