Data-Driven Service Parts Planning

■ Careful application of well-documented analytical techniques, especially for setting inventory targets and developing replenishment plans, can lead to improved performance at a lower cost.

We all struggle with complicated service parts planning. Each industry has its complexities, whether it's a far-flung installed base (oil rigs in the Gulf of Mexico or the North Sea), long product lives (tractors or metal stamping equipment), significant consumer exposure (automobile parts), or complex reverse logistics and repair processes (back-office computers). The fact that life and death sometimes hangs in the balance raises the stakes for planners in the medical instrument business—in addition to those other factors just cited.

In order to maintain high customer satisfaction for service parts availability while keeping a lid on inventory-based costs, the Cardiac & Monitoring Systems business line within Philips Medical Systems applies a rational, data-driven planning process. The process includes:

- Inventory targets based on total expected cost.
- Replenishment plans based on robust statistical techniques.
- Data management to avoid the garbage in, garbage out syndrome.

This article frames the planning problem and describes key points of our process.

The Planning Problem

Apart from some of the industry-specific uniquenesses described previously, service parts planners face a fairly common set of problems. Perhaps the most critical is the high cost of customer dissatisfaction. For many of us, the first and most obvious impact of a parts availability problem is a failure to live up to contract terms. In some cases this might mean penalty fees; in others it might have a softer cost, like a free extension to an existing contract and the corresponding loss of revenue. Longer term, chronic poor service can lead to the loss of future sales of new equipment. And of course, there is the general grumpiness (and worse) that people on the front lines must endure with an unhappy customer.

The classic problem of low volumes and high mix makes things tough, too. Even the most conscientious planner cannot hand-hold all the parts in the plan. At best, the planner can give personal attention to the critical few parts and hope for the best with the rest. The better the overall plan, the fewer escalations for otherwise noncritical parts.

Complicated extended networks further compound the situation. The typical service parts supply chain quickly

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fans out from just a core factory or two to hundreds or even thousands of locations for managing stock. The list includes regional distribution centers, field stockrooms, engineer trunk stock, and even parts consigned to customer locations.

All planners spend a lot of time coping with uncertainty. We get it from both ends—uncertain demand and uncertain deliveries from suppliers.

While not all industries face the following additional issues, many do. The first is differentiating demand from usage. To make the best plans, we first need to know what parts are required by a service engineer to make a particular call. Then, on the back end, we need to know which parts actually were used on the call.

Many service organizations also face the problem of planning for repair. This makes for a rich discussion on its own, with the added twists of monitoring the timely return of defective material—the raw material for the repair process—as well as uncertain repair yields, cycle times, and repair costs.

Among the complications we face in the medical instrument business is the near ubiquity of our products across the landscape—Philips Medical Systems' customers include major hospitals, local clinics, ambulance services, and even airlines (automatic external defibrillators to treat sudden cardiac arrest at 34,000 feet). Also, the FDA and similar international organizations heavily regulate our industry. Finally, as noted earlier, our products save lives, but only when they are working.

Data-Driven Planning

Planners are numbers people. If they're not, they shouldn't be planners. To solve the planning problem, our planners emphasize formal quantitative tools, apply a fair bit of ad hoc analysis, and temper it all with intuition and judgment. Focusing on the core of our process, the quantitative tools—as embodied in our day-to-day planning application—solve two vexing problems for us.

1. Inventory Targets. The conventional approach to parts planning says you pick a target service level and then calculate how much inventory is required to meet it. The equations rigorously include terms for demand, lead time, and the standard deviation of both forecast error and resupply time. This approach leads to a nice chart of inventory as a function of service level.

Pick a service level—call it 95 percent—and on a part-by-part basis, you can say how much safety stock is required to meet that target over the long run. But why 95 percent? Why not 98 percent? Or 85 percent? The weakness of this approach is that while it accurately tallies the cost of inventory, it puts an implicit value on customer service. The trouble is, without analysis it's not necessarily the *right* value.

To borrow a line from *Jerry Maguire*, "Show me the money!" The same textbooks that provide the analytical solution to the service-level problem also describe a more robust, albeit more difficult, approach.[1] They say that the better solution is to find the service level that minimizes total cost to the business. And that is what we do.

Inventory costs generally increase linearly with an increase in inventory. Best-in-class firms apply a complex methodology to tally up all the relevant inventory-driven costs in their system. These typically include:

- Cost of capital.
- Cost of warehousing.
- Cost of possible obsolescence.
- Cost of possible damage or shrinkage.

Every business can generate a comprehensive list of relevant expenses with help from the finance department.

On the other side of the coin is the cost of *not* having inventory—the cost of poor service or stock outs. Again, the long list of factors varies by business. These typical heavy-hitters make most lists:

- Cash penalties.
- Loss of future profit on renewed contracts.
- Expediting costs (overnight freight, manpower).
- Follow-up service calls.

It is also fair to include the direct cost to the customer of having equipment out of service (e.g., the "cost" of an empty bed in the ICU when a bedside monitor has a burned-out power supply). But don't mistakenly confuse the cost of a part failure with the cost of not having a replacement part available when and where needed. Only the latter is a direct cost of poor service parts planning. Even more difficult to quantify is the long-term effect of a reputation for poor parts availability and the consequent impact on the installed base.

Of course, these only apply if you do experience a service failure, so you also must estimate the likelihood of a stock out. This must be done for each possible level of inventory. If demand follows a pattern of a few units a month, it's easy to see that the expected cost of stocking out will be much lower if 20 units of safety stock are held to protect against upside demand than if only two units are held.

Put the two costs together, cost of inventory and cost of service failure, and you get a curve showing the total expected cost of holding a given amount of safety stock. The low point on the resulting curve marks the minimum total expected cost. And given the right level of inventory, the expected service level can be calculated. In fact, it already was calculated to determine the cost of stock out. Because the parameters for each part can differ, this methodology allows the "right" service level to be set for each and every part in the system, and at each location in the network.

2. Replenishment Plans. Replenishment planning requires that you think like a plumber. Picture a tank with water flowing in from above and water flowing out a drainpipe. The planner's job, in essence, is to modulate the flow of water into the tank—or parts into the warehouse—to match the unknown expected flow out of the tank. The goal is to maintain the water level without running the tank dry and without overflowing.

In actual practice, of course, it's a bit harder than that. First of all, demand is unpredictable, as though a malicious demon controlled the exit valve. Moreover, lots of tanks comprise our network, with the resulting effects of time delays and, yes, pipeline inventory.

Because purchase and repair lead times are typically long, we plan to a forecast of demand and buffer with safety stock for the fact that our forecasts inevitably will be wrong. But that doesn't mean we can't apply ourselves to the task. For parts with relatively high demand, we choose from a suite of conventional statistical models. We generally use exponential smoothing, which puts more weight on recent demand.

We also examine our monthly plans for large forecast changes from month to month. They alert us to possible "outlier" demand in the most recent month. When we spot an exceptional order—for example, a large stocking order from a third-party service organization—we can modify our history so that one data point does not unduly influence the forecast model. This is most appropriate when we actually can explain in business terms what happened and why it is not likely to happen again.

We forecast other things to develop our overall replenishment plans, albeit in different ways:

- Credit returns.
- Defective returns.
- Return screen scrap rate.
- Repair yield.

We use simpler analytical methods for these forecasts—moving six-month averages for the most part. Together these forecasts help us to anticipate material that will be available from the reverse logistics supply chain.

Once we have a demand forecast and a feel for likely supply from repair and credit return streams, we have to build our purchase plans for new material. The last link in our data-driven planning process is the order quantity. As a general rule, we follow the economic order quantity (EOQ) methodology familiar from textbooks. The cost of holding inventory from a large order is balanced against the transaction costs of placing multiple small orders. As with the inventory analysis described earlier, we add the two competing costs and purchase in quantities to minimize our expected annual cost for managing that part.

Data Integrity and Reporting

Good analysis requires good numbers. In fact, the hard part of data-driven planning isn't really the fancy algorithms used to calculate safety stock or forecast demand. It's making sure that the data is available to go into those equations, and that the output is applied correctly. This requires rigorous adherence to business processes and a good faith effort to minimize exceptions. This is harder than it sounds when trying to plan for tens of thousands of parts.

At the core of most planning organizations is data from an ERP system, and ours is no different. The system we use manages almost all of the transactions in our business.[2] It gives us a tool that helps force compliance with a fixed way of doing things. However, at times, we do run into data problems that can lead to bad plans, so we also employ a suite of our own data integrity reports to make sure we don't let our plans drift astray. Generalizing a bit, reports we rely on identify the following problems, among others:

- Active parts with no valid supplier.
- Parts with exceptionally high or low lead times (e.g., a typo gives lead time of 300 days, not 30).
- Parts with circular replacement chains (e.g., Part A is replaced by Part B, which is, in turn, replaced by Part A).
- Parts with scrap rates over 100 percent (to flag erroneous material movements).

Only after assurances are made that the data is clean can you tackle the planning problem with any hope of a good result. The spreadsheet is to the planner what the slide rule was to the NASA engineer during the race to the moon. However, the spreadsheet is best suited for ad hoc analyses.[3] We rely on commercial software "bolted on" to our ERP system to provide the bulk of our planning functionality. While there are a number of tools on the market, we chose ours for its compatibility with our preferred cost-based approach.[4] It takes care of all the "blocking and tackling" associated with the demand forecasting and inventory planning algorithms, the key output being timely purchase and repair recommendations for additional supply. Our planning application and our ERP system are united via a data warehouse and secure Internet file exchanges.

Once we have our planning output, we rely on another suite of user-configurable Web-based reports. These facilitate the further identification of planning "exceptions" as well as the careful monitoring of certain classes of parts. Examples include:

- Supplier on-time delivery performance.
- Parts with too much or too little inventory.
- Defective return rates below expectation.
- "Use 'til gone" parts inventory status.
- Parts at or near the end of their service life.

Clean data and plans built from them do not come without pain. The entire organization must be committed to the cause.

Conclusions

Service parts planning offers many challenges. While difficult under ideal circumstances, it is not an intractable problem. Careful application of well-documented analytical techniques, especially for setting inventory targets and developing replenishment plans, can lead to improved performance at a lower cost.

The incentive is great. With a smoothly running data-driven planning process, you endure fewer of the normal crises of planning. Both customers and employees are happier. And with less time spent expediting parts or dispositioning excess inventory, the planners can apply themselves more effectively to different problems. Other areas where data-driven decision-making techniques can be applied include new product introduction planning and end-of-life analysis, to name two examples not covered in this brief article. Process improvement projects also can be undertaken to further improve the business, from attacking long lead times to variable repair yields to warehouse layout. The end result can be a positive feedback loop that leads to higher and higher service levels with lower and lower costs.

References

1. For a solid technical reference, see Silver, Ed and Rein Peterson. Decision systems for inventory management and production planning.

2. R/3 ERP solution by SAP.

3. See, for example, Panko, Ray. 1998. What we know about spreadsheet errors. panko.cba.hawaii.edu/ssr/Mypapers/whatknow.htm.

4. *Prophet by Baxter* planning solution by Baxter Planning Systems.

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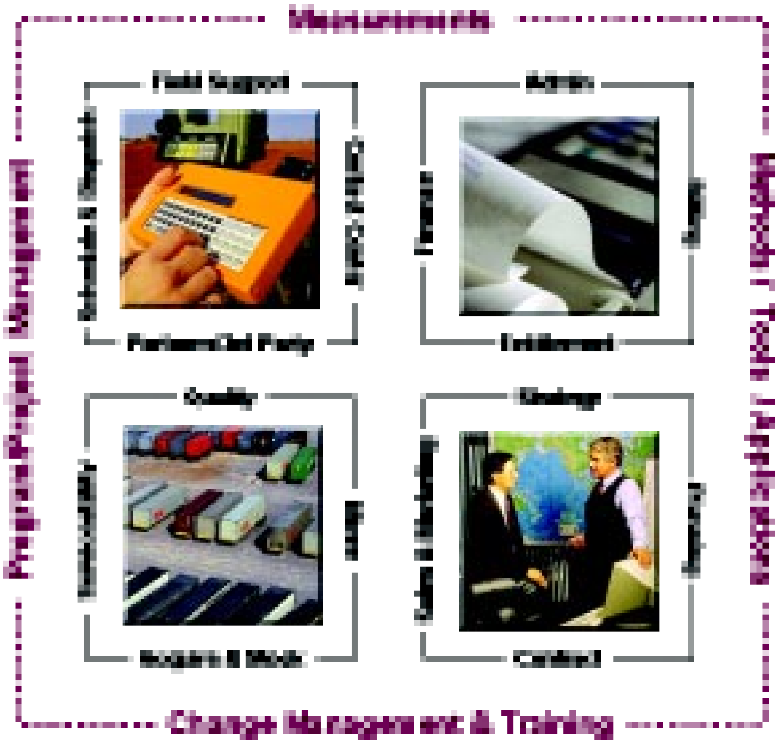

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