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Harshwardhan Gupta's Design Tips–13

Designing Silent Machines

"Shut up and be quiet! Don't make so much noise!" Can one say that to a machine?

Yes, the designer actually can! But first, why is there a need for silence? Many reasons – some are obvious, others not so obvious. Most obvious is the sound pollution, and high noise-level is a definite health hazard. High noise adversely affects concentration and leads to annoyance and fatigue.

Not so well known is the fact that today, noise is associated with bad quality. Many engineers don't quite realize that **if a machine is producing unpleasant noise, then almost as a rule, something is being destroyed somewhere!** I have found this to be very true.

Some machines are inherently noisy: stone crushers, where the stones cracking up themselves produce noise, or a high-velocity air nozzles, hammer mills, wood-shaping machinery, glass-bottling lines, a train running on rail joints. But most others could be made quite silent. Over the years, almost every machine has become increasingly silent: cars, computer printers, even buses and trains. Modern milling machines are quite silent now, thanks to gearless spindle drives… The most noticeable noise reductions have taken place in looms and in automobile engines. This is high-tech – which is nothing but application of science and attention to detail.

So, who are the noisemakers, the culprits – so to speak? Gears, bearings which are not pre-loaded, bearings with too much or too little radial clearances, unbalanced rotating parts, pneumatic valves without silencers, loose parts…

There are two ways noise is transmitted. One through the physical machine – what is called structure-borne noise, and second, one through the air – called air-borne noise. You only feel the first (as vibrations) and you only hear the second.

Some machines like fans and blowers directly produce airborne noise, most others usually produce structure-borne noise, which at some other point in the machine becomes air-borne. Sheet-metal edges, large sheet-metal panels convert structure-borne noise to air-borne noise. Cheap commutators in DC and universal motors often produce a siren-like sound.

Many cheap pumps sold in India produce cavitation noise, (a sort-of continuous rattling noise) which is produced when entrained air bubbles – or water vapor bubbles forming at one place (due to bad rotor design / poor manufacture) and collapsing on a surface somewhere else on the impeller or the casing. This consumes more power, reduces efficiency and ruins the pump in a few years.

So, the designer should attempt to identify sources of noise and eliminate them systematically. Please do not go by gut-feeling solutions and immediate fixes. A very common source is unbalanced parts, so balancing is an obvious remedy in many cases.

Noise reduction is a vast and complex science and noise problems cannot be tackled by hit-and-miss methods. Merely putting padded covers on the machine is only covering up the problem, not eliminating it. In this article, I have merely drawn attention to some of the problem areas and broad reasons. Giving solutions to specific problems would result in a 4" thick textbook! But such books, even handbooks, are available in any decent technical book store.

Here are some tips:

1. Tighten all nuts and bolts. Make sure they remain tight.
2. Stiffen large sheet-metal panels as required. See the stiffening done on the underside of a modern car's bonnet.
3. Make door hinges free of play.
4. Pre-load high-speed bearings with suitable disk springs.
5. Excessively rigid frames only change the natural resonance frequency of the noise the basic machine is producing. Eliminate the source of the noise rather than making other parts heavier and heavier.

6. Stiffen edges of sheet-metal panels by folding them over.
7. Check run-outs of pulleys / couplings, etc.
8. Maintain proper center distances and PCDs in gears. Do not jam gears into each other, nor run them with too much backlash. Backlash in gears should be barely perceptible but not zero.
9. Timing belts produce a whine at high speeds if the pulleys are cut with low-quality hobs, or with hobs whose profile is theoretically incorrect.
10. Properly designed and maintained brakes and clutches should not squeal at all. Glazing on the lining can simply be taken off with emery paper.
11. Much of a good compressor noise is the intake noise. Cleverly mounting a car's or a truck's air-intake filter in place of the OEM filter reduces that to negligible levels. The same can be used to muffle noisy vacuum pump exhausts.
12. An anti-vibration mount is just that! It prevents machine vibrations (not air-borne noise) being transmitted to the ground, and to a very small extent, it dampens structure-borne noise. It is not a solution to heavy noise problems.

Anyway, nowadays the discos and the city roads are noisier than the factories. Noise levels are being measured in most cities, yet most current models of 3-wheelers are being most callously designed and manufactured with no regard to their gross noisiness. The same goes for domestic food-processors and industrial blowers. Who cares?

However, the first prize for the most enduring (but most inaccurate) noise goes to the sound of any and all gunfire in all Indian movies: *Ddhisshhkkyyaaauuunnn…* Have you ever heard gunfire in real life? It sounds exactly like those small Diwali crackers going off: putt… putt… putt… And the prize for the most unendurable noise goes to the "tension" scenes on current soap operas. Dhuddum Dhuddum Dhuddum Dhuddum… I would rather be in a power-loom shed with 500 old dobby looms running together.

Bund karo yeh bakwaas! Tuum aakhir chupp kyun nahin rah sakte Harsh?

Kyunki writer *bhi kabhi* listener *thaa!*

Next Month: Avoiding Overdesign

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