

So, What Makes a Machine Look Good?

By Harshwardhan Gupta

“Ahhh, the million dollar question! This one I am going to read! Hello, Veronica, please don't disturb me for an hour. Say I am in an important meeting. Thank you.”

Now I feel like a hungry mosquito that has landed in a nudist colony. I know what I have to do (rather, what I have to say), but I am not sure where to begin! So please bear with me, as this is a complex issue.

I think I will begin with a real-life incident: I was going around IMTEX '04, when I walked into a small stall, and the rather obvious owner stepped forward and asked for my visiting card, and I gave him one. He had one look at it and immediately pointed to his main product, a dull-looking yet a precision machine-tool, and asked me point-blank, “You are designer no? How much you will charge for outlook improvement of this machine?” When the meaning of this odd turn of phrase dawned on me, I was flabbergasted with this brusque approach. As I mumbled something about having to go into some detail before I could commit anything, he cut me short, “No, first tell me how much, then we will talk.” I was just too stunned to do anything else but somehow excuse myself and walk away.

What's the moral of the story? This is not about civility or good business manners, nor is it an ego thing. I was dumbfounded by the fact that this experienced machine-builder actually believed that he could buy machine aesthetics just like any other retail commodity like ball bearings! And glue it on, I suppose?

Buying 'machine aesthetics' like a commodity simply cannot be done! The easy way out so far in India has been shameless copying. But what do you do when there is nothing to copy from, or copying is infeasible or undesirable due

The author is a Bachelor of Technology from the 1976 batch of I.I.T. Mumbai in mechanical engineering. He is the founder of Neubauplan Machine Design Studio, an independent machine-design firm in Pune. Comments, criticism, questions and suggestions are welcome at neubauplan@eth.net. Website www.neubauplan.com.

to various reasons? This is now increasingly happening everywhere.

So, what makes a machine look good? First of all, machine aesthetics is not 'outlook', in the sense that it is not just the external appearance. Aesthetics (or the lack of it) exists absolutely everywhere in the machine – in every detail, in every corner. Open the hood of any modern 'foreign-designed, Indian-made' car: the whole engine, transmission, suspension and peripherals, are all works of art. Every detail looks good. To see the contrast, also open the hood of, say, a new Tempo Trax. Open your



Figure 1: A German Festo rod-less pneumatic cylinder

mobile. Even the battery and the chip and the chip-holder look neat! Same with a Nikon camera or a BMW motorcycle! See their innards too! The same goes with a Diebold ATM machine, if you can get to see its insides. Same with purely 'industrial things' like a Siemens motor or a Festo cylinder (Figure 1) or an NTN bearing unit, or a Caterpillar earthmover (Figure 2), or a Mannesmann rolling mill, or a Multivac blister-machine (Figure 3), or a Heidelberg printing press! Same with the Intel processor or the Seagate hard drive inside your computer! Do open a useless



Figure 2: An American Caterpillar off-road truck

hard-drive and see the marvellous jewellery-like insides. Each part is a thing of beauty in itself! Open any of these to the last part; their 'industrial' beauty is all pervading!

How come? I will illustrate this with another story: The great artist Michelangelo was carving a human statue that was to be installed in an alcove (a deep, narrow niche in a wall). He was carefully chiselling out the intricate folds in the clothes on the figure's back, when someone asked him why he was taking so much pains over a part that wasn't important, as no one would ever see it (after the statue was installed in the alcove). Michelangelo simply said, “But I am seeing it just now, and it is important to me!” For him, the figure had to be finished in every detail before his aesthetic sense was satisfied with his own work.

This is as true today as in Rome during the Renaissance. Beauty always lies first in the eye of the designer, before it is seen by the eye of the beholder/buyer/user. Likewise, a machine, which has an aesthetically pleasing exterior and yet its innards are indifferently detailed, carelessly made, cheaply bought, disproportionate, shabbily finished... is a phony, and therefore repulsive. Some very pithy lyrics come to mind: “*Parde mein rehne do, parda na uthaao! Parda jo uth gaya to bhed khul jayega!*”

Machine aesthetics cannot be imposed from outside, nor is it limited to the exteriors. Out of sight does not mean out of mind. By the same token, the machine designer must have aesthetic sense in his or her character, in his or her soul, as much as the industrial-aesthetic designer must possess/develop a 'machine' sense too. You cannot – and should not try to – separate the aesthetic from the functional.

Industrial aesthetic sense is culture-dependent, and is learned very early in life. Each industrial society has slowly evolved its own industrial aesthetic language – German machines have that typical German look – very mechanical, very well-detailed and proportioned, very well-finished, rugged, hiding



Figure 3: A Swiss Multivac blister-packing machine

nothing; castings plainly look like castings, sheet-metal doesn't pretend to be something else, everything is built to last. The Swedish are in the same league. The Swiss go ten steps further and their machines are absolute epitomes of perfection in every detail. The English put good engineering above good aesthetics, yet do an excellent job, like the Royal Enfield Bullet in its time. The French have their own way of marrying good engineering with their industrial aesthetic style, which many find rather peculiar – like their Citroens (Figure 4). The Italians make very well proportioned and coherent designs with a much lighter hand than neighboring Germans. The Americans celebrate their independence and make things look big, self-important, decorative, visually complex and flashy – look at their trucks (Figure 5).

The Russians make machines in their own image: heavy and stocky. The Japanese – masters of miniaturization – do the same: make everything small and delicate-looking! Everywhere, engineering designers create art for their own society, and evolve their own style. Now of course everything is getting more global, and more uniform – cars, even printers from everywhere look so similar nowadays.

This is the reason that unlike many other skills and qualifications, industrial aesthetic sense, which is culturally formed early in life, doesn't come so easily to immigrants. And we Indians (including our diaspora of NRIs and PIOs) still haven't started bridging this yawning divide between the aesthetic and the technological, let alone evolving an 'Indian' industrial style. Exceptions can be counted on one's fingers in us billion-plus Indians.

Quietly, the Japanese, then the Koreans, and now the Taiwanese have caught on fast, and are catching up fast. In the seventies and eighties, they would repeatedly invite the likes of Signore Carlucci di Bologna and Herr Messner



Figure 4: A French Citroen Ami car

von Stuttgart, and Mr Black of Liverpool to their country by dozens to 'advise' them on styling their new car or bike or TV, their huge, disciplined 'trainee' design teams ("Sorry onry

Japanese spikking, gozaimaste, dee-saina San!") would keenly watch them work, listen to them, try to understand them, ask well-planned questions through their own 'inta-pita' (interpreters), furiously take notes, and tape and film every minute of the whole mission, then intensely study their methods and quietly try doing it themselves the next time round... Just look at today's Taiwanese machines, and 12-15 year-old Taiwanese machines – you will immediately see what I am talking about! These guys learn very fast.

And we individualistic Indians only learn the hardest way. We are yet to learn to pull those sorts of capers on a national scale, so busy we are politicking, finding scapegoats, excuses; so blind we are to our shortcomings; and so short-sighted a view we have of the future. Should we keep waiting till the average native machines from Mainland China, then Thailand, Malaysia, Vietnam... also start looking and performing better than our average native machines? Remember the days when we used to equate Taiwanese and before than Japanese stuff with junk? Korea was not even on the horizon! Look where they have reached today, and how we lap up their truly well designed products, celebrate our democracy, open our doors to them, and learn nothing!

"Hey don't talk like this all negative-negative yaar, you were telling us about machine outlook no?"

Okay, first lets get back to the main question: what makes a machine look



Figure 5: An American Mack truck

good? Then we will come back to this problem of how-to. Let's start with an obvious point:

Is good machine aesthetics same as good workmanship and finish?

No, though aesthetics and finish-&-workmanship always go hand in hand, they are two completely different entities. You can actually have one without the other. Aesthetics without workmanship is like the old Standard Herald car (Figure 6). Older readers will recall that one! Workmanship without aesthetics is like that boxy range of Kirloskar Enterprise lathes, a jumble of sheer rectangles and parallelepipeds (Figure 7).

Is it same as good proportions?

Good proportions are a fundamental part of aesthetics, but nowhere near the whole. One can often see a total lack of sense of proportions in many Indian-designed SPMs. In one machine, I saw sturdily built, heavily ribbed brackets (fairly well-designed in themselves) capable of supporting a few tonnes supported a pneumatic cylinder weighing about 10 kg (whose forces were completely contained within that assembly), which in turn moved (not very rapidly) something weighing less than a kilogram. This is where it becomes grotesque – like a Preity Zinta with the legs of Arnold Schwarzenegger!

Is it same as good quality?

Good quality compliments good aesthetics, but you can easily have one without the other. Good quality without good aesthetics is like the Cinni table fans (Figure 8). Good aesthetics without good quality is like many of the new super-cheap ink-jet printers from global brands, whose average life is one month more than the guarantee period.

Is it same as good ergonomics?

No. These are two different attributes – a good designer should achieve both. Good aesthetics without good ergonom-



Figure 6: A Standard Herald car

ics is like many executive chairs now in the market. Each looks more sensuous than the other but most will positively give you a backache within a day of use. Good ergonomics without good aesthetics is like Mumbai's BEST (municipal) buses. Their simple seats, steps, standees' stirrups, etc, even the driver's place, are carefully dimensioned (I know this for a fact), and are exceptionally comfortable to an average commuter, but don't have much in the looks department.

Is it same as pleasing colours?

Well, a good colour scheme is part of the aesthetics. However, this is very often the obvious Quick Fix: just change the colours and make it look better! Change that dirty blue hammer-tone paint to a nice semi-matt grey-brown, and hey presto, you have 'improved' the looks! Add a white stripe with a sweeping curve, and you have made a 'magical transformation'! This is fine as a stu-



Figure 7: A Kirloskar Enterprise lathe

dent exercise, and is a favourite of the penny-pinching brigade. No further comments, except that beauty, even industrial beauty, is not skin-deep.

Is it same as good detailing?

Good detailing goes a long way towards good aesthetics, but it still is not the whole picture. Many Indian machines' lack of aesthetics falls in this category. Everything is right – detailing, materials, finishes, engineering, even concepts – but still the sum total goes so obviously wrong! You can have good detailing, good engineering all over, yet the whole machine can look grossly ugly because it is all wrong, like the WAP-1 (Figure 9) to WAP-4 (Figure 10) series electric locomotives which pull some of our prestigious Shatabdi Expresses.

But what on earth do I mean by saying that this locomotive's aesthetics is all wrong? Without going into the theory



Figure 8: A Cinni table fan

of aesthetics, I will try to answer that in simple language. We were talking of detailing, so there are parts, and there is a Whole, and the Whole is much more than the parts – just as a woman is a great deal more than an assembly of body parts, hair, skin, clothes, makeup, accessories, accent and mannerisms!

Now what is the Whole of this WAP-4 locomotive? "Aggregate of assemblies plus 25 kV AC power year, bore mat kar!" Not at all, the Whole is the emotional message it conveys to the observer, and that message is then its character, its spirit! And in this case, the character should be: "I am powerful, very fast, stable, technologically sophisticated, safe, clean, dependable, reassuring... as I am the top-of-the-line, fastest passenger-express locomotive of my country". Now see the WAP-1's and -4's picture again. Does this message come through? Well... not to me at least.

Now compare this with the Inter City Express (ICE) locomotive of the German Railways (Figure 11)! Does that same message come through from this German locomotive? Ja? Loud and clear? Written all over it? Alles Klar? Gut!

This is what machine aesthetics is all about – the message the Whole conveys! That is the spirit of the machine. All its parts and elements and features add to, or detract from, this 'aesthetic' message. Lets go a bit deeper in this case of WAP-4 (some of these observations are over-simplifications). Its shape is a confused bunch of forms. There is absolutely no streamlining, so the impression of 'fast' goes out of the window. The headlight mounting looks like an afterthought – didn't they know a loco would need a headlight? So, 'dependability' is shaken. The obviously poor



Figure 9: A WAP-1 locomotive

quality of the body fabrication takes out the ‘technologically sophisticated’ and ‘safe’ bit. The weird front shape wipes out the ‘stable’ and ‘powerful’ bit. Layers and layers of accumulated filth murder the ‘clean’ bit (strangely, our coaches are designed to withstand washing but our locomotives are not! They could very easily be designed to be washed.) The sloppily painted assortment of motley add-ons, weld-ons, tack-ons, bolt-ons kill the ‘reassuring’ bit!

On the whole, it is the sum total, which does not add up for the WAP-4. The engineering may be good in piecemeal, but the overall looks grotesque. One may argue that this is subjective (yes, it is!), but you cannot convince ordinary people that a hippopotamus is actually a cheetah, because perception is after all subjective.

“But *yaar* in foreign everything is beautiful looking! They are very rich peoples. We are after all poor peoples, no?” Now why do we always hide behind that mask? Are we really a poor country? I don’t think so – we actually are the fourth largest economy in the world in terms of GDP calculated on the basis of true purchasing power of the Indian Rupee – and that’s without counting the colossal invisible economy of the *paan-walla, the dhobi, the hawkker, the nukkad-ki-dukaan...*

Back to square one: So, machine aesthetics is an obvious yet indefinable set of attributes, and for creating that, one must develop a feel and capability. I do wish India’s famous aesthetic design institutions would run specific training courses for engineering designers – I would be the first to enrol.

Today, many consumer machines like cars, motorcycles, mobile phones, telephones, etc, are first conceived and externally styled by a trained aesthetic designer (also called an industrial designer – a queer term coined by the British – or a product stylist or a product

designer...) as 2D sketches, then as virtual 3D mock-ups, and often as real mock-ups too. Then the machine designer – who has been watching from the sidelines – comes in, and working hand-in-glove with the aesthetic designer, puts in bones, muscles, brains, nerves, organs... so to speak... into that attractive shell, thus creating a living design.

Very nice! So, what’s the problem?

The problem is that the same does not happen with many other consumer machines and almost all industrial machines in India. Why? Lets go over the last paragraph again. We are making a series of assumptions here. The first is that the design job is indeed given to a stylist to begin with. Most often, for a majority of Indian-designed industrial machines or products, it isn’t. Reasons are many.



Figure 10: A WAP-4 locomotive

Many machine-builders don’t even know that there exists a professional called an industrial designer. Those who know do not know where and how to find one. Those who can find one are often not very sure whether he will take up their work, because very few industrial designers have ever styled real in-

dustrial machines. Or they don’t know how to brief the stylist, as he often speaks a kind of language they don’t understand. Or he shows them too slick a portfolio, replete with rich visuals of kiosks, corporate identities, toys, school furniture, communication graphics, personal electronic gadgets, even photography and film assignments... All quite relevant, but it confuses and scares off many industrial clients, as they pigeon-hole him as an advertising/marketing-type designer, “What he will know about machinery?”

If all this goes well so far, then the industrial client (understandably) expects the industrial designer to do a comprehensive design/redesign job, and the designer firmly draws a line at external aesthetic styling, refusing to go into the guts, saying that is the job of a machine designer! Amen!

Now again, too often either the clients also don’t know where to find a competent machine designer, or they realise that they now have to pay for two consultants, when even one seems too expensive to them – and additionally, there could be ‘Double Trouble’! Sometimes they do have a machine designer in their employ, but can see right away that these two will not understand each other’s language at all... “Ok sir, thank you for taking so much time and trouble visiting our humble factory. Very nice presentation, very impressive! We will discuss and definitely come back to you!” – our favourite euphemism for saying ‘no’. After this poor guy leaves, “*Hey Bhagwan! Yeh toh tragedy ho gai, Kishorbhai! Now what to do?*”

So, willy-nilly, some machine de-



Figure 11: A German ICE locomotive

signer ends up doing the job of an industrial designer too, for which he has never received any formal training whatsoever, and therefore more often than not he botches it up. Nobody has gotten anywhere.

To make matters worse, there is a class of aesthetic designers gaining ground in India, who merely come in and redesign the uninteresting metal covers of your machine into interestingly-styled fiberglass covers with attractive colours and graphics, make a few more utterly cosmetic changes, then merrily trumpet this whole exercise in the media as a great design achievement, thus making you feel great, and leave you fully convinced that you now have a great product from a great designer, and have received excellent value for fat money. Immediate rise in inquiries and sales lulls you into a false sense of confidence, detracting you from making badly needed improvements in your basic product by research and redesign. One stylist told me very proudly, "I do only the aesthetics; I don't touch the machine!" Personally, I think these are perfect examples of 'Emperor's new clothes'.

Then there are those machine-builders who insist that because competition forces them to keep the costs down, they cannot 'afford' good aesthetics. But good aesthetics is not always very expensive. And in my experience, a good-looking yet reasonably priced machine sells much more easily than a cheaper machine that looks cheap.

Let us start from a different direction: If you compare the curricula, teaching methods and even the basic philosophies of an Indian engineering college and those of an Indian industrial design school, you will find that they have utterly and absolutely nothing in common! It's no wonder then, that an average design engineer can't communicate with an average industrial designer, except perhaps chatting about what drafting package they each use. Even those are not common between them. Unfortunately in India, these two kinds learn and work (even teach) in two mutually exclusive worlds! Rarely, some engineer-stylist team clicks well, and handsome products are indeed born (eg, products from the Maini Group of Bangalore; Figure 12); but as a rule, it is a dreary scene.

How is it different in the US or in Europe? How come industrial design is



Figure 12: A Maini Stacker

such a successful profession there, and how it has contributed so much towards bettering the life and the environs of the average citizen in just a few decades? How come everything around is so well designed? Well, with few exceptions, their engineering designers generally have an excellent aesthetic sense, and their stylists understand the engineer's world quite well too! Socially and pro-

fessionally, living in an industrialized world from birth implies that you are surrounded by, and familiar with, machinery of all sorts from a very young age. As with modern art, if you see a lot of machinery all your life, you develop a sense of good and bad for judging the aesthetics of those machines. Thus, in their heavily industrialised world, industrial and machine designers mesh very well with each other.

So why can't we otherwise-brilliant Indians do that too?

Toh Bhaiyon aur Beheno, after having seen the Indian engineering scene for the last 30 years as a professional engineer, and for 23 years as an independent generalist consulting machine designer, I humbly submit the bitter truth to you, that we Indians are not a technical nation at all, even today! We may make great researchers, remarkable mathematicians, renowned surgeons,



Figure 13: A German Heidelberg GTO offset press

celebrated software designers, all in piecemeal, but a great majority of our mechanical engineer-designers have a far inferior design sense, let alone an aesthetic sense – than an average American high-school-dropout biker-craftsman, or an average Swiss dyed-in-the-wool assembly fitter.

Lets be open about this! Through-out our glorious history, we have always separated physical work and intellectual work, and have considered the latter superior to the former. Historically, our workers and artisans were not encouraged to think, and our thinkers did not work with their hands. We invented the zero, wrote the Vedas and Upanishads, and did so much research in medicine (a purely intellectual endeavour), but for thousands of years we could not discover electricity, or steam power, or invent paper or the screw or the water wheel... Except in medicine and mathematics, we in fact did not discover or invent anything physical of any serious importance before the British came in and dominated us. This trend quietly continues even today.

Now, at least to my mind, a good designer should always be a good artisan/mechanic/machinist/assembly fitter too. This is quite true in the industrial world, equally false in India. And this is our curse, our bane. This state of affairs is showing no signs of changing for the better! We still have a very long, dreary journey ahead of us.

The media is not helping this any! A vast majority of our powerful media-persons routinely choose to remain utterly non-technical, and chose not to understand anything about machinery – machines for them being absolute nono's, completely alien things. Thus, no informed public debate about engineering design or machine aesthetics can take place seriously and continually in any Indian media.

For these same reasons, the way well designed machinery quietly excites designers and engineers in the developed world, it does not excite us! We don't love machines; we just tolerate them! We love our films, actors, cricket, food, clothes, marriages, ornaments, politics, TV serials... but industrial machines are things that we don't emotionally relate to! Very few of us are capable of saying, "What a lovely tram!" "Beautiful lathe!" "That forklift looks so sexy!" "That earthmover is magnificent!"

"Such a good-looking AS-RS (Automatic Storage-Retrieval System)!" I don't mean a reaction of awe or bewilderment, but of aesthetic pleasure. In other words, just a teensy-weensy fraction of us can stand in front of a beautifully designed and made, furiously running sheet-fed Heidelberg printing press (Figure 13) and happily admire it for hours (even the sounds it produces are like music – experience this for yourself. Every city has quite a few around), just the way one can stand in front of the Taj Mahal and admire it for hours. And only an infinitesimal fraction of even that minority knows how to create that (press's) kind of beauty – inside out – from scratch without copying.

You see, aesthetic design is not exactly like analytical chemistry, which can be learned and practiced without any

nation are incapable of writing world-class science-fiction, also are incapable of making Discovery- or National Geographic-type scientific- and technical documentary films. We can't even make world-class machine manuals.

"But why unnecessary you are again getting agitated, Gupta-ji? In a few years aesthetics will also start coming to India, just like BPOs are coming!"

Even if it could (hey, how about a "Milan Aesthetic Technologies and Services (India) Pvt Ltd", wholly owned subsidiary of "Studio Estetici Milanese S.p.A") it simply can't! Far more alarmingly for us, in the Western industrial world, these high-quality design skills are now slowly beginning to disappear, as their elder designers have perforce become too expensive, also these are now edging towards professional retire-



Figure 14: Detail of a modular PLC

emotional involvement and aesthetic sense. Our engineering education system drills into us: "Remember, you are an engineer, not an artist! Art has no place in your professional life! Art is the domain of lowly beings who couldn't score enough to get admission into science!" This is where lasting damage is done. And this is not true either! Engineering design is very much an art. "What? This is sacrilege! Blasphemy!" And any art practiced without an associated aesthetic sense invariably produces monstrosities!

This typically Indian attitude of comprehensively disconnecting art and science is also the reason why we as a

ment by the thousands, and their younger generation doesn't quite want to be engineering designers in sufficient numbers. In their greying, ageing, shrinking world, there simply aren't enough committed young people to fill all the new, needed professional engineer-designers' slots. So, if and when we wake up, whom are we going to learn industrial aesthetics from, since we seem to be quite incapable of developing a style of our own?

"All that is fine, bhai-sahab, but can you tell me how I can make my machines better looking now?"

Ok sir, I will try 'level best' but this can only be awfully basic and general!

Back to Design Tips format, I suppose...

1. As I said in the beginning – do good detailing throughout the machine, inside and out. Plan out even the wiring, conduits, piping, connectors, too; even more thoroughly, else they will thoroughly clutter up your otherwise well-made design, and reduce its aesthetics to a naught.

2. Machine design and aesthetic design are inseparable. Anything superimposed later from outside is a compromise and a third-rate way of doing things. This holds true even for a revamp/redesign also. If a single person cannot do it, then the two designers must work in concert, not one after the other. See the example (Figure 14) of a modular PLC – Messung Nexgen-5000 – done by a single designer, where the top of each module integrates structural support, prevent ingress of objects more than 2 mm in size, houses and retains the mounting screw, supports the PCBs inside, allows a very high degree of natural ventilation, and is part of the overall aesthetics of the product.

3. Keep a uniform detailed engineering style throughout – this itself will make a huge difference. For example, if there are eight different flange mountings on the machine's front plate, don't have some mounted with hex bolts, some with socket screws; some with eight screws, some with six; some flanges round, some square... Or, make some levers with rounded ends, some with square ends, some with chamfers, some straight, some taper... unless you have rational necessity to do so.

4. Try and reduce visual clutter in the machine. Try and put screws from behind if you can, thus making them invisible, or substitute them with different type fasteners that are invisible or look better. If the machine has, say, lots of thumbscrews or levers, like a printing or a bindery machine, make them all look the same, or make them look separate, grouped by their purpose – yet part of a set. Use high-tensile fasteners, thus avoiding cheap, ugly-looking washers, even spring washers.

5. Very importantly, don't make something look like something else, like making fibreglass look like castings, or making sheet metal look like heavy fabrication, or making a PLC's modules look like a row of hard-bound law-books on a shelf. Every industrial material, every manufacturing process has its own

inherent aesthetics. Design with what that material demands. To illustrate, you see many designs of large water-carrying/storage utensils made in thermoplastics by blow-moulding, which exactly imitate the shape of corresponding metal or earthen articles made by drawing or spinning, and that is why they look ugly. Their makers have not done a rethink about marrying the real needs to possibilities of the new materials.



Figure 15: Detail of a blister-packing machine

6. For the same reason, don't finish flat surfaces of a rectangular job on a lathe. It immediately conveys that you are a cheapskate, as everyone knows that turning rate per hour is less than milling rate. Concentric machining marks from facing on a lathe where one would rationally expect milling marks makes it unaesthetic, as it is inappropriate. Parts like end-caps on overhanging rollers and visible ends of thumbwheels are often buffed, where a turning finish would be more rational and therefore look more attractive, so finish these on lathes. In other words, make a part by the most logical process. That in itself makes it attractive. See the example (Figure 15) of a low-cost blister-packing machine.

7. Avoid hand finishing as much as possible – as it does not come out consistently well. Similarly, avoid a lot of bright-chrome plating and buffing, as that does not come out uniformly either.

8. Don't try to hide shabby workmanship, like poor welding, under generous dollops of putty. For visible welding, either use a spatter-free welding technique, or remove spatter carefully with a small chisel. And please ban disk sanders, buffing wheels, and the gas-cutter from your assembly shop. Do

good welding and keep it naked. If you think I am crazy, see German machines. If that still looks bad to you, then redesign it to avoid that welding altogether. Don't design parts in such a way that you first machine pieces, then weld, then machine again, then mount them with all their burn wounds on display. Sand, shot- or bead-blast and remove the burn-marks, or make it in one piece.

9. Don't have a variety of finishes/details on various similar parts of the machine, like plating some screws and not plating others, plating some with chrome, some with zinc; hex bolts in one place, socket screws in counterbores in another place, socket screws without counterbores in a third place, slotted screws in yet another place, Philips screws in another...

10. Don't marry beauty queens to scruffy beggars. I have seen beautiful servomotors mounted on most shabbily fabricated brackets. I have also seen handsome pneumatic cylinders mounted on raw plates gas-cut from pitted steel.

11. Don't design machined parts like levers, plates, etc, with male radii unless you intend to machine them on CNC – otherwise straight portions of the profile would be machined, and the male radius will have to be hand finished – creating ugliness where an ordinary chamfer would be easier to make, and look more consistent, therefore better.

12. Don't put poor-quality hand-made sheet-metal covers on an otherwise quality-made machine. I have come across many machines that look much better when they are bare than when all the covers are put on. I have seen covers on high precision machines that look like as if they were borrowed from a country-made thresher. The sheet metal, even its hinges, deserves as much care and importance as a jig-bored part – this is where the 'made-in-foreign' wins, and we lose.

How can one learn all this? By lots and lots of observation, thinking, looking, watching, seeing, correlating, comparing... Creativity comes later. This is the essence of having 'design in your blood'! Nobody is born a machine- and aesthetic-designer, but one can learn that if one loves machines and admits that he is essentially an artist with a degree in applied science.

*Paagal insaan hai bechaara!
Masheenon se mohabbat karta hai, aur
masheenon mein hi husn dekhnna chaahata
hai. Ya Allah, iss per raham kar!* ■