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Stop digging if you are already in a hole!

One of the biggest problems impacting the engineering industry, in India, is retention of experienced engineers in the design department.

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With fast growing infrastructure requirements, rate of jobs creation is increasing disproportionately as compared to the availability of experienced designers. With many jobs chasing few resources, almost every company is facing a problem of retaining the experienced designers. The average experience profile of designers is going down over the years as companies are depending more and more on the freshers.

On one hand most of the companies are experiencing a boom in order book, on the other hand, the net capacity seems to be depleting. Organizations are dealing with the situation by forcing the designers to stretch beyond the official working hours which in turn is causing burnout of designers and aggravated problems of talent retention. *(It is no surprise that , designers are also moving away from the core engineering industry to the lucrative engineering services industry where the business model is based on selling the available resource hours and hence the load on resources is controlled and pressure is much less)*.

For the core engineering industry, it appears to be an unsolvable problem. Yes the companies in this industry are in a hole but the bigger problem is that they have not stopped digging further! The way, companies are managing the situation; the mess is further getting amplified.

The default working rule for most companies is; design should be worked upon immediately on receipt of an order. This is primarily driven from either the pressure to release specs of long lead time procured items or the pressure from customers to release basic designs for integration with other designs or to provide inputs for civil work of the client's project. With limited resources, this pressure only leads to an environment of bad-multitasking. On receipt of a new job, the design resources drop everything else and start work on the new job. In many cases, the design work is started even without complete inputs. The pressure of time forces the designers to make some assumptions on missing inputs (rather than wait for them) and release the initial designs.

It is no wonder that the released drawings are subsequently revised multiple times. While the initial basic designs gets into iterations, the interruptions on detailed designing causes further delays. The design iterations and interruptions lead to subsequent procurement delays and loss of manufacturing capacity. The problem , is more acute in organizations where design involves complex two way dependencies between the various different designs departments *(for example the output of systems design provides inputs to calculate the load data in electrical design but at the same time, the constraints of location of wiring cut-outs can be an input to the systems design. But at the same time the wirings and corresponding size of cut-outs can be finalized only after the load is known, which requires completion of systems design)*. In such environments the pressure of time for each department to release their designs coupled with an environment of conflicting priorities can lead each department to assume some variables on behalf of other department, when the information is not immediately available. As a result there could be conflicts in the design criteria assumed by various departments, leading to a cascading loop of many iterations and rework. It is not surprising to see each drawing being revised 5 to 6 times along with long elapsed time for design completion.

Many of the iterations are also because of errors made during the frequent switches. Each time a designer works on a design, he builds an understanding of the relationship of all design variables and every time, he switches and comes back to the task , he is forced rebuild this understanding. Under pressure of time, some times, the designer fails to re-build their entire understanding and then errors creep in. Most managers tend to believe that the real reason for design errors is lack of experience and not the bad-multitasking environment. The best way to isolate multi-tasking as the real cause is to run a simulation where the job at hand is well known and we only have an environment of bad multi-tasking. The best way to simulate is to take up two tasks which we know for sure. For example writing alphabets from “A to T” can be considered as one task and writing the odd numbers between “1 to 40” as the other task. We can simulate the multi-tasking environment by writing “A” followed by” 1” and then” B” followed by “3” and so on. In the second round we complete one task after another. (Write “A to T” without interruption followed by the odd number sequence between” 1 to 40”).

Expected Error Rates in environment of Multi-tasking

Type of Job ↑ / Level of Expertise →			
	Complex	A Mess	Significant
	Simple	Significant	Non Zero
		New Resource	Experienced Resource

If you do the two rounds and keep a note on number of mistakes (and rework) in round of multi-tasking versus the mistakes (if any) in the round of no multitasking, you will be surprised to see the difference. Even for a task, where the expertise of resource is well established there are mistakes committed. The mistakes are due to frequent context switching by mind and as a result the errors creep in. So, even when resources are experts in doing the job, frequent multi-tasking can cause errors.

The amount of errors is also directly proportional to the level of difficulty of job (and hence the switching complexity). We can prove this by simulating the two rounds with two tasks having complex numeric series. With a new resource, we can assume the level of switching complexity to be higher and hence, the errors are much higher when new resources work in an environment multi-tasking than in a non- chaotic environment.

The source of errors is not just limited to design resources directly doing the job. It also aggravates due to weak supervision of jobs. In an environment of frequent priority changes, the management band width of the design department (the ones with maximum experience) is used up in either explaining the delays or following up with other departments. At times, due to overload, they directly work on specific design task. Their expertise is not available for important tasks of guidance and checking of many designs in progress in the department. The errors made by less experienced ones goes unnoticed, till late in the project, while the organization keeps on repeating the same mistakes over and over again.

As we have analyzed, in an environment of frequent priority changes, the waste of design capacities manifests in following ways

- Additional set up and set down , each time a designer switches jobs.
- Iterations due to erroneous design assumptions made due to delays in information receipt.
- Rework due to mistakes made designers during frequent switching (despite having complete information).

If each design goes through 5 to 6 iterations, (with non negligible lead time and capacity usage for each iteration) the capacity wastages are of mammoth proportions. However, managers have almost accepted multiple design iterations as fact of life. So if the wastages are considered as fact of life, then only way left is to blame the increasing order book or the scarcity of designers in the job market. Sadly, this way of blaming does not help much.

How about a different approach? Can we not drastically reduce the wastages and release the hidden capacity without the need of hiring more? Why not exploit the capacity of expert resources that are already in the organization?

For an answer we need to understand the causality behind the capacity wastages. The core problem is the starting assumption; every design has to be worked upon immediately upon receipt of order. This way of working, with limited resources, is causing the environment of frequent priority changes and subsequent capacity losses as well as the delays in design. This was of working is with an assumption: the earlier one starts a work, earlier the work will finish. However this assumption is not valid for an environment of multi-projects where limited resources are shared across many projects. We not only lose time but also capacity. What is the way out? We can adopt the solution, a traffic police, tries to implement, when faced with a road jam. He solves the problem by regulating the flow of vehicles - they form a queue. Suddenly we see many more vehicles come out, faster than under conditions of a road jam, with the same limited resource (the width of the road). We can apply this common sense solution to a design department where there is a traffic jam of designs, while resources are limited. We have to limit the number of open designs at any point of time and form a queue. In environments of very bad multi-tasking (observed by frequent priority changes), the number of open work fronts can be reduced by more than half without the fear of starvation. The excess wip, as well as new designs can wait for their turn to get inside once a WIP level comes down A new rule : One out and then One in. The closure criteria have to be clearly defined; else the situation can deteriorate to a bad multi-tasking environment within no time.

The reduction of WIP releases capacity of the key designers in the team. They can now check the missing information of all designs waiting outside in queue for their turn. Their job is to ensure that the full information kit is available before start of the work. For complex designs *(with dependencies with various functional design teams)*, the design interfaces and the criteria can be agreed upon with other design teams before start of the job. The upfront agreement on design criteria and interfaces sets the limits of cost optimization (or the rules of subordination) of various design functions. This helps in further control of iterations. *(For example the civil and structural design limitations can be specified upfront during the initial systems design. The focus on clearly defining the interface limits, as part of full kit, before start of the designs ensures rework is contained)*.

The steps taken to control the bad multi-tasking and full kit has potential to release nearly 50% extra capacity or in other words nearly 100% extra output, particularly in environment of complex designs.

With implementation of these two steps, the lead time of design, of an EPC company, managing large material handling systems projects, went down from more than a year to less than 4 months. The number of design iterations dropped by 80%. The outsourcing of design was nearly eliminated. At the same time, with reduced level of chaos, the designers experienced an environment where burnout was less as they did not have to stretch late beyond the office hours. The design attrition rate has come down.

The company not only stopped digging the hole but managed to come out of it.

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