Service Parts Planning: An Integrated Approach

Executive Summary

Service parts management, or spare parts management as it is more commonly known, is often granted stepchild status relative to its counterpart, production parts management. The fact remains, however, that the service parts business is often the more profitable of the two. Take, for instance, the auto industry, where it is common for parts to sell at three or four times their cost to the supplier, or the high-tech market, where companies often sell printers at or below cost and make money selling print cartridges. The key to effective service parts management lies in being able to optimally plan for availability of spare parts across the supply chain network. So, what makes service parts planning complicated and different from any other supply chain scenario?

The Problem

Issues vary based on the industry analyzed. However, some issues are common to the nature of the service parts business. Issues that complicate service parts planning include the following:

- **Large number of parts**: It is not uncommon for an auto or high-tech OEM to have more than a million service parts on file.
- **Complex distribution networks**: While not as complicated as a fast-moving consumer goods (FMCG) scenario, spare parts supply networks often consist of multiple echelons and multiple distribution centers, with different stocking lists.
- **Nature of demand**: While the demand for spare parts is often low volume, it is also sporadic and intermittent. Standard forecasting and inventory planning models tend to yield unsatisfactory results.
- **High cost of a stock-out**: Service parts typically have up-keep contracts associated with them. This means the cost of a stock-out is much higher than the spare part. For example, large hardware contracts may be accompanied by a four-hour problem resolution guarantee, which means spare parts have to be stocked at the customer location.
- **Preventive maintenance**: The demand for service parts is often linked to use on the field (e.g., gear belts for automotive).
- **Repair/Refurbishment**: Most spare parts companies have units and third-party players that repair defective products returned by customers. This means there is an alternative procurement source that needs to be considered for effective planning.

These peculiarities require planning departments to look beyond conventional paradigms of supply chain planning and into alternative models, such as planning conducted within functional silos. Forecasting for products (and hence spare parts) is often done by the sales and marketing team, while procurement is often done by the purchasing team. This often results in supply deficiencies or oversupply.
Another example is the way inventory planning for spare parts is often performed independently of or without knowledge of forecast errors. This results in sub-optimal planning characterized by knee-jerk actions aimed at balancing supply deficiencies across the network, which in the medium- or long-term results in the network carrying excess stock yet not achieving the desired customer service levels.

A Forecasting Solution

This paper presents an integrated model for service parts planning and forecasting (see Figure 1). The intent is to suggest a unified approach to the service parts problem in order to achieve target customer service levels with optimum placement of inventory across the supply chain.

Forecasting is the process by which an estimated value of demand is achieved. Since service parts planning is predominantly a procure-to-stock process, planning is almost entirely based on forecast. This explains why the forecast is an extremely critical aspect of the service parts planning process. A best-in-class forecasting process for spare parts contains the following steps:

Step 1: Demand history capture and data cleaning

The primary determinant of forecast quality is the input data. It should be ensured that the input data is a true “voice of the customer.” Point-of-sale data is considered the best form of input data. Any data gathered from upstream entities in the supply chain (such as distributor, dealer, factory, etc.) is bound to be different from the original customer demand. This phenomenon is often called the “bull whip” effect.

Step 2: Data validation

Validating data is an important step to ensure stable forecasts. Raw data for spare parts contains various errors, such as manual entry, sudden promotions and inflated orders. Forecasting data with a high level of variability leads to poor forecast accuracy.

Outlier correction is a standard method for validating data. It involves calculating the average and standard deviation of product demand and removing any demand data points that are outside the control limits. The control limits for this are usually set at one or two multiples of standard deviation (see Figure 2, next page).

Points 2, 7 and 9 represent outliers in the demand pattern shown in Figure 2. These demand points will be corrected to either the LCL or UCL values, which may be applicable before forecasting is done for the product.

Since service parts planning is predominantly a procure-to-stock process, planning is almost entirely based on forecast.
Step 3: Deciding which products to forecast

Not all products are sell-equal – that is, some products yield themselves to forecasting, and some do not. It is important to determine which products can be forecast. This is done using a statistical measure called “covariance” – which is the standard deviation of demand for 12 months divided by the average demand for 12 months. Figure 3 serves as a guideline for determining the ease with which products can be forecast.

The results of the first step will result in products being assigned to a forecast code. It is usually a very good rule of thumb to assume that EF1 and EF2 are suitable for forecasting and result in an accurate forecast. Standard forecasting techniques often result in forecast accuracy in excess of 80%. MD, on the other hand, can still be forecast, but the results will often not be as accurate. Forecasts for MD products, on average, are around 50% to 60% accurate. NF1, NF2 and ND should not be forecast, since the forecasts are usually way off. These usually occupy a small percentage of the overall population.

Step 4: Choose a forecasting approach

The next step segregates products into different groups, depending on multiple factors:

1. Whether the data history of the product is expected to yield stable forecasts.
   a. This can be achieved by covariance. If this measure is outside standard limits, it can be assumed that statistical forecasting will not yield satisfactory results. This product can be forecast manually or procured directly based on a stocking policy.

2. Whether the product is in an end-of-life or launch phase.

---

### Covariance vs. Ease of Forecasting

<table>
<thead>
<tr>
<th>Forecast Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF1</td>
<td>Easily Forecastable Cov &lt;= 0.3</td>
</tr>
<tr>
<td>EF2</td>
<td>Easily Forecastable Cov &lt;= 0.5 and &gt;= 0.3</td>
</tr>
<tr>
<td>MD</td>
<td>Medium Difficulty in Forecast Cove &gt;= 0.5 and &lt;= 0.8</td>
</tr>
<tr>
<td>NF1</td>
<td>No Forecast Cov &gt;= 0.8 and &lt;= 1</td>
</tr>
<tr>
<td>NF2</td>
<td>No Forecast Cov &gt;= 1</td>
</tr>
<tr>
<td>ND</td>
<td>No Demand</td>
</tr>
</tbody>
</table>

---

Figure 3
a. Products at the start of their lifecycle often exhibit a peculiar demand surge pattern before stabilizing. These products are best forecast on the basis of manual input or a profile created from a similar product.

b. Products nearing the end of their lifecycle also need special treatment because there is a gradual tapering of demand.

3. Whether demand behavior of the product is known.
   a. If the product is familiar to the demand planner, or is a very high-value product that requires attention, this product is forecast manually by the demand planner or has a standard forecasting method associated with it.

Step 5: Creating the demand forecast

After the general approach for forecasting has been determined, the next step involves creation of the forecast. Forecasting can proceed in any of the following three ways:

1. On the basis of a forecasting method that has been selected by the demand planner.
2. On the basis of a forecasting method chosen automatically (usually by the forecasting system).
3. On the basis of the product lifecycle associated with the product.

The automatic forecast selection logic of a typical forecasting engine proceeds by performing various statistical tests to ascertain the demand pattern of the product. The tests that are carried out by the system include:

1. Trend test
2. Seasonal test
3. Intermittent demand test
4. Error tests to choose between methods

The model selected forms the basis for forecast creation. Most forecasting packages include the following methods:

1. First order exponential smoothing
2. Second order exponential smoothing
3. Moving average
4. Linear regression
5. Holt-Winter's model for seasonal forecasting
6. Croston's method for intermittent demand forecasting

Step 6: Event planning

Event planning is the process in which the demand planner adjusts the demand forecast, keeping in view the various events that might affect customer demand. There can be many types of events that may or may not be under the demand planner's control. These include demand spikes due to promotions on certain products, special event surges, effects due to natural disasters (such as Mumbai rains) and so on. The demand planner typically performs the following steps to plan events:

1. The event calendar is planned well in advance. These include planned promotions for the product, festival effects, etc.
2. The product list for which event planning is to be done is created. This usually means plans are based on high contributors to sales, products that carry frequent promotions, products prone to special events, etc. This can come either from the planner's judgment and experience or an output of system reporting based on certain parameters.
3. The system ideally generates an “event factor” for the products that have been shortlisted. For example, sales data from similar months can be compared without the effect of any events (say 100 in September and 230 in October). Assuming that for the same product, a promotion was run in September in a different year, and the demand was 140 that month and 240 in October, the event factor would be computed as ((140/240)/(130/230)). This is a very simple example, and the accuracy of this kind of computation increases as the number of months of data increases.
4. The factor values are presented to the planner to review and override, if necessary.
5. The planner then modifies the value of the baseline value. This should ideally be stored in a separate data series in order to create a base for further event intelligence for future promotion planning.

Step 7: Product lifecycle planning

A product's lifecycle consists of different phases: launch, growth, maturity and discontinuation. Spare parts are no different in this regard. The demand behavior of the product varies in the different stages of its lifecycle. If the demand planning process does
not take into account these different patterns, the forecast error may be high.

This is done with the use of launch, growth and discontinuation profiles. A profile indicates how the demand is expected to behave during these different phases. A profile can be created in two ways:

1. Based on the demand pattern exhibited by similar products in the applicable phase of the product life cycle.
2. Based on the planner’s judgment and understanding.

The profile can be customized for the new product by using weighting profiles. The weighting profile determines the magnitude of the combined profile. An example of how to use different "like" products in different periods for an automotive client is detailed in Figure 4.

Step 8: Fine-tune demand plan
In a practical scenario, forecasts are rarely bottom-up in the true sense. They often have to be “adjusted,” keeping in mind the annual budget and target values. The demand planner establishes a balance between the demand plan and the annual budget. This may be based on

### “Like” Profile for Product XYZ 500g

<table>
<thead>
<tr>
<th>“Like” Product</th>
<th>Month</th>
<th>History</th>
<th>Weighting Profile</th>
<th>Generated History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product XYZ 300g</td>
<td>January 98</td>
<td>300</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>February 98</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>March 98</td>
<td>300</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>April 98</td>
<td>400</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>May 98</td>
<td>400</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>June 98</td>
<td>400</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>July 98</td>
<td>400</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>August 98</td>
<td>500</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Product XYZ 400g</td>
<td>January 98</td>
<td>300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>February 98</td>
<td>300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>March 98</td>
<td>250</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>April 98</td>
<td>300</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>May 98</td>
<td>300</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>June 98</td>
<td>350</td>
<td>100</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>July 98</td>
<td>400</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>August 98</td>
<td>450</td>
<td>100</td>
<td>450</td>
</tr>
</tbody>
</table>

The generated history for Product XYZ 500g would look like this:

<table>
<thead>
<tr>
<th>Month</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 98</td>
<td>600 + 0</td>
<td>600</td>
</tr>
<tr>
<td>February 98</td>
<td>400 + 0</td>
<td>400</td>
</tr>
<tr>
<td>March 98</td>
<td>200 + 0</td>
<td>200</td>
</tr>
<tr>
<td>April 98</td>
<td>200 + 150</td>
<td>350</td>
</tr>
<tr>
<td>May 98</td>
<td>0 + 300</td>
<td>300</td>
</tr>
<tr>
<td>June 98</td>
<td>0 + 350</td>
<td>350</td>
</tr>
<tr>
<td>July 98</td>
<td>0 + 400</td>
<td>400</td>
</tr>
<tr>
<td>August 98</td>
<td>0 + 450</td>
<td>450</td>
</tr>
</tbody>
</table>

Figure 4
business rules or be a pure subjective evaluation of the demand planner.

**Step 9: Forecast evaluation and improvement**

A robust forecast evaluation methodology is a prerequisite for continuous forecast improvement. Traditional methods of forecast error measurement consist of measuring the deviation between forecast and actual demand for the latest period and acting on outliers. This approach has its pitfalls—namely, most of the comparison is usually done on a short-term basis (i.e., the last one or three periods of forecast/demand comparison). This results in actions that tend to “over-correct” the forecast.

A comprehensive forecast evaluation methodology should involve measurement of multiple dimensions of error metrics — percent error, percent error variability and forecast bias.

The percent error is calculated over a predetermined period (say 12 or 24 months). This is then compared to the UCL and LCL of the percent error to determine if it is out of control.

The error variability is calculated by measuring the standard deviation of error over the same period. This is considered high if it is above the acceptance limit (usually taken as 60% as a rule of thumb).

Finally, the forecast bias is measured using something called the bias indicator. Bias can be measured in many ways – the simplest of the methods involves checking if the forecast is on one side of the demand for five consecutive periods. If yes, then the forecast is said to be biased.

In terms of importance, error variability > error > bias. The process map shows the logic by which the forecast states of products are graded as green, yellow or red. We can get a consolidated view of all these measures by plotting a matrix to indicate the state of the forecast. An example is shown in Figure 5.

The previous process step serves to highlight products that need attention. This is done by placing them in red, green and yellow buckets. This provides the demand planner with an actionable list of issues. In this process step, the demand planner has to analyze the products on a case-by-case basis. The considerations that the demand planner has in mind are typically:

1. Is the product fit to be forecasted?
2. Has the demand pattern changed considerably over the last few periods?
3. Is the product impacted by promotions or special events?
4. Has the right forecasting model been used for comparison?
5. Are the forecast model parameters correctly used?
6. Have the manual updates to the forecast been incorrect?

The output of this analysis is an action plan for forecast improvement.

**What Happens to the Forecast?**

The forecasting process has two main outputs:

- Forecast value
- Forecast error

The forecast value forms the basis for other downstream processes, such as procurement planning and tactical distribution. The forecast
error, on the other hand, is a measure of the variability of the product and, hence, is directly proportional to the safety stock needed.

Change Requirements

An integrated spare parts planning approach similar to the one described above is based on more than just a change of processes. It requires a change in the way planning departments view and approach the service parts problem. This will determine the difference between companies that treat spare parts as supplementary to the main business and companies that view the service parts business as a true source of competitive differentiation.

Conclusion

The impact of an accurate forecast is significant and goes beyond accurate forecasts. Because a forecast drives all downstream planning and operational activities, improvements are observed across the board. Benefits vary based on the industry, process maturity and the nature of the products; however, the list below is a good representation for most demand planning improvement initiatives:

- **Improved customer service levels:** A result of accurate forecasting is better procurement planning. This ensures the right products are present on the shelves at the right time.
- **Reduced safety stock:** Safety stocks are directly proportional to demand variability. Better forecasts reduce the amount of safety stock that needs to be held, resulting in lower operational costs.
- **Slower build-up of surplus and obsolete stock:** Traditional time series forecasting often results in over-ordering. Over time, this leads to the accumulation of slow-moving products in the warehouse. Methods such as a Croston’s method for intermittent demand mitigate this.
- **Better forecasts for new products:** Using new product introduction forecasting techniques, such as modeling, produces accurate forecasts.
- **Better management of events and promotions:** A formal event management process after the forecast is generated ensures events and promotions are handled better.
- **Adherence with continuous improvement principles:** A forecast evaluation and improvement process ensures that the process (and hence the forecast accuracy) is improved based on feedback.

About the Author

Ganesh Iyer is a Consultant with the Manufacturing and Logistics Practice within Cognizant Business Consulting. His work spans the areas of demand planning, overall supply chain planning and execution for automotive and process manufacturing customers. He can be reached at Ganesh.Iyer@cognizant.com.

About Cognizant

Cognizant (NASDAQ: CTSH) is a leading provider of information technology, consulting and business process outsourcing services. Cognizant’s single-minded passion is to dedicate our global technology and innovation know-how, our industry expertise and worldwide resources to working together with clients to make their businesses stronger. With over 50 global delivery centers and approximately 88,700 employees as of June 30, 2010, we combine a unique global delivery model infused with a distinct culture of customer satisfaction. A member of the NASDAQ-100 Index and S&P 500 Index, Cognizant is a Forbes Global 2000 company and a member of the Fortune 1000 and is ranked among the top information technology companies in BusinessWeek’s Hot Growth and Top 50 Performers listings.

Start Today

For more information on how to drive your business results with Cognizant, contact us at inquiry@cognizant.com or visit our website at www.cognizant.com.