Supply Meets Demand: Integrated Planning in a High-Volume Engine Business

Caterpillar learned that better forecasting and integrated planning capabilities yield a nimbler, more cost-effective, and more competitive engine-manufacturing business.

With 90 manufacturing plants, 31 distribution centers, business outlets in 200 countries, and $20 billion in annual sales, it shouldn’t be surprising that Caterpillar, Inc., is the world’s leading manufacturer of industrial equipment. But although Caterpillar equipment seems ubiquitous, a sizeable portion of the company’s business – approximately $5 billion – actually is diesel engine manufacturing. Three divisions comprise Caterpillar’s engine operations: Engine Products Division (EPD) for sales and marketing, Large Engine Products and Fuel Systems Division (LEPFSD) for large engine manufacturing, and Performance Engine Products Division (PEPD) for small engine manufacturing.

Recently, big attention has been focused on Caterpillar’s small engines. Having introduced several new and more efficient products, the Division’s demand patterns were changing, along with its inventory management, distribution, and customer service requirements. Unfortunately, the demand management (forecasting and planning) processes Caterpillar depended on were implemented more than 20 years ago - when vertical integration was a common business practice and lengthy component queues were a necessary evil. Today, 70% of the (roughly 600) parts in a typical PEPD engine are purchased from outside the company, and 85% of assembly components are delivered JIT. In this new environment, 20-year-old processes couldn’t accommodate complex supply chain management demands. They couldn’t support multiple demand streams or help integrate internal and external business environments. When push came to shove, they just couldn’t relate to Caterpillar’s new, demand-driven business.

Caterpillar executives therefore set out to drastically minimize forecast and planning variability, thereby paving the way to create a true build-to-order environment. Other planning-related goals included reduced inventory levels, increased manufacturing throughput, less need for overtime, less reliance on express freight, greater forecast accuracy, and improved customer service.

Working together, our two firms zeroed in on four areas: demand planning, assembly sequencing and scheduling, factory planning, and gear shop scheduling. As is the case with many operational improvement programs, we could see that the optimal solution path would be a combination of developing and/or re-engineering key business processes, and implementing a suite of supply-chain-focused application tools.

Demand Planning

One of the first things we determined was that PEPD’s forecasts did not provide a true upstream representation of demand, nor did they offer a complete demand picture to downstream scheduling processes. Basically the culprits were the limitations of human intervention and regular infusions of human error. For example, the forecast misrepresented upstream demand because it was routinely modified to satisfy operational constraints. If the original forecast (manually developed by sales and operations planning analysts) called for quantities that logistics or manufacturing could not handle, then the forecast was adjusted downward. Conversely, the forecasts failed to provide a complete demand picture for downstream scheduling processes because necessary amounts of forecast-disaggregation from the sales model level to the arrangement (configuration) level only occurred for certain products. As a result, suppliers were routinely asked to accommodate short-lead-time scheduling changes. Other times, engines were partially built and then held in inventory until a key component could be obtained.

Over eight months, a new forecasting process was developed to ensure a truer representation of demand across the Caterpillar supply chain. A key aspect of the new approach is that manufacturing and logistics constraints now are part of the master production scheduling activity and thus do not disrupt the forecasting process. Another improvement was consensus related: representatives from sales, operations, marketing, logistics, and manufacturing now convene regularly to critique and confirm the validity of each forecast.

The next step was to automate the forecasting process, including the disaggregation of engine-family-level forecasts to all engine arrangements. Toward this end, interfaces were developed to automatically consolidate customer orders (daily), shipment histories (weekly) and forecast data (monthly). None of these aggregations had ever occurred on such a consistent basis. Demand planning software also was configured to accept market and customer intelligence before the forecast is created, as well as to weave their implications into the resulting forecast.

Brian B. Buchanan is an experienced manager in Accenture’s Automotive and Industrial Equipment practice.
Gregory A. Marbury and Paul A. Strimaitis are managers in Accenture’s Supply Chain Management practice.
Together, a new process and new technology help Caterpillar develop comprehensive forecasts that better reflect customer demand, minimize variability, and represent the best possible fit for each supply chain constituent. Moreover, the company’s S&OP analysts now have a chance to add value by working with – leveraging – the forecast, rather than manually gathering and manipulating data to create the forecast.

Assembly Sequencing and Scheduling
Two key issues dominated the assembly sequencing and scheduling initiative. First, the assembly schedule – which was based on engine requirements, a mix of orders, and the forecast – was not directly linked to the shipping load configurations and ship times dictated by customer orders. As a result, engines routinely were built in the wrong order, additional time often was needed to re-sequence and move materials, and finished engines often languished at the end of the assembly lines. Moreover, truck loading might begin without confirmation that all required items were available, so a truck could wait for hours while engines were expedited.

The second issue was that assembly sequencing rules were maintained and applied manually by the assembly scheduler and did not consider the order in which finished goods would be loaded onto the trucks. As a result, there was a consistently low probability that constraints were applied properly or that all constraints were being considered, and a sky-high probability that physical re-sequencing would be called for during the assembly operation.

The clear response to the first problem was to integrate customer-ship requirements with assembly line scheduling. This capability – along with automated application of assembly schedule constraints – was identified in a specialized sequencing tool. Following the software’s implementation, the inventory pool shrank significantly, as did assembly cycle times. And with engine-assembly flow improved, trucks could arrive, take on the right load, and quickly be on their way. In one step, PEPD got faster assembly, less inventory, improved logistics, and happier customers.

The same software package also helped solve the assembly sequencing problem. By relying on technology to determine the flow (in minutes rather than hours), the assembly sequencer could focus on programming a better and more detailed representation of constraints. Almost immediately, PEPD experienced a large reduction in re-sequencing activity and finished goods inventories.

Changes or operational issues affecting one department’s schedule wouldn’t be reflected in the schedules of other machining departments. Getting the right materials to the right assembly line at the right time simply was not realistic.

In this case, technology innovation drove successful changes in the process. By implementing specialized planning technology,
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provided daily to the application and an initial, optimized schedule is produced for the gear shop as a whole. A scheduling meeting then is held between the area foremen and a newly appointed gear shop scheduler, who is responsible for all gear shop areas. The participants review the schedule, insert any recent status changes or exceptions, and rerun it. A truly optimized schedule, better staff deployment, improved throughput, and lower inventories are the clear results.

Production Scheduling
The last of the target areas was gear manufacturing - basically a job shop environment divided into gear cell, heat treat, and finishing areas. The problem was that throughput for each area was scheduled manually and independently, which made it nearly impossible to minimize in-process inventories or maintain an integrated, optimized flow of materials. Complicating matters further, each gear requires a different route path and different groupings of machines.

The solution was a process change enabled by production scheduling technology. Now, information about demand, generic routings, and machine capacities is provided daily to the application and an initial, optimized schedule is produced for the gear shop as a whole. A scheduling meeting then is held between the area foremen and a newly appointed gear shop scheduler, who is responsible for all gear shop areas. The participants review the schedule, insert any recent status changes or exceptions, and rerun it. A truly optimized schedule, better staff deployment, improved throughput, and lower inventories are the clear results.

Process and Product
There is no question that Caterpillar’s bold deployment of leading-edge processes and technologies produced significant operational savings (estimated at $20 million to $25 million annually). But another benefit is the extent to which PEPD’s integrated planning capabilities help position the company to be a significant player in the world of e-business. Despite the rust-belt image that most heavy equipment manufacturers shoulder, they too must learn to thrive in a twenty-first century economy. Like few of its competitors, CAT is now positioned to do this by bringing forecasting-related value to each member of its worldwide supply chain. With these capabilities, Cat also is equipped to reach beyond its four walls – enhancing supplier relationships through e-collaboration, sharing planning and forecasting data with supply chain partners, and working directly with customers on build-to-order issues and available-to-promise dates.

Caterpillar also will thrive because it understands that operational improvements are always grounded in the enhancement of key business processes or the introduction of new ones. Each of the process changes that CAT implemented were actualized by innovative supply chain planning tools. But high-impact, sustainable improvement still comes down to finding improved ways to get the job done. Caterpillar’s Performance Engine Products Division is more successful because it found – and embraced – a better way to operate.