Cabin Noise

Recently, many builders have made glowing statements about the quietness of 3 blade props. I have sometimes wondered if they were really that quiet or was the owner justifying the considerable expenditure.

David Knox (SC) is in the process of writing an article comparing the sound level of a 3 blade and 2 blade prop on the same Long-EZ airframe at the same power - airspeed combination. If anyone else has a 2 blade and 3 blade prop for their aircraft and would be interested in running a sound level comparison also, please advise me and I will set you up with a Db meter to run the appropriate tests

A research of literature shows the relationship of different airframe parts' resonant frequency to the prop's fundamental frequency is important. While this is most important to conventional tractor aluminum airplanes it still has application to our birds.

One can determine the prop's resonant frequency by multiplying RPM by the number of prop blades and divide that by 60. A 3 blade prop at 2700 RPM has a fundamental resonance at 135 Hz while a 2 blade's is only 90 Hz. Change engine and or prop RPM and the noise will change greatly. "Bring the prop's fundamental frequency below the resonance point of the fuselage and you'll cut the sound level dramatically.

The following paragraph was taken form a recent <u>AOPA Pilot</u> article.

"Engine vibration from combustion events, internal imbalances, and exhaust pulses - join the party in the lower frequencies as well. It's interesting to note that a four cylinder engine with a two blade prop and a six cylinder engine mated with a three blade prop place their natural vibration characteristics smack in the middle of the prop fundamental frequencies. From an acoustical point of view it's almost as though the common combinations are also the worst low frequency noise makers." In the 70's Cessna did a lot of noise research and determined the lower frequency noise, around 63 Hz, came mainly from structural members. Low frequency is by far the loudest in aircraft and, unfortunately, the hardest to filter out. Higher frequencies, around 2000 Hz, (2 KHz), are influenced mainly by wind noise and can be masked effectively with lightweight headsets or ear plugs."

The <u>AOPA Pilot</u> article noted a considerable noise reduction by going to thicker windows (up to 1/2" - UGH - <u>heavy</u> canopy!) but that the later model Bonanza with a sloped windshield is best of all. Window inserts, like storm windows on your home, are effective too but not as good as just increasing window thickness. Inserts should be 4" away from the outer window for most effect. That makes for a pretty thick canopy. You'd better have a really skinny head. It seems a curved window is generally quieter than a flat pane for the same thickness and area.

The flight tests were on a tractor type airplane and may not be completely applicable to our more rigid composite material pusher configuration. The main point seems to be, smoother air flow makes less noise and that is much more important than trying to eliminate it after it is made.

Earlier flight tests, reported in this newsletter, show significant noise reduction by improving smooth air flow into the prop field. Keep air flow attached and your airplane will be more efficient and quieter. SHHHH.

It seems 3 blade prop operators will agree that a pusher with a 3 blade prop is quieter than one with a 2 blade. At first thought that seems to conflict with the fundamental resonance frequency rule in the second paragraph. The rule suggests a 3 blade should have 1/3rd higher fundamental resonant frequency and therefore make more cockpit noise. This may be true for tractor configured fabric or metal construction. Our composite pushers have more rigid fuselage sides and are out of the prop slip stream so the prop's resonant frequency may be only a very minor player in cabin noise.

It seems noise generated by the prop, when passing through relatively slow disturbed air and then hitting fast smooth air, might be a bigger contributor to cabin noise.

Assuming similar blade design, RPM, airspeed, cowl shape, etc. a 2 blade prop will generate 4 of these noise impulses (bangs) per revolution on a standard cowl. Since each blade of the 2 blade prop hits the disturbed air at about the same time it may appear there are only 2 monster bangs per revolution. A 3 blade prop will generate 6 impulses per revolution. The "bang" frequency is 3 times higher and thus easier to mask with headset/ear plugs. Additionally, an engine generating 100 hp is loading 50 hp on each blade of a normal prop. The 3 blade carries only 33-1/3hp per blade. The 3 blade will probably appear noticeably quieter as the "bangs" are softer due to lower hp per blade and the frequency is higher which is more easily masked.

Prop noise is also highly dependent on tip speed. We've all heard objectionable prop noise of the air show biplanes with larger prop diameters at near supersonic tip speed. Frequently, 3 blade props are smaller in diameter than 2 blade as there is 1/3 more blade area to absorb the power. Therefore, great prop length is not so necessary. The 2 blade, with a larger diameter, will have a higher tip speed, thus generating more noise than a smaller diameter 3 blade at the same engine RPM.

It now seems clear to me. My next prop will be a large air screw. I will have an incredible number of blade elements so my power per blade will be very low and the wing/prop "bang" frequency will be extremely high - maybe even above human hearing range. What a good idea - a quiet cabin and all those irritating little Schnauzer dogs barking in distress. Caution: Don't over rotate on takeoff. You'll drag your air screw in the dirt!