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NEUBAUPLAN
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Common Shortcomings of Indian Machine Design Practice

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Why does Indian Machine Design practice so utterly lag behind the present World standards? In our machine designs, why can't we Indians achieve the German detailing and long, trouble-free machine life; the Japanese compactness; the American clarity; the English engineering sense; the Korean finish, the Taiwanese low-price? This article is appropriate to machines as a product, as well as machines as SPMs.

It is NOT impossible. Nor is it very difficult! To borrow the words of a great American Red Indian Chief, "If the Palefaces (the White men) can do it, the Injuns (Indians) can do it too!"

The reasons for our repeated failures to do so are twofold – one side of the reasons is technical, the other is psychological. Some overlap. I will elaborate on both.

Technical shortcomings of Indian Designs:

One of the major reasons for our awkward efforts at machine designs is the designers' lack of knowledge of the recent developments in technology, materials, off-the-shelf items, etc.

Instead of lamenting about why this is so, I will give you numerous instances of what is clumsy and old-fashioned and what are the new solutions (and the new stuff is not all that expensive either). The order is random, and the list can go on and on – these are some of the most glaring:

- **Gross over-design**, resulting in unnecessarily heavy and unwieldy, and sometimes slow-because-of-heavy-inertia machines. Indian designers often misjudge the strength and modulus of materials, and over design everything as a routine, because the old textbook says so. Today, one can model the part in 3D in any of the popular CAD packages, and do a finite-element stress-strain analysis to arrive at the optimum. Today, this analysis is commonly available as a service by various consultants and agencies.
- **Keeping more space between parts when less will do.** Very often, designers will keep 20-30 mm space between parts, where even 1 mm is sufficient. This is just lack of confidence in their own detailing.
- **Keeping everything adjustable.** This makes adjusting the machine a work of art and needs a super-skilled fitter to set it just right. This is wasteful and not necessary. It is a hangover from the days of grossly coarse manufacturing, where nothing came out within 3 mm of the given dimensions. Designing out all but necessary adjustments is necessary, and once this bold step is taken, the resulting comfort level all around is obvious.
- **Continuing to use gears and roller chains**, where timing belts could do the job much more cheaply and elegantly. Manufacturers' catalogues are available easily and much information is available on the net. The advantages of timing belts are: Low cost compared to gears. No lubrication required. No idlers or tightening arrangement are required as the drive can easily be designed with fixed center-distances, as unlike V-belts, timing belts do not stretch during their lifetime. Noiseless and clean in operation. Shrouds required only on the smaller pulley. Backlash-free, so ideal for motions that go back and forth.
- **Using bush bearings**. Rolling bearings are as cheap, or often cheaper than bronze / brass / gun metal / steel bearings. And they are faster to assemble.

- **Using heavy external covers and seals**, when off-the-shelf sealed rolling bearings could directly be used.
- **Using excessive greasy lubricants in roller chains.** Roller chains ONLY need a few drops of high-penetration lubricating oil (similar to the one commonly available for sewing machines). This oil penetrates the small gap between the leaves of the chain and gets between the rollers, bushes and pins, where it is really needed. Grease never reaches these areas and only gives psychological comfort.
- **Using excessive lubricants in rolling bearings.** Contrary to the popular belief, rolling bearings do not need lubrication for their operation. The lubricant serves only two purposes – to prevent corrosion by maintaining an oily film, and to lubricate the cage, which always rubs lightly against the shoulders or the rolling elements.
- **Designing oversized round flanges.** Few designers realize that in most cases, any flange material outside the PCD is useless, so they may as well reduce the PCD to the minimum, then reduce the OD to the minimum, and have an equally strong but better looking design.
- **Using open rolling bearings without sealing them.** This is absolutely criminal. All rolling elements must be sealed from the atmosphere as they rust very quickly.
- **Designing half-rounded ends in machined parts.** This shape is difficult to machine, or finish by hand, and looks ugly. Two chamfers can very well replace the half-round end of a, say, machined lever.
- **Using hand-made machine covers.** Nowadays job work on turret punch presses, CNC laser cutting machines and CNC press brakes can be done very economically. The finish is excellent and worth the money spent.
- **Using heavy sections for press- or shrink-fitting** where modern industrial adhesives could be used easily and safely. Most designers have a mental block against using industrial adhesives. If the torques are light compared to the shaft section, even keys can be avoided in many cases.
- **Designing disproportionate split-clamps. The s**plit clamp is a very useful feature and designing it needs understanding its principle. Two points to be kept in mind are: firstly, keep the clamping screw as near the shaft as possible – within 2 to 5 mm at the most. Secondly, properly proportion the section in tension. For a 50 mm shaft, a 55-58 mm wide clamp (in mild steel) is right. Make that 65mm and above, and you will almost break the bolt before you get sufficient grip on the shaft. Make it 53 mm and it will yield plastically and the slit will clamp shut before enough grip can be achieved.
- **Individually matching mating parts,** thus destroying the parts' interchangeability, and making subsequent service / replacement extremely expensive.
- **Specifying incorrect bearing fits.** Not knowing which race of a rolling bearing should be made tight and which should be kept loose. Refer to a proper bearing handbook and understand the principle before applying the fits.
- **Using steel parts without surface treatment.** So either the machine is smeared with rust-preventive, or kept bathed in oil at all times. All mild steel and alloy construction steel parts must be blackodised, zinc plated or painted. This includes all threaded fasteners. Blackodising has the advantage of not depositing a measurable layer, but if once cleaned with a strong solvent, the part will start rusting immediately. Wrapping blackodised parts in old newspapers (a very widespread habit) is a direct invitation to rusting. Blackodising is porous and adsorbs oil, thus preventing rusting. Once the oil is removed, or is soaked out by the paper, the part is very vulnerable to rust. This can be taken to the other extreme if springs and circlips are also plated. These will become brittle and crack due to plating, unless they are dehydrogenated after plating.
- **Painting the machine after assembly.** This is the single most obvious factor that makes Indian machines look so pathetic. Today, all over the World, machine parts are first finish-painted / plated / surface-finished, and then assembled. If parts are cared for and assembly is done cleanly and systematically right from the beginning, there is no reason why any assembly should first look like something salvaged from a junkyard, then cleaned and painted to "look new".

- **Using adjustable wrenches, and damaged Allen keys.** Adjustable spanners are meant for an emergency, like a vehicle breakdown on the highway. They have no place on the assembly floor, as with the slightest carelessness, they can damage bolt heads, and the paint around them. Same goes for damaged socket wrenches.
- **Using unmatched pairs of V-belts,** and using improperly dimensioned and shaped pulley groves. Also, using flat belts on pulleys without crowning. The remedy is obvious.
- **Not knowing how to design silent machines.** Only a few machines are inherently noisy – like stone crushers, pneumatic hammers, or circular wood-saws. Most machines can be designed to run with very low noise levels. In today's World, non-inherent noise is considered a nuisance and a sure sign of poor quality. Conversely, a silent machine is considered a good-quality machine. Investigate the source of the noise and fix it in the design itself. Very often, a cheap electric motor is the source.
- **Leaving sharp edges, burrs and flashes unfinished.** Specify proper chamfers, and de-burring on your drawings. Study other well-designed machines to see how this is done.

Psychological roadblocks with Indian Designers:

Indian machine designers (and their employers / bosses) often see their profession as just another job, and usually do not get much exposure to international design practice. This often produces a frog-in-the-well kind of mental state. The common traps they fall into are:

- Making a good-quality machine is very expensive, and nobody will buy it at that price.
- Our workers are incapable of producing international quality.
- We have started using CAD instead of manual drafting, so now our quality will improve.
- ISO-9000/1/2 will solve all our quality problems, and improve our design quality.
- I cannot use good makes of bought-out items as my boss will not allow it, or my customer will not pay for it.
- Any new technology is too expensive and the old-fashioned way is sure and cheap.
- We have got very good sales people, they will sell anything we produce.
- I have diligently made part drawings after opening up an imported machine, so my copied machine will work equally nicely, or, well, at least 60% nicely, so that's okay.
- I will just design the basic machine. The covers, wiring, piping jobs will be done by the respective departments on the assembled machine.
- Anyway, the assembly people will sort out any problems.

Now that much has been said about the poor Indian machine designer, a few words about the silent majority of Indian machine sellers and buyers are also due.

The seller is so often an untrained salesman who was an engineering graduate once upon a time, and now concentrates only on his sales pitch and interpersonal relationships. His product knowledge is often very sketchy, and technical details are often glossed over by glib, uninformed chatter.

The buyer of Indian machinery is so often a purchase executive, who must demonstrate to his boss that he has obtained a sizable discount against all odds, and buy the cheapest by playing one against the other.

To an extent, this is how the whole World works. But this can very easily be carried to extremes without realizing the damage that is done to both their respective organizations. The machine builder is forced to cut corners to survive, and the buyer gets a sub-standard machine and lives with it. It is patently harmful for the buyer to think

that he will only use the cheap machine for a short time till its cost is written off, and then dispose it off and buy a better machine. This is just wishful thinking. The machine would still be around after 20 years, patched up every now and then and still producing. Would the same person buy an equally low-quality car and dispose it off after the investment has paid off?

Machine designers will do well to remember that in our World, doctors are routinely trained by senior doctors, surgeons by surgeons, lawyers by lawyers, managers by managers, cooks by cooks, and fitters by fitters, and so on, but poor machine designers have to learn their trade the hard way. Design being the greatest trade secret, no one is usually around to teach how to design a specific machine, especially an SPM. However, much can be learnt by opening up, studying and re-assembling all sorts of machinery with one's own hands.

The way to learn how to design a machine is to observe good machines a lot, then think – think why and how the great machine is designed the way it is, then to absorb, assimilate and integrate all these observations with engineering theory and a sense of appropriateness; and most importantly, to be in love with well-designed machinery, and develop a sense of rightness of design. The following story will illustrate this point – Michelangelo was busy meticulously carving the back of a statue of a Roman God, which was to be installed in an alcove (a recessed niche) in a wall. Someone pointed out that as the sculpture would be installed in an alcove, no one would ever see the back of the statue, so why was Michelangelo wasting his time carving it in such meticulous detail? He replied that he himself would see it, and it wouldn't look right to him till he detailed it out to his own standards of correctness.

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