

# ***Beyond Lean: It's About Time!***

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## **The Need to Go Beyond Lean**

As technology advances, and products and markets evolve, it is important for manufacturing strategy to keep pace with these changes. In addition, an effective strategy needs to be supported by a precise methodology and appropriate tools. Although Lean Manufacturing has been successful in many situations, we need to understand that Lean strategy and Lean tools may not work well in other cases. In fact, as we look to the markets of the future, it becomes apparent that we need to go beyond Lean.

This issue became clear to us at the Center for Quick Response Manufacturing at the University of Wisconsin where, in dealing with over 200 partner companies during the past 15 years, the following issues surfaced repeatedly:

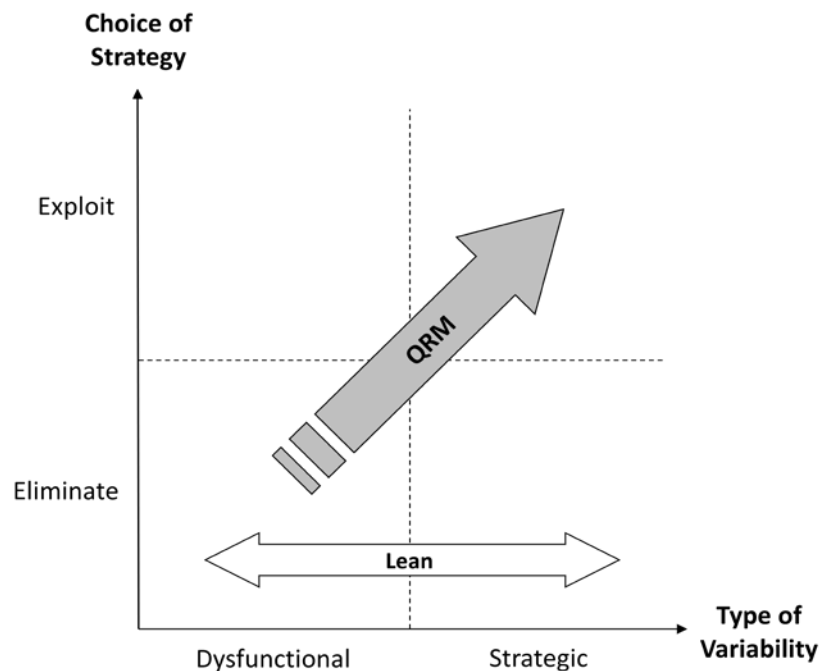
- The origins of Lean are in the Toyota Production System, with high-volume production. Companies today are offering an increasing variety of product options and even custom-engineered products. Our industry partners could not see how to apply Lean methods in such cases.
- Lean tools are designed to eliminate variability. As I explain below, for strategic reasons some of our industrial partners *did not want* to eliminate certain types of variability.
- Executives were asking: if everyone in our industry is implementing the same Lean strategies, then what is our competitive edge?
- And finally, as researchers we were thinking: The Toyota system was designed over 40 years ago—how can we forge new ground for our profession if we only focus on refining and implementing 40-year old methods?

These considerations led us to develop Quick Response Manufacturing (QRM), a companywide strategy for reducing lead times, both internally and externally. The external aspect involves rapidly designing and manufacturing products for specific customer needs. The internal aspect focuses on reducing lead times for tasks within the enterprise. Examples of internal lead times are the time to approve an engineering change or the time to issue a purchase order to a supplier. Such lead times are not directly observed by the customer. However, QRM implementations have shown that reducing both external and internal lead times results not only in quick response, but also in improved quality and lower operating costs. Companies with high-variety and custom products have been able to reduce their lead times by 80-90%, gaining substantial competitive advantage. Companies have also found that the lead time and cost reductions through QRM have enabled them to compete effectively against low-wage countries.

What if you have already invested in other strategies such as Six Sigma or Kaizen? Adopting QRM does not require you to back away from them; QRM builds on these strategies and unifies them under one overarching goal—reducing lead time. If you are already implementing Lean, again QRM will enhance your Lean program and take it to the next level. The origins of Lean are in high-volume, repetitive production, and the core tools in Lean such as Takt times and level scheduling are designed to eliminate variability in operations. However, eliminating variability may not be the right strategy for all companies. To make this clear, I define two types of variability:

- **Dysfunctional variability** caused by errors and poor systems. Examples are: rework; constantly changing priorities; and “lumpy” demand due to poor interfaces between sales and customers.
- **Strategic Variability** introduced by a company to maintain its competitive edge. Examples are: serving markets with highly unpredictable demand; offering customers a large variety of options; and offering custom-engineered products.

The core Lean techniques aim to eliminate *all* variability in the manufacturing system. The QRM approach is aligned with Lean in getting rid of dysfunctional variability. However, you may not want to eliminate strategic variability if it is the basis of your competitive advantage. So in QRM you do not *eliminate* strategic variability, instead you *exploit* it! This is done by designing the QRM organization to effectively cope with this variability and still achieve quick response. QRM includes a detailed methodology and an extensive set of tools to achieve these goals. Hence QRM takes Lean strategy to the next level (Figure 1). This is already important today for many companies that offer high-variety and custom products, but *it will become increasingly important as we look to the future* with customers demanding a wider array of options and customized features – a trend that is often referred to as “mass customization” in the literature.



**Figure 1: QRM strategy enhances Lean programs**

## Challenges to Reducing Lead Time

In principle managers understand the importance of quick response to customers. However, in practice our initial experiences in lead time reduction projects with our industry partners showed that there are many misconceptions about how to reduce lead times, which prevent successful results (see the QRM Quiz in Appendix A). So how can a company exploit strategic variability and also succeed in reducing its lead times?

To address this question we founded the Center for QRM as a partnership with industry to develop and implement principles for lead time reduction, eventually culminating in the QRM strategy. As described in the book *It's About Time* (see “For Further Reading”) QRM is based on **four core concepts**:

1. Realizing the Power of Time.
2. Rethinking Organizational Structure.
3. Understanding and Exploiting System Dynamics.
4. Implementing a Unified Strategy Enterprise-wide.

Many traditional management policies are obstacles to lead time reduction, so application of these four core concepts results in significant changes to existing policies. Even though Lean thinking has already challenged many policies, QRM results in additional changes *beyond* Lean (see Appendix B).

I now explain the four core concepts of QRM.

### QRM Core Concept 1: Realizing the Power of Time

Everyone knows that time is money, *but time is actually a lot more money than most managers realize!* Chuck Gates, President of RenewAire came to this realization after attending a QRM workshop. Then, using QRM principles, he reduced his product lead times by over 80%. As a result, RenewAire, a Madison (Wis.) manufacturer of customized Energy Recovery Ventilation Systems, gobbled up market share; this tiny company competing with industry giants multiplied its revenue by 2.4 from 2003 to 2008. At the same time, the company significantly improved its productivity, requiring only a 73% growth in total employees for this 140% increase in sales.

These numbers highlight the point that as companies reduce their external and internal lead times, they also see significant reductions in unit costs of their products, often 25% or more. This counters a concern for companies in the U.S. and other developed countries: employees live in fear of their operation being outsourced to low-wage countries such as China. But the fact is, for a typical product made in a developed nation, direct labor accounts for only 10% of its cost. Moreover, in terms of the selling price of a product, the number is lower: less than 7% of the price to the customer is attributable to direct labor. Thus, if you use QRM methods to reduce cost by 25%, you wipe out the labor-cost advantage of low-wage countries. When you consider that overseas competitors need considerable lead time for shipping, your short response time makes it impossible for them to compete on the same terms. You can compete against anyone, making products anywhere.

Why is lead time more significant than managers realize? Ponder this question: What is the waste in your enterprise due to long lead times? Do this by imagining a “blue sky” situation: suppose your company’s lead times were 90% shorter than they are today: what are all the activities and tasks done today that could be reduced or eliminated? What investments in materials or resources could be reduced or eliminated? (If these items could be reduced, they are truly “waste” in your enterprise—they are there only because of your long lead times.) Also, what new opportunities would be available to your company? (These are also part of the “waste” because your long lead times are resulting in wasted opportunities for your company.)

To help drive home this point, before you read on think about these questions and make a list of “waste due to long lead times” for your enterprise. Then review Table 1 which shows items listed by managers and employees that have attended our QRM workshops.

*To enhance your learning, think about the questions above before looking at the entries in this table*

**Table 1: Enterprisewide Waste Due to Long Lead Times**

Examples of activities and costs incurred today that would shrink or be eliminated if lead time were reduced:

- Expediting of hot jobs or late orders: requires systems; air freight; management and staff time
- Production meetings to update priorities and change targets
- Overtime costs for trying to speed up late jobs
- Time spent by Sales, Planning, Scheduling, Purchasing and other departments to develop forecasts and frequently update them
- WIP and Finished Goods holding costs and space usage
- Resources used to store and retrieve parts during the long lead time; damage to parts due to repeated handling
- Obsolescence of parts made to forecast
- Quality problems not detected till much later, resulting in large amounts of rework or scrap
- Customers keep changing specifications during the long lead time, consuming personnel time to deal with changes in delivery dates, quantities and options
- Order cancellations or loss of sales to competition
- Sales time for expediting jobs and explaining delays to customers
- Complex computer and organizational systems to manage this constantly changing environment

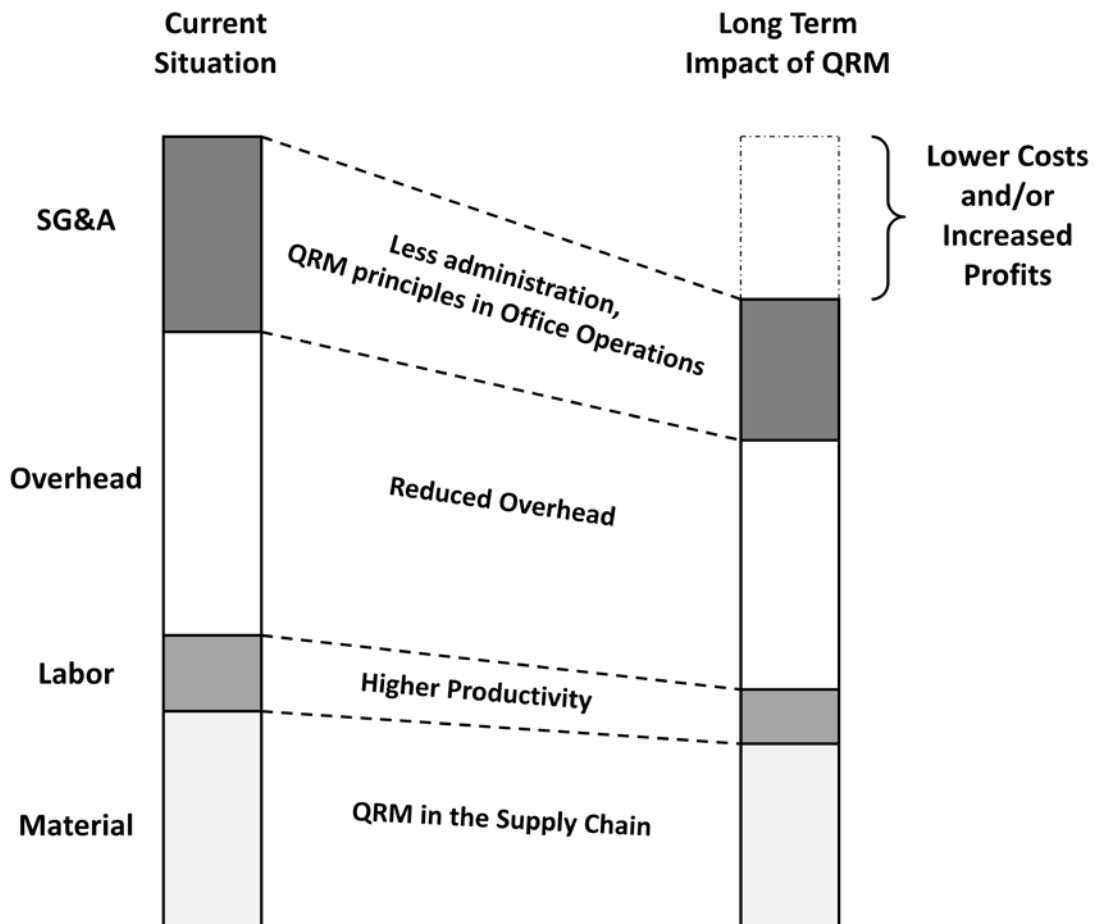
Examples of lost opportunities because of long lead time:

- Opportunity for increased sales due to shorter lead times for current products
- Opportunity to beat the competition to market and gain market share through rapid introduction of new products

As you review Table 1, I'm sure you will see some items that you listed but also some that did not occur to you. Managers find this exercise to be an eye-opener and realize there is far more waste in their enterprise due to long lead times than they initially thought.

Looking at Table 1, very few of these costs relate to direct labor—most of them are in the category of overhead and other indirect costs. In a typical U.S. factory, overhead accounts for 40% of the cost of goods sold (COGS), and raw materials and purchased parts account for around 50% of COGS. The remaining 10% is direct labor as mentioned already. In addition, indirect costs such as selling, general and administrative (SG&A) expenses and Research and Development (R&D) expenses are accounted for separately from COGS and can add another 30% on top of the total of the COGS expenses.

For companies making low-volume and custom products, QRM has impacted all these costs significantly. Reduction of the waste in Table 1 has lowered both overhead and SG&A expenses. Using QRM in the supply chain has reduced material costs. The QRM organization (described in the next section) has improved both office and shop floor productivity. The net result of these has been the 25% or greater cost reduction described earlier (see Figure 2). And the beauty is that this cost reduction does not come at the expense of other performance measures, because at the same time companies achieve lead time reductions of 80 to 90% and huge improvements in both on-time delivery and quality (see Table 2).



**Figure 2: Long-term Impact of QRM on Total Costs and Expenses**

**Table 2: Impact of Lead Time Reduction on Quality and On-Time Performance**

<b>Company (Product Type)</b>	<b>% Reduction in Lead Time</b>	<b>% Rework/Rejects (Before → After)</b>	<b>% On-Time Performance (Before → After)</b>
Seat Assemblies	80	5.0 → 0.05	40 → 95
Hydraulic Valves	93	5.0 → 0.15	40 → 98
Wiring Harnesses	94	0.3 → 0.05	43 → 99

***Accounting Systems Miss the Connection***

Why are managers not aware of this huge impact of lead time? A key reason is that accounting systems miss the connection: they simply do not identify a link between lead time and various activities. Instead, the costs of all indirect activities go into a general overhead pool where they are comingled with other costs and disconnected from their root causes. Then this overhead pool is applied across all products. Also, SG&A and R&D expenses are separately reported and not connected with root causes. Thus there is no easy way for the accounting system to predict the benefits of lead time reduction. And since cost systems form the basis for much decision-making, managers too miss the connection. *In actual fact, squeezing out time throughout your enterprise leads to numerous improvements in cost and other measures seen in Table 2.*

In fact, companies don't do a good job of measuring lead time, especially when it comes to internal activities. QRM theory also provides a precise metric for lead time, called Manufacturing Critical-path Time (MCT). For space considerations I will not go into details here; a rigorous definition of MCT along with extensive examples of how to calculate it in different situations can be found in the book, *It's About Time*.

In summary, the first core concept in QRM shows managers the enormous impact of time on their operation, and why reducing lead time can be so beneficial. To support this view, the driver in QRM is elimination of lead time (as defined precisely through the MCT metric). This contrasts with Lean where the driver is elimination of waste. The Lean view (typically involving seven types of waste) results in more of a local view of waste, while the QRM approach focusing on time encourages a global view of waste throughout the extended enterprise.

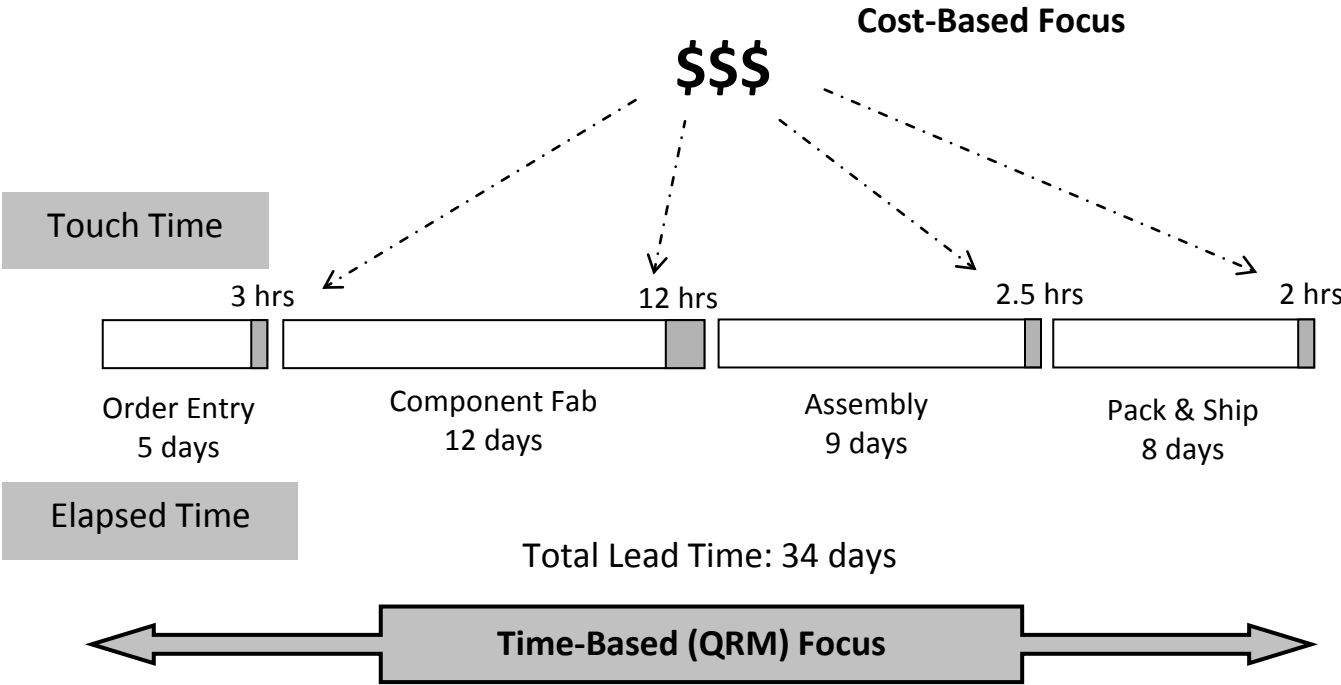
**QRM Core Concept 2: Rethinking Organizational Structure**

Reducing lead time requires rethinking your organizational structure. Why? An obvious reason is that you won't get 80-90% reductions by fine-tuning what you are doing today. But a deeper explanation stems from how most enterprises are organized. Figure 3 shows the progress of an order through a Midwest manufacturing company (the data are sample averages of actual orders). A typical order spends 5 days in the Order Entry department, then it takes 12 days for components to be fabricated, 9 days for assembly to be completed, and 8 days until the order is packed and shipped—for a total lead time of 34 days within the company. Figure 3 also shows the “touch time”—the gray space in the rectangles—when someone is actually working on the job. This accounts for under 20 hours, so based on an 8-hour day, the touch time is less than 2.5 of the 34 days. The rest of the time is the “white space” in the rectangles, where nothing is

happening to the job. This ratio is not unusual at all—from hundreds of projects at manufacturing companies we have observed that touch time typically accounts for less than 5% of lead time, and in some cases even less than 1%!

Traditional efficiency notions focus on reducing the touch time (gray space). This focus is promoted by costing systems which assume that product cost is driven by direct labor and/or machine times. Taking the company in Figure 3, management might target what appears to be the largest cost driver for this job, namely the 12 hours of labor in fabrication. An improvement reduces this to 9 hours—a 25% reduction in labor for fabrication, an apparently big success by traditional measures! But what effect does this have on the lead time of the job? The three-hour reduction is barely a dent in the 34 days and would not even be perceptible to customers.

To reduce lead time, companies need to shift from cost-based to time-based thinking. Cost-based thinking stems from mass production methods where jobs are divided into many small tasks and work on each task is done by people who specialize in that task. This creates many functional departments with lots of handoffs to process each job. Also, the pressure for cost reduction means that managers minimize the number of resources in their department, so both people and machines end up being highly utilized. From our personal experiences (e.g. with highway driving, or standing in line at supermarkets) we know that high utilization creates long queue times. So the high utilization of machines and people in each department means that there are large backlogs of work in the departments. When combined with all the handoffs from department to department, the result is long lead times. Now all the factors in Table 1 (waste due to long lead times) mount up, resulting in poor quality and high costs as well.



**Figure 3: QRM approach is different from traditional cost-based focus**

### ***Four Keys to Organization Structure for Quick Response***

In contrast to the cost-based approach which focuses only on the touch time (gray space), the QRM approach targets reduction of the total lead time (gray space plus white space, from start to finish). In order to reduce this lead time in the face of unpredictable demand and an environment of low-volume or custom products, you need to make four changes to your organizational structure:

- **From functional to cellular.** You must transform the organization of functional departments into one comprised of “QRM Cells.” Although the cell concept has been in use for some time, QRM Cells are more flexible, more holistic in their implementation, and are also applied outside the shop floor. QRM Cells are designed around a collection of processes or jobs that share similar characteristics and where there is an opportunity for benefit through lead time reduction. This collection is called a Focused Target Market Segment (FTMS), defined more precisely in the book, *It’s About Time*. A QRM Cell is a set of dedicated, collocated, multifunctional resources selected so that this set can complete a sequence of operations for all jobs belonging to a specified FTMS. The set of resources includes a team of cross-trained people that has complete ownership of the cell’s operation. The primary goal of a QRM Cell team is reduction of the cell’s lead time (measured via the MCT metric).
- **From top-down control to team ownership.** Instead of managers or supervisors controlling departments, QRM Cell teams manage themselves and have ownership of the entire delivery process within their cell.
- **From specialized, narrowly focused workers to a cross-trained workforce:** In contrast with the approach of having each person do one task efficiently, people are trained to perform multiple tasks. While companies talk about cross-training, managers underestimate its benefits and thus do not invest enough in it. We have seen significant increases in quality and productivity as a result of combining cell structure with cross-training and team ownership.
- **From efficiency/utilization goals to lead time reduction:** To support this new structure you must replace the traditional cost-based goals of efficiency and utilization with QRM’s goal which is a relentless focus on lead time reduction.

Unlike many cells implemented in industry today, QRM Cells do not require linear flow; they accommodate a variety of job types with different routings and the team owns and manages the flows within the cell. Also note that nowhere in the definition is there any mention of Takt times in the design of the cell—I will elaborate on this point in the third core concept below.



### **The power of QRM Cells illustrated by a case study from National Oilwell Varco (NOV)**

Headquartered in Houston, Texas, NOV is the world's largest manufacturer of automated oil and gas well drilling and pipe handling equipment with annual sales of around \$10 billion. Most of NOV's products are engineered to order. A few years ago, a NOV factory in Orange, California faced increasing demand but its long lead time and late delivery record was creating customer dissatisfaction and opening the door to competitors. Management at NOV-Orange felt that Lean was not suited to their customized and low-volume business: they made 60,000 different parts annually, most in low quantities. Managers at NOV learned about QRM, felt it was a good fit, and experimented by putting in a QRM Cell for a set of customized products.

Over the next two years, the cell team reduced the lead time of these products from 75 to 4 days! In addition, as a result of all the process improvements by the team and the benefits from reducing indirect costs in Table 1, the overall cost of the products was reduced by over 30%.

Results from NOV's first QRM Cell were so impressive that management approved substantial capital dollars for over a dozen more cells at Orange. The additional results convinced NOV's Vice President of Global Manufacturing Strategy, Greg Renfro, to roll QRM out to NOV facilities around the world. As stated by Greg Renfro, "QRM and the management of 'time' have been central to our ability to meet the demands of our market. As market dynamics change, it will continue to be an integral part of reducing product costs, improving quality and shortening lead-times."

The organizational structure using QRM Cells is critical to QRM implementation; however, it alone will not ensure success. A manufacturer of specialized transmissions converted its entire operations to cells, yet its quoted lead time was still around 6 months, and even with this long quoted lead time it had an on-time delivery record of just 40%. Thus, simply installing cells will not guarantee short lead times. The cells need to be complemented with other QRM policies described in the next two core concepts.

### **QRM Core Concept 3: Understanding and Exploiting System Dynamics Principles**

This core concept helps managers understand how system dynamics impacts lead time. The need for this understanding is illustrated by a common *management misconception*:

"To get jobs out fast and operate efficiently we must keep our machines and people busy all the time."

This misbelief stems from cost-based thinking: to minimize cost you should ensure that each resource is used as much as possible so that you can make do with the least number of resources. So what is the fallacy in this reasoning? As your resources get busier, you create increasing waiting times for jobs—the opposite of the quick response that you are trying to achieve.

The *QRM principle* that replaces the traditional belief is quite different:

"Strategically plan for spare capacity—the planned loading of your resources should be under 85%, or even under 75% in very high-variability environments."

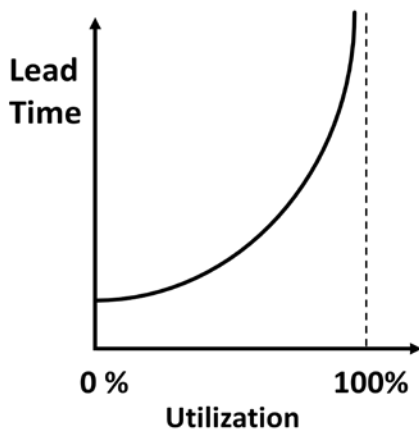
Most managers' first reaction to this is: "We can't afford to do that! Our costs will be much higher than our competition that uses fewer resources." QRM tackles this by using system dynamics theory, which tells us that lead times increase greatly as resource utilizations approach 100%. Worse, now small miscalculations in capacity, or any other disturbances such as hot jobs or machine breakdowns, cause an enormous increase in lead times, as seen from the first graph in Figure 4. The figure shows the QRM way of explaining this theory to managers in nontechnical terms by calling it "The Magnifying Effect of Utilization".

In similar nontechnical terms, QRM teaches managers about "The Miraculous Effect of Spare Capacity." The second graph in Figure 4 shows that when you are operating at high utilization (i.e. very little spare capacity), a small investment in more spare capacity (depicted by the horizontal arrow) results in a large reduction in lead time (as seen from the vertical arrow). As a concrete example, if a resource has 90% utilization, by adding just 10% of spare capacity you can reduce the queue time at that resource by 55%!

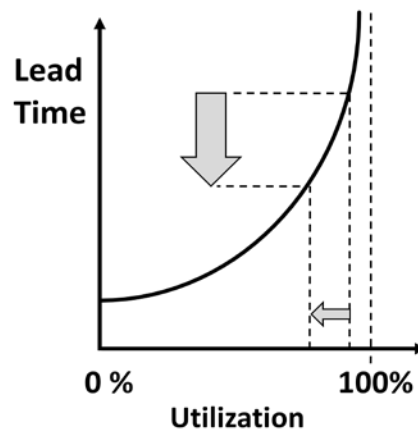
But what about the cost of this spare capacity? This is where the first core concept ("Realizing the Power of Time") comes back into play. While it may cost more to operate an area with a little more labor or equipment, the shorter lead times result in lower system-wide "waste" and the reduction in these costs outweigh the cost of the additional resources—review Table 1 to be reminded of these system-wide wastes and associated costs. When you add to this the potential increases in sales, you understand that companies have found their investment in spare capacity paid back many times over.

Since in QRM you do not eliminate strategic variability, it is important to design your system to cope with some variability. The higher the variability you are designing for, the more spare capacity you need to incorporate, and QRM uses calculations to help managers with such decisions. QRM also uses insights from system dynamics to make batch-sizing decision; these batch sizes differ from those based on traditional economic order quantity (EOQ) calculations.

**The Magnifying Effect of Utilization**



**The Miraculous Effect of Spare Capacity**



**Figure 4: Effect of Utilization and Spare Capacity on Lead Time**

Incorporating system dynamics into its core concepts is a key aspect of QRM. Other approaches base system designs on simplistic assumptions, ignoring this issue altogether. Lean uses the concept of Takt time: a fixed interval within which a resource must complete each job. Takt time is calculated solely from production targets. However, QRM shows that both lead time targets and variability need to be included in the calculations for capacity planning.

## **QRM Core Concept 4: Implementing a Unified Strategy for the Whole Enterprise**

Managers are excited to learn that QRM is a strategy that goes beyond just optimizing the shop floor, and it can be used to improve the entire organization. The same time-based mindset and QRM principles extend to all these areas:

**Office Operations.** Operations such as quoting, engineering, scheduling, and order processing tend to be neglected as a source of improvement in manufacturing companies. Yet they can significantly extend your lead times and increase your overhead costs and SG&A expenses. Using tools geared to office operations, QRM extends the cell concept to the office environment, called a Quick Response Office Cell or Q-ROC (pronounced “queue-rock”). Q-ROCs have enabled companies to reduce office lead times by 80% or more.

**Material Requirements Planning (MRP) System.** QRM theory shows how the planning logic in a traditional MRP (or ERP) system results in a spiral of increasing lead times. QRM restructures the system by simplifying it to support the cellular organization. This simpler system is called a High-Level MRP (HL/MRP) system. When supplemented by the POLCA shop floor control technique described below, it results in much shorter lead times.

**Supply Management.** By including time as a primary metric in the supply chain, instead of just cost, and by making executives aware of the full cost of lead times on their operations, QRM makes two fundamental changes to supply management: it uses lead time as a primary focus of supplier improvement programs, and it impacts the way sourcing decisions are made. For example, for certain types of parts QRM encourages the use of local suppliers rather than low-cost suppliers half-way around the world. Despite the shift from cost to time, companies have found that lead time reduction helps reduce overall supply chain costs by 10-15%. There are other benefits too: one equipment manufacturer reduced lead times by an average of 78% across its supply chain and this resulted in a five-fold reduction in supplier quality defects and late deliveries.

**New Product Introduction (NPI).** With today’s fast-paced changes in technology and markets, new products are the lifeblood of a manufacturing business. There are many proven techniques for NPI, such as concurrent engineering and quality function deployment. Even so, QRM further improves the NPI process. The key again is awareness of the impact of NPI lead time on your business, and rethinking conventional decisions in terms of their impact on this lead time. For example, QRM’s time-based approach results in new tradeoffs during prototype construction and novel ways of thinking about product options during design. The combined impact of these changes can be substantial. By training its NPI teams in QRM, a manufacturer of medical instruments reduced its NPI time from two and a half years to less than six months.

**Shop Floor Control.** As part of the Lean toolkit, Kanban systems are popular for shop floor control. Indeed Kanban is simple and highly effective in higher volume production, but it is not the best system in all situations. Kanban requires that you have containers of stock for each part at various stages of your operation and supply chain. If a part has low annual usage, with Kanban you carry a lot of inventory which spends most of its time sitting around. Further, if you need to make a custom-engineered part then you simply can't have stock of that part ahead of time, so Kanban fails altogether. Instead, QRM uses POLCA, a system designed to work with the QRM structure of cells and HL/MRP.

POLCA stands for *Paired-Cell Overlapping Loops of Cards with Authorization*. POLCA connects pairs of cells with circulating cards like Kanban, but with two key differences: (i) while a Kanban card is an *inventory* signal (“replenish these parts”), a POLCA card is a *capacity* signal, indicating availability of capacity at the downstream cell; and (ii) POLCA builds on the schedules from your existing MRP system—through the HL/MRP logic—and does not have problems with low-volume or custom parts. POLCA reinforces the cellular organization by orchestrating the flow on the shop floor to ensure the best use of capacity while avoiding congestion. After implementing POLCA, companies have seen the elimination of “hot jobs” and expediting, along with substantial reductions in WIP and improvements in on-time delivery.

#### **Case study of POLCA application at P&H Mining Equipment**

Located in Milwaukee (Wis.) P&H manufactures large custom equipment such as mining shovels and draglines, with annual sales of over \$1 billion. P&H had been implementing QRM Cells for several years and in 2006 it decided to connect a dozen shop floor cells and facilities such as heat treat using POLCA. During the first year that POLCA was implemented P&H reduced its WIP by \$3 million—and this even occurred in the face of increasing production targets. According to Bob Mueller, Factory Manager and Kathy Pelto, Project Manager at P&H, “Kanban was simply not an effective option for us...POLCA has been a good fit for our shop. Our process is complex; parts move from cell to cell, and sometimes to non-cell areas as well. POLCA keeps all of these areas working together.”

### **Implementing QRM: From Cost-Based to Time-Based Decisions**

In this article, I have repeatedly talked about replacing cost-based decisions with time-based decisions, but how can managers justify such decisions? QRM helps in a number of ways: it provides rules of thumb to predict the cost impact of lead time; it shows how to move from cost-based to time-based justification of projects; and it provides ways to adjust your accounting system. On the last point, QRM does not require that you change to new accounting practices such as Lean Accounting. In fact, in the book, *It's About Time* I provide five simple adjustments to your existing accounting system that go a long way toward supporting time-based thinking.

## **Securing Your Company's Future With QRM**

With the growth of global competition, with the changes brought about by outsourcing of jobs to low-wage countries, and with the difficult economic conditions around the world, companies need to reexamine their competitive strategy. Over the past two decades organizations have implemented strategies like Kaizen, Six Sigma, and Lean. Modern technology has allowed companies to vastly increase the variety of products they can manufacture; at the same time it has given customers the ability to interact with companies through the internet and to expect higher levels of customization. You need a strategy that will explicitly take advantage of the market shifts that are occurring as a result—and QRM is designed to do just that! The good news is that you do not need to turn your back on improvement strategies that you have already implemented and start over: QRM builds on the foundation created by previous methods and takes your competitiveness to the next level.

The track record of companies that have already implemented QRM shows that if you can understand and implement QRM before your competition figures out how to do it, huge market opportunities, improved profitability, and a highly stimulating work environment await your enterprise and your employees.

### **For Further Reading**

*It's About Time: The Competitive Advantage of Quick Response Manufacturing*, by Rajan Suri, Productivity Press, 2010.

Additional readings, case studies, and other resources can be found at: [www.qrmcenter.org](http://www.qrmcenter.org)

### **About the Author**

Rajan Suri is Founding Director of the Center for Quick Response Manufacturing, and Emeritus Professor of Industrial Engineering at the University of Wisconsin. He received his Bachelors degree from Cambridge University (England), and his M.S. and Ph.D. from Harvard University.

Dr. Suri has consulted for leading firms including Alcoa, AT&T, Danfoss, Ford, Harley-Davidson, Hewlett Packard, IBM, John Deere, National Oilwell Varco, Pratt & Whitney, Rockwell Automation and TREK Bicycle. Consulting assignments in Europe and the Far East, along with projects for the World Bank, have given him an international perspective on manufacturing competitiveness.

Professor Suri has received awards from the American Automatic Control Council, The Institute of Management Sciences and the IEEE. In 1999, Suri was made a Fellow of the Society of Manufacturing Engineers (SME), and in 2006 he received SME's Albert M. Sargent Progress Award for the creation and implementation of the Quick Response Manufacturing philosophy. In 2010, Suri was one of only 10 people to be inducted into the Industry Week 2010 Manufacturing Hall of Fame, which recognizes individuals who embody the best of U.S. manufacturing.

## Appendix A: QRM Quiz

Most managers understand the competitive advantages of being fast in responding to customers, and companies are attempting to improve their responsiveness. However, there are many misconceptions about how to reduce lead times and implement quick response. These misconceptions prevent successful results. My early experiences in implementing QRM led me to develop a simple quiz which I have used to document the state of manufacturing management strategy.

Before I present the results, you may find it interesting to take this “QRM Quiz” on the next page. If you are in industry, complete the quiz as follows. For each of the assertions in the quiz, ask yourself: Do the key managers in my company consider this statement to be True or False? If you are in a consulting organization or in academia, choose a company you know that is struggling with lead time reduction, and ask: Do the key managers in that company consider this statement to be True or False? Let me set some ground rules though, to make sure you are being completely ruthless in your evaluation. You need to answer the quiz based on the policies in use at the company, not based on your own opinion of what is correct. Take the first statement in the quiz as an example:

1. Everyone will have to work faster, harder, and longer hours, in order to get jobs done in less time.

True       False

As you look at this, you surely think, “We all know that to be false. We need to work smarter, not harder.” But then, ask yourself, “Does the company frequently use overtime? Does it take a lot of expediting to get jobs out on time? Do people at the company often have to work on weekends to deal with late jobs?” If the answer to any of these is yes, then it is clear that key managers in the company believe item #1 is true! Use this same probing mindset as you approach each of the remaining items.

Mark your answers in the boxes in the quiz, and then read on to evaluate the results.

## Quiz on Implementing QRM

Developed by Rajan Suri

For each statement below, ask yourself: Would the key managers in my company consider this statement to be True or False? Mark your responses in the boxes, then compare them with the answers given in the text.

1. Everyone will have to work faster, harder, and longer hours, in order to get jobs done in less time.  
 True       False
2. To get jobs out fast, we must keep our machines and people busy all the time.  
 True       False
3. In order to reduce our lead times, we have to improve our efficiencies.  
 True       False
4. We must place great importance on "on-time" delivery performance by each of our departments, and by our suppliers.  
 True       False
5. Installing a Material Requirements Planning (MRP or ERP) System will help in reducing lead times.  
 True       False
6. Since long lead time items need to be ordered in large quantities, we should negotiate quantity discounts with our suppliers.  
 True       False
7. We should encourage our customers to buy our products in large quantities by offering price breaks and quantity discounts.  
 True       False
8. We can implement QRM by forming teams in each department.  
 True       False
9. The reason for implementing QRM is so that we can charge our customers more for rush jobs.  
 True       False
10. Implementing QRM will require large investments in technology.  
 True       False

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Now I present the answers to the quiz. Experience with hundreds of QRM projects has shown the following: for successful implementation of QRM it is necessary for a company's key decision-makers to believe that *every single one of those assertions in the Quiz is False!*

This may be obvious to you in some cases, such as item #1, where you know you have to find ways to work smarter. But what could be wrong with improving efficiencies (item #3)? And isn't on-time delivery (item #4) a cornerstone of every JIT program? And what about teams (item #8)? Aren't they all the rage these days, in everything from shop floor work to office operations? How could all those assertions possibly be False?

It is precisely these surprising points that make QRM unique and are explained in detail in the book, *It's About Time*. But what is the significance of these quiz questions and why should they matter to you? Each item for which you answered "True" will, sooner or later, become an obstacle to the success of your QRM program—or worse yet, belief in one of these assertions by a senior manager could increase your lead times instead of reducing them! And, as your lead times get longer, the same senior manager will push harder on that belief, thinking it is not being followed sufficiently, resulting in a vicious cycle of even longer lead times.

To illustrate the magnitude of misconceptions that exist in management circles, I present a simple statistic. I interviewed over 400 U.S. executives and managers in dozens of industries, and even though all of them were from firms that were trying to cut their lead times, 70% of the policies in use by these managers and their companies were major obstacles to lead time reduction. Worse yet, it was not as if these managers were working on changing the policies. In most cases they had no awareness that these policies were the source of the problem. If over two-thirds of the policies in use at an average U.S. firm are preventing it from cutting its lead times, what's the chance that your company also suffers from this malady?

Let us return to your own experience with the Quiz: how well did your chosen firm score? Give your company a score of 0 for each True and 1 for each False. Count up the number of times you checked the False box, and that is your company's score. This score is on a scale of 0 to 10, where 0 denotes a company that will have to undergo a gargantuan change to succeed at QRM, while 10 denotes a company that is a "veteran" of QRM. In reality, most companies will score somewhere in between. Do not be surprised if your company's score is low. The typical score for a U.S. company is around 3. In summary, 7 out of the 10 questions are typically answered "True", which leads to my earlier assertion that 70% of the policies in use at U.S. companies are working against lead time reduction.

The peril of this situation is that not only are the wrong principles in operation, but managers may not know that these principles are wrong. More important than the correct response to each Quiz item, however, is an in-depth understanding of why it is the correct response, as well as the numerous issues that must be addressed to change from the current way of operation to the QRM way. Only when management clearly understands the basis for each QRM principle can it lead the organization along the QRM journey.

This article explains a few of these misconceptions and the key QRM principles. A detailed explanation of why each of the questions should be answered "False" can be found in the book *It's About Time* (see "For Further Reading").



## Appendix B: How QRM Goes Beyond Lean – A Ten-Point Summary

Factor	Lean Approach	QRM Approach
<b>1. Origin</b>	Derived from the Toyota Production System. Works best for high-volume, repetitive production.	Designed from the ground up for low-volume and custom-engineered products. (Also enables you to compete with low-wage countries.)
<b>2. Dealing with Variability</b>	Tools such as Takt Time, Standard Work and Level Scheduling target the elimination of <i>all</i> variability.	Eliminate dysfunctional variability. Strategic variability provides competitive advantage: exploit it using QRM tools.
<b>3. Driver and Metrics</b>	Driver is elimination of waste. Metrics based on seven types of waste; these measure the “micro” impact in seven areas, but may not give insight into “macro” system-wide waste. Hard to evaluate success of projects when seven measurements are involved.	Driver is elimination of lead time, identified by the Manufacturing Critical-path Time (MCT) metric. Encourages global view of waste throughout the extended enterprise. MCT provides a unified measure of system-wide waste and a single metric for improvement projects.
<b>4. Cell Design</b>	Cell structure is rigid, based on Standard Work, Takt Time and linear flow. Highly effective for repetitive production.	QRM cells are flexible and allow multiple flows for higher variety. Emphasis is on teamwork, ownership and cross-training.
<b>5. Material Control</b>	Use Kanban for material control. Simple, visual system and works well for high-volume parts, but creates excess inventory for low-volume parts, and cannot be used for custom-engineered parts.	Use POLCA for material control. Builds on cellular structure and your MRP system. Slightly more complex than Kanban, but works equally well for high-volume, low-volume and custom parts.
<b>6. Material Planning</b>	Replace Material Requirements Planning (MRP) with Kanban. Again, not practical for low-volume or custom parts.	Build on your existing MRP system, but simplify it to a “high-level” MRP system and supplement it with POLCA for material control.
<b>7. Capacity Planning</b>	Use Takt Time for planning capacity at operations. Takt Time is calculated solely from production targets. Simple and easy to understand, but not applicable to high-variability environments.	Strategically plan for spare capacity. Include job variability and lead time targets to decide amount of spare capacity needed (e.g. more spare capacity in higher variability operations).
<b>8. Supply Management</b>	Emphasis on waste reduction tends to be local and inward focused. Not clear how to extend to supply chain. Takt time and Kanban may not be the right tools for extended and global supply chains.	Focus on lead time reduction results in a global outlook through time-based supply management – for example, revising goals of supplier improvement programs and rethinking sourcing decisions.
<b>9. Companywide application</b>	Message not clear to nonmanufacturing areas; seven lean wastes may not apply in other areas. Key tools such as Takt Time and Kanban also stem from shop floor operations. Not clear how to apply them to nonmanufacturing operations.	Being responsive to customers provides unifying goal for the whole enterprise. QRM approach can be used in all areas. Specific tools for office operations, including Focused Target Market Segments (FTMS) and Quick Response Office Cells (Q-ROCs).
<b>10. Decision-Making and Justification</b>	Ongoing struggle to convince executives to change policies. Local waste elimination focus may not provide sufficient justification. May require new accounting methods (“Lean Accounting”).	Teaches executives about huge financial impact of time; encourages time-based decision-making and financial justification. Small adjustments to existing accounting system are sufficient.