The benefits of advanced planning and scheduling systems

Integrating software can improve manufacturing, supply chain processes

By Steve Greene

Advanced planning and scheduling (APS) systems are manufacturing management software programs that simultaneously plan and schedule production based on available materials, labor and enterprise capacity. The five primary components of APS systems are demand planning, production planning, production scheduling, distribution planning and transportation planning. With this broad scope, APS can realistically simulate production and distribution throughput so more thorough and feasible plans can be executed.

APS systems, developed in the 1990s, balance product demand, facility capacity and operational constraints. Given these times of business uncertainty, including supply chain shortages, geopolitical conflicts and the lingering impacts of COVID-19, APS systems provide managers with valuable tools that support decision-making about future, dynamic demand.

Earlier legacy production planning and scheduling systems, such as material requirements planning (MRP), use a step-by-step procedure to allocate material and production capacity. Although this procedure is simple, it does not readily adapt to changes in demand, capacity or material availability. Materials and capacity are planned separately under MRP. Further, many of these legacy systems do not consider material or capacity constraints, which leads to infeasible production plans.

A main APS system advantage over a legacy planning system is it can provide alternative scenarios to make and deliver goods in the supply network. By providing multiple scenarios for managers to consider, an APS system can prevent bottlenecks, note whether a master production schedule was optimal and show what a company can promise to customers.

An APS system also improved upon a legacy system as it can plan capacity at multiple sites, integrate production and logistics capacity analysis, and use both transactional and operational data. In addition, APS could operate on individual transactions, such as customer orders, without the batching characteristic of MRP.

How APS systems work

APS systems use advanced mathematics and logic to perform optimization and simulation. Their multiple scenarios can account for a wide range of constraints and business rules, such as finite capacity scheduling, sourcing, capital planning, resource planning, forecasting and demand management. Most APS systems allow the use of "what if?" simulations so managers can decide which option best meets their desired result, whether it is the fastest response, lowest cost, balanced production schedules or other objectives. Management then selects one scenario to use as the "official plan."

After establishing the official plan, APS systems generate related production and distribution schedules based on achievable operations within a set time period. These schedules note what should be produced, which materials to source, when and where production should occur and the sequence of processes that should be followed. APS uses various scheduling techniques to achieve the best throughput times. These techniques include finite capacity planning, constraint-based scheduling and forward and backward scheduling. Even further, APS can undo a schedule change if need be.

The scenarios, plans and schedules are based on input data from one or more business databases. These databases are known as enterprise resource planning (ERP) systems.

APS systems improve manufacturing agility and increase distribution efficiencies. When managers use it to its fullest extent, APS can (in no particular order):

- Improve customer service levels.
- Improve delivery times.
- Reduce or contain costs.
- Optimize inventory levels.
- Increase the accuracy of both lead time and safety stock.

Four-phase implementation of APS

The cost of an APS system is usually small with respect to a company's total process costs or potential increased throughput. To help realize the success of an APS system, consider a four-phase implementation outline:

Chartering phase. This phase includes the research and decisions leading to fund an APS system. Typical activities require planners to fully visualize the as-is and to-be states, analyze the related gaps, define the key performance indicators, make a strong business case, identify the project manager, approve an implementation budget and schedule and select an APS software package.

Project implementation phase. This phase includes the activities to prepare the production environment – to get the APS system up and running. Typical activities include model building, set up of internal data structures and databases, data migration, validation/testing, staff training and go-live production.

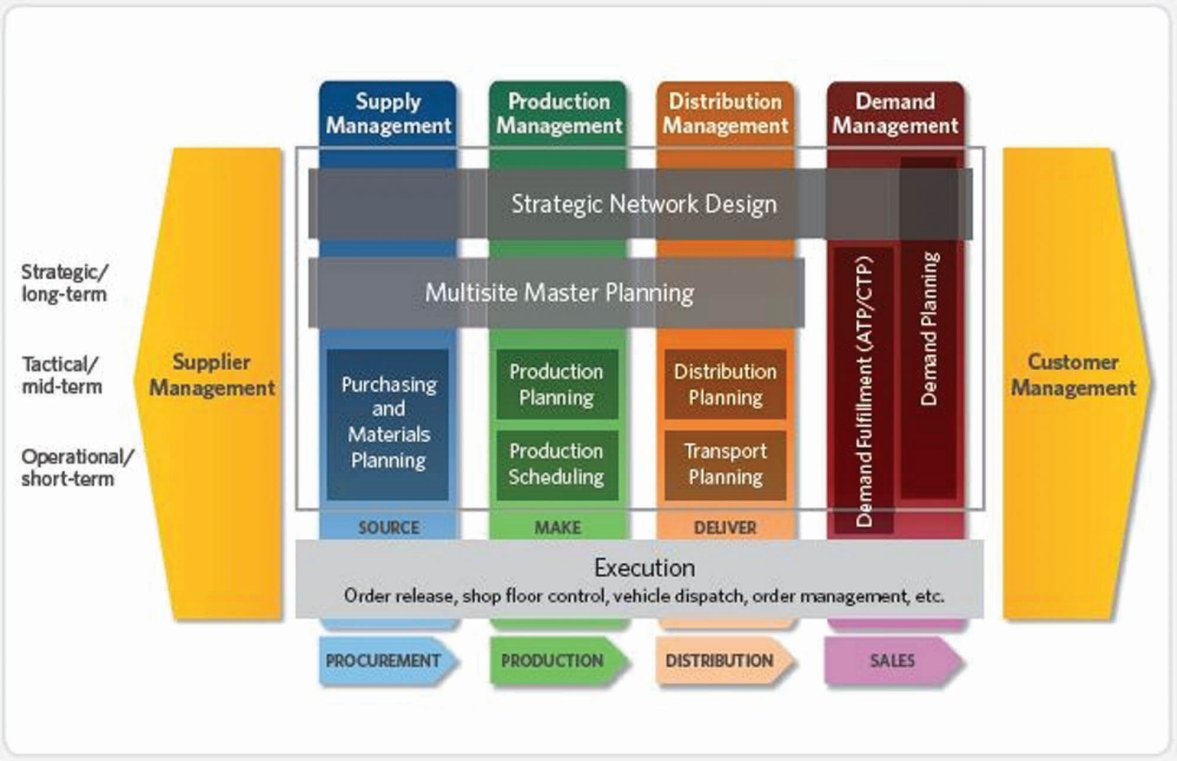
Shakedown phase. This phase is where a company comes to grips with the information system in normal operations. Typical activities include quality assurance tasks, the cleanup of data and parameters, working with vendors and consultants to resolve software bugs and additional training for system users, such as with business processes.

Onward and upward phase. This is the phase that continues from normal operations until the system has been upgraded or replaced. Typical activities include postimplementation audit, continuous business improvement, technical upgrades and additional end-user skill building.

FIGURE 1

APS system structure

How APS plans and schedules both supply chain and manufacturing efforts for different time structures. (Source: Martin Rudberg and Jim Thulin, "Centralized Supply Chain Master Planning Employing Advanced Planning Systems," *Production Planning & Control*, March 2009)



- Decrease throughput times.
- Show better utilization results.
- Improve sequencing for more efficient setups and changeovers.
- Better manage for trade-offs between conflicting objectives, such as mass customization and cost reductions.

APS plans and schedules both supply chain and manufacturing efforts during time periods that are long term (strategic planning such as supply chain network design); intermediate term (tactical planning such as optimizing the supply chain elements of production, distribution and inventory); and short term (operational planning such as demand forecasts, daily production, inventory and logistics). See Figure 1 for details.

More specifically, during the short-term operational time frame, the APS proposes ideal inventory and production levels to a forecast. APS subsequently helps planners to procure, produce and distribute available materials, labor and plant capacity, even across multiple network locations. Finally, APS allows planners to respond faster to disruptions on the shop floor and more quickly see the impact of their changes.

APS supports integrated business planning in these three time periods but does not itself execute actions or record transactions.

When and where an APS system is best used

An APS system is best used in production environments where products are complex, have frequent changes in customer requirements, have frequent schedule changes and/or have multiple market competitors.

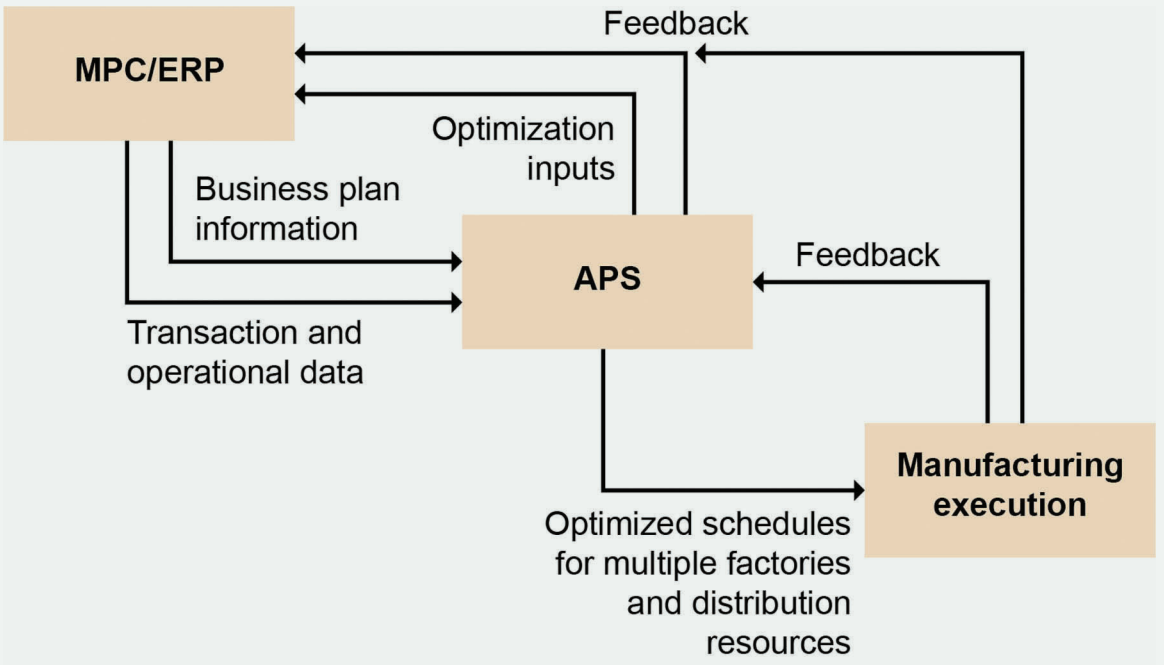
More specifically, an APS system is often used in one or more of the following production settings:

- Make-to-order and engineer-to-order manufacturing environments.
- Products that require many components or manufacturing tasks.
- Capital-intensive production processes, especially when and where plant capacity is constrained.
- Products that compete for capacity, i.e., different products are made in the same plant.
- Production that requires frequent schedule changes that cannot be predicted.
- Plants that need specialized labor, have excessive work-in-process (WIP) and/or have costly machine downtime.
- Complex distribution requirements planning (DRP) environments to fill dynamic market demand. (DRP is a function to determine when, where and how much inventory is needed at a distribution center or warehouse. It also helps in

FIGURE 2

APS process flow

The use of APS to synchronize the ERP and manufacturing execution system provides a company and its supply chain partners with a highly adaptive and responsive structure for manufacturing planning and control (MPC). (Source: APICS CPIM Part 2 Learning System)



determining which logistics resources are needed to replenish inventory).

While an ERP database focuses on managing resources, APS software focuses on managing constraints. APS complements the ERP by providing toolkits for production planning, capacity management and constraint resolution.

APS programs were developed to fill the performance gaps of ERP databases. These ERP gaps include little or no consideration of the capacity of external partners and suppliers, no creation or analysis of different production scenarios and low support for decision-making of future demand.

However, APS programs are not transactional systems. They need to be linked to the ERP, which fulfills the APS optimal plan and accompanying schedules. The ERP handles basic activities and transactions, such as customer orders, production-MRP, accounting, finances, logistics, materials, inventory and human resources, etc.

APS programs use system input data from an ERP database. This input data includes size of an order, order due date, available capacity, product type, process routine, process time, cycle time, setup time, yield, takt time, preventive maintenance, mean time to repair, mean time between failure and work-in-process. APS outputs, that are fed back into the ERP, include equipment loading, equipment utilization, line utilization, order release time and order start/finish time.

APS enables real-time decision support by integrating the ERP database with a company's manufacturing execution system (MES) software program that executes, monitors and controls the operations on the shop floor. It can detect and analyze actual constraints, such as machine capacity, efficiency and changeover time. (See Figure 2).

The use of APS to synchronize the ERP and MES provides a company and its supply chain partners with a highly adaptive and responsive planning, scheduling and control structure. This integration allows for rapid decision-making that improves production agility as it enables the use of real-time data, reduces manual work and automates data transfer.

This three-level software integration helps ensure production throughput is matched more closely to real demand by analyzing various planning possibilities across multiple touchpoints. This results in better production schedules with the right resources applied to the right orders at the right time.

The four APS modules

An APS software program has four primary modules that take input data from an ERP system, to provide production scenarios, an optimized plan and related schedules. (See Figure 3 on Page 42.)

The four APS modules and their functions are (in order):

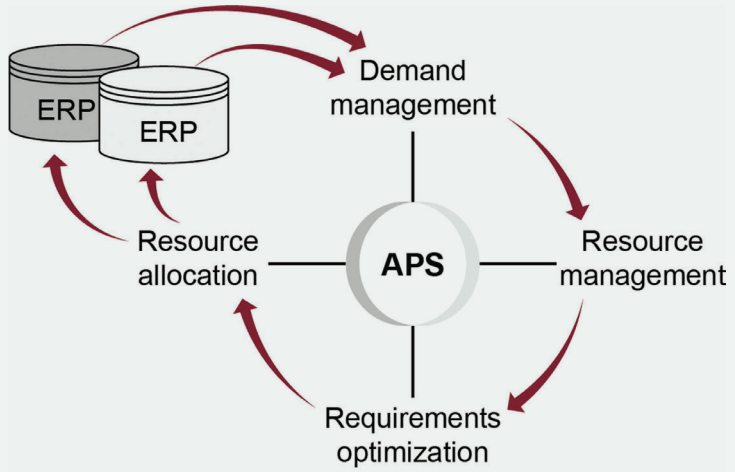
Demand management. Performs supply chain forecasting for production, logistics and transportation.

Resource management. Coordinates the capacities and constraints across the supply chain.

FIGURE 3

APS circular flow diagram

The four APS modules and their functions. (Source: APICS CSCP Learning Systems)



Requirements optimization. Generates multiple scenarios, evaluates multiple planning options, and recommends an ideal systemwide solution. Can also simulate the changes in demand, capacity, etc.

Resource allocation. Once a plan is approved, it sends requirements back to the ERP. It also provides sales and customer service decision support for order fulfillment – what a company can promise its customers, such as able-to-promise (ATP) or capable-to-promise (CTP).

The primary modules are also referred to as demand planning, network optimization, supply planning, factory scheduling and order promising. Whatever the names of the modules, they are typically independent pieces of software that satisfy different business needs. Although normally coded to be independent, they are designed to work together to optimize production and supply chain performance.

Measuring APS system success

Successful implementation of an APS software program depends on what makes a company unique in terms of its competitive position, production environment, production constraints, product complexity, operational needs, costs distribution and customer demands. At the outset of an APS implementation, it is important to fully understand both current business needs and the related performance metrics. In addition, performance monitoring should be done both before and after the APS implementation.

For example, if a company is running out of materials during production too often, then it should establish and monitor metrics to measure the frequency and impact of the shortages on the shop floor. If excessive WIP or long lead times are problems, then it can track process time and queue time. If managers must change schedules too often, they can record the time spent on their updates. If on-time shipments are a challenge, they can track due-date metrics.

Hard data on the financial value of APS systems is difficult to collect because managers rarely conduct controlled before-and-after measurements of an APS implementation. Most APS success stories have an anecdotal nature. For a ballpark estimate, the available data suggests that the estimated overall improvement using an APS system is 5% to 15%, as measured by a decrease in process costs and/or an increase in process throughput.

To achieve maximum capability, an APS system must be used in an effective business process where both the data used is accurate and APS schedules are executed with reasonable precision. To maintain consistent results, APS use should be repeated when business conditions change considerably. Many managers use ground rules to warrant when to rerun APS scenarios. Otherwise, slight changes in forecasting, production and shipments will likely cause "twitchiness" in the overall production system.

As an APS system can combine multiple ERP systems, it can help partnering companies progress into higher stages of supply chain development. In fact, the key use of APS is to help make sourcing and timing decisions when multiple facilities are available to provide the supply required to meet demand.

When ERP system input data is complete and accurate, APS provides each ERP system with timely requirements and best start dates. For example, APS systems deliver the ability to identify and well integrate supplier operations, which improves supply chain management by reducing the bullwhip effect, reducing system bottlenecks and enabling integrated business planning.

APS systems create holistic production and supply chain plans that range from strategic, aggregate planning to operational, detailed scheduling. When information is exchanged across multiple ERPs, the external supply chain is connected to the shop floor to improve production planning, scheduling and control processes. A company's supply chains can be many steps closer to enterprisewide optimization. ❖

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