So What's the Big Deal with Chemicals?

Featured Author - Olin Thompson and PJ Jakovljevic - May 10, 2006

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For the chemical industry, the last decade has been a rollercoaster ride. Until two years ago or so, sales of everything from petrochemicals to paint were sluggish; inventories all but overflowed the storage tanks, and the pricing power of producers was weak. But a reversal of fortune has almost emptied those tanks, and plants are operating around the clock (and still barely meeting the increased demand). This increased demand is giving sellers the upper hand in pricing. As a result, many chemical vendors are virtually minting money—in some cases reaching historically high levels of profitability and cash flow.

Part One of the series So What's the Big Deal with Chemicals?

However, this boom should not deceive anyone, since the fact remains that chemicals are a mature, slow-moving industry. It might even expose quite a set of challenges and complexities within the industry:

- low asset turnover
- limited production flexibility
- decreasing product innovation (especially for basic chemical manufacturers such as commodity producers of plastics and rubber; fibers; raw materials and intermediates; inorganic materials; fertilizers; and so on), given the increasing rarity of new chemistry discoveries.

Furthermore, while the soaring prices of crude oil—to well above $60 (USD) a barrel—have been a godsend for some back-integrated petrochemical industries, the downside lies in increased prices for natural gas and other raw materials, which forces the same manufacturers to consider building new plants closer to the supply source, in order to reduce costs and be closer to the demand source too (given their customers' likely relocation for similar reasons).

Globalization and the rise of the Chinese, Brazilian, and Indian economies have opened new markets. However, this has resulted in fierce competition and the dispersal of supply chains across the globe. All chemical players have thus been scrambling to reposition their offerings, which has typically resulted in a spate of mergers and acquisitions (M&As) and joint ventures, and a race to add new plant capacity as well as to eke out some return on colossal capital investments before the cycle turns downwards yet again.

But, regardless of the economic cycle (up, flat, or down), chemical companies have to maintain tight but smooth supply chains featuring visibility, flexibility, responsiveness, and speed in forecasting demand, as well as the agility to ramp up (or down) plant output and manage customer expectations (and increasingly—the latest vogue—their consigned inventories). All players have been striving to create more predictable product supplies despite volatile demand, given that customers will likely pay more to achieve this predictability. Success in this endeavor might be the best way for any chemical manufacturer to achieve enduring profits once the economic cycle returns to sluggish demand, chronic overcapacity, and downward pressures on prices.

This is certainly not an easy feat, given the growing network of new products, plants, subsidiaries, trading partners, and above all, new inter-enterprise business processes. These have not yet been connected properly: each major function has a separate interface, often running on separate enterprise systems platforms. Adding to the difficulty are the industry's own idiosyncrasies (for example, some manufacturers can be their own major customers, and some companies often look to third-parties—even including, occasionally, to fierce competitors—to outsource key process steps).

Forecasting Tools

Certainly, everyone needs powerful yet flexible forecasting tools in order to develop timely, accurate forecasts, starting with a statistical forecasting engine, which provides a first-cut projection based on methods and criteria tailored to a particular business. Some advanced forecasting tools are able to prioritize high-value customers and key accounts with individual attention, and to handle smaller and less important customers collectively. Emerging collaborative features enable key stakeholders to focus on important details, easily share information, and arrive at a consensus; customers can also be included in the collaborative process to achieve more accurate forecasting.

Also, in optimizing product mix and asset usage, the advanced analytical techniques of supply chain optimizing tools should help to map demand forecast across the supply chain, thus providing sales and production plans that accommodate capacity limitations while maximizing profitability. The product and customer mix can be analyzed interactively to find a business blend that improves the use of equipment, while alternative scenarios can easily be run to assess the impact of various customer and production options.

However, given the inevitable limitations of projection accuracy, of course it is vital that chemical manufacturers be capable of sensing major trends before it is too late to catch up. For instance, if a customer's tank sensors or radio frequency identification (RFID) scanners in the paint aisle of the retail home improvement stores are the first harbingers of increased or decreased demand, then the manufacturer's IT systems may be able to share this with trading partners. For more information on this trend, see As Hype Becomes Reality, a Radio Frequency Identification Ecosystem Emerges.

New streams of automated and actionable data—arriving from the plant floor, storage facilities, and so on, all with the help of real-world-awareness technologies—have to enable network members to more swiftly identify new market challenges or opportunities; reallocate inventories accordingly; reconcile customer needs with research and development (R&D) efforts; strike a balance between long production runs (for economy of scale reasons) and the flexibility needed to dampen demand (and inventory) spikes; and above all, create a unified view of their increasingly complex businesses.

Appropriate supply chain event management (SCEM) applications should monitor up-to-the-minute events within the supply network, to aid in more rapidly identifying problems and corrective actions to maintain a balanced inventory. Deviations from the plan should be instantly highlighted in on-screen consoles, to ensure that the performance of every inventory decision point in the supply chain is continually measured and communicated. This holistic planning and execution approach should help truly inventive chemical producers in several ways: in aiding segmentation of their product and services with respect to customers; in helping them redesign their supply networks; and in assisting in the implementation of price management strategies that reward the (hopefully) faster delivery of expected product supply to downstream customers in industries such as consumer products, automotive, and high tech and electronics.

Challenges

It might be beneficial to review several of the challenges facing all chemical companies today, regardless of whether their products are benzene, soda ash, semiconductor polishing slurry, pigments, food additives, paints, and so on.

First of all, the so-called inventory bloating “bullwhip effect” (whereby a small change in demand at the consumer level can lead to massive changes and inventory buildups upstream with suppliers, on short notice) is especially painful for basic chemical manufacturers (such as soap and cosmetics ingredients, chewing gum flavors, additives, dyes, and so on), since these companies live far upstream from the final product and end customers. Given the length of downstream supply chains (leading back upstream to basic chemical manufacturers), demand signals at the consumer level usually take quite a long time to reach the upstream trading members. Unfortunately, at this stage little can be achieved about improving demand visibility, except for some end-consumer chemical producers (such as the paints and coatings sectors) that might have the privilege of leveraging point-of-sale (POS) data.

Secondly, the dichotomy between the efficiencies of long product runs and the adaptive capabilities of shorter runs is more apparent than in most other industries. Chemical production encompasses many types of inventory, such as raw material, work in progress (WIP), in-test or sample material, rework or scrap material, products in transit, safety stock, and cycle stock. In these contexts, changes in one component can significantly impact other components. Smaller batch sizes reduce WIP levels, but also reduce productivity, whereas cycle times can be shortened to reduce cycle stock, but end up increasing the time spent making production transitions.

Traditionally, chemical companies, especially with a continuous production model, have opted for lengthy production runs coupled with an after-the-fact sales and marketing strategy. This was due to the maturity of the industry, especially on the basic chemicals side; efficiency comes via economies of scale, which means running plants around the clock around the year (except for some annual maintenance shutdowns), with infrequent changeovers. Entire plants are often specialized for a single product (or a few at best). This rigidity leaves manufacturers vulnerable to the aforementioned bullwhip effect.

In fact, chemical companies tend to pride themselves on their “operational excellence”; the entire industry has invested heavily in capital assets for economies of scale and competitive variable costs, resulting in high fixed costs of depreciation and often limited refusal ratios. During lean times, the push for maximum capacity plant use and expedition of short production schedules actually consumes capacity, and introduces quality variability and reject material, which negatively affects manufacturing costs and profit margins. According to AMR Research, manufacturing operating costs make up more than 80 percent of bulk chemical manufacturers' total supply chain management costs, and average more than 40 percent of revenue, which is almost 3 times that of other industries. Most players are still unable to profitably respond to highly variable demand, or to execute predictable product supply strategies.

The high fixed cost of the plant tradittionally drives a management objective of maximum possible capacity use. A common approach to this objective is to set prices at a low enough level to drive to 100 percent use. But as use approaches the maximum, the demand for perfection in the supply chain plan increases, since changing anything at 100 percent use has a direct impact on other parts of the plan, supply chain, and customers. The system must recognize this fact and help manage the inherent conflicts (see Supply Chain Planning - Issues for Continuous Chemical Companies).

The logic is well-known: When the right products in the right amounts are in the right place at the right time, the enterprise is able to provide reliable deliveries to its customers while controlling inventory costs. However, the demands of the global chemical marketplace make this balancing act more challenging than ever, since distribution networks are increasing in size and complexity, which multiplies the difficulty of inventory decisions. On the other hand, customers demand shorter lead times and faster deliveries, creating pressure to increase rather than decrease inventory levels. As mentioned many times before, efficiency targets for production lines dictate longer runs for each product, resulting in larger stockpiles. Most importantly, unbalanced inventories are a significant drain on working capital, at a time when every manufacturer is under tremendous pressure to keep costs down.

Overcoming Chemicals Industry Challenges through Optimization of Distribution and Inventory

Featured Author - Olin Thompson and PJ Jakovljevic - May 11, 2006

Optimizing Distribution and Rationalizing Inventories

Most chemical companies are still unable to profitably respond to highly variable demand, or to execute predictable product supply strategies. A previous note, So What's the Big Deal with Chemicals?, presented the current state of the chemicals industry, including a discussion of the challenges the industry faces.

Part Two of the series So What's the Big Deal with Chemicals?

Optimizing the distribution network and rationalizing inventories at each point in that network are hence the keys to an efficient supply chain and smoother operations. An optimal inventory targeting capability that calculates all the components of inventory at every point in the supply chain, and that then compares historical forecasts to actual sales data, and models all the processes that contribute to inventory, should allow users to quickly identify problem areas and make adjustments that decrease inventory without reducing customer service. As for maximizing inventory efficiency, at each point in the supply chain one should get the information needed to determine optimum inventory levels, and redeploy the excess to improve service at high-priority locations.

Additionally, some optimization tools should help companies minimize the combined costs of manufacturing and holding inventory, without necessarily sacrificing service. These tools must allow users to examine all the factors that contribute to inventory and production costs, such as cycle times and cycle stock levels, production line transition costs, inventory tradeoffs, and so on. By using the cycle optimizing tool, production planners should be able to determine optimal policies for product frequency, cycle length or production campaign length, as well as target levels for cycle and safety-stock inventories. In this way, it might be possible to set realistic inventory policies that support both good service and good profit margins.

Furthermore, industry roles are fluid and ever-changing, given that nearly 30 percent of chemicals sales are to other chemical companies. The largest players are typically basic life science (pharmaceuticals and agrochemicals), industrial gases, and specialty chemicals (perfumes and cosmetics, paints and ink, soaps and detergents, dyes and pigments, and so on) producers. The rest are critical middlemen, who process and add value to basic commodities, and resell the still unfinished products for further processing. Some large companies might sell the product of their commodity division to their specialty division (thus becoming their own major customer), or they might sell basic commodities to an intermediary and then buy back the finished product for further use by the specialty division.

On the other hand, the manufacturing process is often the weakest link in the supply chain as a whole, since component products and semi-finished materials require long lead times that impede quick-acting demand-driven principles. Manufacturers can do very little to accelerate the subassembly processes, since the laws of chemistry (in other words, the processing times) are largely inflexible, posing challenges for manufacturers who want to integrate their demand forecasting, sales teams, plant floor personnel, and so on. It is thus not that uncommon for fierce competitors to temporarily partner so as to reduce costs: they will often swap a commodity in one location for the same one in another location. Tracing these complicated transactions is very difficult, the more so because of the fluctuating prices of these commodities.

Production Planning and Scheduling

In addition to inventory management, effective production planning and scheduling is the other required core competency of competitive chemical supply chains. But, as in the aforementioned case of inventory management, the growing complexity of the chemical industry has made achieving this goal more challenging, due to the need for long-term upstream scheduling with short-horizon finished product plans. Accordingly, savvy production planners should know how to reshape plans smoothly and responsively, without breaking the rhythm of the plant, and they should be able to visualize the impact of a planning decision on the entire supply chain. Competent scheduling software has to be built on a production model unique to chemical operations, with features like product-to-product transitions, lot quality variability, cycle and campaign simulation, tank farm and complex storage modeling, available to promise (ATP), capable to promise (CTP), and sales monitoring, all in a production environment that runs at maximum capacity.

One should be able to obtain aggregated and detail views of the supply chain model for decision support during sales forecasting, production scheduling, and product distribution. Also, there is often the need to stabilize production cycles in a “make to inventory” business, through calculated inventory target levels based on planned customer service levels. These levels typically must calculate inventory target levels at the product, package, and location level, and show the aggregate inventory levels required for a business to support a given service level.

Management of inventory at customer and other consignment locations, with customer specifications of quality, packaging, and transportation, is also often required. Additional intricate features that the system should support include variable scheduling horizons (to decouple packaged from bulk material); rate-based production (long batches); the handling of flow rates from feedstock to bulk (rail cars and barges); pipeline versus “on-hand” inventory management; the modeling of unprocessed materials (including recycles and multiple produced items) from a single feedstock; the ability to find equivalent products, locations, and packages; and so on.

Producing chemicals typically involves all of the three common physical states of ingredients, namely, solids, liquids, and gases. From a formula and mixing perspective, this necessitates an impeccable unit of measure (UOM) conversion engine. Whether the formula requires conversion of US measurements to metric or imperial measurements, liquids to solids, or gases to liquids, such conversions should be transparent to the production of the finished goods; in some instances free form conversion tables can be extremely useful. The aforementioned ATP capability comes in handy here for providing a tool to almost instantly analyze and commit customer orders while keeping an eye on profitability; users can also instantly determine if an order is within forecast, and see the best way to fulfill the order (whether from existing inventory, planned production, or alternate sourcing locations).

Furthermore (principally in specialty chemicals), customer service is increasingly becoming the differentiating lever, since beyond the trend toward consignments or vendor-managed inventories (VMI), customers are demanding services that go far beyond mere delivery and replenishment. For instance, a sanitation chemicals maker might sell, procure, manage, and ultimately dispose of its products on behalf of its hospital customers, while a paint producer might oversee and operate spray painting facilities within auto assembly plants of customers.

Research and development (R&D) is steadily becoming more about customer service than about mere product and process innovation, and might include developing unique products for preferred customers. New product development, at least for specialty chemicals, is often more about a one-to-one relationship with the customer and understanding its need than it is about building a better molecule, since in this industry, brands matter much less than in, say, the retail or automotive sectors. Brand loyalty is not what keeps customers, but rather the right price, along with an accommodating relationship (for example, consignment inventories), and, especially for specialty chemical manufacturers, special customer care and service, bundled with the ability to develop proprietary ingredients.

Consequently, defining and formulating recipe-based products requires industry-tailored solutions to adequately allow product development. Effective recipe management is a must, which means developing, perfecting, and protecting franchise products, their potential successors, and the failed prototypes that preceded them. Many specialty chemical producers, for example, are still struggling to compare development and production costs (factoring in the impact of manufacturing capacity and supply chain speed) against the potential value of a new product. Combining process-industry-oriented product lifecycle management (PLM) capabilities with counterpart process-manufacturing-oriented enterprise resource planning (ERP) capabilities can produce a unified sample management solution that would allow free-of-charge product samples (for evaluation purposes) to be shipped in the same manner as commercialized products.

Combining these PLM solutions with process-manufacturing-oriented supply chain solutions could further provide unique recipe optimization capabilities for evaluating current inventory to develop least-cost or best-fit product formulations or recipes, and thereby accelerate the process of new product development and introduction (NPDI) or new product development and launch (NPDL). This will help achieve globally compliant products with lower R&D costs and a shorter time-to-market.

In the domain of specialty chemicals in particular, the NPDI process wins more business by recognizing and exploiting a customer need for more (for example) adhesives, flavoring or scenting agents, polymers, and so on, than from trailblazing a new market with a purely technological innovation. Faster time-to-market and time-to-volume means a greater advantage for these companies over their peers—and a greater chance to gain market share, since in many chemical companies (and particularly in specialty chemical companies) every order may represent a new product. For example, it might suffice to tweak an existing formula, or to replace one chemical ingredient with another chemical ingredient, but this places three demands on the functioning of the software.

First, since the resulting chemical is being produced for the first time, a quote would normally be required; consequently, the software needs to have the ability to easily convert prospective quotes into firm orders and trigger an event in the production schedule. Second, since new formulas will be needed, the maintenance and management of formulas needs to be streamlined and responsive to customer inquiries, possibly while the customer is still on the phone. Templating ("copy from/to") would be a useful tool in this regard; one would start with an existing formula as a template for the new formula, and make ingredient changes as warranted. And third, to complement the templating concept (and because many chemical properties are interchangeable), a suggested ingredient substitution would facilitate the production process. Automated or suggested ingredient substitution could allow the user company to fulfill customer orders that otherwise would have to be abandoned or, at best, delayed.

Lagging in Data Integration

However, the chemical industry customarily lags behind other manufacturing sectors in terms of data integration and reconciliation, in terms of creating comprehensive and accurate customer profiles. Consequently, there has been a lack of ability to prioritize customers and answer the basic question of whether the customer is worth keeping after all. There is an increasing awareness of the need for a customer segmentation that would grant a high degree of attention for the most profitable customers, while using more efficient means (such as an e-commerce Web site, price increases, or additional surcharges) for high-cost, less profitable customers—and even abandoning the worst ones. Many rightfully wonder about the point of squeezing costs out of the manufacturing and upstream supply chain, if the company cannot manage its transaction margins (see Applications Giants Bolster Their Pricing Management Capabilities).

Thus, savvy chemical companies are using sales and operations planning (S&OP) processes to better anticipate and more profitably respond to demand, but they are also prioritizing the use of price optimization to develop price elasticity (customer sensitivity) curves to outline price or volume tradeoffs, linking these to sales contract and raw material purchase contract compliances and risks. Also, given their fluid and often competitive relationships with other players, they also try to develop plans to sell excess capacity in sluggish times, profitably allocate capacity in boom times, and identify which products need to be manufactured and which need to be bought as finished goods (outsourced) from other chemical suppliers. This last need may be driven by the requirement to satisfy contractual elements, which often make up the majority of sales volume, and constrain opportunities to change product mix.

Of paramount importance is an efficient optimization engine that can map the demand forecast across the supply chain, and provide sales and production plans that accommodate capacity limitations while maximizing profitability. Product and customer mix can then be analyzed interactively to find a business blend that improves equipment use, and alternative scenarios can be easily run to assess the impact of various customer and production options.

Don't Forget Environmental Regulations

Environmental regulations impose strict monitoring and production restraints; the manufacture and use of hazardous chemicals requires strict adherence, especially in North America and the European Union (EU). The chemical industry (and companies that rely on chemicals within their plants) must address a myriad of new regulations, including the Restrictions of Hazardous Substances Directive (ROHS), and other regulations that require compositional analysis, the development of material safety data sheets (MSDS), environmental analysis, and hazards identification.

The chemical industry faces particular scrutiny from a regulatory perspective. Companies have been discussing the impacts of various programs, including European Classification and Labeling Inspections of Preparations including Safety Data Sheets (ECLIPS); Registration, Evaluation and Authorization of Chemicals (REACH); Science, Children, Awareness, Legislation and Evaluation (SCALE); and Global Harmonized System for the Classification and Labeling of Chemicals (GHS). For more information, see Process Manufacturing: Industry Specific Requirements; Part Two: Chemical.

Mission-critical processes that contribute to the cost of doing business include implementing (and ensuring compliance with) employee safety guidelines; implementing food contact rules; monitoring emissions (this is often delineated by regulatory permits); and even validating the origin and composition of products. In other words, the introduction of hazardous materials and dangerous goods (which are closely regulated and must be reported) constitutes a new complexity for chemical industry process manufacturing: this creates two conditions that can be greatly simplified by software.

First, when creating a new formula or modifying an existing one, the formula must be analyzed for the presence of hazardous materials. This check requires a continuously updated and current list of regulated materials that are considered hazardous. Also required is the percentage of these materials relative to the other ingredients. Secondly, the reporting of hazardous materials must comply with a specific format, namely MSDS; these sheets will usually accompany the customer's bill of lading (BOL), and therefore must be integrated with the billing process. While MSDS copies can be kept on file and manually matched with the BOL, most companies will not want to risk noncompliance and would rather seek an automated remedy. Companies who like to haphazardly "live on the edge" will rely on manual procedures to determine when a formula or product requires an updated MSDS.

More prudent companies, however, will seek to have update notification incorporated in their enterprise-wide software, along with a new, automatically generated MSDS, as needed. The programming of hazardous material compliance is not trivial, particularly when one considers that it involves list processing and matching, percent of total analysis, scheduling, and formatting. Bolt-on solutions do exist, but because of the requirement for tight integration, it is hard to argue against an enterprise-wide software solution that includes this functionality straight out of the box. Depending on the importance of formula analysis and MSDS reporting within the user organization, the inclusion of this functionality in a software offering could be a deal maker or, at the very least, a tie breaker. Also, each mode of bulk chemical transportation, including rail, truck, and marine transportation, must comply with regulations and safe-handling specifications.

Managing Demand: Considerations for the Chemicals Industry

Olin Thompson and PJ Jakovljevic - May 12, 2006

Managing Demand Effectively

Due to the inherent challenges of the chemicals industry, most chemicals companies are still unable to profitably respond to highly variable demand, or to execute predictable product supply strategies. Thus, optimizing their distribution networks and rationalizing their inventories are the keys to an efficient supply chain and smoother operations. Chemicals companies must also resolve the challenges posed by environmental regulations and the need for seamless data integration. For more information, see So What's the Big Deal with Chemicals? and Overcoming Chemicals Industry Challenges through Optimization of Distribution and Inventory.

Part Three of the series So What’s the Big Deal with Chemicals?

With limited agility in manufacturing, logistics can provide some maneuvering space for the chemical industry. According to AMR Research, bulk manufacturers spend a median of 7 percent of revenue on total transportation costs, which is almost 5 points more than other industries pay on average. While inbound costs are often negligible because of co-location with suppliers (which sometimes requires nothing more than a simple pipeline), outbound transportation costs can reportedly reach up to 5 percent of revenue, compared to the 0.5 percent figure of other industries. With ever increasing numbers of products and delivery points, an efficient distribution network is vital to controlling inventory costs. Enterprises should be able to optimize the supply chain network by finding the most economical way to supply each customer, such as by changing distribution locations to support more frequent service; changing transportation modes; making packaging changes; or improving forecasts to reduce overall inventory levels.

Chemical manufacturers have historically tended to sell what they made (batches or a continuous stream of prime products, by-products or co-products that cannot be reprocessed, or specialty chemicals for a particular customer), but this strategy is no longer working (except for some commodity manufacturers). The aforementioned increasing complexity of the business (in terms of more competitors, more customers, more products, broader geographic coverage, and prohibitive occurrences of the “bullwhip effect,” whereby a small change in demand at the consumer level can lead to massive changes and inventory buildups upstream with suppliers, on short notice) has forced manufacturers to make only what they can sell with certainty, instead of adopting the “if we make, they will buy” approach. Recently, they have been crafting plans based on historical data, executing those plans, and developing analytics to measure performance, so as to be able to discern whether the right product is being made and sold.

Managing demand effectively (with accurate prediction and timely fulfillment) is fundamental to optimizing the supply chain, given that demand is the force that drives the chemical supply chain. But as mentioned many times before, the complexity of today's global chemical industry creates significant hurdles for effective demand management, since both suppliers and their customers are subject to market uncertainty and price volatility. The growing trends towards customization and segmentation mean that producers have a wider variety of products to manufacture, and more difficult choices to make to maximize their production efficiency and profitability. While more accurate forecasting can be achieved by blending statistical analysis, customer projections, and the knowledge of sales and service teams, there is a natural limit to planning and forecasting accuracy, since inventing a better correlation from past events can only help so much.

With the novel sense and respond approach, the gap between planning and reality (execution) can be closed (see SCP and SCE Need to Collaborate for Better Fulfillment), since sensing signals from the real world (such as vendor-managed inventory [VMI] updates, supply chain exceptions—events and non-events alike—and downstream promotion-based demand peaks) and responding to them promptly should allow a company to better adapt its fulfillment and manufacturing capacity to real-time demands. Order fulfillment features should assure that flexible demand plans are instantly available throughout the organization. Distribution planners can thereby target inventories to meet specified customer service levels; logistics managers can concurrently receive just-in-time (JIT) replenishment plans to maintain proper service and inventory levels; and production schedulers can see the status of every order and the impact of every change. Most importantly, the planners can see the financial impact of every decision, whether major or minor.

Better Business-to-plant Links

There are some cross-industry capabilities that are especially pertinent here as well. The chemicals industry may be the one that has the most recently realized the need for better business-to-plant (B2P) links, to achieve more predictable product supply and deliveries, more agile manufacturing processes, and a reduction in manufacturing costs (see The Importance of Plant-level Systems). Plant-level system investments in chemical companies have thus far typically involved a data historian (a database with series-based time rather than relational data); advanced process control (APC) and plant automation software; data reconciliation and yield accounting (in order to create mass flow and energy balance snapshots of continuous process flows); and—particularly of late—a plant or manufacturing intelligence software layer to make sense of real-time production data for improved, also real-time informed decision making (see Plant Intelligence as Glue for Dispersed Data?).

The B2P integration process is being driven by Instrumentation, Systems, and Automation (ISA)-95, an international standard for defining the interface between business and manufacturing systems. The first part of ISA-95 consists of a dictionary of common information technology (IT) terms for both business and manufacturing personnel. The second part adds details to illustrate these terms, and describes production by personnel available, materials used and produced, equipment used, and production for scheduling and costing. The third aspect of ISA-95, still under development, defines contextual models for the disparate activities between manufacturing and business systems.

User Recommendations

When looking for a vendor, various considerations should be included:

§ Can the vendor provide a list of relevant chemical industry references?

- Does the vendor provide for the unique requirements of the chemical industry? (If the model cannot fully define the realities of the user-specific chemical processes and practices, it cannot possibly manage these realities.)
- Was the solution built specifically for the chemical industry (good), or does it use a generic solution employing templates (OK, but not necessarily excellent), or is it simply a generic product (bad)?
- Is the solution a single, integrated application with one common model, or is it a collection of interfaced modules?
- Is the solution a complete application, or is it a modeling language that forces users to create their own solution?
- Can existing personnel (such as planners or IT staff) support the system, or does it require specialized assistance from an operations research or modeling group?

Enterprise systems have brought many benefits to chemical environments, but for individual enterprises, gaining these benefits requires the selection of a solution that can deal with the unique needs of the business. Although only a handful of vendors claim they can support these needs, some first-class options do exist. Only by focusing on the requirements that will make or break the project will the chemical operation select the right solution and gain these benefits.

Process Manufacturing: Industry Specific Requirements : Chemical

Featured Authors - Joseph J. Strub and Olin Thompson - May 27, 2004

Introduction

Traditionally, manufacturing is categorized by two methods: process and discrete. Many differences exist, but most can be grouped into two areas: those derived from material issues and those derived from production issues.

Process materials are different than discrete materials. Process materials are powder, liquids or gases; they must be confined, and they are more difficult to accurately measure. Process materials are close to their natural sources (farms, mines, etc.) and, therefore, are of inconsistent quality. Inconsistent quality means extensive quality procedures, segregation (lot control), restriction of use (for example, this lot is okay for one customer but not another), and usually the inclusion of quality attributes as part of their inventory definition. Process materials vary with time. They get better, they get worse, and they change their identity.

Production issues give us the simplest definition of process manufacturing. Specifically, once you produce your finished product, you cannot distill it back to its basic ingredients. Have you ever attempted to return orange juice back to its original water, sugar, sodium, and, of course, oranges or extract the pigments out of paint? However, you can disassemble a car back to its tires, spark plugs, carburetor, and engine block. There are similar components in process and discrete manufacturing: ingredients versus parts; formulas versus bill of materials; several units of measure (i.e., pounds, ounces, and liters) versus EA (each).

There are, however, subtle differences. Process manufacturing is scalable. For example, if the formula calls for a 1,000 pounds of oranges but you only have 500 pounds, you can still make orange juice, just not as much. If you only have three tires, you are going to have wait for the fourth tire before the car can start rolling off the production line. In process, you tend make product in bulk or batches as in a vat of coke or a 500-gallon tanks of solvent and then pack it off to fulfill customer orders. On the other hand, in discrete manufacturing you would expect to see one computer at a time coming down the production line.

For a quick refresher on process manufacturing, peruse the articles, Process Manufacturing: A Primer or What Makes Process Process.

The remainder of this article focuses on process manufacturing. However, to say process manufacturing functions are the same in all industries is tantamount to saying that a Ferrari and a Ford truck are simply means of getting from point A to point B. Just as you would not use a Ferrari to haul lumber, aspects of process manufacturing cannot be applied equally and with the same importance to all industries. This article looks at the unique requirements of process manufacturing in three industries: food and beverage, chemical, and a hybrid industry, textiles. One way or another, these requirements must be satisfied. If a software vendor can provide this satisfaction, your organization’s anxiety level concerning the implementation of enterprise-wide systems can be significantly reduced.

If you are not in these industries, you can stop reading … No, wait! Perhaps understanding how a particular requirement or aspect of process manufacturing relates to one of these industries may give you better understanding or insight on how it can be applied in your company. Whew! Thought that I had lost you! Glad you're back.

Editor's Note: For the purpose of this article, process and continuous-flow manufacturing are treated as synonymous. Continuous-flow manufacturing is the eradication of product stagnation in and between processes. Once a product has entered the manufacturing process, it moves on without having to be stored. Special considerations, such as one-piece-at-a-time production and multi-process handling for establishing a continuous-flow operation, will not be addressed in this article.

Chemicals Industry

A new wrinkle that has been added to process manufacturing by the chemical industry is the introduction of hazardous material. As you would expect, the use of hazardous materials is closely regulated and must be reported. This creates two conditions that can be greatly simplified by software. First, when creating a new formula or modifying an existing one, the formula must be analyzed for the presence of hazardous materials. This check requires a continuously updated and current list of regulated materials that are considered hazardous. Also required is the percentage of these materials relative to the other ingredients.

Secondly, the reporting of hazardous materials must comply with a specific format, namely material safety data sheets (MSDS). These sheets will usually accompany the customer's bill of lading (BOL) and, therefore, must be integrated with the billing process. While copies of MSDS can be kept on file and manually matched with the BOL, most companies will not want to risk non-compliance and would rather seek an automated remedy. Likewise, companies who like to "live on the edge" will rely on manual procedures to determine when a formula and product requires an updated MSDS. More prudent companies, however, will seek to have update notification incorporated in their enterprise-wide software and automatically generated new MSDS when needed.

The programming of hazardous material compliance is not trivial when you consider that it involves list processing and matching, percent of total analysis, scheduling, and formatting. While there are bolt-on solutions because of the required tight integration, it is hard to argue against an enterprise-wide software solution that includes this functionality straight out of the box. Depending on how important formula analysis and MSDS reporting are to your organization, the inclusion of this functionality in a vendor's software offering could be a deal breaker or, at the very least, a tie breaker.

Every Order Is a New Product

In many chemical companies, but particularly in specialty chemical companies, every order represents a new product. For example, tweak an existing formula or replace this chemical ingredient with that chemical ingredient. This places three demands on the functioning of the software. First, since the resulting chemical is being produced for the first time, a quote would normally be required. As a consequent, the software needs to have the ability to easily convert prospective quotes into firm orders and trigger an event in the production schedule.

Secondly, since new formulas will be needed, the maintenance and management of formulas need to be streamlined and responsive to customer inquiries, possibly while the customer is still on the phone. Templating would be a useful tool in this regard. You start with an existing formula as a template for the new formula and make ingredient changes as warranted. Finally, to compliment the templating concept, and because many chemical properties are interchangeable, a suggested ingredient substitution would facilitate the production process. Automated or suggestive ingredient substitution could allow your company to fulfill customer orders that otherwise have to be abandoned or, at best, delayed.

Producing chemicals typically involves all of the three common states of ingredients, namely solids, liquids, and gases. From a formula and mixing perspective, this necessitates a very robust unit of measure (UOM) conversion engine. Whether the formula requires conversion of US measurements to metric or imperial measurements, liquids to solids, or gases to liquids, such conversions should be transparent to the production of the finished goods. Furthermore, depending on the unique requirements of your company, software that allows the entry of free form conversion tables can be extremely useful.

Supply Chain Planning - Issues for Continuous Chemical Companies

Featured Author - Olin Thompson - August 4, 2002

Why SCP for a Continuous Chemical Company?

Why does a continuous chemical company need a supply chain planning system? Because the high fixed cost of the plant drives a management objective of 100% capacity utilization. A common approach to this utilization objective is to set prices at a low enough level to drive to 100% utilization. As utilization approaches 100%, the demand for perfection in the supply chain plan increases. This, and other operating realities introduce a number of objectives including:

- Changing anything at 100% utilization has a direct impact on other parts of the plan, supply chain, and customers: the Supply Chain Planning system must recognize this fact and help manage the inherent conflicts.
- Trading off customer service and inventory carrying costs against the production efficiencies of operating at full capacity.
- Quickly identifying and responding to customer demand changes
- Identifying distribution bottlenecks
- Reducing the likelihood of "shutting down a customer" because required products are not at its plant when needed. The issue is magnified for "sole sourced customers".
- Reducing inventory carry costs across the supply chain
- Increasing rail car, tank car or barge turns
- Reducing transportation costs by planning for inventory to be in the right place at the right time
- Reducing inventory carrying costs to free up working capital
- Reducing transition costs including minimizing the production of off-spec or twilight material
- Optimizing production schedules
- Increasing production efficiency
- Improving customer satisfaction
- Integrating with the existing ERP system

Vendor Considerations

If a continuous chemical company decides that these objectives are adequate to justify a Supply Chain Planning project, an SCP product must be selected. Many alternative vendors exist for SCP. The vast majority designed their SCP product with little or no regard for the needs of continuous chemical companies. Although these vendors may be large and well respected, does their product serve the specific needs of a continuous chemical company? As we will see below, the needs of continuous chemical companies are unique and demanding. Most generic SCP products will fail to meet these needs.

How can you determine if a vendor is focused on the needs of your industry? Sales presentations and brochures are not a reliable indication; both can be customized to make the company look very focused on any market. For a view of the vendor's marketplace interest, look at the company web site. It is designed to cover all possible markets. How deep into the web site do you have to go to find substantial information on companies like yours? If it is on the first page, the vendor is very interested in your needs. If you need to go three or more levels before you begin to see meaningful information about your type of business, maybe the vendor's interest in your needs is minimal at best.

When looking for a vendor, some considerations should include:

§ Can the vendor provide a list of continuous chemical industry references?

§ Does the vendor provide for the unique requirements of the continuous chemical industry?

§ Was the solution built specifically for the continuous chemical industry (good) or, does it utilize a generic solution employing templates (OK but not good) or, is it just a generic product (bad)?

§ Is the solution a single, integrated application with one common model or is it interfaced modules?

§ Is the solution a complete application or a modeling language that forces you to create your own solution?

§ Does the vendor use independent consultants for implementation or does the vendor use its own full-time chemical industry experienced professionals?

§ Can existing personnel (IT, Planners) support the system or does it require specialized assistance from an Operations Research or modeling group?

Product Considerations

When looking at the features that should be considered when evaluating an SCP system for your continuous chemical business, the key issue is modeling the unique characteristics of your specific chemical processes and practices. If the model cannot fully define the realities of the processes, it cannot possible manage these realities.

These include cyclical production, complex transition wheels, lot quality matching, available to promise, capable to promise, and sales monitoring in a production environment that runs at 100% capacity. Other examples include:

- Aggregate and detail views of your supply chain model for decision support during sales forecasting, production scheduling, and product distribution.
- Stabilizing production cycles in a "make to inventory" business through calculated inventory target levels based on planned customer service levels. These levels typically must calculate inventory target levels at the Product, Package, and Location level and show the aggregate inventory levels required for a business to support a given service level.
- Manage inventory at customers' and other consignment locations?
- Customer specifications - quality, packaging, and transportation
- Functionality to support sole sourced customers
- Long-term upstream scheduling with short-horizon finished product plans
- Production Reports addressing variable quality issues
- Variable scheduling horizons (de-couple packages & bulk)
- Rate based production (long batches)
- Tolling management and schedules
- Exchange agreements planning
- Handles flow rates from feedstock's to bulk (rail cars, barges)
- Inventory management
    - Pipeline versus "on-hand" inventory management
    - Consigned inventory management
- Handles work in process and unreported production
- Additive consumption projections
- Models unreacted materials including recycles
- Models multiple produced items from a single feedstock
- Production wheel - dynamic vs. static analysis production resource requirement
- Transition matrix
- Equivalent products, locations, and packages
- Collaborative forecasting

Summary

Supply Chain Planning has proven to bring many benefits to a continuous chemical environment. Gaining these benefits requires the selection of a SCP solution that can deal with the unique needs of these businesses. Although few SCP vendors can support these needs, first class options exist. Only by focusing on the requirements that will make or break the SCP project will the continuous chemical operation select the right solution and gain these benefits.