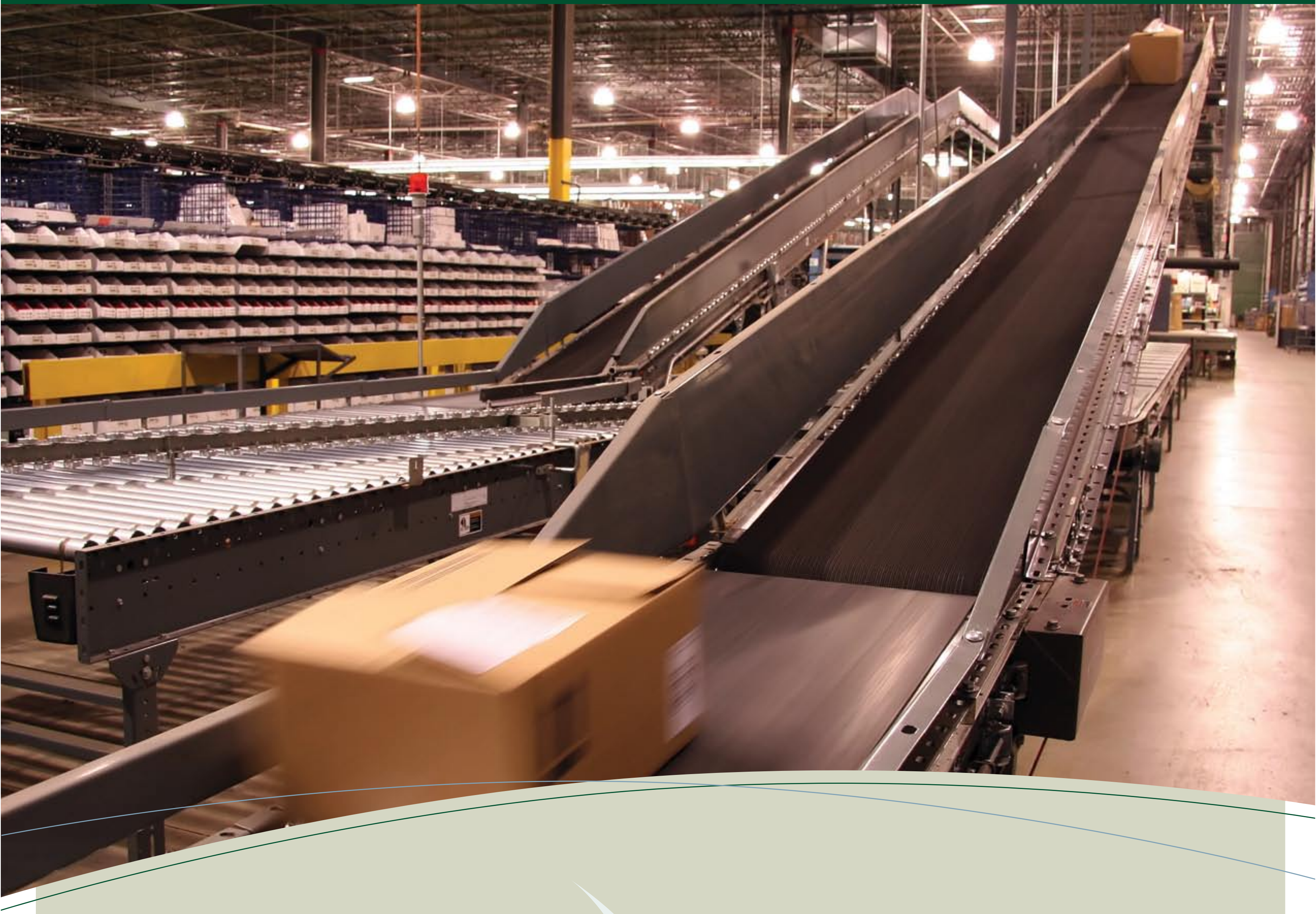


An Introduction to Advanced Planning and Scheduling Systems

SPINNAKER

DELIVERING SUPPLY CHAIN EXCELLENCE

ABSTRACT

Advanced Planning and Scheduling (APS) systems, also know as Supply Chain Planning (SCP) systems, are decision support software applications used by companies to improve supply chain performance. APS systems are usually implemented as add-on software that complements a company's transaction software system by providing advanced analytical and optimization functionality focused on improving supply chain planning. The purpose of this white paper is not to discuss the latest innovations in supply chain planning software but to provide an introduction to the use and functionality of the core APS tools that serve as the foundation of planning systems for best-in-class supply chain companies.

The paper begins by presenting some basic concepts useful in the discussion and understanding of APS software, then introduces the different modules of Demand Planning, Network Optimization, Supply Planning, and Factory Scheduling software that provide "core" APS functionality, discusses how these modules work together to solve strategic and tactical supply chain business problems, and finally provides detailed information about each core module. Benefits and challenges associated with implementing and integrating APS software are discussed throughout.

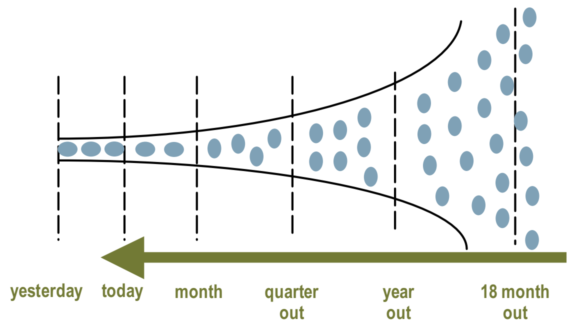
BASIC APS CONCEPTS

Before discussing the different Advanced Planning and Scheduling (APS) modules and the business processes supported by the tools, some APS and supply chain concepts will be presented that will be useful in understanding how APS tools approach supply chain problems.

Time in APS Software

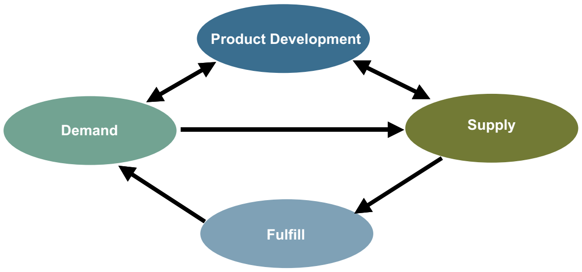
APS tools often work in what are called "time buckets", which define a period of time bucketed together with no detail as to what occurs within the bucket. For example, a demand planning (forecasting) tool could be configured to work in weekly buckets, meaning it would create a forecast of customer orders aggregated in weekly time buckets with no distinction as to which day of the week the forecasted demand is expected to fall on. While there is no formal distinction between the terms planning and scheduling, the term "planning" is most often used when time is modeled in buckets while "scheduling" is used when an exact time of day is also considered.

The APS framework stresses the ability to provide multi-horizon visibility. To do this, it provides the ability to aggregate and disaggregate data and plans across various time dimensions. Additionally, time buckets typically increase the further they get from the current period. This reduces the computation burden on the APS engines as well as buckets uncertainty growth over time.



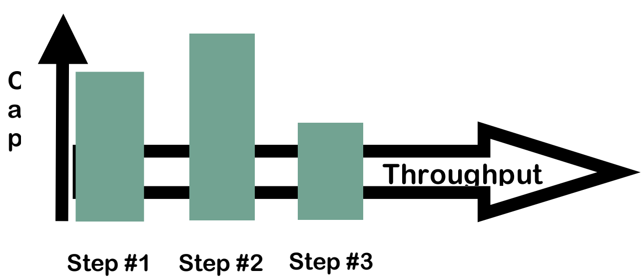
Concurrent Planning

Many parts of older planning frameworks break business processes into multiple steps which are performed separately and pieced together to generate feasible plans. For example, in the MRPII framework, requirements planning is separated from rough cut capacity planning and constrained planning. The APS approach combines these functions to combine a single source of truth in a supply plan. In addition, new product introduction, demand planning, supply planning, and fulfillment are tightly coupled to drive improved performance across these silo based business processes.



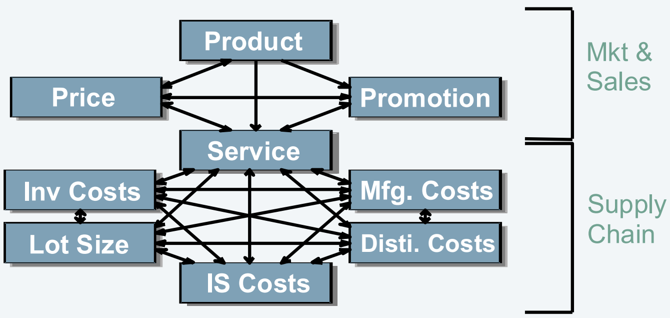
Constraint Management

The APS framework seeks the overall bottleneck to the supply chain system and models the throughput in the system to align with the limitations of this bottleneck. Modern day APS tools not only find the bottleneck but are design to handle situations where multiple bottlenecks exist as well as situations where the bottleneck changes location in the supply chain over time.



Global Optimization

Previous planning approaches usually generated local solutions to sub-processes which did not always combine to provide a good solution for the overall supply chain. APS based planning systems seek to drive global coordination and optimization of the demand and supply chains. While universal global optimization is not yet a reality, APS modeling techniques combined with increasingly faster computers have driven an explosion in global optimization within the past decade.



Collaboration

The APS framework extends the supply chain by providing methods to collaborate with both customers and vendors. By clearly defining business processes and information structures, companies are able to exchange information on a planning level much like EDI allowed companies to efficiently communication on the execution level.

Supply Chain Modeling

The foundation of any APS tool is a model of supply chain data that represents a company's operations. An example of a graphical supply chain model is shown in Figure #1 as a graph of nodes and arcs. In this case, the nodes depict plants, distribution centers, and customers. The arcs connect the nodes and represent potential transportation lanes from one node to another. Manufacturing operations at a single facility can easily be modeled in a similar fashion.

Depending on the supply chain being modeled and the purpose of the APS tool being used, the data included in the supply chain model will also define time buckets and other product, facility, manufacturing, distribution, and demand information necessary to analyze supply chain decisions.

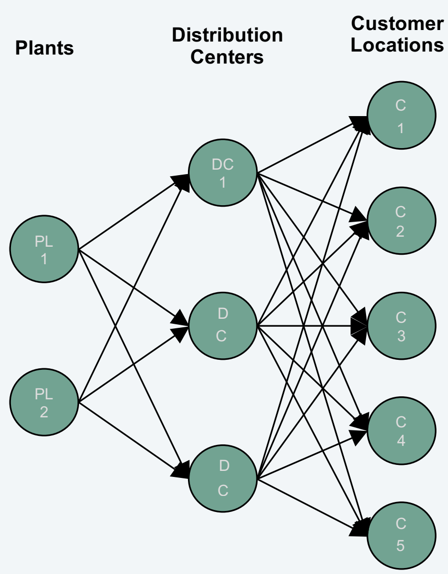


Figure #1–Supply Chain Model

From a processing standpoint, the APS tool will turn this information into a set of mathematical equations that describe the logical relationships that exist in the supply chain. Designing the data model and collecting the required information (or developing integration) is often one of the major tasks faced in implementing an APS solution.

APS Solvers

A significant advantage of APS tools over their predecessors in planning technology is the powerful mathematical solvers that allow APS tools to make intelligent supply chain planning decisions. The term "solve" is a loosely used one in the context of supply chain software, but depending on the problem being modeled, a variety of optimization, heuristic, and/or statistical methods may be applied to develop a solution.

Common statistical methods used by APS software include regression analysis, exponential smoothing, or Bayesian forecasting methods. Optimization methods often used include linear and integer programming. Many APS software vendors have also developed proprietary heuristics, which apply rules-based approaches to solving problems. Often, a combination of these different methods is used to capture the benefits of each.

APS Graphical User Interfaces

While the supply chain model and solvers provide the data and intelligence at the core of APS software, the graphical user interface (GUI) allows the software's users to interact with and interpret the information. These user interfaces, some examples of which are shown in Figure #2, utilize spreadsheet-like displays of information and may also provide graphs, Gantt charts, or pictorial representations of supply chain information. In addition to presenting information, user interfaces also provide data analysis functionality that can be used to quickly identify, diagnose, and solve problems that might occur and enhance the decision support functionality of APS software.

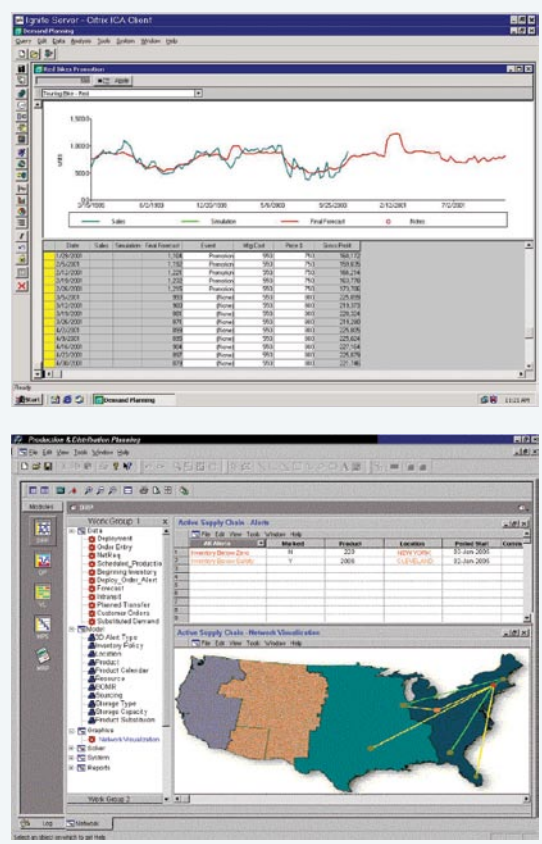


Figure #2 – Example APS GUIs

Core APS Modules

With the variety of software tools on the market that are considered supply chain applications, it is useful to start by defining what is meant by Advanced Planning and Scheduling and the different software modules that can be called "core" APS applications. Considering that APS can be defined differently depending on the software vendor, consultant, or manufacturer being asked, this categorization is not a rigid one, but as an introduction to the software it is useful to understand the software as it is typically deployed. In most full-suite APS scenarios, the primary modules involve are:

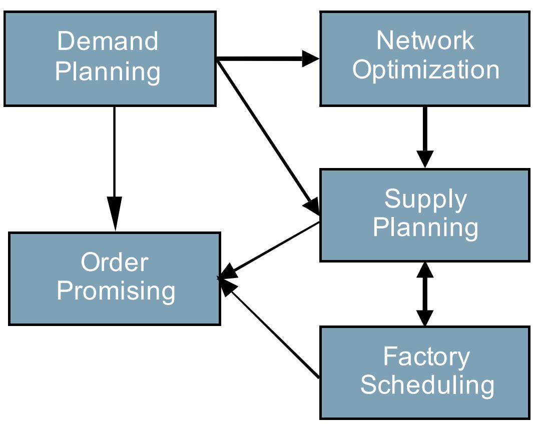
- Demand Planning
- Network Optimization
- Supply Planning
- Factory Scheduling
- Order Promising

These modules are typically independent pieces of software that satisfy different business needs, but are designed to work in concert to optimize supply chain performance.

HIGH-LEVEL DESIGN OF AN INTEGRATED APS SYSTEM

The typical configuration and flow of information between APS modules is depicted in Figure #3. In most cases, the systems are designed to use the same based supply chain model data, which is often managed in a company's ERP system and brought into the APS tools through integration software.

Figure #3 – Typical APS Information Flow



The starting point of an integrated APS solution is a Demand Planning (DP) module that is used to forecast future customer demand. Demand Planning tools typically create a forecast at the SKU/customer/ship-to level and also include product family hierarchy information to allow the forecast to be aggregated and disaggregated based on business needs.

Network Optimization modules use the forecast developed by a Demand Planning and a model of supply chain capacities and costs to make supply chain design or other long-term decisions. These decisions typically involve where to locate facilities, what modes of transportation to use, and long-term sourcing decisions. The output of this tool are network design and sourcing decisions that will provide the supply chain model to be optimized on a more tactical level by the Supply Planning tool.

Supply Planning tools develop daily or weekly supply plans that satisfy customer demand based on the supply chain model developed in the Network Design and a combination of the forecast from Demand Planning and true customer demand. In essence, Supply Planning software figures out how much product is needed when and where, and then determines a capacity-feasible and cost minimizing plan to provide the required supply. The result of this process is a distribution plan for movement of product between locations (often called "planned deployments") and manufacturing requirements (called "net requirements"). Typically, deployments and net requirements are determined in daily time buckets for a week or two early in the plan and then later in weekly or monthly time buckets.

Factory Scheduling software is used to take plant-level requirements from Supply Planning and develop a detailed schedule for manufacturing resources. Typically, companies that use Factory Scheduling tools are faced with either products that have a complex bill of material (BOM) and many manufacturing steps or manufacturing processes where sequencing and change-over time have an impact manufacturing throughput. The output from a Factory Scheduling tool is sequenced work orders by each manufacturing resource.

Order Promising translates customer requests into promise supply dates. Once promised, Order Promising engines monitor progress within the supply chain against this data and provide early warning signs of potential trouble with delivery. Most Order Promising modules contain one or more of the following capabilities: ATP (Available to Promise) where projected unconsumed availability is given to customers on a first-come, first-served basis, AATP (Allocated Available to Promise) where projected unconsumed availability is first allocated to demand streams or channels which are then allocate to individual demand, and/or CTP (Capable to Promise) where production plans are re-created in order to provide supply availability to demand requests.

IMPLEMENTING APS SOFTWARE: "BIG BANG" OR "BABY STEPS"?

While the integrated APS scenario presented in Figure #2 depicts how different APS software modules work together in a full-suite solution, in reality many companies choose to implement only some or one of the modules based on business needs. It is also common for companies to choose to implement a full suite but do so one module at a time.

In practice Demand Planning is the module most companies implement first. Logically speaking, sales drive supply chain decision-making and a supply chain planner must have an estimate of demand before using a Network Optimization or Supply Planning tool. Additionally, from a practical standpoint the data requirements for DP are usually less than for the other modules, making this tool an easy place to begin implementing APS.

Network Optimization models are also often implemented as stand-alone models. This topic is discussed in more detail in the detailed section of this paper about Network Optimization, but this is most common when the tool is used for strategic-level supply chain design.

For companies with relatively simple supply chains where there are few design or sourcing decisions to be made the Network Optimization application might be left out entirely and demand might flow directly into a Supply Planning model. In this case the Supply Planning tool can evaluate the alternate sourcing decisions usually modeled in a Network Optimization tool.

There are also cases where the daily bucketed net requirements from a Supply Planning tool are adequate to communicate production requirements to manufacturing – so no Factory Scheduling tool is used. This often occurs when sequencing is not important or the manufacturing staff can follow simple rules to order and execute daily production requirements.

It is also common to find Factory Scheduling software used without other APS supply planning tools in situations where few distributions options exist or the company just is not ready to implement an integrated Supply Planning solution. In this scenario, an individual plant scheduler will often maintain the Factory Scheduling model for his or her facility. Demand in the model might be received from a Demand Planning, ERP Order Management application, or can even be entered manually by the scheduler. Many of the original users of Factory Scheduling tools continue to use the software in this fashion.

As these cases indicate, there is no "one size fits all" approach to implementing APS software. An organization's needs, priorities, budget, and ability to accept change should be considered when choosing, designing, and implementing an APS solution.

APS MODULE DETAIL: DEMAND PLANNING

Demand Planning, or Forecasting, is the traditional starting point for a company considering an APS solution. These tools are used to developed unconstrained demand forecasts based on previous sales history and input from experts.

The Business Case for Demand Planning

The main business proposition of Demand Planning software is improved forecast accuracy. Improved forecast information translates into better decision making throughout the supply chain from high-level strategic planning and capital budgeting to facility-level staffing and capacity management. Improvements in forecast accuracy translate into direct dollar savings in inventory and facility costs but also can lead to top line revenue growth by helping a company meet demand or focus marketing dollars on high-growth opportunities.

Demand Planning Software and Business Practices

Best-in-class companies use a combination of historical sales information and business expert guidance to develop a sales forecast. To facilitate this process, APS Demand Planning applications provide both an automatically generated baseline forecast and a single repository where experts can modify the forecast based on additional information such as the output from a Sales and Operations Planning (S&OP) process. Demand Planning tools also facilitate the ability to measure forecast accuracy over time, which ultimately helps drive improvement of forecast accuracy over time.

Demand Planning Modeling

Demand Planning tools are typically based on a relational database storing historical sales information and other causal factors to be analyzed by the forecasting engine. One of the most important decisions made in the design of a Demand Planning system is what level of demand will be forecasted. While data availability or other considerations sometimes dictate otherwise, the ideal situation is that demand is forecasted at the lowest level possible – usually for each SKU for each ship-to location for each customer.

Data aggregation and disaggregation rules that allow a forecast to be sliced and diced as needed are important design factor in Demand Planning modeling. To illustrate, if a forecast is created at the SKU/customer/ship-to level, it might also be required to view or adjust the forecast rolled up to a product line or family, geographic region, plant or distribution center, or customer. To achieve this, rules and hierarchies for aggregation must be defined in the DP model.

Time buckets are another important design consideration. Statistical laws dictate that aggregated forecasts will always be more accurate than disaggregated forecasts, so for example a monthly forecast for a product family will be more accurate than a daily forecast for a SKU, but on the other hand a monthly forecast might not be useful from a planning perspective for a company with short manufacturing cycle times. Given the cyclicality in demand that often exists over the course of a week, most companies use weekly buckets for near-term planning.

Demand Planning Solution Methods

Demand Planning tools almost exclusively use statistical methods including variants of regression analysis, exponential smoothing, or Bayesian methods to analyze historical sales data and predict future sales. The advantage of these approaches versus manual forecasting techniques is that they are able to analyze large sets of data very quickly to predict sales trends (sustained increases or decreases in sales), seasonality (variations in sales based on the time of year), or cyclicality (variations in sales based on factors other than the time of year). The statistical methods also allow for outside causal factors that can influence a forecast, such as weather, to be modeled. The statistical methods aim to increase forecast accuracy and, while the input of experts is required to validate the results, the initial solution provides a valuable starting point in the demand planning process.

It is worth noting that the mathematical methods used by Demand Planning APS applications tend to be quite different from the optimization-based math used by other APS tools. This has historically resulted in vendors having particular strengths in either Demand or Supply focused APS applications. In recent years consolidation in the APS vendor market has resulted in most vendors selling both Demand and Supply tools. However as a result of this historical divide, while many companies try to implement a full-suite of APS software from one vendor, it is not uncommon to choose Demand Planning software from a different vendor than the rest of the APS solution.

APS MODULE DETAIL: NETWORK OPTIMIZATION

As the name implies, Network Optimization tools seek to optimize performance across an entire supply chain network. Depending on an organization's needs, these tools can be used either as an integrated part of an APS system or as a stand-alone application created solely to analyze supply chain design decisions.

Network Optimization Business Case

The potential savings from the use Network Design software is enormous – in some cases the payback period for a Network Design project can be a matter of months. Companies often find that revisiting their supply chain design decisions uncovers facility location or sourcing decisions that, if left unchanged, would have resulted in supply chain cost structures millions of dollars more expensive than they needed. Opening and closing facilities is not a trivial matter, but the use of Network Design software ensures that operational impact of such decisions are effectively analyzed.

Network Optimization Software and Business Processes: Integrated Scenario

In the scenario where integrated Network Optimization software is used, a company might use the tool to make decisions on sourcing and meeting seasonal demand. Sourcing decisions trade off plant, distribution center, and transportation costs and capacities to determine which facility or facilities should supply products to distribution centers and customers in order to minimize the cost of meeting demand. This type of Network Design model is useful for companies with large numbers of plants and distribution centers and therefore many possible sourcing options.

Integrated Network Optimization tools can also help meet seasonal demand optimally by evaluating trade-offs between options such as pre-building and holding inventory, adding more expensive surge manufacturing capacity, using non-standard seasonal sourcing, or using third-party contract manufacturing. In this scenario the software will provide pre-build inventory targets to manage the buildup of seasonal inventories.

In addition to the above uses, integrated Network Optimization tools are also often configured to perform the same type of "what-if" analysis described in the following section on stand-alone Network Optimization tools.

Network Optimization Software and Business Processes: Stand-Alone Scenario

Design decisions evaluated using a stand-alone Network Optimization models typically involve capital investment decisions related to manufacturing or distribution capacity. Often this type of analysis is performed as "what-if" analysis.

For this type of decision, a Network Optimization tool allows the customer to evaluate the trade-off between investments in fixed assets and reductions in variable costs. These types of decisions are often called Network Rationalization or Capital Asset Management analysis.

Network Optimization Modeling

Network Optimization tools typically model the entire supply chain and include forecast information; product and facility information; manufacturing, storage, and distribution rates, capacities, and costs.

While other APS tools almost always model a supply chain at the SKU/location level, this is not always the case for all Network Optimization models. While Integrated Network Optimization tools used to evaluate detailed sourcing to customer locations and location-specific inventory builds sometimes model individual SKUs and customer locations, many models to evaluate strategic decisions use aggregated data. Aggregated data is used because this a) reduces the difficulty of adding new plants, distribution centers, or demand for what-if scenarios and b) because aggregating data reduces model size and solve times therefore allowing what-if scenarios to be easily solved and evaluated.

Network Optimization Solution Methods

The optimization methods most often used to solve Network Optimization models include linear and integer programming methods. While methods to solve these type of mathematical programs have been available for many years, sufficient computing power to make the solution of these problems practical for the business community has become much cheaper in past 10-15 years and done much to spur the development of APS tools. In addition to optimization-based methods, many software vendors also use proprietary heuristics to complement optimization methods and improve solutions.

Other Network Design Considerations: User Interface and Reporting

The user interface and reporting features of network design tools are an important consideration when selecting a Network Optimization tool. The interface must allow a user to set up what-if scenarios, solve the scenarios, and then evaluate the results – ideally this should all be possible without IT support. Output reports should be user configurable to provide comparative data that can be used to develop business cases. In addition to numerical reports, network design tools also provide usually maps and graphical representations of the supply chain that illustrate different network configurations for presentation purposes.

APS MODULE DETAIL: SUPPLY PLANNING

Supply Planning software helps companies create day to day operating plans by modeling manufacturing and distribution constraints and creating a supply plan to satisfy expected demand. The results of a Supply Planning solve are a daily distribution plan for movement of product between locations ("planned deployments") and time-phased manufacturing production requirements ("net requirements").

Supply Planning Business Case

The ability to develop a supply plan that improves service and reduces costs is the primary objectives most Supply Planning implementations. However, with regards to the specific problems companies hope to solve by using a Supply Planning tool, different companies tend to implement Supply Planning software for different reasons. For some, developing a master production schedule for manufacturing is the primary challenge and distribution is an afterthought. For others, sourcing distribution center demand to manufacturing facilities or choosing transportation modes is the highest priority.

A common secondary motivation to implement Supply Planning software is the desire to develop standardized global planning processes and performance objectives across the entire supply chain. A successful Supply Planning implementation requires organizational and physical coordination across the different entities that manage the supply chain. Given this, many companies use this implementation as the impetuous to make strategic changes in the design and standard business processes of the supply chain planning organization.

Supply Planning Software and Business Processes

Supply Planning software can be fairly considered the "backbone" of an APS solution because this module bridges high-level strategic planning and day-to-day operations. While Supply Planning is probably the most difficult APS tool to implement, organizations that successfully do so have laid a strong foundation for best-in-class performance.

Operationally, the largest benefit of a Supply Planning application (and indeed any good decision support system) is that the software can effectively manage routine operations while allowing a planner to focus on exceptional circumstances, problems solving, and identifying area for improvement. In cases where capacity and inventory are available the software will automatically create a workable plan. However, when inventory, capacity, or other resources are not available the software will provide alerts that highlight problems and allow the planner to make intelligent trade-offs to meet business objectives – whether they be cost or customer service related. Often, premium production capacity (overtime) or premium transportation is available (albeit at a higher rate) and the planner can make the decision as to whether incurring the additional cost is necessary.

Supply Planning Modeling

At the network level, Supply Planning software uses a model similar to Network Optimization – often a pared down version of that model based Network Optimization sourcing decisions. This includes a sourcing matrix of all possible/desirable supply locations and manufacturing, storage, and transportation costs and capacities. Demand is typically combination of near-term customer orders and long-term forecast. At the level of the individual facility, the manufacturing model can consider of line-level capacities and product level routing requirements. Additionally, batch-sizing functionality is available to make sure that the deployments and net requirements generated by the Supply Planning tool reflect realistic quantities that can be used in execution.

Supply Planning Solution Methods

The methods used to solve Supply Planning problems differ with the problem being solved. Typically, optimization methods (linear or integer programming) similar to those used in Network Design form the basis for the solution and heuristics are used to modify the initial solution to reflect batch sizing or other business requirements.

Other Supply Planning Considerations: Multi-User Functionality

While other APS modules – Demand Planning, Network Optimization, and Factory Scheduling – often function as single user applications, Supply Planning software, as required by the business problems being addressed, is most often a multi-user tool. Roles are commonly divided up by facility, geography, or product line. To accommodate this, the software architecture must accommodate many users and be designed to allow users to make and evaluate changes within their scope of responsibility and also communicate changes to other users.

Other Supply Planning Considerations: ERP vs. APS Supply Planning Functionality

In many ways, Supply Planning is similar to familiar Distribution Requirements Planning (DRP), Master Production Scheduling (MPS), and Manufacturing Requirements Planning (MRP) functionality available in ERP systems. The similarity between these systems is that each calculates planned deployments and net requirements. But the approach to solving these problems is notably different.

In the ERP (or perhaps more correctly MRP II) world, a MPS or DRP plan is created and after creating the initial plan, inventory and resource availability are checked to ensure that the plan is feasible. If infeasible, a feedback loop provides this information to the schedulers so they can manually create a plan that will not violate constraints.

Supply Planning is a quantum leap forward in that the serial planning and capacity checking process of DRP, MPS, and MRP tools is replace by a single solve. Unlike the ERP functionality, the APS solve is able to evaluate alternative options and consider costs and capacities to develop a feasible cost-optimal supply plan without iterative steps.

Other Supply Planning Considerations: Vendor Functional Specialties

Just as companies implement Supply Planning software for different reasons, it is also the case that software functionality and the ability to model and solve different problems using Supply Planning applications varies in the software from different APS vendors. Some packages focus on manufacturing and have the ability to model detailed routings and line capacities for complex production processes. Others model manufacturing rather generically. Similar differences exist in distribution capabilities with some applications allowing modeling of different modes of transportation and carriers to be modeled while others do not. From an inventory management perspective, some packages include methods to calculate safety stock and reorder point quantities while other packages assume these numbers are provided as inputs. The important point is that choosing a Supply Planning software package requires a careful assessment of needs an even more careful evaluation of the functionality offered by each vendor.

APS MODULE DETAIL: FACTORY SCHEDULING

Factory Scheduling applications are used to model factory-level production constraints and develop detailed schedules for production lines.

Factory Scheduling Business Case

The business objective for companies who implement a Factory Scheduling solution is usually to either improve operational performance or to decrease the effort required to generate or modify a schedule. Improving performance usually means increasing throughput or decreasing work-in-process inventories and manufacturing cycle time. Decreasing the effort required to generate a schedule sometimes means head count reductions but more often results in freeing up scheduling personnel from the tedious tasks of creating a basic schedule to allow them to more time to evaluate and improve the schedule.

Factory Scheduling Software and Business Processes

As previously mentioned, Factory Scheduling software is most often used in situations where the sequencing of work orders on individual machines has a large impact on the feasibility of executing a schedule. For example, when changeovers are sequence dependent, sequencing work orders to minimize changeover time can effectively increase the capacity of manufacturing resources and allow a manufacturing organization to meet customer demand. In other situations where there are several stages of manufacturing and many subassemblies are required, Factory Scheduling software can be used to help ensure that these subassemblies are available on time without build-ups of costly work-in-progress (WIP) inventories.

From a business process perspective, the involved nature of factory scheduling means that companies often choose to physically locate schedulers at manufacturing locations. Whereas Supply Planners might publish a new solve as infrequently as once per week, Factory Schedulers typically make daily adjustments to the schedule to reflect the realities of the manufacturing shop floor. In addition to helping the scheduler develop the schedule, evaluate what-if scenarios, and make changes to the schedule on the fly, Factory Scheduling software often provides the side benefit of being a mechanism to communicate the schedule between plant and corporate supply chain personnel.

Factory Scheduling Modeling

Given the variety of manufacturing processes and problems that exist, Factory Scheduling models are often the most customized among the APS tools. From a modeling standpoint, the factory can be represented similarly to the supply chain model in Figure #1 except that the nodes represent machines and the arcs the flow of material between machines. Additional complexity in Factory Scheduling models arises from factors such as sequence dependent changeover times, physically constrained WIP inventory buffers, and alternate manufacturing for products. Include these factors with the requirement that subassemblies from previous steps in the manufacturing process must be available before a manufacturing process on a given machine can take place and the model can become incredibly complex.

Factory Scheduling Solution Methods

From a mathematical perspective, scheduling problems are incredibly challenging problems to solve. Sequencing problems, while easy to formulate, are hard enough to solve in isolation but the addition of batch sizing, routing and storage considerations as well as continuous time (no time buckets) makes manufacturing scheduling especially difficult.

To deal with these challenges the most common approach to solving scheduling problems is to use a combination of optimization and heuristic techniques that create feasible schedules that meet demand and seek to minimize costs. There is no such thing as an “optimal” factory schedule in the real world but Factory Scheduling models are typically designed to achieve changeover minimization, inventory reduction, and capacity utilization business objectives.

Given the variety of scheduling problems that exist and the complexity of the math involved, different software packages tend to be better at solving different scheduling issues. So, in reality, companies must often prioritize their requirements of scheduling software – for example sequencing considerations vs. multi-stage manufacturing modeling – and choose the Factory Scheduling tool that will provide the most benefit in supporting their business needs.

Other Factory Scheduling Considerations: Aligning Factory Scheduling and Manufacturing Execution

Beyond the plant design and physical constraints that exist, the Factory Scheduling model must also account for the production management system that will be used to execute the schedule. Ideally, the production management system will make the scheduler's job easier. Modeling and attempting to optimize the scheduling of complex manufacturing processes can be incredibly difficult and sometimes counter-productive, so in practice production management systems often seek ways to either eliminate the need to develop detailed schedules or at least reduce the challenge of the scheduling task. Two such systems will be briefly discussed.

Lean manufacturing is a well-known system attempts to simplify manufacturing processes, build flexibility and quick-changeover capabilities into the system so that sequencing become less of a concern, and use self-regulating inventory buffers to control production. In a lean environment, daily or weekly schedules are provided to manufacturing and simple business rules are used to order and execute these orders on the shop floor – so a detailed Factory Scheduling system is rarely used. This approach, while most effective in situations where the product mix is low and demand constant, nevertheless serves as a valuable reminder that sometimes, rather than optimizing a complex system, it is more effective to reduce system complexity.

The Theory of Constraints (TOC), a concept developed by Eli Goldratt and first discussed (although not named) in his book The Goal, is another noteworthy production management system. This system advocates developing a "drum buffer rope" system in which a capacity-constrained "bottleneck" machine is identified as the pacemaker of the entire manufacturing system and small inventory buffers are used to ensure product flows smoothly through the upstream and downstream production stages. In this case the scheduler must simply schedule the bottleneck operation and other upstream and downstream processes are scheduled based on the bottleneck.

APS MODULE DETAIL: ORDER PROMISING

Order Promising applications are used to generate and monitor projected delivery dates across products and customers.

Order Promising Business Case

At the core of a manufacturing/distribution company is the ability to satisfy customer demand with products and subsequently collect revenue.

The problem with simply handing projected supply out on a random or first come/first served basis is that all demand is not created equal. Some demands generate better revenue than others, some generate better margins, some belong to key customers or to strategic regions across the company's market.

Unfortunately, customers don't tend to form a line where the customers with the "best" demand are at the front of the line and the customers with the "worst" demand are at the back of the line. In addition, not all customers show up with their demand at the same time, forcing companies to make tradeoffs between satisfying short term demand vs. holding supply in the anticipation of future demand of "higher quality".

This is the business process which order promising modules seek to address. When utilized effectively, they can have significant impact on both profit and customer service. Although they cannot magically overcome a poor supply planning process, they certainly can take a solid supply plan and inefficiently match it to the market.

Order Promising Software and Business Processes

Modern day order promising modules serve three basic functions: they provide a mechanism to prioritize demand, they provide a mechanism to allocate supply based on this prioritization, and they keep a scorecard which alerts users when order are in danger of being satisfied late.

Prioritization can take many forms within order promising modules but a hierarchical structure is often used. Take a simple customer prioritization of a high priority vs. low priority customers. A common prioritization would allow the high priority customers access to the entire projected supply stream but restrict low priority customers to a subset of the projected supply stream, thereby preserving supply for high priority customers regardless of how much low priority demand arrives.

When considering not only a customer dimension but also product, geography, time and sales channels, the order promising priority hierarchy can become quite complicated.

Once a priority scheme is defined, the order promising engine seeks to make efficient use of the project supply stream within the bounds of the defined priorities. Very strict priorities can lead to "too much" supply left awaiting demand at the end of month or quarter while lenient priorities can leave the company with no supply left for top tier demand. Priorities are adjusted (most often relaxed) throughout the month or quarter as business conditions change and financial reporting boundaries approach.

CONCLUSION

This paper has provided a brief introduction to Advanced Planning and Scheduling software, discussed how this software helps solve supply chain management problems, and discussed some issues related to choosing, designing, and implementing APS software.

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