

Harshwardhan Gupta's Design Tips-14

Avoiding Overdesign

We Indians overdo everything in our lives! Look at our weddings, festivals, politics, interiors, houses, movies, soaps, food, travelling, corruption... As a people, we really don't know when to stop.

I have given various tips for avoiding overdesign in various past Design Tips, especially in # 3: Saving on Weight (IPF January 03), # 4: Saving on Raw Material Costs (IPF February 2003) and # 8: Saving on Energy (IPF June 2003) besides others. I don't want to repeat them. So, lets talk about this Deity called Safety Factor, before which every designer must pay his/her respects everyday!

Most of our indigenously designed machines are grossly overdesigned, unless they are ditto-copied from some foreign design. "Copying fully safe no? If 6mm pin works there, it should work here also! I am having full faith in reverse engineering sir!"

I think before proceeding I must legally caution you:

So be witnesseth that it shall hereinafter be Expressly and Mutually agreed upon that the Reader Present as Party or Parties of the Other part including and also not excluding whomsoever Absent before whom these Matters have been reduced to the Writings and thus heretofore has come to be placed before the Reader Present now hereby be Informed that the Author of this imputed Article styled and titled as "Avoiding Overdesign" in the allegedly popular and deemed to be well-circulated monthly and additionally annual Magazine having its name and masthead styled as "Industrial Product Finder" and also of aforementioned Writings and all his legal Heirs and Executors stand ab-initio Automatically and/or Consequentially

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There, I have covered my backside now with this overdesigned legal clause! I am totally safe!

That's the whole point! How much of this omnipresent "Safety Factor" is rational, how much of it is lack of knowledge, fear of getting it wrong, laziness, contempt for your employer, and how much of it is a device to cover one's backside?

I'll give you a real-life example: I once saw a "robust" 6-station visual inspection table of 1 meter dia designed to carry 4 Kg connecting rods, with a pick-and-place mechanism to load and unload, rotating (not indexing) at 1 rpm! It was made from 30mm thick (for rigidity no?) MS plate covered with a 10mm rubber sheet. The table was supported on a thrust bearing of 150mm bore, not the light 51130, but the heaviest 51430. It was directly driven from below via a 1 hp motor driving a worm box of 1.5 hp rating, which drove another worm box rated at 1.5 times the rated output torque of the first box since a single reduction could not reduce the speed by 1400:1. This gearbox had an upward pointing 100mm dia output shaft that drove the turntable through a massive coupling! The whole contraption weighed around a ton! Moreover, the table was so high the inspectors had to sit on high, uncomfortable stools with no legroom.

Now, the 51430 thrust-bearing's static capacity is 180 tonnes! And the final worm box's output-torque is 1800 Kg-M. This can actually support and rotate a locomotive on its turntable at one rpm! Indian Railway's heaviest loco is only 145 tonnes.

How did this come about? I did some detective work. The designer started with an 'adequately' powered motor: Put one hp no? Sales have committed already bhai! Competitors were giving only half hp. Customer should not feel cheated! And Sir also said no put sufficient power? Ok? Ok! Next, go by the book: all transmission elements should have at least 1.5 times the capacity of driving element, so first gearbox should be 1.5 times capacity of motor, second gearbox rating 1.5 times first, coupling 1.5 times second gearbox! Then for such heavy table shaft should be also rigid no? 150mm dia seems OK, why take chance? Table should not dance no? Bearing also Sir said don't use light grade, Boy. Sir has worked in England you know! He calls me Boy only, never calls me Shankar! Anyway, radial load is negligible, so thrust bearing alone should be okay. And machine is going in forging industry, man! Evvrything is heavy built! You have seen knuckle bearing of their trimming press for this con-rod? Aishwarya Rai can pass through the bore, man! You should design all pucca, no lightweight things here! If anything happens tomorrow who will be responsible, tell me?

I know this is an extreme case, but not an exception at all! It happens all around all the time to different degrees. Lets learn our lessons from this real-life case:

1. Don't overdo the basic specs: Because you have to 'crack' the competition, your marketing whiz kids make up extravagant specs – mine is bigger than yours! Needless to say, you are putting cracks in your own profits.
2. Acquire basic engineering commonsense. Once you have put a safety factor of 1.5, (I would work with 1 in this case), you don't have to compound it!
3. See that your starting point is not wrong. Safety factor on what? The specification of 1 hp by itself is grossed by a factor of 10! Just 80 watts can do this job – 1/4th hp if you want a standard 3 phase motor. A pity that we still don't make smaller frame sizes. Even this motor would not be overloaded because of such heavy reduction, so you can underrate the gearboxes too.
4. Have a sense of scale. Two cheap 100mm

bore tapered roller bearings back to back could take that entire load and more. A truck wheel runs on bearings even Aishwarya can't put her slim hand through.

5. Think laterally. Look for parallels in a different context. Have you seen the drive of the turntable of an old-fashioned gramophone record-player? Doing a similar thing would eliminate the bigger gearbox and that fat coupling altogether!
6. Scale everything to match. If the drive and loads are so light, why have a 30mm thick steel plate? 8mm can do, with some stiffening. Now if table and drive are so light, reduce the frame sections to a sensible size, ISMC-100 instead of ISA-100x100x16?
7. Have an overview once you have done the basic detailing. In this case, have pity on the real users and lower the table top sufficiently and provide legroom, so they can sit comfortably.
8. Rein in your electrical designer too! Their idea of safety factors is worse than us mechanical simpletons! They start with the thickest possible wire their pet fat connector can take, and then chose a make or type of cable that gives the fattest insulation for that fat bundle of copper wires. Then there will be secondary and tertiary insulation if you mention the word 'multi-core' or 'flexible conduit'! "No, no, no, no, no, no, we can't reduce anything! Everything is all as per standard only!" Nothing short of a blowtorch or masonry chisel can cut through their armour, literally and figuratively! (Sorry sorry, I used the word 'short', really sorry yaar! Oh my god, I also mentioned 'armour'! Now I have to multiply everything by 6, because everything better have armoured cables and IP65.) I have actually seen 150mm thick cable bundles going into ordinary packaging machines. No one ever realizes that the electrical guys need the least of safety factors, as they work with an overdose of safety devices anyway – fuses, fail-safe contactors, MCCBs, ACBs... and what have you. You think I am overreacting? Just open the control panel of a recent European or Japanese machine.

9. Understand the concept of MCA- Maximum Credible Accident. In this overdesigned monster, what can go wrong? Can something fail or crack in this engineering marvel? Never! Therefore, that is an incredible (impossible) accident, so don't provide for it. Simply put: don't design against accidents that cannot credibly happen! So, what can credibly happen at worst – in other words, what is the maximum credible accident possible for this machine? Well, if someone's fingers got stuck into the fixtures, he would be dragged into the pick & place and lose life or limb because nothing can stop that monstrous gearbox. When that happens, don't be a cad (no pun intended) and say, "I had given emergency button no, why didn't he press it?" Oh-ho, so you need an overload clutch also, no? No! Instead, just scale the drive down to a few watts, and make it a friction drive like I said

above. If something gets stuck, the table stops spontaneously without any fancy sensors and hardware and controls!

10. And finally, have the professional courage to stand in front of your safety factor, not hide behind it.

And we still make unsafe machines, despite habitually overdesigning.

Abey laloo! Safety factor se panga nahin lene ka, samjha kya? Kuchh lafda ho gaya to woh &%\$#@ Gupta tere ko bachaane ke liye aayega kya?

Next Month: Ergonomics

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