今天，研制时间是以分钟计算的。快速响应制造（“QRM”）使公司能够快速满足客户需要，允许业务继续评估增值，并对竞争压力做出反应。“QRM”降低了对预测的依赖，提高了对市场需求的响应，并最终为盈利做出贡献。这种做法行之有效，因为1）在设计产品的同时确定产品和过程序数据（为制造确认数据）；2）通过使用标准工具和过程序，增加制造过程的灵活性；3）精确详细的进度表；以及4）缩短准备时间，以便可按需求制造产品，从而减少在制品。

Enabling Quick Response Manufacturing

Doug Johnson and Vern Harrison

Still using your pick-and-place for debugging? Tools for surviving a zero-forecast world.

Quick Response Manufacturing (QRM) enables organizations to meet customer demand quickly, permitting businesses to continually evaluate and react to competitive pressures. QRM eliminates non-value added activities and waste through continual reduction of lead times within the supply chain and manufacturing process.

In 1903, Ford Motor Co. began mass producing automobiles. Cars were available only in black and lead time was measured in weeks. Today, customers demand variety and lead time is measured in minutes. Yet as time from concept to mass production for new products shrinks, so does profit margin. QRM is a way to increase customer satisfaction while improving the returns of the organization (**Figure 1**).

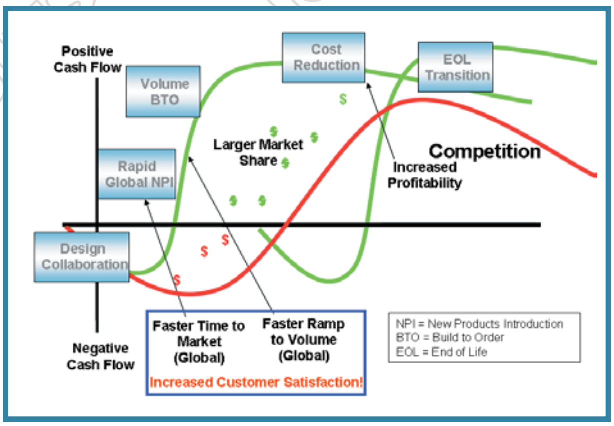

FIGURE 1: Quick Response Manufacturing cuts lead time and improves responsiveness, leading to better profits.

Historically, businesses build redundancy within internal processes and supply chains for safety measures. This results in wasted time and resources. Material within the supply chain can quickly depreciate or even become obsolete. The challenge is to be more responsive to customer needs and increase flexibility while reducing inventory and waste.

QRM also requires a shift in company culture. Historically, a fixed manufacturing schedule was the norm; today it is virtually nonexistent. QRM systems support lead-time reduction, reduce reliance on forecasts, increase responsiveness to market demands and ultimately contribute to the profitability of the organization.

Here are QRM's key benefits.

• **Concurrent and time-compressed processes.** Defining product and process data at the same time the product is being designed permits faster new product introduction. By using an open programming system that imports CAD and BOM files, design data can be easily inspected and validated against current processes. This is further simplified by using centralized management of part number and component libraries enabling consistent product and process data.

A good example of software's capabilities to permit high-quality products to be defined and built is placement equipment. Effective NPI processes quickly turn incoming data and materials into finished product with little-to-no waste, errors or scrap. The benchmark for NPI is complete offline simulation prior to new model introductions. This permits the production line to focus on running production jobs instead of being used for (expensive) debugging and programming.

Debugging on the placement system reflects a failure to meet expectations and results in waste as well as increased response time. Tying up the production line to resolve NPI issues adds uncertainty to fulfillment schedules. If a company's central NPI department exports data to multiple production lines, or if facilities have suspect, non-validated or incorrect data, the entire enterprise may be put at risk. A central NPI department requires feedback from all customers to ensure that common problems are resolved in the source data. Using a single database with consolidated manufacturing and product data components reduces the dependency on informal communication.

A second benchmark for NPI is showing the CAD location of the components graphically on a scanned image of a bare PCB. This placement simulation permits complete first-article verification at the programmer level, where modifications can be easily made. This process eliminates the need for tape or trial builds. Feeder setup sheets that include a graphical depiction of the component and its orientation, coupled with user validation, enable flawless definition and execution of setups.

Although implementation of QRM processes requires reconsideration of the entire NPI process, using concurrent and time-compressed processes increases machine utilization and reduces NPI time.

• **Flexible manufacturing processes.** Common lead-time reduction methods include the standardization of tools and processes to enable product portability and to provide additional schedule flexibility. When the definition is centered on the product itself (as opposed to preparing machine-specific programs), the movement of products from line to line or from facility to facility is easily accomplished. Common modular machine elements such as feeders, programming and similar operational aspects permit workcells to become product-oriented and staff to control the activity at the cell level (**Figure 2**).

• **Accurate and detailed scheduling.** The ability to evaluate production demands quickly and accurately against resource requirements – including material availability, system capabilities and human resources – needs to be constantly analyzed. This continual analysis improves accuracy and reduces deviations in the expected production plan. Less time spent reacting to missed production plans means more time for building product.

• **Reducing setup time and use of group technology.** Setup and changeover activities in a high-mix environment can be the predominant workload and a large contributor to lead time. Software tools that apply group technology in planning to reduce setup activities and to meet operational scenarios, including "what if" and "delta setups," can manage and reduce setup workload. Coupled with well-conceived hardware and software to enable offline setup, and rapid tooling and setup changeover, it is possible to conduct concurrent activities.

The best setup changeover, of course, is no changeover, but minimizing setup time permits frequent model changes. By managing the setup activity, it becomes practical to build products on demand, to achieve small WIP inventories. This practice is also known as Heijunka, or production leveling. Frequent model changes reduce WIP, as well as embedding the ability to support quicker responses into the system. QRM focuses on the customer's specific needs and not on production for production's sake.

FIGURE 2: Common and modular machine elements, such as feeders and programming, make workcells product-oriented and permit staff to control activity at the cell level.

• **Process analysis to identify NVA activities.** The QRM environment mandates making decisions with accurate and current information. Time delays associated with manually collecting, formatting and distributing reports may result in decisions that hurt lead time. Real-time information supports real-time reactions and adjustments.

It is important to comprehend the commitments of the production system, the progress that the system is making and the system's capability to engage new tasks to meet customer demands. Up-to-date information provided by the system to support other business systems may include: unit completions, lot status, material consumption and attrition, and replenishment notifications.

• **User-targeted tools and technology.** Technology, including IT integration, is intended to inform and empower users, wherever they may be or whatever they do. The capability to tailor information to users' needs, as well as provide the information where and when the user needs it, can save time and improve user effectiveness. User-customized report content and presentation can enhance performance. Real-time alerts and alarms can enhance responsiveness. Visibility wherever the user may be, including the factory floor, enables quick response. What should happen next becomes obvious for all participants within the manufacturing organization. QRM enables organizations to quickly meet customer demands by requiring constant evaluation and response.

Yet agile systems that support QRM are only a part of the solution. Leadership and change within each company will determine the effectiveness of the QRM initiative. A company driven to embrace rapid planning and execution as core principles will gain a competitive advantage. ■

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