Advanced Production Scheduling And Capacity Management

MRP II Extended

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Many assumptions about MRP II are invalid, which can result in a very false sense of security regarding the precision of schedules generated by the system. In most cases, however, enhancements can provide a much-needed capability to predict manufacturing performance in terms of product availability and financial results.

Management's desire to be more competitive and to increase profits through manufacturing is evident. Customer responsiveness, increased output, lower manufacturing costs, better quality, short cycle times, bottleneck control and operational predictability, among many other opportunity areas, are hot management issues. Improvement in these areas offers enormous potential in profit improvement and competitive advantage for the overwhelming majority of manufacturers. Largely untapped, more modern tools and techniques for effectively scheduling production and managing capacity in an MRP II environment offer tremendous potential.

Performance test

A quick profile of a company's true performance can be obtained by answering yes or no to the 10 performance statements below. When evaluating each, you must seriously consider and honestly judge your company's performance. Only a yes answer receives 10 points. Nothing less than a total score of 100 is really acceptable, considering the tools and techniques that are available. As a guideline, a score of 80 points or less indicates that substantial performance improvement potential exists.

- Regularly meet quoted deliver dates.
- Routinely meet operation completion dates on manufacturing schedules.
- Manufacturing lead times are shorter than competitors.
- Production meetings focus on corrective action for anticipated *future* schedule problems identified by the system.
- Queue time is less than production processing time.
- Master production schedule is not overloaded.
- Constraining/bottleneck work centers are highly visible and controlled.
- Capacity adjustment information is accurate and readily available.
- Master production schedule attainment is predictable and continuously monitored.
- Schedule simulations can be easily performed for "what-if" analysis of specific capacity requirements, including identification of bottlenecks.

"New wave" technology

Investment in the "new wave" of information technology, including ERP (enterprise resource planning) is expected to reach massive proportions. There is no doubt that we are in a new cycle of information technology capabilities. Yet, history has demonstrated many times that leading edge informa-

tion technology rarely produces significant profit improvement quickly for most companies. For now, too many questions remain for manufacturers, such as:

- Will realistic production scheduling with highly predictable factory output result in the near-term?
- Will significant, measurable profit and competitive improvements result?

The new wave of information technology is not the immediate answer to the very real problems that need to be solved now. The risk and sad possibility of a leap of faith to new information technology may postpone, to the distant future, the operating improvements that are needed *now*. Remember, organizations tend to evolve relatively slowly through the new system transformation and absorption process.

Should you scrap MRP?

American industry has invested vast sums of money into MRP with the results being less than expected or, more importantly, needed. Many years ago, merely implementing a working material requirements planning system was a significant step forward. With the evolution to MRP II, more structure was brought to the management planning process. However, MRP II emphasizes planning management, not the execution of the plan. We need to recognize that real progress can be made in a relatively short period of time by enhancing the schedule execution capability within an MRP II environment. While many would advocate adopting JIT production, unfortunately, the typical lengthy period of time required to get management to truly embrace JIT across all functions may postpone the improvements needed now in operational predictability. This is not to say that JIT is bypassed, but worthwhile prerequisites can be accomplished quickly, while effective re-engineering of the business process takes place over a longer period of time.

Real progress in production scheduling and capacity management is possible with a system that is *dynamic* and based on *facts*. This is an MRP system enhancement that will provide the much needed capability of predicting manufacturing performance in terms of product availability and financial results.

What happened to MRP?

Many companies have been led to believe that standard MRP II systems perform effective short term scheduling of production. Nothing could be further from the truth! In a complex production environment, the fact is, valid production scheduling and capacity management with standard MRP II logic is an illusion which is essentially concealed within the system's output. This illusion often results in a very false sense of security regarding the precision of MRP II-generated schedules.

MRP II systems emphasize planning management and do very little to effectively schedule resources on a day-to-day basis. Changing the detail scheduling and capacity management logic contained in most MRP II systems is required to correct the fundamental weaknesses inherent in "standard MRP II." Consider such invalid assumptions contained in MRP II logic that include, for example, fixed lead times, constant queues and infinite capacity.

These assumptions alone cause the standard capacity management process to be nonfact-based. In addition, numerous other factors compound the problem. For example, the backward scheduling and loading algorithms used in most MRP software packages often defy logical explanation, at least in terms of effectively managing production operations. The simultaneous checking of material and capacity availability, scheduling to bottleneck constraints and automatically developing job chain networks, are necessities to really close the loop with an automated system.

Critical questions

The questions that need to be answered, for more effective manufacturing control, govern system functionality requirements. The most critical questions of manufacturing control that can not be answered with standard MRP II systems are:

- When will specific orders really be completed?
- Which orders will be late?
- What are the specific problems that are delaying the schedule?
- What are the future schedule problems?
- What is the best schedule, considering material and capacity availability, that will maximize through-put?
- What are the right jobs to work on now?

The answers to these questions require a system with comprehensive functionality. For example, the scheduling or allocation of capacity would only be done when material availability is known. In other words, the enhanced MRP II system would be able to perform a material *and capacity* availability check before order release.

The ability to answer the "critical questions" will provide a capability that management has sought for a long time—the capability to predict output!

Finite vs. infinite scheduling

If we define the term "scheduling" as a process of committing capacity, then scheduling rather than loading becomes the more appropriate term.

The age-old controversy of finite vs. infinite is often based on myths and half-truths. First, let's look at the problem. Infinite scheduling allows more than one job to be scheduled for production within a limited capacity resource at the same time. When many jobs are scheduled at the same time, which is often the case, the same limited resource is in a state of "scheduled chaos" rather than governed by an achievable schedule. The only alternative is classic; supervisors and production control personnel must take hands-on control of shop floor schedules and essentially ignore the MRP-generated dispatch lists. The original goal was to get control of schedule priorities and the goal is not being met. The infinite scheduling approach, and the problem of assuming capacity will be available at the time it is needed, is often countered by those who advocate finite scheduling.

Finite scheduling makes sure that simultaneous schedule contention for the same capacity resource is avoided. The

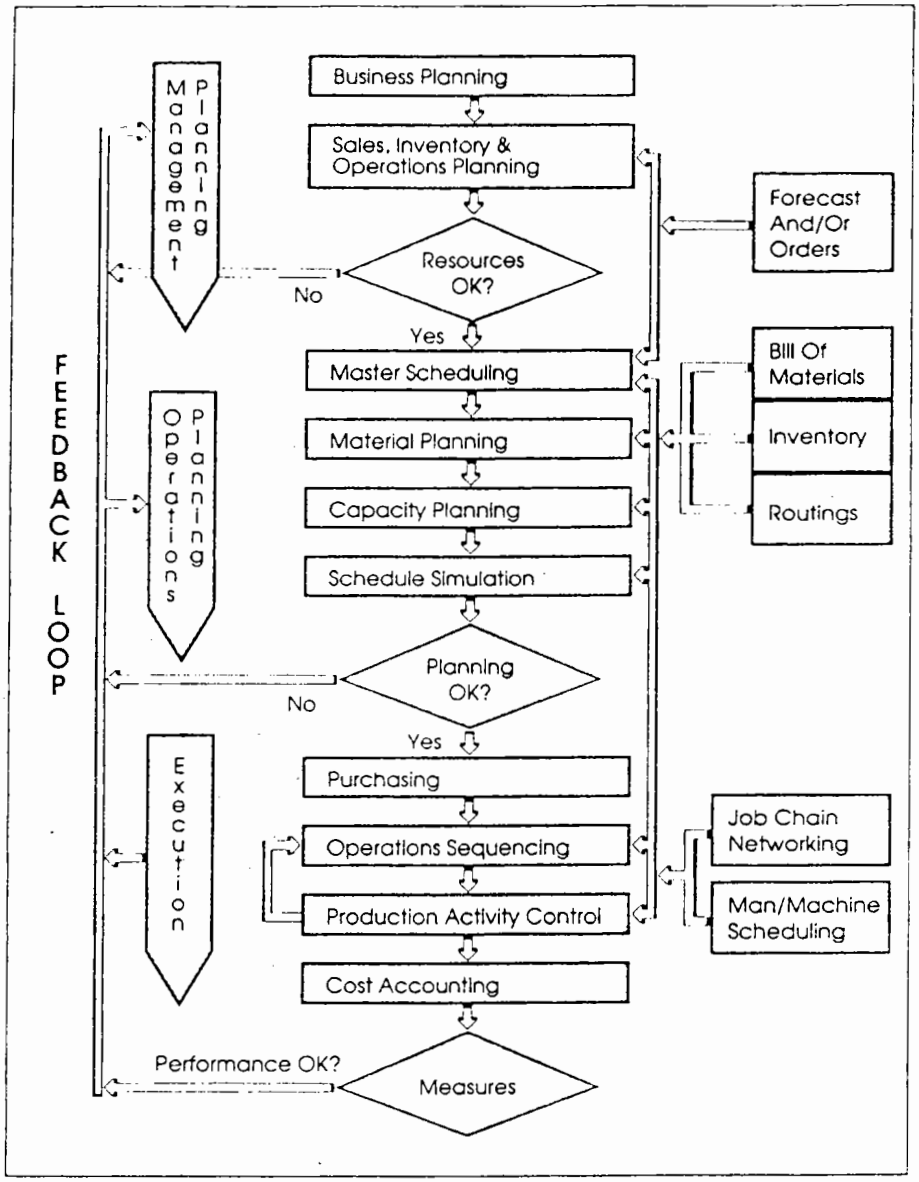


***Figure 1**. Enhanced closed-loop manufacturing control system.*

overly simplistic approach of finite forward scheduling jobs in the sequence they are introduced for scheduling will allocate capacity without considering the priority of the jobs. The more complex the product and process environment, the more difficult the problems become using finite forward scheduling, or infinite, for that matter. One major difficulty caused by "automatic in sequence" finite scheduling is that it does not consider job priorities or the job chain when allocating capacity. The illogic of this approach is easily understood with the example of two jobs in sequence for the same capacity requirements. The first job is to replenish inventory and the second is to fill a customer order for immediate shipment. Certainly, the second job should receive a higher priority than the first; however, prioritization rules do not always exist or work effectively in finite forward scheduling systems.

Consider a second example that justifies the need for a prioritization system. In this case, there are multiple customer orders of differing sales values simultaneously competing for multiple resources. More complicating for sure, but add another factor, such as 'not all customers are created equal,' which makes preferential treatment a certainty, and the case for prioritization is more evident.

Bottleneck scheduling

Production bottlenecks are constraining resources that are *currently* needed to produce saleable product. These control points for material flow limit manufacturing output. The fact is, you cannot produce more saleable product than the bottlenecks will allow. Bottlenecks are not always at the same work center, usually as a result of the variability in queues. If a bottleneck operation is not producing:

- Through-put is reduced,
- Cycle times increase,
- Cash flow will be reduced,
- Queues start to shift up and down,
- WIP inventories inflate,
- Production flow is interrupted,
- Output is increased via expediting at non-bottleneck in response to chaotic operations, and
- More meetings, telephone calls and information searching are necessary.

Although this is not an exhaustive list of the problems bottlenecks can cause, the list illustrates the importance of having the capability to flow-schedule production at the rate a bottleneck will allow.

Operations sequencing

Operations sequencing is a computer simulation of what is likely to happen, in terms of output, on the shop floor considering planned and released orders, staffing and machine availability. With computer processing power of much less concern today than in the past, simulation of resource availability has become an important tool for production scheduling.

The addition of operations sequencing as a production simulation scheduling tool provides doable pull scheduling of priority operations. Operations sequencing works by calculating the production sequence priority of all jobs, considering material and capacity availability. The actual sequencing of jobs in production is performed by forward scheduling the highest priority job in the next available work center. Then, the next highest priority job is scheduled,

and so on, until everything is scheduled. *Actual* queue is calculated and used for lead time in the process. Then, the system is run again for the next shift or day. The output provides for scheduling adjustments to maximize on-time throughput with shorter cycles.

The effect of pulling through the factory what *should and can be made* results in flow scheduling to the bottlenecks, shorter cycle times, increased on-time performance, reduced work-in-process inventory and better overall control of factory resources.

Synchronizing the schedule

The approach used in "standard MRP" for detailed operation by operation scheduling *assumes* that all work will be completed by the scheduled receipt date. Even though establishing the scheduled receipt dates takes place during MRP processing, the prioritization logic assumes work completion will occur by the end of the fixed lead time. During the scheduling and rescheduling process, MRP systems do not recognize the need to synchronize the schedule dates of related dependent work orders based on material and capacity availability, as well as actual queues.

A requirement of a good production scheduling system is the ability to synchronize the job chain network. One important requirement for effective synchronized scheduling is that networked jobs are only scheduled to start based on projected and updated completion dates of related dependent jobs. Early identification of lower level jobs that are actually or projected to be late allows for corrective action to be taken in time for the entire job network to be kept on schedule.

Schedule problems often develop with related materials that are needed to complete the upper level job but the problem, and its cause, is not known until the upper level job is already late. Dependent jobs in a network must have a higher schedule completion priority than the parent item. If the priority of the parent item changes, then the priority of all related dependent jobs in the network must be changed and synchronized.

Once a dependent job in a network is a known schedule completion problem, the system should automatically report what parent items and sales orders will be impacted. The ability to predict impending schedule problems of lower level jobs and their impact on upper level jobs is invaluable. This requires a system networking capability that considers the dependency of job-to-job relationships and queues on the shop floor when scheduling and rescheduling jobs and committing resources.

Enhancing the closed loop

In Figure 1 we have incorporated a number of enhancements we think should be standard, such as Schedule Simulation, Operations Sequencing, Job Chain Networking and Man/Machine Scheduling.

The major improvement, as a result of the enhancements shown in Figure 1, is for a manufacturing control system to become truly capacity-sensitive and highly responsive to inevitable, rapid change on the shop floor. The old MRP approach of weekly or more frequent updating cannot keep up with short cycle, high velocity manufacturing. The enhanced approach described provides for a quick response planning and scheduling system. It makes no difference whether you manufacture to order and/or to stock—you need a production scheduling system that will actually work in managing capacity constraints.

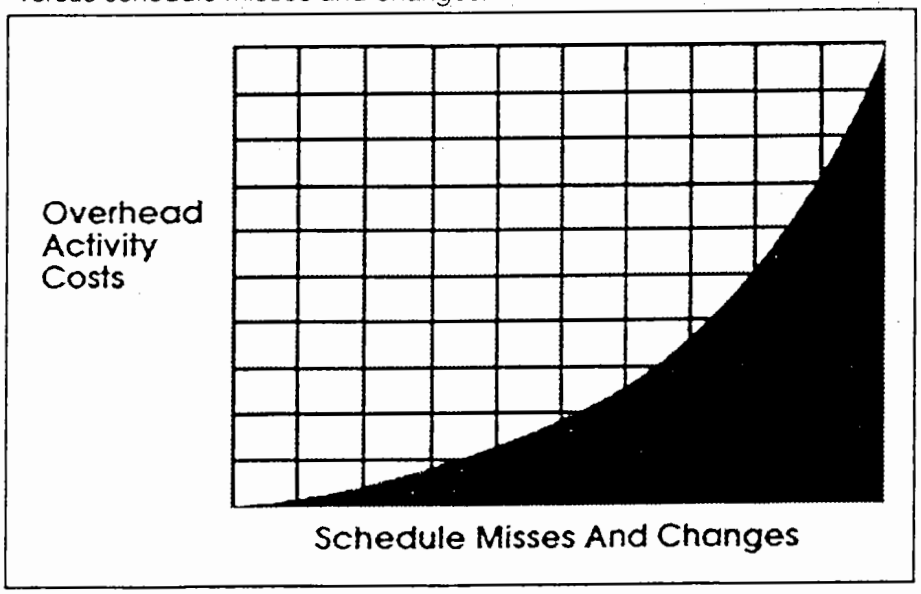
Users of MRP II systems do not have to scrap their systems. They need to enhance the system to meet the new generation of system capability. The new capability provides for a dynamic, fact-based approach that results in realistic production scheduling and capacity management.

Is it worth it?

The traditional approach to system justification should work when revamping your production scheduling and capacity management system. However, with a traditional system justification approach, you run the risk of putting a much needed manufacturing control improvement into a heap with all the other investment proposals that are competing for corporate funding. Certainly, improvements such as: 98 percent-plus on-time delivery to promise, a 25 percent-plus reduction in work-in-process and a 10 percent-plus increase in throughput would be more than enough for any executive to certify the system investment worthwhile.

Think for a moment about the potential of a 10 percent-plus increase in throughput. If overhead expense is fully covered (absorbed) at the current rate of output, then usually the only significant additional cost to manufacture is material. With cycle times significantly

***Figure 2**. Graphic representation of overhead activity cost behavior versus schedule misses and changes.*



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reduced and on-time delivery exceeding 98 percent, a potential increase in marketshare will result, according to most sales executives. If the increased output is truly saleable, then 30-50 percent of every sales dollar is increased profit because the only additional expense is direct material. This factor alone could be as much as a $500,000 profit increase for every $10 million of sales.

There are other valid justification viewpoints of a non-traditional nature to examine, as well. For example, a substantial amount of overhead activity costs are a direct result of poor schedule performance. Figure 2 is a graphic representation of "overhead activity cost behavior" versus "schedule misses and changes." This illustrates overhead activity costs increasing rapidly at a point where the number of schedule misses and changes exceed the organization's ability to effectively respond to schedule change. While these costs are buried by most accounting systems, the fact is they exist in a manner as represented by Figure 2.

To further the analysis of "overhead activity cost behavior" versus "schedule misses and changes," think about the true cost of expediting, which cascades down the financial statements. This is often an unseen and unknown cost for most manufacturers. Expediting, schedule misses and schedule changes have a costly ripple effect by inefficiently consuming resources which can be counted in missed shipments, lost sales, higher production costs and quality problems, among other things.

The question "Is it worth it?" is, in most cases, easy to answer with an overwhelming yes.

What about scheduling software?

There is no shortage of packaged software for finite scheduling, much of which has just been recently marketed. The problems associated with much of the packaged software are numerous. For example, some of the packages provide for finite scheduling only and others use fixed/non-varying queue times for scheduling. Some packages have so many different scheduling rules that many users are not sure which rule should be selected. The most critical issue in selecting software for enhanced production scheduling and capacity management is that the system can realistically simulate everyday conditions in a production environment that has more than a few part numbers and processes. This means the system must do a lot more than just finite scheduling.

The following list of 10 system attributes will help you pinpoint where your systems need strengthening in production scheduling and capacity management. This checklist must be used, of course, by people who, without question, understand the capabilities of the current system.

- System calculates expected lead time to assign accurate delivery dates to orders.
- Capability to quickly and accurately assess the time-phased load impact of a master production schedule on each work center.
- Capability to quickly and accurately assess where and when a bottleneck will occur and what orders will be effected.
- System calculates the schedule completion date for every order considering actual queue and available capacity.
- System continuously monitors every order in the master production schedule, comparing the predicted new completion date to the need date.
- Capability to automatically schedule work by management's priority preference.
- Automatically calculates and recalculates work priorities and predicts schedule completion based on the dependent network of purchase and manufacturing orders.
- System automatically develops short cycle flow schedules, calculating operation overlapping and minimum send-ahead quantities.
- System continuously monitors and reports status of every order and work center predicting delays in advance.
- System provides for quick "drill-down" capability to evaluate the specific details of predicted schedule misses for corrective action.

Getting improvement started

After getting accurate yes or no responses to current system capabilities, a highly focused assessment process should take place over a short period of time. This focused assessment process is intended to quickly evaluate what improvements are needed and what is the impact on overall business performance. The end product of this process should be a results-oriented action plan for measurable performance improvement that should begin immediately.

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