INTEGRATING THE PLANNING OF SPORADIC AND SLOW MOVING PRODUCTS WITH THE NORMAL PLANNING PROCESS.

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INTRODUCTION

This article looks at the challenge of managing the forecasts for sporadic and/or slow moving parts within normal business forecasting processes. It discusses techniques that have been developed to forecast demand and manage the inventory for such items. These techniques have proved to have a general application for many items with a sparse demand pattern, not just true slow movers, but also those items that sell in large volumes when they do sell.

BUSINESS REQUIREMENTS

Existing time series forecasting techniques have proved invaluable to many companies that supply the market from stock rather than by order. Such techniques have evolved with the advent of computing power from simple exponential techniques to modern applications that use Bayesian techniques and apply Dynamic Linear Models (DLM) to the demand history to produce forecasts [1].

Typical requirements of a business application can be characterized as follows: -

- Need to be able to use the normal business periodicity to report the sales/demand history to produce forecasts.
- Need to be able to produce a forecast by period that fits with this business reporting periodicity.
- Need the forecast to be general purpose. It should drive the planning processes and be used in forward estimates of the business by item or group. It may also be the budget or form the basis of the budget and targets.
- The forecast should also be capable of driving an inventory policy that is based around the actual inaccuracies seen between the past forecast and actual sales/demand.
- All this is against a backdrop of continual new product introduction and supercession.

A traditional time series approach provides a good solution to the requirements listed above for items that are regular movers, but it falls short when dealing with sporadic or slow movers (SMP's). A typical SMP may be an item at a location that sells one or two units in a period and then there will be a number of periods where no sales are seen

before the next event. An SMP may have history that looks similar to that shown in Figure 1.

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998		0	0	0	2	0	0	1	0	0	2	0	0
1999		0	3	0	0	0	0	0	5	0	0	1	0

Figure 1. Sporadic or Slow Moving Part History.

Some businesses create many SMP's in their planning process by forecasting at locations 'close to the customers' rather than simply producing forecasts at stocking locations. Recent trends in Vendor Managed Inventory (VMI) and collaborative forecasts have accentuated this issue for many forecast analysts. Other companies produce SMP's by the minimum lot quantities that they impose on their customers. Such SMP's could be dealt with by structural changes in the forecasting processes or by changing the ordering lot quantities.

However, the business benefits of VMI processes and collaborative forecasting mean that the market levels that the forecasting process is run at will become increasingly focused towards the consumer level. Even if a company could solve all these issues there will still be some SMPs left that require forecasting. This could range from 10–50 SKU's in a pharmaceutical business to 100,000's for a service parts application. At the top end of this scale it is obvious that any SMP process should give robust and reliable forecasts that can be produced with minimum intervention. It should also be possible to use such forecasts for procurement and production planning, using techniques from a simple ROP process through to full blown MPS planning.

Often the only practical approach when dealing with SMP's using traditional time series analysis is to identify a level and perhaps trend, but with no seasonality. This produces a simple forecast that at best gives an estimate of average sales per reporting period. What it fails to indicate is how big those sales may be in any period where an order is received. A further problem with this approach is that the measure of error (standard deviation) between the forecast and the actual demand is very poor, as it is strongly influenced by the many periods where no demand was seen. This dilutes the measure of variance that the business should be interested in - the comparison between the forecast of the sales expected in the next period with some demand and the demand actually seen. The other main problem with this approach is the high level of manual effort required to produce accurate, robust and useable business forecasts. A typical forecast produced for an SMP by normal time series techniques is shown below in Figures 2 and 3.

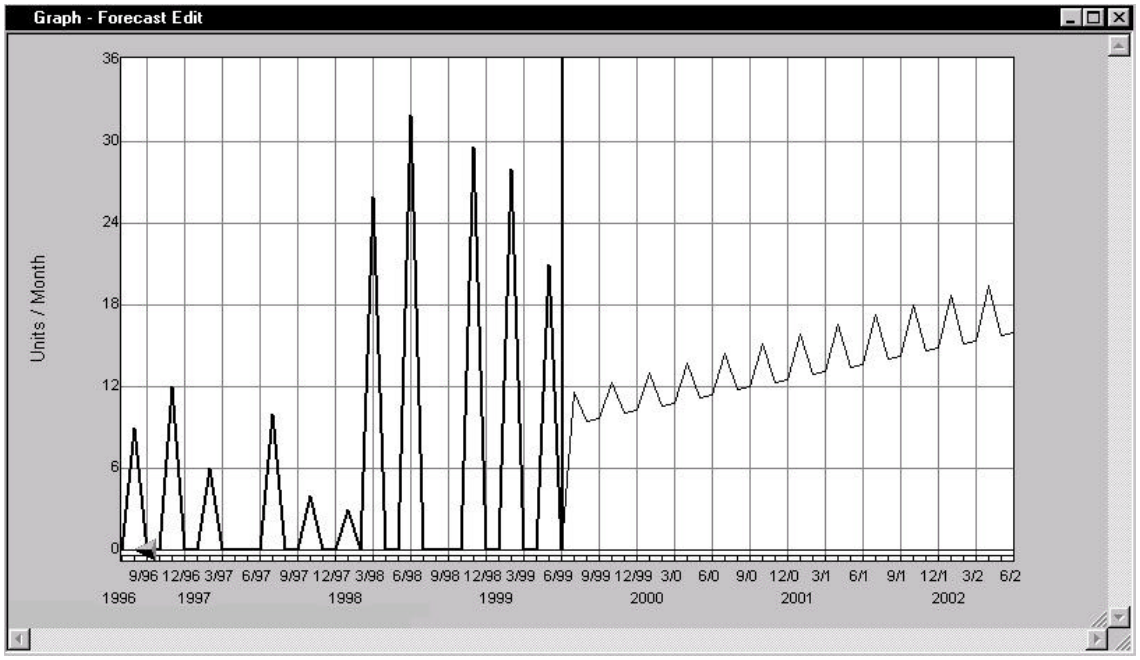

Figure 2. Traditional forecasting technique applied to slow moving product. Graph of history and forecast

Fiscal Year - Forecast Edit

	1996	1997	1998	1999	1999	2000	2001	2002
Jan		0	3	0		13	16	19
Feb		6	0	28		11	13	15
Mar		0	26	0		11	13	15
Apr		0	0	0		14	17	20
May		0	0	21		11	14	16
Jun		0	32	0		11	14	16
Jul	0	10	0		12	15	17	
Aug	9	0	0		10	12	14	
Sep	0	0	0		10	12	14	
Oct	0	4	0		12	15	18	
Nov	12	0	30		10	12	15	
Dec	0	0	0		10	13	15	
Total	21	20	91	49	64	150	179	101
Outlook					113			

Figure 3. Traditional forecasting technique applied to slow moving product. Table of history and forecasts.

Figure 2 shows a simple regression model with no dynamic smoothing applied through a sparse history set. Figure 3 is the same history and forecast in figures, July 1999 being the first period to forecast. N.B. the slight 'waviness' of the line is due to the unequal lengths of the months. This approach only gives an estimate of approximately 10 units

per month, with a steady (and perhaps spurious) growth and there is no indication of how many may be sold when the next sales event occurs. Also the technique does not take into account the obvious step in the history data, and a more realistic average monthly forecast would be 7 or 8 units per month. One last point to consider is the standard deviation produced for this item is approximately 12 units, which will have a major effect on the statistically derived safety stock.

What a business requires is the ability to use a forecasting system that can identify normal and slow movers automatically and apply forecasting techniques tailored to the type of item being forecasted. Ideally such a system should employ modern and powerful time series techniques to forecasting the normal items. It should then be able to switch to SMP techniques automatically, utilising the same periodicity of history as supplied for the normal items and with a minimum requirement for other information, control fields or user intervention. The SMP techniques should be targeted at providing an estimate of the demand the business should expect in the next period that any demand is seen. It should also be targeted at producing a good statistical measure of variance between the expected demand in any period with sales and the actual demand seen. In addition to this, the technique should provide the information required to drive the other business processes that require a forecast, such as target and budget setting and group reporting. A further major consideration is that the process should require minimum analyst intervention and be very fast at processing each item.

These requirements are obviously true of service parts suppliers but our work with other industries has convinced us that most if not all companies supplying the market from stock have some SMP's and that the planning of these items would benefit from better techniques.

THE SOLUTION

Various solutions have been proposed in the past to deal with SMP's. The process that we have developed was evolved in house from first principles, but can be seen to be closely related to a solution proposed by Croston [2] and expanded by Johnston and Boylan[3]. Croston suggests that each event should be monitored and that an exponentially weighted smoothed average can be generated through the quantities seen in each event. This average then gives an estimate of the next event that will be seen. He also proposes that a smoothed average is created to estimate the gap between events. One of the key differences in our approach is the assumption that demand in any business reporting period is a logical event. This approximation allows the use of the normal history reporting mechanism in a business, and to marry together the normal and SMP forecasting processes in one system by allowing them both to work from one set of history data. The other key difference is the forecast process applied. When an SMP is detected two forecasts are generated. The first forecast is an estimate of the average event size and the second forecast is an estimate of the gap between the logical events. Both of these models are single term DLM's. This forecasting approach allows the development of dynamic models that react to the most recent events seen. The sensitivity

of this reaction is under user control but default discount factors (smoothing ratios) are applied that make the models highly dynamic. The estimate of the next logical event is the forecast that is used to produce ROP quantities. The result of multiplying the estimate of the next event and the chance of an event gives a good average period forecast for the other business processes that need weekly or monthly estimates. Figures 4 and 5 show the data set used before but now forecasted using the SMP technique.

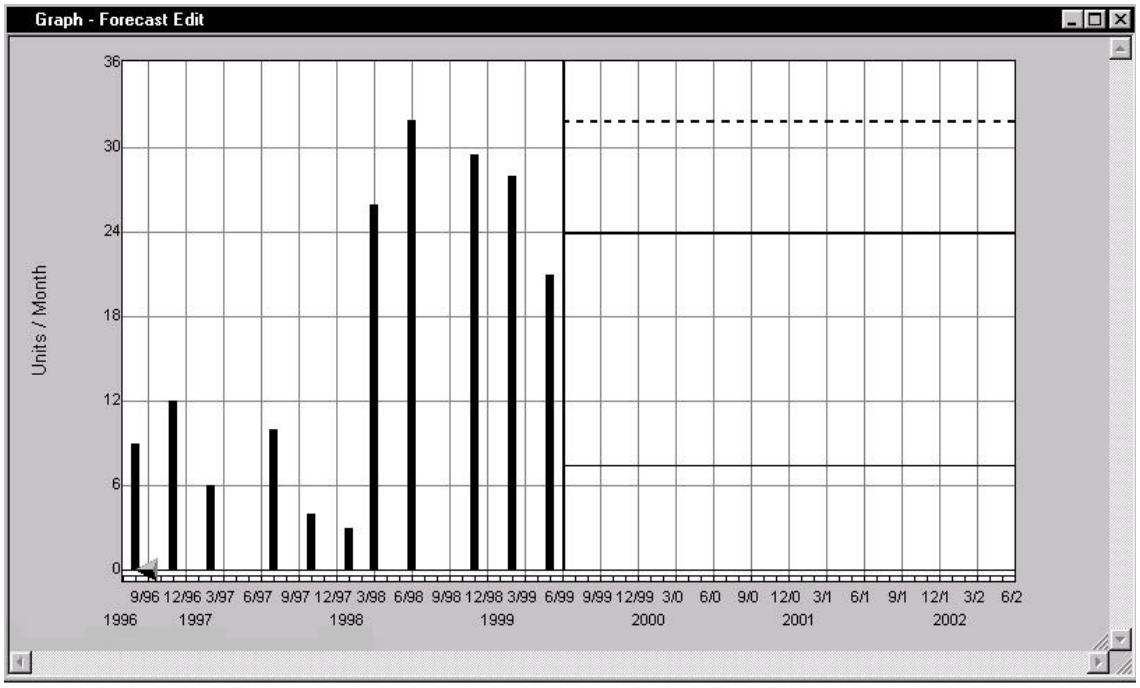

Figure 4. SMP forecasting technique. History and forecast graph.

Figure 4 shows the forecast produced using the SMP technique. Three lines characterise the forecast. The lower (fine) line is the average monthly estimate of sales, which is important when looking at annual volumes and aggregate forecasts. In the example data set this is about 8 units. The middle line is an estimate of the next logical sales event and this is approximately 24 units with a standard deviation of 9 units. In both of these lines it can be seen that the dynamic aspect of the DLM model has picked up the fact that the average event size in the history has increased. This means that the technique is giving a better estimate of monthly demand than the standard technique as well as providing an estimate of the next event. The top (dotted) line is a representation of the re-order point required to give the requested service level (in this case 96%), approximately 31 units.

The ROP uses a different calculation for SMP items than for normal ones. The ROP for a standard product is typically the forecast over the re-supply lead time plus the required safety stock. When applying the SMP process the ROP calculation needs adjusting to be the number of potential events in the lead time multiplied by the forecasted average event quantity plus the required safety stock. In this example the chance of an event during a month is about 0.3, or just less than 1 event every three months.

Fiscal Year - Forecast Edit

	1996	1997	1998	1999	1999	2000	2001	2002
Jan		0	3	0		8	8	8
Feb		6	0	28		8	8	8
Mar		0	26	0		8	8	8
Apr		0	0	0		8	8	8
May		0	0	21		8	8	8
Jun		0	32	0		8	8	8
Jul	0	10	0		8	8	8	
Aug	9	0	0		8	8	8	
Sep	0	0	0		8	8	8	
Oct	0	4	0		8	8	8	
Nov	12	0	30		8	8	8	
Dec	0	0	0		8	8	8	
Total	21	20	91	49	45	90	90	45
Outlook					94			

Figure 5. SMP forecasting technique. Table of history and forecast.

Figure 5 shows the history and average monthly forecasts for the item. This average monthly projection can be used by the normal business forecasting processes, such as budget creation or the reporting of aggregated forecasts across groups of items.

CONCLUSION AND KEY BENEFITS

Using the same technique to forecast both normal items and SMP's can be problematical, and require extensive analyst intervention. Methods specifically designed for SMP's can provide a good result, but have the disadvantage of working at a level outside that of a company's normal forecasting cycle. The proposed methodology allows the automatic treatment of SMP's as a special case of the DLM, within the existing reporting periodicity.

We believe the benefits of this approach include:

- Reduced analyst effort in managing sometimes very large numbers of SMP's.
- More realistic forecasts for SMP's, especially when used for annual and group totals.
- Lower forecast error, resulting in better safety stock calculations.
- ROP takes account of both size and chance of an event within the lead time.
- Replenishment plans can be easily produced from the results of the SMP analysis.
- Consistent approach across the whole inventory.

REFERENCES

[1]. Pole, A, West and J. Harrison, *"Applied Bayesian Forecasting and Time Series Analysis"*, New York: Chapman & Hall. 1994.

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3. FR. Johnston and JE. Boylan, "Forecasting for Items with Intermittent Demand",. *Journal of the Operational Research Society.* Vol. 47, 1996, pp. 113-121.

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