Execution-Driven Manufacturing Management for Competitive Advantage

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Introduction

Manufacturers are being driven to deliver higher quality products tailored to the specific needs of individual customers in shorter periods of time. To maintain competitiveness in this fast-paced business environment, manufacturing companies are searching for ways to generate higher levels of productivity from existing manufacturing capacities, while also reducing work-in-process inventories. They are looking to run their plants using the best possible schedules at the lowest possible costs.

Achieving these goals is complicated by the fact that every manufacturing company is a complex web of activities and information flows. Properly managed, these activities and this information can help the company achieve its goals. Improperly managed, these activities and information flows can become the agents of disaster, resulting in poor quality, late deliveries and burgeoning costs, which ultimately drive the manufacturer out of business.

Opportunities for Productivity Gains on the Shop Floor

At most manufacturing plants, there is no shortage of work on the shop floor, only a shortage of coordination in deploying available factory resources (people, information, materials and tools) to manage the work efficiently. Factory floor workers face a constant set of challenges as job queues grow deeper and customer orders pile up. Thousands of inter-related events and exceptions occur on the manufacturing floor every day, expediting has become the standard way of doing business, executing the planned schedule has become the exception.

The confusion on the shop floor is not the result of a lack of effort. It takes production control personnel and supervisors many hours each day to research the current status of all of the jobs on the floor and develop a work schedule. Their efforts are made more difficult because schedules often run a day or two behind what is really happening on the plant floor. The manufacturer is trapped between fast-paced demand and lagging information to make decisions.

Facing the New Realities in Manufacturing

Despite advances in manufacturing and computer software technologies, most manufacturers are basically managing their shop floor activities the same way they were twenty years ago. If you visited the computer rooms or looked over a planner shoulder, you'd find dated computer systems and time-worn management strategies which simply don't fit the new realities of global manufacturing.

As markets and competition become increasingly global, competing according to the old model simply no longer works. According to that model, the more of a given product you could make at the lowest cost, while charging the highest price to your customers, the greater

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the profit you could realize. This system pitted the needs of the supplier, which also wanted to make the greatest margin it could, against the needs of the customer, which wanted to buy the product for the lowest price. This model caused manufacturers to produce as much of a product as they could in-house, to focus on product and to strive for a efficient, if static and unimaginative organization. Once the "best" way to do something had been found, there was no need to reconsider it, since change was inherently disruptive and only gradual improvements in performance were enough to keep ahead of the competition.

New Realities of Global Manufacturing

The world of manufacturing simply doesn't work this way any more. Markets have become global, with more suppliers competing for the same customers with high quality, reasonably priced products. In this new environment, the static organization will be overtaken by its competition. The emphasis has shifted toward partnerships with customers and suppliers; toward nimble, highly flexible organizations and processes which can produce exactly what the customer wants in a fraction of the time at a fraction of the cost of the old methods.

OUT	IN
Mass Production	Customization
Product Driven	Customer Intimacy
Incremental Change	Discontinuous Change
Gradual Improvement	Reengineering/Optimization
Functions	Processes
Hierarchical Structure	Self-Organizing Teams
Do It All	The Virtual Enterprise
Customers vs. Suppliers	Supply Chain Management

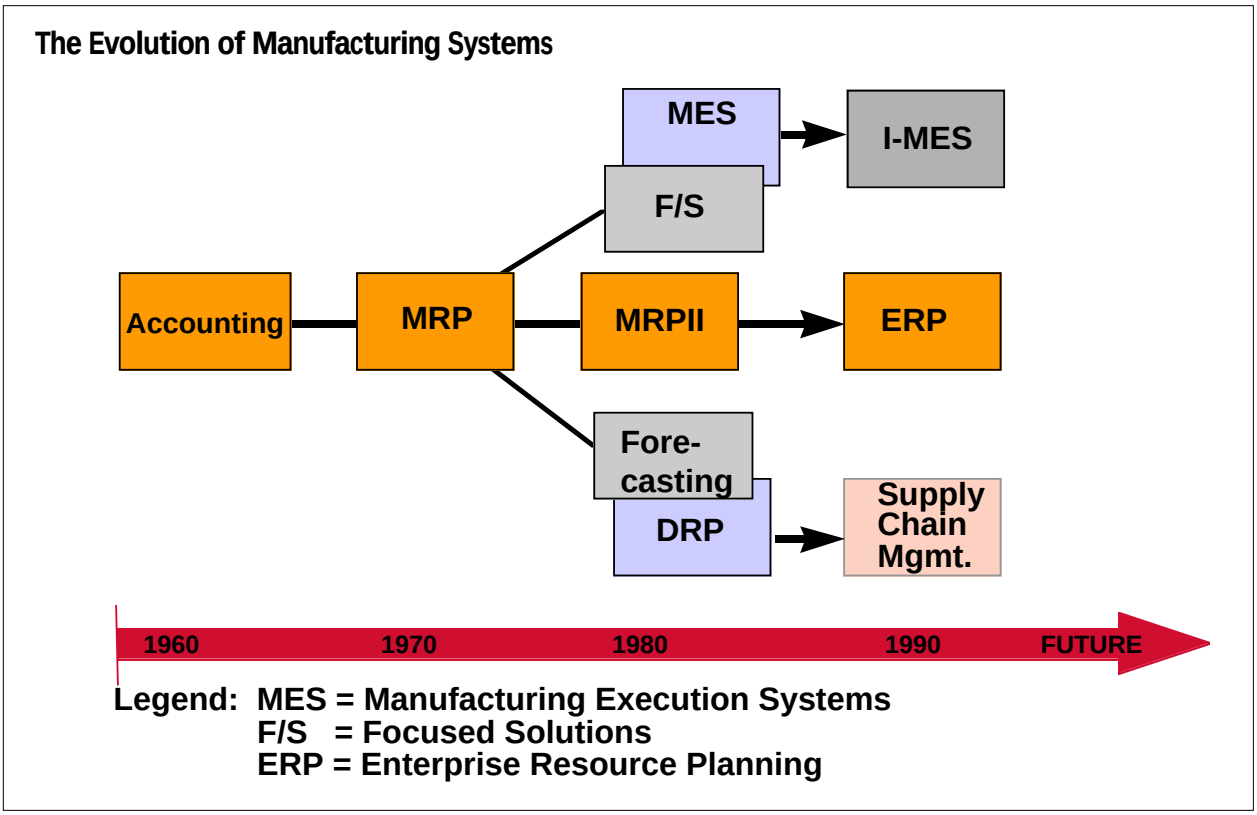
It has to, because if the manufacturer doesn't respond, a competitor will. Responsive, adaptive organizations are focusing on the processes required to meet specific customer demands and are looking to improve their performance at all phases of the demand fulfillment process. One of the realities of this new manufacturing environment is that the old ways of managing information and the systems used to do so, simply don't meet the new requirements. Without real-time systems which can plan, schedule and execute the operations strategy effectively and efficiently, the manufacturer is flying blind. It's not that the old methods, such as Manufacturing Resource Planning, are no longer valuable; they're no longer enough.

The Evolution of Manufacturing Systems

Understanding where manufacturing systems need to go requires some understanding of where they've been and why. Most people are familiar with the concept of Manufacturing Resource Planning (MRPII). Estimates of the number of commercial and homegrown systems installed around the world vary from a low of 30,000 to upwards of 70,000. By all accounts, MRPII is the dominant manufacturing management methodology in the world. It hasn't always been so, nor was MRP originally intended to include all of the business functions now considered part of "the standard system." In fact, the standard system has evolved to include so much functionality that many vendors now market "Enterprise Resource Planning systems" (ERP).

The history of manufacturing management systems doesn't begin with MRPII systems, however. As computing has evolved, so have manufacturing management systems. The first computerized business systems were used in accounting. By the late 1960's or early 1970's, from these accounting systems evolved material requirements planning (MRP), which was intended to help manufacturers better plan material availability. By the late 1970's or early 1980's, computers were more powerful and capable of handling more data and being used interactively by more people. MRP evolved into MRPII as shop floor reporting systems, purchasing systems and related functions were added.

At about the same time, many companies began to realize they needed other systems to manage other aspects of their businesses. MRPII didn't address the requirements of forecasting and managing demand in distribution, nor did it do much of a job of managing the shop floor and the many disparate activities that took place there. To address the requirements in distribution, forecasting and distribution resource planning (DRP) were developed. Likewise, manufacturing execution systems (MES) and a number of unique, function-specific systems such as quality management, evolved. While these systems helped manufacturers solve specific business problems, they weren't integrated and often couldn't take advantage



of data from or pass data to other systems.

In the late 1980's and early 1990's, another generation of systems became available. These systems attempted to solve the "islands of information problem" by providing broad comprehensive solutions. MRPII systems became Enterprise Resource Planning. DRP became Supply Chain Management and the shop floor solutions evolved into Integrated MES systems. In all cases, solution-focused systems such as quality or maintenance management, remained viable alternatives for companies which required more functionality that that available in the integrated solutions.

At the same time these management solutions were evolving, a similar evolution was taking place at the controls level, where computers gradually replaced manual controls, and process and machine management became increasingly sophisticated. In all industries control technology added new precision to real-time execution. Systems to manage these controls and consolidate and evaluate the data they produced, supervisory control and data acquisition (SCADA) systems also became available. With the advent of graphical user interfaces, toolkits to build control-specific interfaces are also available.

In the late 1990's these boundaries between traditional manufacturing systems are becoming blurred. SCADA systems are beginning to acquire many of the functions of traditional MES. MES vendors are adding manufacturing management functions formerly thought to be part of MRPII, such as purchasing and available-to-promise. Some ERP vendors have responded to the interest in manufacturing execution management by adding MES functionality to their product suites.

The New Manufacturing Software Reality

Companies shopping for a solution today will find all of these alternatives available to them. While each is a viable solution to real business problems, the demands of the market and the march of technology are moving the manufacturing systems market toward yet another generation of products. In this new generation of systems, customers will be able to choose the functionality they need and the vendors who provide the functions best suited to the manufacturer's needs. Systems and

functions will be interoperable and integration between the functions, or "objects," provided by many vendors will be standardized. In a sense, the manufacturing software market is changing in the same way the manufacturing market is changing: toward customization, partnerships and rapid response. For manufacturers, these changes mean an opportunity to realize dramatic improvements in performance, competitiveness and profitability.

An Execution-Driven Approach

These changes in the manufacturing environment and in manufacturing software systems mean substantial change for the traditional manufacturing organization. Fortunately, dramatic change can mean dramatic benefits. To achieve dramatic benefits, manufacturers must go beyond the traditional planning-oriented approach and move toward an execution-driven environment. A manufacturing execution system (MES) approach would enable manufacturers to schedule work orders, coordinate support functions, manage shop floor execution, and communicate work status and problems. It tracks and analyzes work orders based on current shop floor activities, providing immediate knowledge of changes from the proposed schedule due to operations taking too long, quality issues, the expediting of other jobs, or a myriad of other show stoppers. The system also includes dynamic rescheduling capabilities that allow companies to implement real-time schedule changes and project the impact of schedule variations. It would manage the interdependencies among work orders and allocate resources accordingly.

An execution-driven approach can complement existing systems such as MRP, but manufacturers gain real-time visibility to capacity (a work center that can't perform a scheduled task) and non-capacity (a shop floor operator is waiting for an approval before starting a task) constraints in the manufacturing process. It allows companies to look for potential problems or bottlenecks before they occur, and coordinate shop floor and support department activities so they execute work assignments as a synchronized operating unit. In this new work place, MRP could still plan while MES provides the management of value-added manufacturing activities on a minute-by-minute basis.

By moving execution capabilities out to the operators, manufacturers can create a pull environment on the shop floor, creating a process that contains nothing but value-added activities. Support activities would be done in parallel to manufacturing activities so they do not constrain the creation of value. Activities that do not create value for the manufacturer or its customers are eliminated. When deploying an execution system, manufacturers can take three steps that further them along the value-added activities path.

The first step for a manufacturer is to monitor and understand its existing factory operation. By using the real-time manufacturing management capabilities of an MES application, operators can record when jobs start and stop, and track existing work flows through the factory. Once a manufacturing process is understood, companies can apply proven techniques to manage the resources and work flow associated with the creation of value. An MES application provides dynamic finite scheduling that furnishes operators with a continuously updated shop floor schedule and real-time dispatching of

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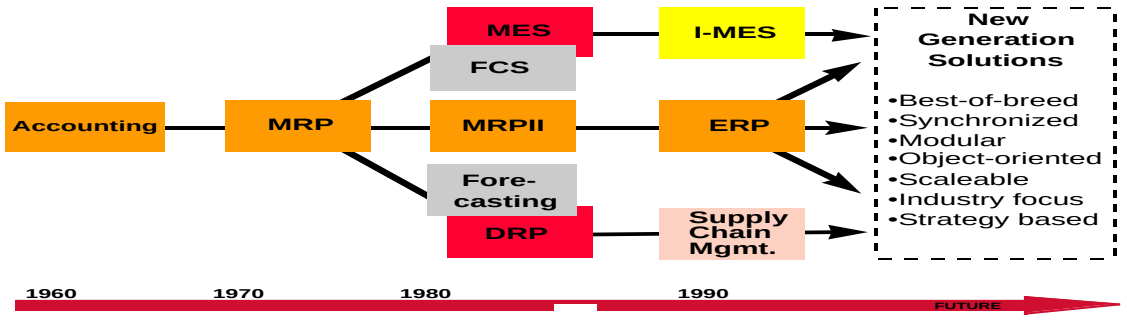


when and where events should occur. By managing execution, companies gain control of the shop floor and have immediate visibility to any schedule variations.

Second, manufacturers need to remove support activities from the critical path of a work order. According to one survey of manufacturers, the task of collecting all of the necessary support materials (prints, tools, materials and instructions) in order to run a job typically requires 38 percent of the effective capacity of a plant. Execution systems enable users to itemize support tasks involved in fulfillment of customer orders, communicate these requirements to support groups and track their status. With this capability, everyone — including personnel not on the shop floor but in important support functions such as the tool room, engineering and stock room — knows in advance the requirements of factory floor operators to run scheduled jobs. By synchronizing support activities, the delivery of materials to an operator's work center is expedited on a just-in-time basis. This improved coordination provides the operator with everything required, in the right place and at the right time, to execute a scheduled job.

Third, with support activities removed from the critical path, factory managers can tightly control which orders are released to the factory floor. An order should not go to the shop floor until all the resources required to complete the job are in place. Thus, every released order will proceed through the factory as fast as possible, significantly reducing non-value added activities. This improved work flow management creates a pull environment on the factory floor that dramatically improves lead time, productivity and inventory management.

Taking a Look at the New, Integrated Shop Floor

To understand better, the effect that a real-time manufacturing management software application can have on a plant, let's examine some of the key players involved in effective manufacturing operations.

Shop floor operators

Execution-driven applications provide operators with real-time dispatch lists that show work orders in priority sequence. The job sequence information is continuously adjusted as actual manufacturing operations take place or as priorities are changed. Operators input work order completion, with the system immediately showing availability for the next operation. Shop floor operators have access to detailed work order status screens that provide them with support requirements for each job, including engineering drawings, programs, tooling, materials and special instructions. They can communicate actual work order status, in real-time, to production control personnel and to the scheduling system. Information on jobs in queue, set-up, run and problem states can be entered and communicated continuously. Real-time communication of problems to production scheduling and support functions expedites problem resolution.

Production schedulers

Scheduling personnel are able to easily change order priority, routings and schedules (due to alternate routings, engineering changes, quantity changes, rework and cancellations) and communicate these changes to the shop floor instantaneously. Schedulers have the capabilities to override the schedule and change an order's place in the job sequence, or group similar jobs to save set-up time. Work orders and routings can be downloaded from MRP systems or entered manually. Support function resource requirements, such as tools, documents and fixtures, can be easily imported into the system for communication directly to work center operators. Job status information facilitates their working with customer service, managers and supervisors to prioritize schedule changes. "What if" simulation capability allows them to test alternative scenarios prior to finalization of changes.

Support groups: stock room, tool room, maintenance, engineering

The manufacturing management system provides work order priority, location and requirements on a real-time basis to all support functions in order to maximize manufacturing throughput. The system supplies each support function with detailed plans of what to do and when to do it, on a minute-by-minute basis. Real-time alarms identify problem situations occurring on the shop floor, allowing support personnel to respond quickly. Support groups can input in advance when they are unable to meet scheduled requirements, providing information that automatically revises schedules.

Customer service and supervisors

The execution system provides customer service, supervisory and other personnel the work order status for any functional area within the plant. The system offers them multiple views of production status information

including historic, current and projected data. Customer service personnel can use production information to make sure new customer commitments can be met without impacting previous promise dates. Supervisors can use the information to make decisions on whether to employ alternate machines or work centers to relieve shop floor bottlenecks, and to identify problem order and material shortages.

Managers and manufacturing engineering

The system provides detailed data on individual work centers and tools for identification of performance improvement areas. Complete backlog analysis and trending, input/output control and throughput calculations provide the information needed to identify production bottlenecks. It also enables detailed analysis of queue, set-up, run and problem times so that the best opportunities for cycle time reductions can be pinpointed.

Execution Management in Action

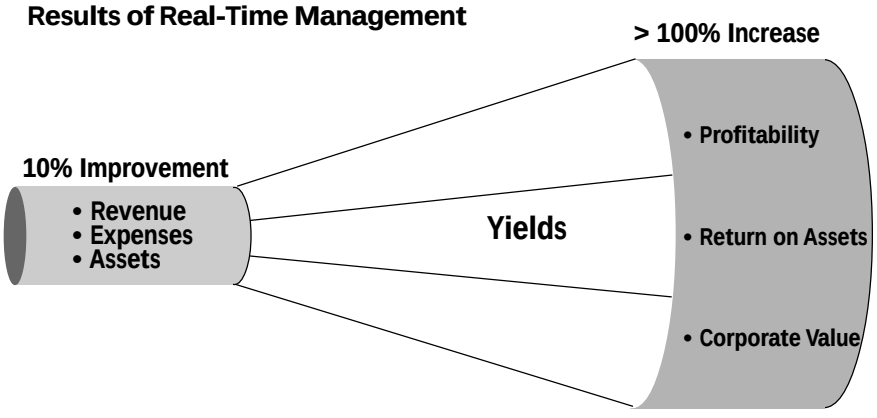
The impact that real-time manufacturing management systems can have on a company is quite dramatic, in both operational and financial terms. In operational terms, the company becomes more responsive to its customers, better able to anticipate their requirements and provide them with high quality products in the shortest possible time. By understanding its manufacturing processes, core competencies and market and using the information available through real-time management systems, a manufacturer can achieve true competitive advantage. This, in turn, translates into increased market share and improved profitability.

Because real-time management systems give manufacturers tight control over the basic processes of their businesses, improvements can be achieved quickly. By cutting waste, lowering inventories and improving order fulfillment cycle time, costs are significantly reduced and requirements for new plants and equipment drop as well. These improvements, taken together, result in reduced requirements for working capital, less short and long-term debt and improved profitability

While these improvements on the expense side of the ledger are substantial by themselves, they are often matched by similar improvements in revenue. By reducing costs and being more responsive, manufacturers improve their margins, can sometimes charge a premium for their products and can use their increased competitiveness to gain market share or enter new markets. The result is increased revenues. Confidential surveys of companies implementing real-time management systems show results most managers in those companies thought impossible.

Effective Manufacturing Execution

Real-time manufacturing management systems can help companies reengineer factory floor operations by enabling increased visibility, control and coordination of the multiple resources, people, equipment and parts involved in the manufacturing process. These systems allow users to change the way work orders are released to the shop floor, reducing the work-in-process inventory at



each work center and creating a pull system in which the next work order is released only after the existing task is complete.

In today's manufacturing marketplace, top-tier customers assume manufacturers will provide high-quality, market-priced products. By helping companies to improve their internal operations, execution systems can enable manufacturers to create value-added operations that improve productivity and enhance strategic advantage.

Appendix: Participants

The following members of MESA International participated in this work:

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