

The principles of quick response manufacturing



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Abstract

Quick Response Manufacturing (QRM) is a strategy which needs to be applied throughout the company and whose primary goal is the reduction of lead-time in each and every operation of the company while simultaneously reducing costs and improving quality.[1]QRM can be defined in two contexts: (i) Externally (Customer's point of view): QRM means quickly responding to customer needs by designing and producing goods customized to cater to those needs. (ii) Internally, QRM stresses on reducing the lead times throughout the organization, leading to lower inventory, better quality, reduced cost, and greater responsiveness.

QRM uses Manufacturing Critical-path Time (MCT) as the metric for measuring the success of QRM processes. MCT is an extension of the concept of lead-time, which is the time from the receipt of order from the customer till the product is delivered to the customer. There are 2 ways of implementing QRM: one is using large breakthrough improvements and the other is through continuous improvements.

QRM was developed by Rajan Suri, a Professor at the University of Wisconsin-Madison, who is famous for his works on continuous improvement programs. He not only gave the theory but also the practical ways by which QRM could be successfully applied and integrated in the operations of the company. QRM is basically an extension of Time based Competition (TBC), which was a strategy used by Japanese firms in the 1980's. TBC's philosophy is to use speed to gain competitive advantage. QRM is more particular as it is restricted to manufacturing firms only. QRM finds its first foray in history in

1993 with the foundation of the Center for Quick Response Manufacturing at the University of Wisconsin-Madison.[2]In 1995, Rajan Suri published the article “ Slaying the Beast” which put forth some bad policies which were prevalent in manufacturing companies and also offered explanations for the same. This helped QRM gain a lot of recognition and importance. 1 The positive response spurred Dr. Suri to continue working on this subject and this further led to his consulting businesses in implementing QRM and successfully applying the same in many companies. Since then, the Center for QRM has helped in applying QRM in nearly 180 companies resulting in reduced lead times and increased market shares. 2

QRM Principles

It's not necessary to work harder, faster and longer hours to complete job earlier. One can focus on finding new ways to complete a job that takes lower time. Most of the time a job spends in a queue instead of in process and traditional approach only look to reduce processing time (touch time) and in QRM focus is on lead-time (total elapsed time) and not just processing time. Out of total lead-time 34 days only 19.5 hours is a touch time so it makes sense that we should focus on whole 34 days.

But generally organizations are not designed to focus on lead-time. Mainly because organizations don't recognize the cost of waiting they mainly focus on processing time like one need to reduce batch sizes to reduce waiting time but it will increase number of setups that will increase their processing time which is mostly opposing to company goals.

So, Companies need to change their accounting systems and reward systems so that benefits of reduction in lead-time can be measured and rewarded appropriately.

Table 1: Examples of Organizational Waste Due to Long Lead Times

Expediting of hot jobs or late orders:

- Requires Systems, Air Freight, People, even Top Management time
- Production Meetings required to change and update priorities
- Overtime costs for trying to speed up late jobs
- Time spent by Sales, Planning, and other Departments to develop and update forecasts
- WIP and Finished Goods holding costs, including space
- Obsolescence of parts made to forecast but not used
- Quality problems not detected till much later; lots of rework or scrap
- Opportunity for:
 - Order changes or even cancellations
 - Feature and scope creep
 - Loss of sales to competition
 - Sales time devoted to expediting and explaining delays to customer

- Complex systems required to manage the dynamic environment

There is one major problem with cost based systems that hinders QRM implementation that is functional structure of an organization. Looking the figure one can see how organizations fell into vicious circle by delaying regular jobs because of “ hot jobs” and then again increase in “ hot jobs” due to insertion of safety time due to delay in regular jobs. This is also called response time spiral. And so the spiral grows.

QRM focus on reducing system in time like we do in service industry but this will require substantial reorganization of most of the processes. Basically, we will end up with cellular organizations in shop floor and also in offices and each cell will focus on its customers. The POLCA material control system helps coordinate production across multiple cells. Also, new operating methods such as time slicing are described, to help cells share non-cell resources.

This principle is hard to digest as we believe that we should utilize capacity to its maximum possible value. Any reduction in the same would mean losing out on productive opportunities, resulting in increasing costs. However, by keeping all the machines busy at tall times does not necessarily transform into higher output or higher productivity. We frequently encounter the problems of growing queues due to the presence of a few bottleneck machines and jobs spending a lot of time waiting for resources due to mismanagement. All this ultimately results in increasing the lead time of the jobs which culminates in the increase of the organizational costs, which have been enlisted in the previous table. In the long run, these costs actually

prove to be greater than the opportunity costs of not utilizing the spare capacity. Hence, the spare capacity should be considered as a strategic investment that will pay for itself many times over in increased sales, higher quality, and lower total costs.

This is again a measure which is very hard to digest. We always measure the usefulness of any process through its efficiency and utilization. However, the problem with the traditional belief is not that efficiency is not an important measure, but that most measures of efficiency result in increased lead time which ultimately harms the organization. Large batches are used in a lot of companies in a bid to reduce the setup costs. However this very measure results in increasing the lead time which can culminate in the same problems as enlisted in the previous principle. There are numerous examples to show the scope of reduction of lead time in organizations, a prominent one being the case study in Becker (2001) which showed how lead time for a line of spare parts for the oil drilling industry dropped from 40 days to 5 days using reduction of lead time as the main performance measure in a manufacturing cell.

QRM says that the quantities as calculated by EOQ are not appropriate and consistent with the goal of reducing lead time as EOQ doesn't consider many costs of large lots like expediting of late orders, overtime cost for trying to speed up late jobs, WIP holding costs including space. Also quality problems are detected much later than with small lots and the amount of rework and scrap generated is also much larger. At the same time, another important point which is missed in EOQ is the lack of responsiveness which occurs when the process is carried out with large lots. Large lots and planning for

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the same makes it difficult for the organization to respond quickly to change in customer needs. Nor can good lot sizes for QRM be predicted by the MRP system, since it assumes fixed queue times regardless of workload.

Hence, in order to reduce the lead times throughout the organization, it is important for everyone in a manufacturing firm, and especially for senior managers, to understand the dynamics of factory operations. The senior managers need to have a broad outlook and decide on the policies of manufacturing and performance measures only after fully understanding the effects of capacity utilization, efficiency measures, and lot sizing policies on lead time.

Figure 3. Traditional Versus QRM Views of Capacity and Lot Sizing

Source: QRM and POLCA: A Winning Combination for Manufacturing Enterprises in the 21st Century – Rajan Suri

The differences between the traditional and QRM views can be observed from the figure given above. Traditional performance measures of utilization and efficiency encourage managers to exploit their resources to the maximum possible value. Production is considered infeasible only when the capacity utilization exceeds their maximize resource utilization, and only think about their capacity limit as a boundary between feasible and infeasible production targets. Also the perception is that larger lot sizes lead to increase in efficiency. However, QRM's focus is solely on reducing lead time, and hence the impact of utilization and lot size on the same is studied. Higher utilization leads to increase in lead time, whereas lead time first

decreases and then increases with increase in lot size. It is essential to consider all such manufacturing dynamics in order to come up with a process that minimizes the lead time and thereby costs.

According to QRM on-time performance is an outcome not a performance measure. Because if on time is considered as performance measure departments will quote longer lead-time to match up with on-time delivery. Again this will result in Response time spiral and results in poor performance of organization. But with QRM, organization will focus on shortening lead-time as a performance measure. In QRM it's called QRM Number (measure of lead time reduction). This will eliminates Response Time Spiral and performance of organization will improve. For example see Table 2.

MRP systems are of great help in managing material supply and ordering but lead-time cannot be reduced using MRP. MRP should be used on high level planning and coordination not on cell level in a cellular structure implemented by QRM, whereas POLCO can be used to manage material between cells and inside cells. POLCO basically a hybrid of push and pull systems using benefits of both.

This phenomena can be again seen as entering in Response Time Spiral in which if company buys in large batches this makes supplier to have longer lead time and company to order even larger batches. Internal and external incentives like discounts motivate ordering in large batches. The results this can be verified in John Deere where implementation of QRM with suppliers reduced cost and also improved quality with shorter lead-time and batches.

Not only at the supply side, the small lot concept needs to be applied at the distribution end too. Normally it is the tendency of the sales force to get higher orders by offering quantity discounts. This will again lead to the spiral of increasing lot sizes, both during the process as well as on the procurement side, ultimately leading to lowering of delivery performance. By implementing QRM, a company can reduce its costs manifold which can then be passed on to the customers. There is a need to demonstrate to the customer that the company can deliver high quality at low prices even for small lots, which would be more beneficial both to the company as well as the customer. Thus, the idea of small lots percolates throughout the organization, from top to bottom, as well as throughout the supply chain, from supplier to customer.

The traditional approach might result in local quality improvements in the respective departments. However, QRM is more concerned with the overall organization than just one department. The requirement is to cut the overall lead time for manufacturing as well as office operations for which Q-ROCs are more appropriate. Such Q-ROCs result in significant reduction of lead times for jobs such as cost estimating, quoting, and order processing.

Closed-loop implies that the team would be self-sufficient in dealing with all the problems related to reducing lead time. This implies cutting across functional boundaries and changing the reporting structures to ensure the success of the process. Needless to say, this team needs to be given power in order to make the decisions as reducing lead time is the primary goal of the organization. The best example would be that of Ingersoll Cutting Tool Company, in Rockford, which reduced its engineering and order processing

time for customized cutters from 10 days to half a day after implementing QRM principles. However, QRM should not be considered as an application of Reengineering as by using principles of system dynamics in the design of Q-ROCs, providing specific engineering and management principles for manufacturing organizations, plus by changing management principles and performance measures and adopting a company-wide approach, QRM goes much deeper than Reengineering.

Charging more for speedy response is sustainable only in the short-term. In the long run, it is quality which differentiates a product from its competitors, and the same purpose is served by QRM. Searching for ways of squeezing time out uncovers quality problems and wasted efforts. Changing policies and adopting measures to rectify the same results in higher quality, lower WIP, less overhead, lower operating costs, and greater sales. The QRM Approach yields even better results than Lean Manufacturing as it ignores the wastes caused by long lead times. QRM takes the goal of waste reduction to the next level, creating an even leaner enterprise that will remain a formidable competitor for years to come.

As we have seen in many quality improving methodologies like Six Sigma, House of Quality the most important factor in the success of these initiatives is their acceptance by all the members of the organization; and QRM is no different. Realigning of all employees, from the shop floor to the boardroom, from desk workers to senior managers, to the QRM principles is a pre-requisite for the success of QRM, and hence training gains significance. Normally, performance measurement is tied to the cost accounting system which is an impediment to the successful implementation of QRM.

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Performance measurement must be aligned with the principles of QRM if the company has to benefit from the same.

In a nutshell, the following points can be summarized about Quick Response Manufacturing:

It requires measurement and efforts to minimize the metric, Manufacturing Critical-path Time (MCT), which is defined as the typical amount of calendar time from when a customer creates an order, through the critical-path, until the first piece of that order is delivered to the customer. This can be measured using the QRM number.

Some changes in the structure of the organization are necessary to ensure the success of QRM. It basically requires the strategy of the organization to change from cost-based to entirely time-based with full emphasis on lead time minimization.

Functional to Cellular: Cellular manufacturing is a pre-requisite of QRM as the cells yield greater flexibility in manufacturing

Top-down Control to Team Ownership: QRM requires the formation of closed-loop, cross-functional teams which need to be given complete power for monitoring the processes.

Specialized Workers to a Cross-trained Workforce: Since the success of the process requires reduction in lead times across all the departments, there is a need to provide proper training to the workers so that they can perform multiple tasks and have a broader outlook.

Efficiency/Utilization Goals to Lead Time Reduction: The evaluation parameters, performance measures have to shift from the traditional accounting measures to the goal of lead time reduction.

The following steps need to be implemented in the organization so that QRM is a success:

1. Creating a QRM mindset: The most important part is to make people realise the advantages of QRM over the previous measures i. e. the wastes created due to long lead time which are even ignored in Lean Manufacturing. Thereafter, a high-level QRM Steering Committee needs to be formed to oversee the QRM efforts. Also, like Six Sigma, by providing QRM training, some employees can be made QRM champions who can then be entrusted with the responsibility of the projects on a daily basis.

2. Changing of organizational structure

Cross-functional planning team are formed to study feasible projects to which QRM can be applied. This would require the management to indulge in a detailed analysis of various consideration like Manufacturing Critical PathTime, product volumes, needs relating to strategy and other factors. Thereafter, QRM cells are formed and training and cross-training is provided to the operators in these cells by an implementation team which consists of members in the new cell as well as planning team members. Measurement of MCT is done to monitor lead time

3. Including of system dynamics

QRM requires going through the policies on utilization and efficiency in order to determine the proper loading of the cells. It also calls for making

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provisions for spare capacities and reduction in the batch sizes in order to reduce the lead time.

4. Enterprisewide expansion of QRM

The process would typically begin with a single project. If the project is a success, its results need to be conveyed to all the members of the organization and more projects need to be undertaken based on QRM principles. QRM should not be restricted to the organization alone but should be extended through the entire supply chain. E. g. the suppliers should also be motivated to inculcate and apply the principles of QRM which would have mutual benefits for both parties

POLCA: The Material Control System for QRM

POLCO is Paired-cell Overlapping Loops of Cards. To implement this system the company need to create cells of the production process focusing on subsets for similar parts and then it processes a given customer order through differing cells depending on the needs of that order.

High Level MRP is used to provide high level planning and coordination of materials from external suppliers and across these internal cells. But cells are managed individually.

To explain POLCO we can take an example of a shop floor shown in below figure.

Assume P1 focuses on color printing and P2 on black & white printing after which we have three Formatting Cells, F1, F2 and F3, which convert the printed sheets into reports with the desired pages. After formatting comes

binding operation, which include punching holes and notches, cutting the sheets, and bending, A1 to A4. Finally, all orders go to the Shipping Cell S1, where the packaged plates are placed in shipping containers and then loaded onto carts. The material control system used is POLCA where High Level MRP and a cellular organization is a prerequisite.

In this case all Release times are created with the help of High Level MRP. But even after authorization of POLCO work will not begin until all conditions are met.

POLCO cards are used to communicate and control the material movement between cells. As Figure shows the POLCA card flows for a particular order at any organization based on initial design. This order's routing takes it from P1 to F2, then to A4 for binding, and finally to S1 to be shipped. This order will therefore proceed through the POLCA card loops with the pairs P1/F2, F2/A4 and A4/S1, as shown in the figure.

If cell P1 has a job authorized that is going to F3 next, then a P1/F3 card must be available at P1 in order for it to begin that job. If a P1/F3 card is not available, that means that there is a bottleneck at F3 and working on that job will only add to the work-in-process at F3. Instead, it would be better for P1 to put its resources into a job that is needed by another cell that is not backlogged. So the cell team at P1 skips the P1/F3 job for now, and looks at the next authorized job to see if a card is available for that job, and so on.

Differences from KANBAN

POLCO cards only control flow between cells not within

POLCA cards are not product specific but they are specific to particular pair of cells.

POLCO cards are used as capacity signal whereas Kanban is used as inventory signal. As return of POLCA card from a downstream cell signals that the cell has available capacity.

Benefits yielded by POLCA:

POLCA helps in managing short-term fluctuations in capacity and also assists in reducing congestion on the shop floor. If a POLCA card from a downstream cell is not available, it means that that cell or some other cell further downstream is backlogged with work. Hence it does not make sense allocating further work to that particular job, without replanning of resources, as this will only increase inventory in the system since somewhere downstream there is a lack of capacity to work on this job. A better alternative would be to use this cell for some other job during the time being.

POLCA cards flow in longer loops which allows the production to respond to changes in demand or differences in the complexities of jobs. The additional jobs in the loop can act as a buffer to absorb variations in demand and product mix which makes it highly suitable to meet the needs of responsiveness. On the contrary, the pull system stresses on achieving constant takt times throughout the organization, ignoring the fact that a variety of products will require different manufacturing times.

Benefits of Quick Response Manufacturing

Product Leadership:

The main objective of QRM is to minimize lead times. By implementing QRM, a company attains many beneficial and competitive advantages.

Benefits of Quick Response Manufacturing

Product Leadership:

QRM enables a firm to have shorter time to market. Thus a firm can reach out to customers with the latest technology while competitors play catch-up. There are two ways of looking at it. The first is that a given point of time a firm's product would be superior to that of its competitor. Another point of view is that since a firm has shorter lead time it can deliver technology that is openly available to the market much earlier. Thus, the firm can skim the market due to its superior product. This can be depicted on a time line as shown below.

FIRM USING QRM

FIRM NOT USING QRM

2007 2009 2010

FIRM USING QRM

FIRM NOT USING QRM

2007 2009 2010

Lower working capital:

Lower lead times permit companies to have lower raw material and finished goods inventory. As a result the working capital requirement is decreased. This places the firm in a better strategic position to utilise their resources and capital.

Better position to increase market share:

The lower lead times increase the firm's responsiveness to opportunities in the environment. This increased responsiveness helps the firm attract customers and increase its market share.

Increased inventory turns:

Since the production system is triggered by demand, smaller batches are produced, inventory decreases, and the number of inventory turns increases. Many inefficient producers have substantial amounts of capital tied up in inventory; therefore, their inventory turns are low.

Reducing the cost of quality by minimising rework

Cellular manufacturing places more responsibility and accountability on specific production teams. This results in specialization which inherently increases the quality of the product. It is much easier to pinpoint defects since the problems are directly traceable to certain teams or members. This has a positive impact on the quality of products.

Cost Reduction:

QRM aims at finding opportunities to improve the existing process. This results in lower operating costs. Using QRM, companies are able to save, in

some cases, up to 25% of total operating costs by solving problems before they happen.

Increasing Long Term competitiveness

QRM ultimately aims at enhancing the long term competitiveness of the team. The above mentioned benefits are only the stepping stones in the right direction. The enhanced competitiveness of the firm ensures that its objective of enhancing shareholder value is fulfilled.

Issues of Quick Response Manufacturing

Increased reliance on suppliers

QRM requires a strong relationship with one's raw material suppliers and partners. To react to demand, a manufacturing firm must closely partner with suppliers that will quickly accommodate the firm's production schedule. However, if the supplier cannot provide raw materials due to problems such as quality assurance/control, equipment repair or union labour, the manufacturing firm may not be able to meet customer requirements. This could result in stock outs and backorders.

Change Management

It can be very difficult to implement QRM in a manufacturing environment. QRM is a business enabling philosophy that works top-down and therefore, changes the roles and responsibilities of the employees. "Traditional" roles, from lower levels through upper management, are drastically modified and the corporate infrastructure is typically altered. Employees can be extremely apathetic to these changes, which is a barrier that could significantly hinder the implementation process and the success of QRM. To implement QRM,

companies must have representation from all functions i. e line and support functions (production, planning, purchasing, engineering, manufacturing, quality, finance and human resources) to facilitate the implementation. All functional areas need to buy-in to QRM philosophy to successfully implement such a major change in the way the firm does business.

What Differentiates QRM from Lean?

First and foremost is the QRM mindset: the driver for all the principles and strategies in QRM is reduction of lead time. This time-based mindset results in many operating policies that are different from traditional ones. In contrast the driver in JIT/Lean is waste reduction.

Although the business press has been talking about the importance of lead time reduction, or “ speed”, for over a decade, we find that most companies still lack the knowledge and the tools to effectively reduce their lead times. Worse still, policies are in place that are lengthening, rather than shortening, lead times. QRM devotes a substantial amount of effort in educating management and workers on why these traditional policies result in long lead times, and in showing them the QRM principles that must be put in place instead.

QRM is a companywide strategy. While the original implementation of JIT/Lean at Toyota may well have encompassed the whole company, most Western implementations of JIT/Lean have focused on manufacturing and materials management. In many cases, JIT/Lean has been interpreted even more narrowly as merely implementing a “ pull” system with “ kanban” cards. In contrast, QRM clarifies at the outset that it is a companywide

strategy with implications far beyond the shop floor, and principles for other company areas, such as, office operations, are clearly presented as part of the QRM philosophy.

QRM provides rational principles and tools for lead time reduction. QRM uses an understanding of system dynamics, and exploits this understanding to define the best structures and policies that will reduce lead times. QRM begins by educating employees and giving them insight into these system dynamics. This then helps justify, to management and workers, the need for changes in policies. State-of-the-art analysis tools such as the MPX software package incorporate this analysis of system dynamics and help to derive the specific changes needed and to quantify the benefits that would be achieved.

For companies making a large variety of products with variable demand, as well as for companies making highly engineered products, the JIT/Lean strategy of “ pull” is either wasteful or breaks down altogether. For such companies, QRM provides an alternative strategy called POLCA which combines the best features of “ push” and “ pull” without their drawbacks.

While the JIT/Lean approach tries to eliminate variability, QRM recognizes that in certain markets responding to this variability may provide competitive advantage. Instead of eliminating variability, QRM creates an effective organization structure to cope with it and serve the market. QRM does this by exploiting its understanding of system dynamics.

A specific example of the difference between JIT/Lean and QRM is the issue of delivery of material or components. “ On-time delivery” is a cornerstone of <https://assignbuster.com/the-principles-of-quick-response-manufacturing/>

JIT/Lean is implementation. And yet QRM understands of organizational dynamics shows that promoting on-time delivery results in dysfunctional dynamics with longer lead times and higher costs. QRM provides alternative metrics based on lead time reduction that promise greater improvement in the long run.

The QRM approach extends to supply management as well, and is called time-based supply management (Ericksen, 2000). Companies such as John Deere are finding that, particularly for smaller suppliers, the time based mindset and QRM principles offer an effective approach to target improvements at the supplier's operation. In addition, rapid results can be achieved, with significant improvements in supplier deliveries and quality, and reduction in supplier cost and lead time (Golden, 1999; Ericksen, 2000; Nelson, 2000).

To summarize, QRM pursues the relentless reduction of lead time – all QRM principles stem from this singular driving concern. Instead of management announcing dozens of programs and acronyms, QRM enables management to present one unified message to the organization, and all policies follow from this one driving strategy.

Examples of implementation of Quick Response Manufacturing:

Trans-Coil Inc.

The Milwaukee Company is a manufacturer of equipment that supports variable-speed electric drives.

Problem:

Trans-Coil Inc.'s process sometimes dragged longer than couple of weeks they promised to the customers. Improving its record for production time and meeting deadlines was the only way not to risk losing business. Had Trans-Coil built large numbers of components in advance, ready for shipping, it would mean spending loads of money on raw materials, production and handling, without assurances of turnover of the warehoused products. The company would be stuck then with unused, obsolete components in situations when customers made even minor changes to their specifications.

Solution:

Having quick-response manufacturing, companies can minimize the time it takes for products to flow via their operations. It makes companies nimble, responsive, and lower costs. For changing operations, Trans-Coil commenced with its factory. Production workers were cross-trained to learn all jobs in the plant. That was a huge change from days when employees occasionally stepped out of their work areas. Trans-Coil employees are now separated into work cells which focus on smaller order sizes which includes custom work, with teams responsible for getting products out o