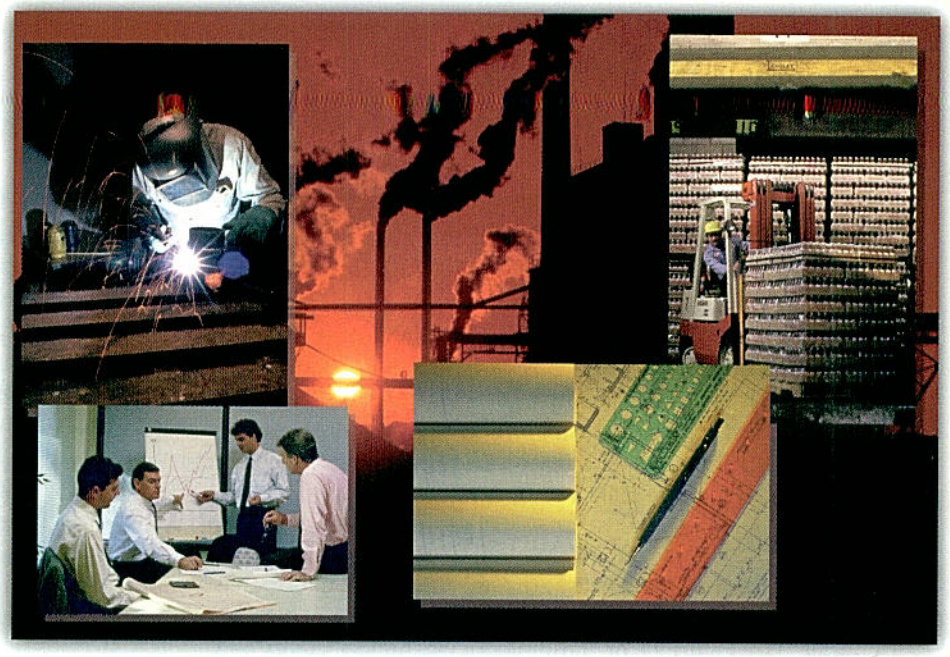

Slaying the Beast

ARE YOU TRYING to reduce lead times by hammering on efficiencies, making sure machines are never idle, and emphasizing on-time performance? These traditional assumptions could have the opposite effect. The realities for lead time reduction are surprisingly different.

The basis for lead time reduction is a strategy called time-based competition. While this strategy can be applied to any business, we focus on its application in manufacturing firms, and call this quick response manufacturing (QRM).

QRM strategies have helped some firms cut lead times by 75-95 percent while improving product quality and reducing costs. As a result, articles on quick response abound, and senior management everywhere is trying to implement this strategy.

But is your organization ready to embark on the QRM journey? Firms have begun QRM programs only to find them stalled a few months later. Worse, some found lead times getting longer. Why? Because organizations continue to operate with traditional assumptions.

Through working with dozens of firms on implementing QRM, we have found the common assumptions that undermine QRM programs, and have developed the new realities that must replace them (see Table 1).

Assumptions and Realities In Implementing Quick Response Manufacturing

BY RAJAN SURI

REDESIGNING OUR ORGANIZATIONS

Traditional assumption: *Everyone will have to work faster and longer to get jobs done in less time.* Stopwatches, efficiency studies, overtime, expediting: these are the worst ways of achieving quick response.

QRM reality: *Find whole new ways of completing a job, with the focus on lead time minimization.* This takes major organizational restructuring. The reason is, our organizations are designed to manage scale and cost, not to manage time.

FROM SCALE-COST TO QUALITY-SPEED

After the war, the U.S. was the only industrial nation that could supply global markets. The name of the game was "scale" (see Figure 1), or "how big can you build a factory and still manage it?" In the 1970s, European and Japanese firms crept into the lower end of markets with cheaper goods, so U.S. firms fought back with cost reduction.

These two trends laid the foundations for the entrenched management systems of today: Organizational structures, accounting systems and reward systems are based on managing scale and cost.

The 1980s presented a paradigm shift that suggested there is no tradeoff between cost and quality. If a company focuses on improving quality, then cost competitiveness will follow as well.

A paradigm shift to speed occurred in the 1990s. Taking the quality paradigm further, competing on speed results in both quality and cost improvements, and shortens lead times.

THE PLANNING LOOP

A legacy of scale/cost-based management, and the greatest enemy of QRM efforts, is the "planning loop." First noticed at MIT in 1958, this phenomenon was connected to QRM in 1988 by George Stalk of the Boston Consulting Group.

Orders go through many departments, each with its own lead time. The result is a long total lead time for the orders. These long lead times require sales forecasts for planning. As lead times lengthen, the accuracy of forecasts declines. Due to forecasting errors, there is need for safety stock at all levels. Also, some inventory is not used as expected. Inventories grow for both reasons.

Now comes the biggest punch: unforecasted orders are received. This leads to unscheduled jobs being expedited. These crowd out scheduled jobs, whose lead times become longer! After customer complaints pile up, the organization uses the longer lead times for its quoting and planning. The longer lead times then result in worse forecasts, more inventory, more unscheduled jobs and even longer lead times ... and so the spiral goes on.

Why is this planning loop a legacy of the scale/cost eras? To make items in volume at low cost, companies organized similar operations (e.g., milling) in one department with minimally skilled labor. For QRM, this type of organization is disastrous. Products suffer tortuous routes through many departments. Low skill levels lead to low quality. Since many products are produced in each department using general purpose machines, setups are long. Coupled with minimization of handling between departments, this results in large batches. All the elements are in place for the planning loop to spiral outward beyond control.

This planning loop cannot, in fact, be controlled—it has to be killed. How? By reducing the consumption of time throughout the system. However, our methods are focused on cost reduction, not time reduction. Taking time out of the system thus requires us to rethink how we organize production, materials supply and white collar work.

REORGANIZING PRODUCTION

This involves three changes:

1. *Reorganize process components from functional to product-oriented.* Place all processes necessary to deliver a finished product (or family of products) in one department, called a cell. The cell comprises not just shop floor processes, but white collar work, as well.

2. *Replace complex, centralized scheduling systems with simpler, local procedures.* In the traditional layout, a job would visit a multitude of departments. Since each department saw a multitude of jobs, it needed to be told which job to work on next.

In the cellular organization, there is high visibility. The cell team is given the delivery schedule and takes responsibility for equipment

TRADITIONAL ASSUMPTION *To get jobs out fast, we need to...*	QRM REALITY *To get jobs out fast, we need to...*
Work faster and longer	*Find whole new ways of doing the work*
Never have idle machines or people	*Plan to operate at under 80% capacity*
Improve our efficiency	*Reward reduction of lead times*
Emphasize "on time" delivery	*Stick to rewarding reduction of lead times*
Install an MRP system	*Restructure manufacturing, then use MRP*
Buy long lead time items in large lots	*Help suppliers implement QRM*
Get customers to buy in large quantities	*Negotiate a schedule to move to smaller lots*
Charge customers more for rush jobs	*Realize QRM leads to a more secure future*
Invest in technology	*Recognize the biggest obstacle is mindset*

TABLE 1

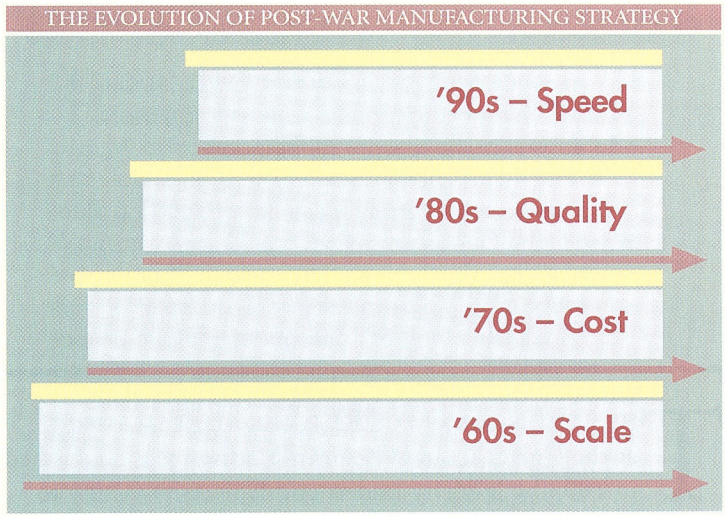

FIGURE 1

schedules. The function of the central system becomes one of assigning delivery schedules, ordering material and coordinating between cells.

3. *Focus on how to run smaller batches.* Since each cell is responsible for a small family of products, setups can be tailored and setup times decreased. With cross-trained teams, additional improvements are realized. Products that were made in lot sizes of 100 will be made economically in lot sizes of 20, 10 or even one. The reduction in lead time will be phenomenal. A product that was stocked in large quantities because it had a two-month lead time will be made-to-order in two days.

Implementation of cells takes more than just restructuring. It requires a new attitude toward management of capacity and efficiencies.

QRM APPROACH TO CAPACITY PLANNING

Traditional assumption: *To assist in getting jobs out fast, we should never have idle machines or people.* Traditionally, keeping machines and labor busy is synonymous with good management. Yet planning for 100 percent utilization can be disastrous for QRM—queues grow and jobs spend a lot of time waiting.

QRM reality: *Plan to operate at 80 percent or even 70 percent capacity on critical resources.* Resources are not being wasted. This idle capacity is a strategic investment that will pay for itself many times over in increased sales, higher quality and lower costs.

RETHINKING "EFFICIENCY"

Traditional assumption: *To reduce lead times, we have to improve our efficiencies.* The problem with this attitude is that most measures of efficiency work counter to lead time reduction. As one example, a typical output measure for a work center counts only good pieces. The incentive is to run large lot sizes, minimizing on setup and maximizing pieces produced.

QRM reality: *Measure the reduction of lead times and make this the main performance measure.* The benefits of this bold step were experienced by Beloit Corp., a manufacturer of papermaking machines in Beloit, Wis. Lead times for a line of spare parts dropped from 36 days to six.

UNDERSTANDING FACTORY DYNAMICS

Figure 2 drives home the need for new management attitudes. Traditional measures of utilization and efficiency encouraged managers to maximize resource utilization and only think about their capacity limit as a boundary between feasible and infeasible production targets (graph A) and run large lot sizes (graph B). With the current focus on reducing lead time, it is important to understand the impact of utilization (graph C) and lot size (graph D) on lead time.

Graphs C and D show how high utilization and large lots result in long lead times and high work-in-process. Graph D also illustrates the pitfalls of making lot sizes too small before the organization is ready—setups increase, leading to higher utilization and longer waiting times. Somewhere in between are "good" lot sizes that lead to low lead times and WIP.

These "good" lot sizes bear little relation to the values calculated by the economic order quantity (EOQ) formula, which fails to consider many costs of large lots and ignores the value of responsiveness. Nor can good lot sizes for QRM be predicted by an MRP system, since it assumes fixed queue times regardless of workload.

So how can a factory determine good lot sizes for its products? We have used a PC-based approach called rapid modeling technology (RMT) to set lot sizes and resource utilizations for companies implementing QRM (see sidebar).

MATERIAL PLANNING AND CONTROL

Traditional assumption: *We need to place great importance on "on-time" delivery by our departments and suppliers.* While

PUTTING THE SQUEEZE ON CYCLE TIME

IN PAST DECADES, economies of scale and total quality management dominated discussions of competitive advantage in manufacturing. Now, however, the focus is turning to issues of customer satisfaction, expressed best in obtaining virtually zero defect product shipments to the customer on schedule and in variable lot sizes. Time to market serves well in expressing these issues.

Most manufacturing systems are severely limited in their ability to analyze time to market problems. Production and inventory control engineers who have struggled to reconcile lot size with work cell capabilities know that MRP systems often can't solve such delivery time questions.

Simulation programs, when brought to bear on cycle time reduction, often require inordinate time to

on-time performance is desirable, over-emphasizing it is dysfunctional. Human nature being what it is, instead of trying to reduce lead times, departments or suppliers pad them so their on-time deliveries look good.

QRM reality: *Stick to measuring and rewarding reduction of lead times.* Shorter lead times will kill the planning loop, and delivery problems will disappear.

Traditional assumption: *Installing an MRP system will cut lead times.* MRP systems serve an important function of assisting with materials supply. However, don't expect MRP to solve lead time problems. MRP works with fixed lead times for each department: one that will be achieved regardless of workload. Hence, all the lead times in MRP are "worst case." Adding these up gives long total lead times, exacerbating the planning loop.

QRM reality: *Use MRP to plan and coordinate materials. Restructure the manufacturing organization into simpler product-oriented cells.* Do not use MRP for micromanagement of work centers. Let teams run their own cells. Provide the teams with simple tools such as RMT to manage their capacity and continually improve their responsiveness.

CUSTOMER AND SUPPLIER RELATIONS

Traditional assumption: *Since long lead time items are ordered in large quantities we should negotiate quantity discounts with suppliers.* If you purchase items in large lots, suppliers make them in large lots, resulting in long lead times at their factories. These lead times, in turn, cause you to order large lots. Also, your purchasing agents are trained to negotiate quantity discounts. With the large orders that result, suppliers' quality suffers, costs rise and lead times lengthen.

QRM reality: *Motivate suppliers to implement QRM, resulting in small lots at lower cost, better quality and short lead times.* Also, don't underestimate the difficulty of retraining your purchasing staff. They may find it hard to believe this new approach will work.

Traditional assumption: *We should encourage our customers to buy our products in large quantities by offering price breaks and quantity discounts.* This is the reverse of the above situation.

QRM reality: *Educate customers on your QRM program and negotiate a schedule of moving to smaller lot sizes at reasonable prices.* Explain to customers how they will soon see benefits: smaller lots at lower cost. However, they need to be patient while you embark on QRM, and not order large lots.

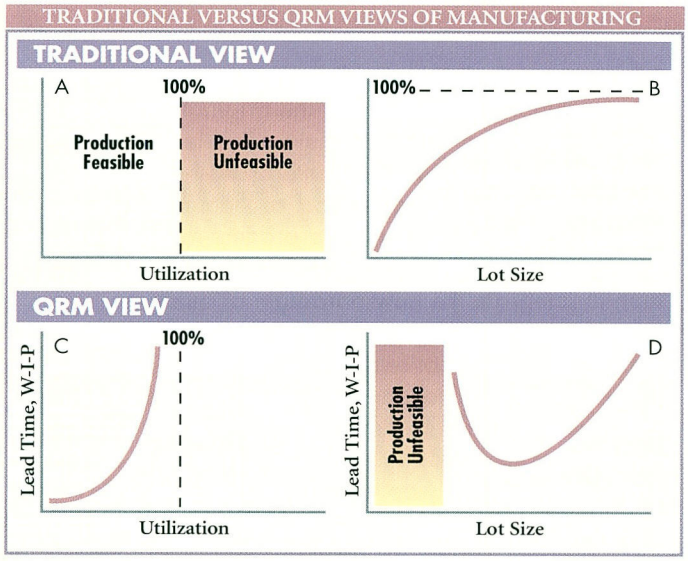

FIGURE 2

WHITE COLLAR WORK

Cells are not restricted to the shop floor. Much of a firm's lead time is in white collar areas. To cut these times, firms are creating teams. If implemented incorrectly, this can be ineffective.

Traditional assumption: *We can implement QRM by forming teams in each department.* A team with all its members in one functional department may be useful for local quality improvements, but will do little to cut lead times.

QRM reality: *Cut through functional boundaries by forming a "closed-loop," multifunctional, cross-trained team responsible for a family of products, and empower them to make necessary decisions.* This is the only way to get significant reduction of lead times for jobs such as estimating and quoting, order processing and engineering. "Closed-loop" means that all the steps can be done within the team, so you will have to cut across functional boundaries and change reporting structures.

Within a year of implementing such a team, Marathon Electric Manufacturing Corp. in Wausau, Wis., saw its lead times cut by half *(see sidebar)*.

NEW PRODUCT INTRODUCTION

This requires the ultimate cross-functional team. Many functions are included, such as marketing, finance, design,

produce results. Colorful animation may be thought provoking, but in bidding and production planning situations where leisurely reviews are impossible and intuition and rules of thumb just don't make it, the ability to do reliable, easily modified and timely rough cut analysis is vital.

What's needed is a computationally facile program that can accurately analyze such complex variables as lot size, the dynamics of machine and labor utilization, queue times and other important variables. "Greenfield" analysis in plant startups is also susceptible to the approach. In all such circumstances, easy modeling capabilities—where input is relatively quick and straightforward, and output is easily modified to create alternative scenarios—are crucial.

Programs based on an obscure branch of mathematics called queueing network theory turned out to be ideally suited to the job.

engineering, manufacturing, purchasing and even suppliers. This approach is known as concurrent engineering (CE).

While much has been written about CE, companies creating CE teams have encountered two main obstacles. First is incomplete implementation, when team members continue to have homes in functional departments. Second is prevalence of the cost-based mindset, which pushes employees to do well on tasks that improved efficiencies in functional departments, but run counter to CE.

CREATING THE MINDSET FOR QRM

Traditional assumption: *The reason for implementing QRM is so that we can charge our customers more for rush jobs.* While customers may pay more for speedy delivery, this should not be the main reason for engaging in QRM.

QRM reality: *The reason for embarking on the QRM journey is that it leads to a truly lean and mean company with a more secure future.* Searching for ways of squeezing time out of a process uncovers quality problems and wasted efforts. Fixing these items results in higher quality, lower WIP, less waste, and thus, lower operating cost. At the same time, sales go up. The resulting company is hard to beat.

Traditional assumption: *Implementing QRM will require large investments in technology.* New technologies, such as rapid prototyping and CAD/CAM, offer great opportunities for time reduction. While these are important, there are several steps that precede them.

QRM reality: *The biggest obstacle to QRM is not technology, but "mind-set."* Combat this through training. Next, engage in "low-cost or no-cost" lead time reductions. Leave big ticket technological solutions for a later stage. Education must be the first step, or else other efforts will fail.

QRM: MANAGEMENT PROBLEM OR OPPORTUNITY?

Lead time reduction cannot be done as a tactic. It would be naive for senior managers to think that they can order their staff to cut lead times in half, delegate the responsibility and expect that it will eventually happen.

To significantly affect lead times, firms must change traditional ways of operating and redesign organizational structure. This requires total commitment from top management. Thus QRM has to be an organizational strategy led by top management. For management that understands and implements QRM with these points in mind, the rewards of profitability and growth can be substantial.

FOR FURTHER READING

A detailed report, Misconceptions and Blunders in Implementing Quick Response Manufacturing, by R. Suri, is available from the Center for Quick Response Manufacturing, University of Wisconsin-Madison.

CULTURE SHIFT LEADS TO CYCLE TIME REDUCTION

"PROGRESSIVE" is a word they take seriously at Marathon Electric, one of the original "Wausau Group" of companies—a loosely allied league of manufacturing and financial enterprises—whose roots go back to the early years of the century in Wausau, Wis. Greg Cemke, a product manager at Marathon, has been instrumental in leading Marathon to integrate the new paradigm of quick response manufacturing into the firm's electric motor manufacturing operations.

Cemke and his colleagues recognized customer satisfaction was the ground on which the company would have to stand if it was to enhance already high levels of quality and service. Consistent with the guidance Cemke was getting from the Center For Quick Response Manufacturing at the University of Wisconsin-Madison, he helped form a multi-functional team to "zero-in on cycle time reduction from order entry through product shipment."

Although the motor team is little more than a year old, it is already making dramatic improvements. Empowered to make changes in any functional area of the manufacturing process, team efforts are paying off—cycle time at Marathon, from order placement to ship date, has been reduced by more than 48 percent.

Marathon is beginning to model product flows through work cells, looking for the key variables that can help diminish bottlenecks. MPX, a rapid modeling technology software package developed by Burlington, Mass.-based Network Dynamics, Inc., is one of Marathon's choices in this initiative. Inventory and setup time reduction are two other key variables the Marathon team is addressing in seeking to compress lead time even further.

What does Cemke like best about the brave new world of quick response manufacturing? "Our old mind-set about cycle time reduction has been replaced by a new approach to getting the job done. Our joint relationship with the Center For Quick Response Manufacturing gives us the opportunity to experiment with new methods while meeting other industry participants with whom we can share real life situations and learn from each other's experiences."

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