

Machine-Design - India's blind spot

By Harshwardhan Gupta

India is marching towards the twenty-first century with a reviving economy, software skills, marketing and media skills, but without any significant culture or skill-pool of machine-designers. Ignoring the crucial role machine-design skills play in our industrialising economy is a dangerous trend for our country, which is potentially a global player. Generally, Indian industrialists, investors, policymakers, academia, and research scientists either do not recognise this blind spot, or recognise it and do not care much. This could be because they can take a short-cut to buying equipment and machines from abroad, or are unwilling to do something about it because they believe they cannot afford it. Technological advances in every field invariably need machine designers somewhere down the line. Even an emerging non-engineering field like biomedical research or tissue culture needs equipment and machinery, which again has to be designed by someone. Every aspect of the modern economy research, production, transport, communication, health - needs machines; and machines need to be designed. Despite having the World's second largest pool of engineers and scientists, we as a nation are ever increasingly depending on imported equipment and imported designs.

A Historical Perspective:

When the various battles were being fought in the Americas in the seventeenth and eighteenth centuries, the guns and other weapons for them were being made by craftsman in Europe. As the guns wore out or broke down in far away lands, the soldiers could not cannibalise them (use parts from one gun to repair another of the same type). This was because each gun was handcrafted and assembled by an artisan, and parts from one would not fit another of the same type. To counter this problem, some of the gunsmiths in England got a brilliant idea, that all the parts of a (particular

type of) gun be made in such a way (with exactly same size and shape) that they could be interchanged by the soldier in the battlefield. This "concept of interchangeable parts worked so well that its use spread like wildfire to all gun-making companies, then to other industries, and then snowballed into what we today call the industrial revolution. This aspect has usually been underrated or ignored by most historians and economists. Today we simply take it for granted that when a part of some machine or gadget becomes unserviceable, a new part to replace it will fit perfectly in place of the old. This concept of interchangeable parts changed the fate of the craftsman forever. Slowly, the importance of the craftsman declined, and that of the machine-designer increased with advancing centuries - to the extent that today in the First World, virtually no machine or equipment is ever made without being first conceived and detailed on the drawing board. Similarly, the researcher has replaced the inventor's role.

The Indian Machine-Design Scenario; Rather, The Lack Of It:

We in India have not realised the deep significance of this shifting of focus from the craftsman to the machine-designer. India has always prided itself on its long tradition of craftsmanship and on its craftsmen, but today even in India, the industrial craftsmen (usually called 'skilled workers') produce goods according to designs -given to them by the machine designers - not by their own sense of design. Small countries like Taiwan and Korea have quietly been encouraging their machine-design efforts; and today Taiwanese and Korean machinery is giving tough competition to the Indian machine manufacturers in the domestic its well is in export market. In Europe and North America, many engineering companies have been started by design engineers, and have become veritable giants today. Even today, machine-design professionals are at the helm of many great engineering companies in the West. On the other hand, not many Indian companies employ a good, strong machine-design team; nor does such a team, if it exists, form the basis of their growth plans for the future. The English, in their typically British way of speaking, always called their machine-designers (besides their theoreticians and

researchers), the 'back-room boys', but they never belittled their importance. We seem to have taken that phrase literally, and actually been treating our machine-designers as such - boys to be put in a dingy back room and forgotten about.

The result is that large number of machines that are developed indigenously very often turn out to be clumsy and poorly designed, to say nothing of being ugly looking. A fair amount of these machines are proudly sold at 'internationally cheap' prices to undeveloped countries, as those poor blokes cannot afford anything else. Many such designs are 'developed' in the assembly shop by a 'good mistry', not on the drawing board! One does find in India a handful of good machines created by good machine-designers, but these are extremely few and far between - too insignificant for the health of the industry-based economy of a huge country like India. In the days when our doors were closed to imports, our machine-builders put craftsmen to work to copy foreign designs, instead of machine-designers; then put junior draftsmen to 'make drawings' from the handiwork of the artisans. They were very happy with the resulting financial successes, as they were selling in a seller's market. When the business was good, many such manufacturing companies did not plough their profits into design and development. Instead, they put it into opulent interiors, real estate, financing companies, or into the share market. Now that our economy has become open and global, and global competitors have started selling vastly superior machines in India at prices cheaper than these manufacturers' outgoing costs, these same successful businesspersons are today struggling for survival.

What will happen when India signs the intellectual property protection bill and the WTO agreements, and the ongoing opportunistic and short-sighted copying of (usually badly outdated) foreign designs becomes illegal? In reality, many of the thus copied machines made in India by our indigenous machine-makers are already outdated, uneconomical to produce, and difficult to sell in a competitive market, as the original designs were appropriate for a different industrial environment that of a heavily industrialised country. At the same time, those industries, which have officially imported designs from abroad, are either

prevented from making cost-reducing design changes because their collaborators have legally tied their hands. Or they are so overawed by the "superiority" of the foreign designs that they refrain to make any changes in them to suit the Indian environment.

Do we then have enough machine-designers to carry out the enormous amount of necessary engineering design work this whole situation needs? In one word, NO! Our engineering colleges have not been educating machine-designers at all! They have always been teaching machine-element-design in the name of machine-design - how to design a spring, how to design a gear, how to design a shaft for bending strength, etc., and no one has woken up to this lapse. Of all engineering textbooks, the machine-design textbooks are usually the oldest, many having been written in the thirties and forties. The other casualty has been engineering drawing, which is the basic tool of communication between design engineers and others. In each and every Indian engineering college the author has known, engineering drawing is considered a necessary nuisance at best, or treated with utter and total contempt by the faculty and students alike, at worst. The resulting lack of machine-design competence is evident everywhere. It is a weakness many industrial houses try to hide most carefully from outsiders. Many do not even recognise this as their organisation's weakness. Many machine-manufacturing industries have been priced out of the market, but what is not evident is that many more have been 'designed' out of the market, by better designs from the First World, and many more are following suit.

Computer-aided design (CAD) software is often proudly painted by many as a panacea for this ill. But very few realise that all CAD software is a nothing but a tool. CAD software is as useless in the hands of a person who does not know where to begin to design a machine, as a pen is useless in the hands of a person who doesn't know how to write. We as a country are proud of our IT and software skills and the media - being a direct beneficiary - is going overboard about it. There are countless training institutions springing up to cater to this mad rush. Every parent today dreams of his child becoming a software prodigy. People do not

seem to recognise the obvious fact that a room full of electronic hardware and gigabytes of software driving that hardware cannot move even a paper clip from point A to point B, without having a mechanical device or equipment connected to it. Obviously then, someone has to design that machine too.

One increasingly hears this ludicrous opinion; "There is no future in mechanical engineering!" Ironically, the term 'mechanical engineering' itself is a misnomer. 'Physical engineering' would describe it more accurately. We live in a physical world of ever increasing number of manufactured things. If this is true, then who is going to design and manufacture these things, and who is going to design the machines which would make these manufactured things, if everyone chooses to become an IT specialist? A few years ago, it was the MBA degree. Before the MBA, it was chemical engineering. In a few years, when the Y2K bug is finally exterminated, it will probably be biotechnology.

It has been argued by some that machine-design skills cannot be taught in a classroom, as machine-design is an art. Machine-design is indeed an art. Though, unlike the fine arts and applied arts - where the creativity and imagination of the artist is the only boundary - machine-design is an art with twofold external boundaries, within which it has to be practised. The first are the absolute boundaries of physical and engineering principles and the second are the flexible boundaries of economics, producibility, availability, need, etc. The quality, simplicity, elegance, 'appropriateness', and aesthetics of the resulting machine or equipment is the result of the machine-designer's artistic qualities. Yet, just like the fine arts and applied arts, it can certainly be taught.

Our folly has been further compounded by our print media and the electronic media as well. They have always firmly believed that the educated middle-class - their prime target audience - is not interested in things technical. To see the fallacy of this, one only has to look at the enormous popularity of the Discovery channel, though this fact has been completely overlooked by the media! I personally know of many educated middle-class homes where the parents and children alike are

glued to this channel, to the almost total exclusion of the multitudes of lion-stop entertainment, "entertainment" (sic) and political-news channels. This channel has single-handedly demonstrated that there is fascinating drama in technology itself. There has always been, and no technology is possible without machine and equipment-designers.

One not-so-obvious reason for the phenomenal success of IT companies is that the success of their product is completely development-dependent. The rest of their activities are peripheral to their success. Their owners recognize this fact as such, and their central effort is to develop a good product. This mindset is almost nonexistent in Indian manufacturing industries, where the running of the company from day to day is of cardinal importance to the owners. Design and development are given a back seat, or no place at all.

Manufacturing companies often hire professionals in fields like advertising, business management and nowadays IT, etc., and willingly pay inflated amounts of money for their services, even when, usually, there is no way of evaluating the returns or efficacy of the services rendered. Yet, when it comes to something basic like engineering or machine-design, they usually balk at employing a competent professional. They sincerely believe that they themselves can somehow get the necessary work done - because they are dealing with a tangible entity like machinery. Very few people realise that a good design is a simple (not simplistic) design, and a simple design is the most difficult to create. A good design's simplicity is obvious only after it has been produced. Ironically, such good results often reinforce the manufacturers' false belief that they themselves could have done it, or can do it the next time round without professional help - "It's so obvious!"

To compound this, in today's opened economy, marketing moguls believe that they can shop around anywhere in the world for products, so where is the need for design? In reality, a good design makes the marketing professional's job easier, as it sells by its own virtues. We in India always seem to wait to act till the future is upon us. Then it's always a case of doing too little and too

late. It's time our industries and policymakers wake up to this situation and take corrective steps, otherwise our dreams of becoming a powerful nation will remain just that. As a nation, we have shaken off the tyranny of colonial rule. However, without becoming self-reliant in designing machines and equipment, we will never be able to shake off the yoke of foreign domination in technology. Because all technology, at one stage or the other, MUST pass through the designer's drawing board.

The only silver lining is those tiny handful of industries that have the good vision (and good fortune) of having capable and well-motivated designers engaged in working on new machines.

The author hopes and prays that this trend will grow and accelerate in the near future.

(In this article, I have avoided shortening 'machine-design' and 'machine-designers' to 'design' and 'designers' as, unfortunately in India, the latter words usually connote an artistic designer, like a graphic or a fashion designer, or an industrial designer. A machine-designer designs the whole machine, from its nuts-and-bolts and working parts to its external appearance.)

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