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An Introduction to:

Advanced Planning and Scheduling

Utilizing Advanced ERP Technology to increase profit margins for the Make and Engineer To Order Manufacturing Business

Introduction of Advanced Planning and Scheduling

Contents

Glossary of terms

Capable to Promise, (CTP)

Advanced Planning Scheduling, APS

Available-To-Promise, (ATP)

Bill of Materials, (BOM)

Capacity Resources Planning, (CRP)

Enterprise Resource Planning (ERP)

Finite Capacity Scheduling (FCS)

Master Production Schedule (MPS)

Material Req'ments Planning (MRP)

Rough Cut Capacity Planning (RCCP)

Infinite Planning and Scheduling (IPS)

Executive Summary

Commit now. Deliver on time.

This is the essence of Advanced Planning and Scheduling (APS) systems. These remarkable tools, when integrated with Enterprise Resource Planning (ERP) systems, add a new ability to effectively plan and manage manufacturing customers' requirements. With APS, a company can immediately determine the impact of a new or modified customer order and set a realistic ship date based on existing information and conditions. The company can commit now, promising the customer a ship date that is both realistic and obtainable. Because the guesswork is removed from the process, manufacturers are able to deliver on time as never before. Changes to Customers delivery dates and quantities are communicated in minutes rather than days. This is the value of CTP.

What's different? Traditional Material Requirements Planning (MRP) is restricted by the limits of the technology that existed at its inception. Though greatly improved over the years, its structure and some basic underlying assumptions prevent MRP from advancing beyond its current capabilities. Traditional MRP has served the manufacturing community well for three decades and some companies may find its capabilities still adequate for their needs. But many customer-driven environments can benefit greatly from the application of APS to their planning and scheduling needs.

APS evolved from basic MRP, master scheduling, resource/capacity planning and production scheduling tools through a series of technological advances and the application of sophisticated calculation methods. Advancing technology is the enabler for a radically new approach to planning and scheduling that provides a clear picture of the impact of schedule changes and management decisions— in minutes— making APS a true decision support tool for today's fast-paced and highly competitive world. APS is not a replacement for ERP. APS replaces the planning applications within ERP and leverages the ERP transaction handling and order management (execution) capabilities.

The economic value of APS lies in its ability to manage the planning and scheduling conflicts created by a customer-driven manufacturing organization. Companies utilizing APS are recognizing that "whatever it takes manufacturing" can be accomplished without adding manpower, inventory or capital expenditures. Indeed, APS can make most every manufacturer a very profitable and a more competitive business strategy.

Introduction

The term Advanced Planning Systems (APS) has only recently been applied to a category of software that performs the planning function within a manufacturing management application suite such as Manufacturing Resources Planning or now known as ERP. APS represents a fundamental departure from traditional planning methods. The current accepted method of planning in most manufacturing plants around the world is Material Requirements Planning (MRP).

Before computerization, inventory replenishment was based on some form of order point, in which material was ordered to replace what had been used. These simple methods were adequate in simpler times when shortages were tolerated, excess inventory prevailed and late shipments were a routine occurrence. Computerized inventory and order point systems did not change the approach and offered only marginal improvement. During the 1960s, MRP changed the entire approach. It improved planning and scheduling by tying the acquisition of materials directly to customer orders and forecasts. By looking forward to expected need, rather than replacing past usage, MRP was able to lower inventory and reduce shortages at the same time; a real breakthrough.

MRP was the first technique devised to help manufacturers plan for the future, rather than react to the past by applying new algorithms, or calculations, to the materials replenishment problem. Thus, it was a major advancement and so successful that it became the definitive manufacturing planning methodology through the 1970s, 1980s and into the 1990s.

Still, there has been some measure of dissatisfaction with MRP throughout that time. While a large number of companies have been able to apply MRP and successfully manage inventories and schedules, others have found its logic limited and ineffective for their fast-changing businesses. Yet a number of attempts to supplant MRP have failed because none was able to provide even the limited applicability and effectiveness of MRP. Imperfect as it was, it was still the best solution available.

APS systems are now changing conventional wisdom and even manufacturing practices. They are evolving the planning function in many significant ways.

- APS plans materials and capacity simultaneously. The major shortcoming of MRP is that it plans material first, while assuming that plant and resource capacity will always be available (the “Infinite Loading” assumption). Separate capacity planning programs must validate the material plan. Because material planning and resource planning run serially—in a linear progression—any interaction or potential conflict is ignored. As a result, material planning can cause capacity problems which, when resolved, can invalidate the material plan. A circular logic is created. APS eliminates uncertainty and creates a valid, integrated production plan by planning materials and capacity simultaneously.
- APS is fast. An MRP “run” (recalculation) can take several hours to complete. Even with today’s more powerful processors, it is rare to find an MRP generation that is finished in less than two hours. In contrast, APS runs are frequently measured in minutes and sometimes in seconds.
- APS removes unrealistic planning assumptions. Because capacity is not considered during the material planning process of traditional MRP, lead time is assumed to be fixed and definable. Lead times are not fixed; they vary with load, product mix, resource availability changes and other factors. And because lead times vary widely, they cannot be predetermined and still generate a dynamic, accurate schedule. In contrast, APS systems match reality because they accommodate flexible lead times. They determine lead times on-the-fly by scheduling each production activity during the planning process.
- APS applies advanced logic. The MRP process is very straightforward and mathematically simplistic and logical: multiply, subtract, apply lot size rules and use a bit of date calculation. APS systems apply rules-based logic, optimization, heuristics, artificial intelligence and other modern-day methodologies to resolve order conflicts and production constraints. This more sophisticated logic can recognize conflicts and apply “reasoning” to resolve a problem using an array of options, much like a human being will consider many alternatives before deciding on the “best” solution. The resulting plan offers a realistic and holistic view of the dynamics of the plant floor and how they can be exploited to achieve the desired results.

Why is this significant? APS provides speed, accuracy and ultimately superior customer service. APS grants the ability to schedule an order or potential requirement on-the-spot. For the first time, manufacturers have a real-time decision support tool that makes it possible to quote shipment dates confidently based on a thorough analysis of the current situation—

the availability of real resources (people, machines, uncommitted capacity) and the demands of other orders and commitments. The ship date is not a guess arrived at using questionable assumptions. It is real, calculated using a realistic model of the plant, its resources and its other demands. Bottom line: APS enables manufacturers to commit now. The customer can be given a realistic ship date almost immediately. Furthermore, since the original promise date is based on an accurate assessment of all pertinent factors, it is very likely that the product will ship as promised— allowing manufacturers to deliver on time.

MRP's limitations are a product of the early Information Age; computer technology was not sufficient to handle any more than what MRP presented to it at the time. Even MRP's simplistic approach taxed the computers of its day with the regeneration of a plan often taking 20 or 30 hours to complete.

But times have changed and technology has advanced spectacularly. There is more computing power in the average laptop PC than could be had for millions of dollars in 1975. The mid-sized computers of today offer computational speed and memory capacity that was almost unimaginable ten years ago. The ready availability of such tremendous power opens the door to a world of computing possibilities.

The sophistication of mathematical models and algorithms has also grown, taking advantage of expanded computer resources. Match technical and mathematical advances with the development of new management theories and approaches and the stage is set for a new generation of business planning— Advanced Planning Systems.

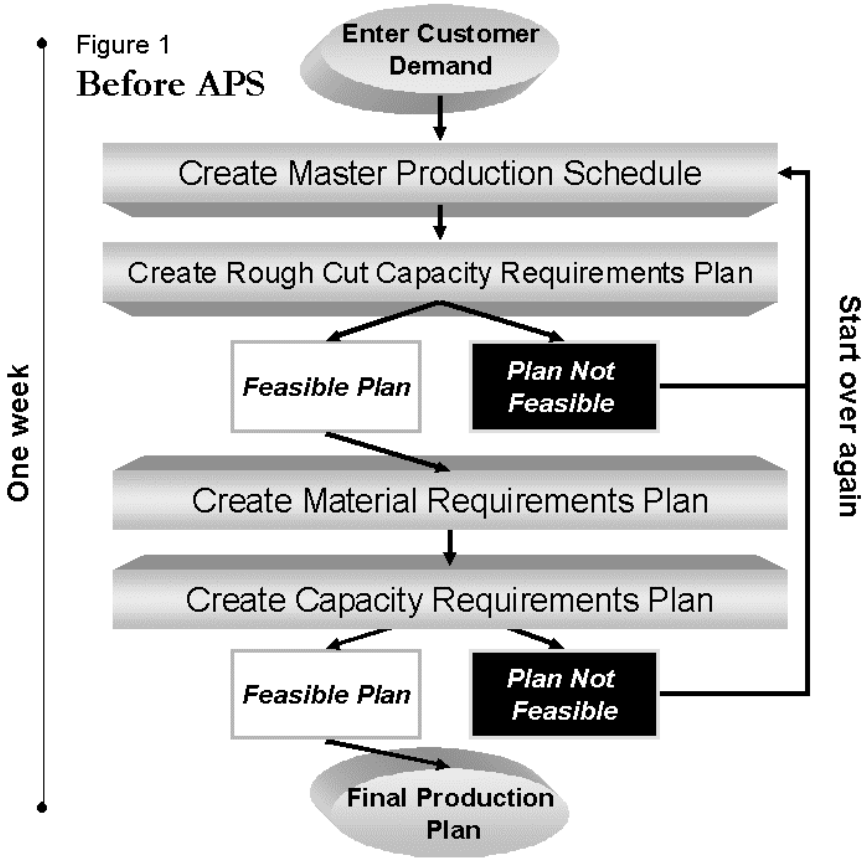
What Is APS?

Fundamentally, APS represents a radical change in the way material and resource planning is executed in a manufacturing company. Traditional planning, MRP, is a step-by-step, sequential process. Ideally, material is planned without regard to capacity constraints, then the capacity plan is devised and matched to the materials plan. But the process is often not as streamlined as the designers intended. The MRP sequence encompasses multiple steps (Figure 1):

1. Enter Customer Demand— consolidate demand requirements, then
2. Create a Master Production Schedule (MPS)— develop a first-cut production schedule, then
3. Create a Rough Cut Capacity Plan (RCCP)— test the production schedule for feasibility against available plant capacity prior to gauging the materials available.

4. Validate— determine whether or not the RCCP plan is feasible and start over again if capacity is in question. Make adjustments, retest the production schedule and rough capacity plan, evaluate feasibility and if finally acceptable, then create a Material Requirements Plan— once a realistic production schedule and rough capacity plan are finally derived, create a detailed materials plan to determine the feasibility for all levels of the Bill of Materials (BOM), then
5. Create a Capacity Requirements Plan (CRP)— once the materials plan is developed, develop the capacity plan, then
6. Validate— check once again for feasibility and adjust as necessary if material and capacity plans are inadequate, start over again at the beginning with the Master Production Schedule; make adjustments, retest, and if entire process is finally acceptable, then
7. Create the Final Production Plan.

MRP, as you can see, is a top-down, single-direction, and sequential process involving many potential restarts prior to resolving the final plan. During this often lengthy process, adjustments made to accommodate capacity problems may cause material problems and vice-versa. It is sometimes necessary to cycle through this process several times before a complete, balanced plan results. Time and resource limitations often leave the planning process incomplete or not fully resolved.

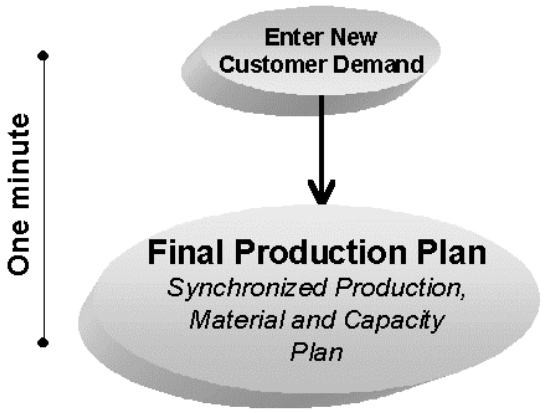


Before APS, planning and scheduling required a lengthy, circular combination of starts, tests and restarts.

APS, by contrast, plans all material and capacity resources at the same time. Each step of the planning process and each level of the Bill of Materials is planned simultaneously and completely.
Stated in the same terms as the MRP example on the previous page, the APS process is designed as follows (Figure 2):

1. Enter New Customer Demand— capture demand information and define the resources, constraints and priorities (rules), then
2. Create the Final Production Plan— generate a realistic, fully synchronized production, material and capacity plan by simultaneously calculating material requirements, testing resource availability and gauging capacity resources.

Figure 2
With APS



A generation apart from MRP, Advanced Planning and Scheduling permits one-step planning with all the previous MRP steps conducted simultaneously and transparently.

APS uses a Finite Capacity or constraint-based approach, meaning the plan will not over-commit manufacturing resources beyond available capacity. Because resources are planned at the same time as materials, there is no need to make unjustified assumptions about resource availability. Each activity is fully planned and coordinated with other demands on work centers, people, machines, etc. to generate schedules that are based on reality, not based on fixed lead time estimates and cavalier assumptions about resource availability. Flexible, not static, data is used to build the plan.

APS is fast. Exploiting recent advances in computer technology, the APS planning cycle is typically carried out immediately— and measured in minutes or even seconds— as opposed to being generated slowly and after business hours or over the weekend. The significance of this point is that planning now becomes a decision support tool, not simply a reporting tool. Resource availability questions can be answered, alternatives immediately explored, and the impact of disruptions— and your proposed solutions— can be identified without delay.

Where Did APS Come From?

APS grew out of the convergence of two movements:

1. A pressing need within certain segments of the manufacturing community for more sophisticated tools to schedule the plant, determine realistic ship dates and manage in a rapidly changing environment in order to better respond to customer demands.
2. The increased application of sophisticated technologies from mathematical disciplines (calculation methodologies and algorithms) to the manufacturing planning problem, enabled by the ready availability of dramatically increased computing power.

First Came Finite Capacity Scheduling (FCS)

The evolution of APS has its roots at the plant floor end of the process with solutions which addressed the challenges of production scheduling. The schedules developed by MRP often rely on capacity that is, in reality, not available. Capacity Requirements Planning (CRP) offers visibility but relies on human judgment to resolve any load-versus-capacity mismatch. MRP uses “standard” lead times for planning the production of manufactured items. These lead times are loaded into the data files by the users and should represent a “typical” length of time required to make the item. These lead times are fixed or, at best, have a variable component related to order size.

Real lead times, however, are not constant; they vary with shop loading, priorities, availability of equipment and personnel and a number of other factors. Unfortunately, MRP cannot know any of these conditions so it must rely on the “standard” lead times.

After the material-based plan is complete, CRP calculates the resulting shop load for each day at each work center. The user then identifies situations where the schedule requirements exceed capacity and manually resolves them one-by-one. This is an iterative process because changes that resolve one work center’s overload may result in an overload (or scarcity of work) elsewhere. Sometimes it is also necessary to revise the material plan to ensure that it, also, is still valid.

Finite Capacity Scheduling (FCS) systems brought rules-based logic to the scheduling problem along with the computer’s growing ability to coordinate numerous related flows and calculations. Hundreds of computer-generated iterations can be completed in less time than a human can complete one, resulting in fast, fair and balanced plant

schedules and an increased ability to meet customer commitments. FCS success stories cite benefits as increased efficiency (better use of available resources), reduced lead time (fewer disruptions, less congestion) and increased on-time performance. Yet, just as MRP focused solely on creating the best materials plan, FCS worked solely to solve the capacity problem. Each was still a standalone system.

Fast MRP

The second major breakthrough in the evolution of APS was "Fast MRP," a technological advancement rather than a conceptual one. Fast MRP systems employ conventional MRP logic while exploiting the processing speed and abundant memory of modern computers to accomplish the planning process in a few minutes rather than many hours.

Initially deployed using UNIX Workstations and later, high performance PCs, the Fast MRP systems were designed to load all program logic and the entire database into the system's memory, where the calculation could proceed at the speed of the processor— uninhibited by slow read-write chores to-and-from disk drives. Fast MRP introduced the concept using a separate processor (application server in today's parlance) strictly for planning calculations.

Fast MRP provided decision support; users could try various scenarios and "what if" cases, comparing the results of any number of "runs" within a short period of time. Thus, if a customer called and asked "Can manufacturers do this by…" or "How soon can manufacturers…" the Fast MRP tool could provide an answer within minutes.
After deciding on the best scenario, the changes would then need to be made in the operational system because Fast MRP was not integrated. The MRP system's planning files were downloaded to the Fast MRP system where they were processed in a clone or shadow environment. Later, some Fast MRPs were redesigned to upload the new plan back to the main system. The processing was still separate, however, and only connected to the operational system on a batch load basis.

New Thinking

The final piece of the puzzle fell into place with the introduction of artificial intelligence, rules-based logic and heuristics, to the overall planning process. Advanced Planning and Scheduling combines the critical reality of finite capacity, the technical achievement of memory-resident fast

planning and the latest thinking and advanced logic to create a new standard for planning.

APS applies these new approaches to the full planning process from the top-level Master Schedule right down to the sequence of products that run on a given machine and what time they should be started and completed. APS plans each requirement and develops each schedule in conjunction with every other requirement and schedule. The outcome is a plan that can be managed and executed. These capabilities let manufacturers confidently promise a delivery date to the customer.
APS reduces or eliminates schedule disruptions, unnecessary delays, excess Work-In-Process (WIP) inventory and expediting. The consequent increased visibility and knowledge allow the company to control the plant schedule better and significantly reduce lead and cycle times. The enterprise will know in advance which products will be run when and have full confidence that the production plan falls within available resources.
Nothing said here is meant to take away from the tremendous contribution of MRP to the manufacturing community. For three decades, MRP was the best tool available for coordinating resources and scheduling material acquisition and production. But just as the prop plane has given way to the jet, and networks of thousands of tiny but powerful processors are replacing water-cooled mainframe computers, MRP must make way for its heir and logical successor. But prop planes still serve the short-haul market very effectively and the mainframe is far from retired.

Likewise, MRP has a long and useful life ahead in applications where capacity constraints are not critical nor order fulfillment cycles flexible. But as customers demand tighter bonding with and expect flawless service from manufacturers, the planning horizon demands the powerful toolset and technology advantage that Advanced Planning and Scheduling can provide.

The Value of APS

Deliver a customized solution and deliver it faster than the competition. These are the key manufacturing principles for the new milioum. Product quality has become a given. Cost leadership has been driven down to fractions of product cost. International competition is commonplace. Real differentiation is tough. It can no longer be derived from a set of common practices or industry standards. Differentiation is dynamic. It means something unique for each and every customer. Competitive differentiation in today's markets can best be summarized as doing whatever it takes to satisfy each customer, every time. Stated more succinctly, differentiation means doing whatever it takes. But at what cost?

The cost of "whatever it takes"

Whatever it takes is a great marketing proclamation, but it results with very expensive manufacturing. The cost of creating customized orders and accelerating delivery dates can be substantial. We don't have to look too hard to identify the substantial cost for doing whatever it takes business. Confusion on the plant floor, accelerating product costs, and alternating product shortages and product stockpiles top the list.

Manufacturers who hope to succeed at whatever it takes manufacturing must put methods in place to manage demand-driven manufacturing. Yet with traditional manufacturing approaches, this can translate into a list of costly requirements:

- Increased manpower cost to expedite the increasing number of rush orders and rush quotations and customer estimates.
- Increased overtime to meet shorter and shorter delivery cycles
- Increased safety stock inventory to ensure uninterrupted materials availability
- Increased work-in-process inventory to ensure smooth product flow
- Increased facility and equipment costs to respond to rush orders
- Increased obsolete inventory held to anticipate unfulfilled customer demand

Unfortunately, manufacturers can no longer choose whether or not to create "a whatever it takes" environment. They must choose between the methods available to get it done. Adding increasing manpower and inventory costs is obviously not a long-term answer. Adopting the new manufacturing techniques available with APS is the more appropriate and economically sustainable alternative.

The economic value of APS lies in its ability to manage the planning and scheduling conflicts created by a customer-driven manufacturing organization. APS recognizes that capital resources (machinery, tools, etc.) are fixed in the short term. Inventory moves and stockpiles grow based on the effective use of these fixed resources. Because most resources are fixed, each customer order must vie for its share.
Then, collisions occur. It is not uncommon to see orders— and inventory — stockpiled at a workstation waiting to be processed. It is not unusual to see expediters pushing rush orders through the bottleneck resources while other orders and inventory sit in the queue. And, it is not uncommon to see manufacturers create “stock” inventory to ensure that components are available to meet due dates. Thus, inventory grows.
However, APS’s superior planning techniques make it possible to create a steady flow of orders through fixed resources. By effectively managing when customer orders are “launched” in the factory, inventory can move much more effectively through the rigid resources. Orders are staged to adjust for collisions. Inventory is no longer stockpiled, expedited, or built in advance. APS mathematically analyzes the effect of each order in the factory on each and every other order in the factory— simultaneously. Then the APS production schedule creates a plan that minimizes conflict at each manufacturing operation and increases the product flow through the factory. The result: significant decreases in work in process inventory, expediting costs and “safety” stock inventory.
The resultant cost savings can be outstanding. According to Advanced Manufacturing Research (AMR), a leading manufacturing research and advisory group, companies which have utilized APS methods are achieving significant business benefits.

In 2004, AMR surveyed a number of companies about their experiences with the different APS products. The companies in the survey ranged from a $10 million industrial products division using APS to a $16 billion tobacco company using APS across all plants. The results were overwhelmingly positive. Many reported significant improvements in planning cycle time.

One capital equipment manufacturer reported that after implementing APS, its ability to meet delivery commitments increased to 99.9 percent. A glass manufacturer using APS reported that Available-To-Promise (ATP) response time improved from two days to four seconds. An assembler of printed circuit boards using APS software reported that the time to make schedule changes went from days and weeks to just seconds and minutes.

In a report released in March 2005, AMR found that ROI payback for APS was usually achieved in three to six months. An electronics distributor projected an $8 million inventory savings, but achieved a $50 million savings in less than one year. Some manufacturers credited APS with essentially saving their business as customer service levels had deteriorated to dangerous levels. In several cases, customer service levels increased from 40 percent to more than 85 percent over several months.

Companies utilizing APS are recognizing that whatever it takes manufacturing can be accomplished without increased manpower or inventory growth. They are learning to do more with less! Many are drastically reducing inventory and manpower and improving business metrics. APS can make “whatever it takes” a very profitable and competitive business strategy.

The Power to Commit

Companies that benefit the most from APS and the resultant CTP technology are those facing intense competition, particularly where customers demand short lead times and plant capacity is a constraint. Make to order and Engineer to Order manufacturers environments benefit where:

- Dynamic environment: lots of customer orders, many with short lead times; constant changing of the plant schedule to accommodate fluctuating customer demand
- Rapid response build-to-order or configure-to-order situations
- Capital intensive industries, in which idle machinery and equipment can be costly
- Situations in which one or a few critical resources control plant throughput— and all plant schedules must be coordinated around these constraining resources
- Continuous run manufacturing where run sequence is important (changeover time varies depending on which product is run before and after the change)
- “Campaign” production situations where products are grouped to run together according to a predetermined constraint (i.e., all 5 inch diameter parts items run on Tuesday, all odd size casting run on the Thursday)

Deploying APS

Advanced Planning and Scheduling software is the planning engine that will likely change the theories and practices of manufacturing more profoundly than any other advancement in the last 20 years. It will do this not only because of the power of its capabilities but because it can actually be deployed within current manufacturing business systems. It works with ERP. It offers new capabilities to replace the planning portions of ERP: MRP, Master Scheduling, Capacity Planning (at all levels) and plant-floor scheduling systems. The remaining ERP applications continue to provide data management, transaction processing, order management (customer orders, work order reporting and tracking, purchase order control), forecasting and analysis and reporting functions.

APS is a planning engine and a business support system which cannot operate in a vacuum. It must be fed with basic data including Bills of Material, routings and inventory availability. The planning engine also needs to know about current activities— on-going production activities, order/schedule status— in order to create a plan that is as up-to-date and realistic as possible. In other words, the planning engine must be integrated with the operational parts of the manufacturer's business system. The actual production information already exists in ERP; therefore integration is the answer. Integration, in this sense, means simply that APS is tied into the ERP database and can access its current information. It is important for APS to be tightly integrated with these remaining ERP functions— and given on-line access to real-time information. It would be self defeating to implement a state-of-the-art real-time scheduling and planning system only to blind it with batch updates of the vital data that it needs to do its work. The real value of APS comes from its ability to map current plant floor information with requested changes and additions. Integration and interaction creates the value. Therefore, integration works in the other direction as well. As new plans are developed, they must be made available to the operations areas so that they can be carried out. This two-way exchange of information forms a closed-loop system that is every bit as vital to APS as it has always been to the engines of MRP and ERP.

In conclusion, when a manufacturing company's planning and execution are in sync using Advanced Planning and Scheduling, the resultant increase in business efficiency, customer retention, sales revenue and long-run profitability are radically increased.

About The Author

Daniel Williams is a Manufacturing Management Consultant, author, educator and frequent speaker at regional and national business meetings and conferences. He has worked with manufacturing companies of all sizes, in all industry areas, helping them select, implement, understand and benefit from information management systems such as CRM, ERP, APS, MES and related technologies.

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Dan has worked with ERP suppliers and their customers that are both Tier I and Mid- sized, from start up to 8BB in annual sales.

He is certified in Production and Inventory Management (CPIM) and holds a Bachelors of Science degree in Business Administration from the University of Kentucky.