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Automation Concepts

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Atomization, Atomation, Aatomesan, Automatization, Otomassion, Odomattig, Atometick, Automission, Yes-pee-yum, Rabot, Robut… Automation *tere anek naam*! Each different different idea making all confusion and quotation also become all ockward no? Somebody is quoting 10 Lakhs; somebody is quoting 50 Thousand. Very difficult taking proper decision! (This Design Tips fellow is not serious only, anything he is writing nowadays and this IPF also just going on printing! See? He is nowadays just making fun only, and but where are the design tips then?)

Well, here they are: Every Indian engineer has his own automation god he prays to. Just what is automation? It covers the whole range from a simple mechanical crank-driven strip-feeder in a power press, to the most sophisticated multi-axis robot in automobile body shops; from simple, rugged mango-juicers to intricate high-speed tea-bag making machines. Automation has various degrees, and it is impossible to draw boundaries between mechanization, automation and robotics – one man's automatic machine is another man's robot!

It is also impossible to draw a line between where the basic processing machine ends, and where its automation begins. Therefore, this article is relevant even to the basic machine designer of any kind.

1. Firstly, there is no need to be afraid of automation. If properly conceptualized and executed, automation can be fairly simple, reliable, inexpensive, and can save a lot of money and headaches even in the short run. But this is easier said than done – Indian factories' backyards are full of junk that various SPM and automation makers very proudly created.
2. You must begin with a clean slate. Pre-conceived notions will cause you grief later. In automation, if the concept is wrong, then everything spins out of control, and then usually it is too late to come back and start on the right track. A person can't get on the train to Mumbai if he is already half-way through a mountain trek in the Sahyadris.
3. A special word of caution to machine-tool designers who attempt to design non-machine-tool SPMs: First come completely out of the machine-tool mindset (V-flat guide ways, pre-loaded bearings, 40mm thick GG25 cast-iron framework, pressurized lubrication systems, ground and lapped spacers, ultra-rigid dovetail clamps, 10KW spindle motors, heat-treated spindles, ground ball screws with pre-loaded nuts, ground / lapped / shaved helical gears, backlash-controlled worm shafts, perpendicularity in 10µ over 300mm, 300+ bars hydraulic pressures…) then get to work. If you are required to design a deer, don't design a rhinoceros, just because you have always designed rhinos of various types, and you think rhinos are great animals.
4. First decide how much can sensibly be automated, how much is best left to manual working, how much should be mechanized… Consider options, costs, feasibilities, and your own capabilities – this is the automator's art!
5. Debate every feasible concept thoroughly in your mind. **Think it through to the end many times**, being very critical of yourself. Don't bring politics of any kind into the concept at any level. And don't leave loose ends anywhere in the concept, and later in detailing too. I have seen machines where you have to gas-cut a 45mm thick welded bracket every single time you dismantle a clamping plate for re-surfacing, and re-weld it afterwards.
6. And NEVER ever assume, take for granted, suppose, presume, presuppose, guess, believe, take a chance, accept unqualified 'experience' or 'explanation' as the truth (even from the customer), or have faith in God, if you are attempting some fairly original automation! Materials don't behave the way you predicted or imagined, what works at low speeds doesn't

work at 20% higher speeds, clamps don't clamp, machine crushes the job, machine ruins itself, shaft keeps breaking into two, cylinders jam, motors trip, gears strip their teeth… Sir, working fully now Sir but Sir only 18% output coming Sir I don't know why Sir yes Sir Gurdeep Singh Sir measured himself Sir! Now, pray as much as you want, have Satyanarayana Puja, break coconuts, ask for special blessings from the Father, ask for asirwaadam from swamiji, offer chaadars on fakir-ki-mazaar, keep jaagaran, rozaa, upawasam, akhand paath, distribute sweets among the destitute… But if you screwed up your thinking process, no God of any kind can save your machine. Automation is the express-highway to atheism.

7. Study the **problem** deeply, very deeply in the beginning. *Do not, I repeat thrice, do not* start your thinking in terms of possible solutions. You do not start building a house without digging an appropriately deep foundation, do you? This is the reason for many an automation attempts' failure: that alternate roads were never even thought of, in the beginning! How do you feed this job? Vibratory feeders, what else? When that doesn't perform well in final testing, it is too late. Other solutions like magazine feeders, center-board feeders, pin feeders, ladder feeders, disk feeders, walking beams, centrifugal feeders were never even given a passing thought. This is a very serious and very widespread shortcoming among Indian engineers, that when it comes to automation and SPMs, they directly jump at ONE 'obvious' solution, without closely looking at all aspects of the problem, and start running at full speed from that one solution onwards. They will even give you very convincing (to themselves) reasoning as to why that concept is correct and no other, obstinately digging their heels in and taking offense at your pointing out their folly. This reasoning is invented after the concept, not before, by the way. A plain case of putting the cart before the horse!
8. A great majority of automation buyers / users will invariably put a concept or a solution in front of you to flesh out, and quote; not the problem, in its totality. It is up to you to drag them back into first describing the problem in detail, asking more and more questions till you discover all the ghosts lurking underground – What would happen to the input paper roll if it is thrown down from the lorry instead of being rolled down gently? Will the machine run in synchronization if the line frequency in that area keeps varying? Does the coating on the film react with the aluminium forming die? What would happen if after punching the part fell a little crooked on the conveyor below? What would happen if your special chuck clamped on a forging that has not been properly fettled? What would happen if vibrations loosened the flimsy sensor mounting? What would happen to the cutter blades if the material were slightly contaminated with sand (a grain of sand meets the blade only once, but the blade meets a grain of sand many times a second, and sand is harder than high-speed steel, by the way)? – And then and only then, attempt a solution.
9. Don't ever believe that sexy electronics can achieve what the physical machine fails to do. For example, if two drives at some distance must forever run in synchronization, just couple them mechanically with a universal shaft or a chain or a timing belt, or gears, even electrical clutch-brakes, whatever – even if that becomes a bit clumsy, instead of putting two fancy servo drives and permanently programming them as rapid-response absolute zero-slip dynamic-RAM 551MHz incremental backup master-slave arrangement with battery-backup and fail-safe double-redundancy with high-frequency ultra-stable transience sensors for detecting any phase-shift in real time with a ring-counter type in-synch electronic-cam with phase modulation through a CE certified 997XN3-processor with a backlash-compensated interlock with the drive, (supplied in IP-55 housing at 33% extra cost)! Get the message?
10. Don't marry state-of-the-art electronics to mechanical junk. A half-micron digital scale is not going to compensate a worn-out guide-way. And vice versa is true also!

11. You will do well to remember that, unfortunately in India, most mechanical engineers are extremely, astonishingly and extraordinarily poor communicators, and most electrical / electronic engineers do not have any mechanical sense of any kind whatsoever – I meet these gems everyday!

12. Don't try to copy other automation systems without full, deep understanding of the underlying principles. "Sir This is same to same as Kettler machine Sir same to same Sir performance may be little less but price is very very economical compare to Kettler Sir Kettler landed is 3-4 times our price Sir world-best Sir but Indian customers say we use 2-3 years then scrap Sir yes Sir little 2-3 problems are there Sir you are very sharp-eyed Sir very sharp-eyed Sir your points we will take full 100% seriously Sir our engineer is making now all new Sir earlier was heavy problem we faced Sir now 80% is in control only 20-30% now left Sir it is almost perfect now today Sir by delivery time you will get 110% OK Sir I assure you 110% Sir 200% Sir I am confident Sir we are trying level best Sir we made same to same as Kettler Sir Kettler original in Deccan Star is there you know Sir we fully total opened and copied that one Sir we even done material hardness micro everything Sir you can yourself check part to part Sir their Thakur is working with us now Sir best man in this line Sir!" This is "duplicate" entrepreneurship in action, in the name of "reverse engineering"! Nobody wants to be the first to develop (and buy) a particular machine, and nobody wants to be the third either!

13. Often, complex interrelated motions at high speeds – as in a cartoning machine or a tea-bag machine for example – are often possible only with continuous-motion mechanical drives with a train of gears and cams. Pneumatics have their limitations, hydraulics are even slower. Start-stop systems have their upper limits. Complex groups of repetitive high-speed motions are best done with cams. Don't put an expensive servo-drive because (secretly) you don't know how to design a sophisticated cam. (If you have the data, the author can generate optimal jerk-free profiles for you for a small fee, which can directly be fed into a CNC machine for manufacture.)

14. Leave your ego at home. If you made a mistake, your machine will make you eat crow in public. Be ready for taking failure, frustration and humiliation in your stride, as nobody is perfect. And the designer of a perfect-SPM-in-one-shot is yet to be born among humans. This, however, does not mean that you accept – or yourself do – shoddy workmanship, drafting mistakes, or engineering blunders within known theory, and create a scrap heap bigger than the machine itself, or make a machine which itself looks like junk before it is gaudily painted, or just blunder along and do shoddy patchwork with tacked-on weldments to cover up your mistakes.

15. Leave your vanity also at home. Don't use AC servos just so you can boast about them to your drinking buddies. Pneumatic servos have severe performance limitations. Hydraulic servos are very sensitive to contamination in the oil. Brushes and commutators of DC servomotors are maintenance headaches. For a given torque, stepper motors are bulkier than other types. And AC servo-drives are expensive. See if a cheaper vector drive can do the job of your servo-drive, or a cheaper still variable-frequency control can do the job of your vector drive.

16. If you are continuously running motors variable-frequency drives on a speed less than 2/3rd of rated, then don't forget to check the motor for overheating, as the cooling fan is running slower too!

17. Continuous Vs. Cycle-automatic: If you are evaluating between a system which is driven by a continuously running motor, with continuously moving (e.g. cam) mechanisms, a system where each action is driven by an air cylinder, or a start-stop driver like a stepper motor or a servomotor, and a system which is a combination of these two, then comprehend the following: Each physical task (say, clamping, indexing, punching, forming, filling, screw-tightening…) takes a certain optimum time, and this time will vary with voltage, line frequency, air pressure, ambient temperature,

incoming material variations, tooling change, etc. In a continuously driven system, you will have to provide for the worst-case timing for each task. After trials, if one task needs more time, the whole cycle has to be slowed down. In independently driven tasks, individual tasks can be slowed or speeded up independently, thus saving cycle-time. Make your initial design choices accordingly.

18. As you do the detailed design, imagine, understand and analyze how forces, reaction forces, torques, torque-reactions, vibrations, mechanical energy, heat, etc. generate, interact, store and flow throughout the machine and its structure. Don't go by simplistic notions. Failing to analyze this flow and interaction is one of the most common pitfalls in your road to success.

19. Don't work by trial-and-error, hit-and-miss methods. You may succeed once, but may very well not be able to repeat the first machine's performance in the next. Work systematically with a mind clear on theory and design.

20. If your machine is going to be set up to handle various kinds of jobs, make the prototype with arguably the most complex job the machine will encounter, not the simplest or the average job or the job most urgent for the customer. Vehicles are tested on frightening test-tracks, not on smooth highways.

21. Never, ever, believe that, "Theoretical you may be right but practical it will not work!" This is the excuse of an uneducated engineer. Theory and practice are NOT two different entities – they are two sides of the very same coin. If the theory is right, it MUST work in practice. If it doesn't work in practice, then you are either applying the right theory wrongly, or applying wrong type of theory, or do not know enough theory to analyze the failure, or cannot see the one theory interfering with another.

    For example, if a hard-chromed shaft or roller is fracturing under normal stress, the typical cause is not insufficient sectional strength, it is hydrogen embrittlement – and the solution is to heat the part after hard-chrome plating and before grinding for 48 hours at 200°C. The solution is not increasing the diameter and using a more expensive base material. So, if your practical observation goes against your theory, then you can be 100% sure you don't know your theory well enough. By theory, I mean the sum total of mechanics, metallurgy, physics, chemistry, geometry, material properties, statics, dynamics, heat-transfer, thermodynamics, aerodynamics, control theory, structural stability theory, vibration mechanics, electro-deposition characteristics… Read up on the theory, friend, instead of watching Saas-Bahu! You can never learn enough theory. I am still learning new things every single day, after 28 years of designing automatic machines.

22. One of the cardinal rules of automation is: Once you have got an object in the right orientation, don't let it get disoriented and then try to re-orient it again. This is true everywhere, from chocolate bars to crankshafts and light bulbs to labels.

23. Another cardinal rule is: Don't try to reproduce motions of human hands. You are designing a machine, not a humanoid robot in 'Terminator IV'. In other words, if the original manual task requires great dexterity, or well-trained hand-eye coordination, or skilled finger movements, it will be difficult and / or expensive to automate. Think in terms of easy mechanical motions, not easy human motions.

24. A third cardinal rule is: Don't just solve problems linearly: "Pull-rod is breaking? Increase the diameter!" "Part is interfering? Cut it off!" "Bearing is tight? Take one cut on the shaft!" "Vacuum cup not holding that cardboard sheet? Put bigger diameter! Still not holding? Put bigger vacuum pump! Still not holding or what? Joglekar, inform bank to stop that vacuum pump party's cheque! Let him come and solve the problem all lies he is telling."

    SPM naram hai, Patchwork ke liye hum besharam hain! What's there! The problem here lies in the high porosity of the cardboard, not in the vacuum system at all. The moral is – investigate the problem itself. Don't jump to

obvious, linear, 'logical' solutions, and then do a proper modification, not a shoddy, patchwork job.

25. Another cardinal rule is: Don't have pre-conceived notions about the basic concept. Right in the beginning, think of various ways of doing the job. Don't just start with things like, "Oh, we only have to visually inspect the items by automatic machine no? We'll put a conveyor and a camera on top to inspect the items on the belt. Camera software will take care of everything!" It won't!
26. And lastly, just like you should get a cardiogram done BEFORE you get a heart attack, please get an evaluation of your concept (or better, of the problem itself) done from well-qualified engineer before your automation SPM develops a cardiac problem. If you want to do this and still be commercially safe, sign a mutual non-disclosure agreement with your adviser.

All my friends love the prime-time program "Junkyard Wars" on the Discovery Channel, but it depresses me. Because in most places I go, I see real junkyards engaged in a real war producing real junk SPMs and automation devices with real time running out. The bitter truth for such people is that, in the end (if they recover their money, that is) there is only a sense of relief, not a sense of reward! Most SPM manufacturers' factories look exactly like junkyards. Most traditional factories in India look like junkyards anyway!

Chalti ka naam SPM? No Sir, do a good job that stands the test of time, and makes you, and the user, and India proud, and richer. We are just beginning to win, so this is not the time for continuing with old shameful habits.

SPMs are increasingly needed all over the World, and we Indians are best equipped to tap that market, better than the Chinese, Koreans, and Taiwanese too, but we are pitted against the West Europeans. To be able to design, make and export SPMs against European competitors, we will have to completely discard our *"Chalta Hai!"* and "What to do!" attitude, be very professional and deliver international quality and workmanship.

Happy automating!

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